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PROCEEDINGS

BEEM 2020

4th International Conference on Bioresources, Energy, Environment, and Materials Technology

September 6 (Sun)–9 (Wed), 2020

Songdo Convensia Incheon, Korea.

Organized by KOSSGE 한국지하수토양환경학회 | 한양대학교 환경공학연구소 E²RI Environmental Engineering Research Institute | KOREA UNIVERSITY OJERI @ KU OJEong Resilience Institute | SEJONG UNIVERSITY | YONSEI UNIVERSITY

Supported by KOFST | Incheon Tourism Organization

Sponsored by PHILIP MORRIS 한국필립모리스(주) | YONSEI UNIVERSITY Department of Atmospheric Sciences

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Welcome Address

On behalf of the organizing committee, we are delighted to announce that the 4th International Conference on Bioresources, Energy, Environment, and Materials Technology (BEEM 2020) will be held at the Songdo Convensia on September 6-9 in Incheon, Korea.

This conference was specifically designed to stimulate new research activities in the technological fields of bioresources, energy, environment, and materials. We encourage you to participate in the progress of the shares of research with eminent researchers through active discussion collaboration.

Much to our dismay, there have not been appreciable changes in the COVID-19 situation all over the world. Considering this circumstance, the BEEM 2020 committee has decided that all oral & poster sessions will be proceeded mostly online.

The attendees & speakers who are not able to physically attend the conference can join the conference through the online system.

We believe that you could kindly understand this decision in light of the challenging situations we all encountered newly. Hopefully, we would like to see all of you attend the conference to share your valuable findings and ideas.

We eagerly hope to meet you face to face without any concerns at the next BEEM conference. Stay fit and safe until we see each other next time.

Best regards,

Co-Chair	Co-Chair	Co-Chair	Co-Chair	Co-Chair
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Hanyang University, Korea	Sejong University, Korea	Sejong University, Korea	Korea University, Korea	Yonsei University, Korea

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Online Presentations

ORAL SESSIONS

All video presentations are played through the online presentation platform.

[Presentation Time]

Presentation	Time
Plenary Lecture	40 min
Keynote Lecture	30 min
Oral Presentation	15 min

POSTER SESSIONS

Poster presentations are showed through the online presentation platform.

PROCEEDINGS

Proceedings (PDF file) is posted at the conference website.
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TOPICS

(BR) Bioresources

- Biodiversity, Bioresources & Biomonitoring
- Food/Organic Waste Recycling and Biomass Valorization
- Agricultural Waste Processing and Recycling
- Biochar/Compost Production and Application
- Waterworks/Sewage/Industrial Sludge Treatment and Recycling
- Life Cycle Assessment and Cost-Benefit Analysis on Biological Waste Management
- Environmental Impact and Toxicity/Risk Assessment of Recycling and Recovery Practices Energy

(EG) Energy

- Sustainable Energy Recovery from Renewable Resources
- Ultimate Carbon Management in Energy Aspects
- Analysis and Optimization on Energy
- Computational Modeling and Prediction of Energy
- Endocrine Disruptors

(EN) Environment

- Food/Organic Wastes Management
- Conversion of Biomass and Wastes into Value-added Products
- Environmental Application of Waste-derived Materials
- Fate of Emerging Contaminants in Water/Wastewater Treatment and their Health Effects
- Environmental Planning, Sustainability, and Policy

- Livestock Manure Management
- Emissions of Gas and Odor from Livestock
- Soil and Groundwater Remediation
- Atmospheric Environment
- Environmental Pollution

(MT) Materials Technology

- Metal Organic Frameworks
- Materials for 4S: Sensing, Separation, Sorption, and Storage
- Materials for Biological & Medical Applications
- Materials for Energy & Environmental Applications
- Materials for Advanced Applications

Topic / Oral Session

Date	Time	ROOM 1	ROOM 2	ROOM 3	ROOM 4
September 6 (Sun)	15:00-16:15	Environment	Environment	Environment	
	16:35-17:50	Environment	Bioresources	Environment	
September 7 (Mon)	9:30-10:10	Plenary Lecture 1			
	10:30-12:00	Environment	Bioresources	Materials Technology/ Energy	Environment
	14:20-15:00	Plenary Lecture 2			
	15:20-16:35	Bioresources	Energy	Environment	Materials Technology
	16:55-18:10	Energy	Bioresources	Environment	Environment
September 8 (Tue)	9:00-9:40	Plenary Lecture 3			
	10:00-12:00	Environment	Materials Technology	Bioresources	Special Session 1 -Mitigation and Adaptation for Climate Change and Particulate Matter
	14:20-15:00	Plenary Lecture 4			
	15:20-16:35	Environment	Bioresources	Environment	Special Session 2 -Air Pollution, Health and Urban Climate
	16:55-18:10	Environment	Environment	Materials Technology	

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Program

Program at a Glance

Date / Time	September 6 (Sun)	September 7 (Mon)	September 8 (Tue)	September 9 (Wed)
9:00:00		Plenary Lecture 1 (9:30-10:10)	Plenary Lecture 3 (9:00-9:40) Break	Group Activities
10:00		Break - Keynote Lectures - Oral Sessions (10:30-12:00)	- Keynote Lectures - Oral Sessions (10:00-12:00)	
11:00				
12:00		Lunch (12:00-13:30)	Lunch (12:00-13:30)	
13:00		Poster Session 1 (13:30-14:20)	Poster Session 2 (13:30-14:20)	
14:00		Plenary Lecture 2 (14:20-15:00)	Plenary Lecture 4 (14:20-15:00)	
15:00	- Keynote Lectures - Oral Sessions (15:00-16:15)	Break - Keynote Lectures - Oral Sessions (15:20-16:35)	Break - Keynote Lectures - Oral Sessions (15:20-16:35)	
16:00	Break - Keynote Lectures - Oral Sessions (16:35-17:50)	Break - Keynote Lectures - Oral Sessions (16:55-18:10)	Break - Keynote Lectures - Oral Sessions (16:55-18:10)	
17:00				
18:00				

Program Timetable

September 6 (Sunday)

Room	ROOM 1	ROOM 2	ROOM 3
Session	Environment	Environment	Environment
15:00-15:15	**[6KEN-01]** Preparation of Aromatic Compounds by Catalytic Hydrogenation of Lignin in Biphasic System *Shicheng ZHANG (Fudan University, China)*	**[6KEN-03]** Microwave Vacuum Pyrolysis Conversion of Biomass Waste into Cleaner Biofuel, Bioplastic Feedstock and Value-added Carbon *Su Shiung LAM (Universiti Malaysia Terengganu, Malaysia)*	**[6OEN-03]** Graphene Quantum Dots Decorated BiS Nano-flowers for Improved Photoelectrocatalytic Water Treatment *Aima Sameen ANJUM (Hanyang University, Korea)*
15:15-15:30			**[6OEN-04]** Catalytic Pyrolysis of Fishing Net Waste using a CO_2 as a Reaction Medium *Dongho CHOI (Sejong University, Korea)*
15:30-15:45	**[6KEN-02]** The Role of Renewable Energy in Global Transformation for a Sustainable Energy Future *Keat Teong LEE (Universiti Sains Malaysia, Malaysia)*	**[6KEN-04]** The 2019 Report of The Lancet Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today is not Defined by a Changing Climate *Meisam TABATABAEI (Universiti Teknologi MARA (UiTM), Malaysia)*	**[6OEN-05]** CO_2-Cofeeding Pyrolysis of Pine Sawdust with Utilization of Steel Slag as a Catalyst *Sangyoon LEE (Sejong University, Korea)*
15:45-16:00			**[6OEN-06]** Relation Formula(R2) between Energy Efficiency Method(R1) and GHG Mitigation at Korean MSW to Energy Facility. *Hyeok Young KWON (Seoul National University, Korea)*
16:00-16:15	**[6OEN-01]** Abundant Biogenic Oxygenated Organic Aerosol in Atmospheric Coarse Particles: Plausible Sources and Atmospheric Implications *Qiao ZHU (Peking University Shenzhen Graduate School, China, Emory University, USA)*	**[6OEN-02]** Characterization and Biogas Production Potentials of Aqueous Phase Produced from Hydrothermal Carbonization of Biomass - Major Components and their Binary Mixtures *Muhammad USMAN (Fudan University, China)*	**[6OEN-07]** Estimation of Ammonia Emission During Growing Seasons of Perilla in Plastic House *Sae-Nun SONG (National Institute of Agricultural Sciences, Korea)*
16:15-16:35	Break (20 min)		

Room	ROOM 1	ROOM 2	ROOM 3
Session	**Environment**	**Bioresources**	**Environment**
16:35-16:50	**[6KEN-05]** Oil Field Contamination and Remediation in Mongolia *Buyan CHULUUN (National University of Mongolia, Mongolia)*	**[6KBR-07]** Recent Developments of Biomass Catalytic Fast Pyrolysis: Strategies for the Optimization of Bio-oil Quality and Yield *Haiping YANG (Huazhong University of Science and Technology, China)*	**[6OEN-10]** Structural Variations and Generation of Binding Sites in Fe-loaded ZSM-5 and Silica under the Effect of UV-irradiation and their Role in Enhanced BTEX Abatement from Gas Streams *Nishesh Kumar GUPTA (University of Science and Technology (UST), Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*
16:50-17:05			**[6OEN-11]** Reversible and Irreversible Foulings Associated with Membrane Photobioreactor for Wastewater Treatment *Jungmin KIM (Jeonbuk National University, Korea)*
17:05-17:20	**[6KEN-06]** Mechanical, Durability and X-ray Micro-computed Tomography Investigation of Biochar-admixtured Cement-mortars *Ajit Kumar SARMAH (The University of Auckland, New Zealand)*	**[6KBR-08]** Effective Dispersion of MgO Nanostructure on Biochar Support for Glucose Isomerization *Daniel C.W. TSANG (The Hong Kong Polytechnic University, Hong Kong, China)*	**[6OEN-12]** Characterization of Submicron Aerosols over the Yellow Sea Measured Onboard the Gisang 1 Research Vessel in Spring 2018 and 2019 *Minsu PARK (Yonsei University, Korea)*
17:20-17:35			**[6OEN-13]** Evaluating the Role of Ballast Surface Charge for Floc Development in Ballasted Flocculation *Muhammad QASIM (Hanyang University, Korea)*
17:35-17:50	**[6OEN-08]** Community-Engaged Assessment of Soil Heavy Metal and Metalloid Contamination in Atlanta *Eri SAIKAWA (Emory University, USA)*	**[6OBR-09]** Investigate the Effect of GAC on Anaerobic Digestion of Waste Water from Hydrothermal Liquefaction of Biomass *Muhammad USMAN (Fudan University, China)*	

❂ September 7 (Monday)

9:30-10:10	- Plenary Lecture 1 - [Room: ROOM 1] **[7PL-1]** Role of Waste to Energy (WtE) in Waste Management with Reviewing Korean Practices and Recent Activities Yong-Chil SEO (Yonsei University, Korea)			
10:10-10:30	Break (20 min)			
Room	**ROOM 1**	**ROOM 2**	**ROOM 3**	**ROOM 4**
Session	**Environment**	**Bioresources**	**Materials Technology / Energy**	**Environment**
10:30-10:45	**[7KEN-09]** Can Biochar`s a Solution to Remediate Contaminated Paddy Soils? *Jörg RINKLEBE (University of Wuppertal, Germany)*	**[7KBR-11]** Coupled Sulfur and Iron (II) Carbonate-driven Autotrophic Denitrification Nitrogen Removal *Aijie WANG (Chinese Academy of Sciences, China)*	**[7OMT-07]** Evaluation of Thermal Performance of PCM Based Electrically Conductive Heat Storage Concrete using Biochar *Young Uk KIM (Yonsei University, Korea)*	**[7OEN-13]** Biofouling Mitigation by Modified Polypropylene Feed Spacer using Polydopamine-vanillin *Chansoo PARK (Hanyang University, Korea)*
10:45-11:00			**[7OMT-08]** Oxidation of Oxytetracycline by Oxygen-doped Graphitic Carbon Nitride and Peroxymonosulfate *Do Gun KIM (Kyung Hee University, Korea)*	**[7OEN-14]** Shaping Reactor Microbiome to Optimize Caproate Productivity : Application of Design-Build-Test-Learn Framework *Byung-Chul KIM (Seoul National University, Korea)*
11:00-11:15	**[7KEN-10]** Fate of (E)- and (Z)-Endoxifen in Water and Secondary Treated Wastewater under Sunlight *Eakalak KHAN (University of Nevada, USA)*	**[7OBR-03]** Efficient Production of 2-methyltetrahydrofuran and 1,4-pentanediol from Biomass-derived Levulinic Acid *Shinje LEE (Kyung Hee University, Korea)*	**[7OMT-09]** Enhanced Acetaminophen Degradation by Fe and N Co-doped Multi-walled Carbon Nanotubes *Do Gun KIM (Kyung Hee University, Korea)*	**[7OEN-15]** Colloidal Activated Carbon as Highly Efficient Bifunctional Catalyst: Implications in Activation of Persulfate for Phenol Degradation *Ardie SEPTIAN (Kyungpook National University, Korea)*
11:15-11:30		**[7OBR-04]** The Role of Biochar in Alleviating Soil Drought Stress in Urban Roadside Greenery *You Jin KIM (Kyung Hee University, Korea)*	**[7OMT-10]** Exceptionally Porous g-C_3N_4 Nanosheets for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction *Hossein FATTAHIMOGHADDAM (University of Ulsan, Korea)*	**[7OEN-16]** Implication of Microbial Community to the Overall Performance of Tree-box Filter Treating Parking Lot Runoff *Franz Kevin GERONIMO (Kongju National University, Korea)*
11:30-11:45	**[7OEN-01]** Responses of Fine Particulate Matter and Ozone to Local Emission Reductions in the Sichuan Basin, Southwestern China *Xue QIAO (Sichuan University, China)*	**[7OBR-05]** Biomass Waste Valorization to Generate Modified Biochar to Recover Phosphorus from Animal Manure Wastewater *Tao ZHANG (China Agricultural University, China)*	**[7OEG-11]** W Doped α-Fe_2O_3 Heterojunction with MoS_2 Nanosheet for Improving Photoelectrochemical Performance *Zohreh MASOUMI (University of Ulsan, Korea)*	**[7OEN-17]** Understanding the Difference in Performance between High and Low Infiltration Systems for Urban Stormwater Runoff Management *Heidi B. GUERRA (Hanseo University, Korea)*
11:45-12:00	**[7OEN-02]** Convergence of Submerged Membrane Filtration and Cold Plasma for Enhanced Livestock Excreta Treatment *Hyeonmin AN (Jeonbuk National University, Korea)*	**[7OBR-06]** Magnetic Ball-milled FeS@Biochar as Persulfate Activator for Degradation of Tetracycline *Jingchun TANG (Nankai University, China)*	**[7OMT-12]** Synthesis of Cosmetic Grade TiO_2-SiO_2 and TiO_2-stearic Acid Core-shell Powder Comparison with Commonly used TiO_2 *Basudev SWAIN (Institute for Advanced Engineering (IAE), Korea)*	**[7OEN-18]** Synergetic Collaboration of Graphitic Carbon Nitride With an Insulator for Enhanced Visible-light Photocatalytic Activity *Milad JOURSHABANI (University of Ulsan, Korea)*
12:00-13:30	Lunch			

13:30-14:20	Poster Session 1			
14:20-15:00	- Plenary Lecture 2 - [Room: ROOM 1] **[7PL-2]** In Search of Practical Options for the Treatment of Gaseous Indoor Air Pollutants: Adsorption and Catalysis –based Techniques *Ki-Hyun KIM (Hanyang University, Korea)*			
15:00-15:20	Break (20 min)			
Room	**ROOM 1**	**ROOM 2**	**ROOM 3**	**ROOM 4**
Session	**Bioresources**	**Energy**	**Environment**	**Materials Technology**
15:20-15:35	**[7KBR-12]** Responses of Plant and Soil to Iron-Modified Biochar in a Paddy Soil Contaminated with Heavy Metals *Hailong WANG (Foshan University, China)*	**[7KEG-14]** Advances in Biofuel Production from Microalgal Biomass *Wei-Hsin CHEN (National Cheng Kung University, Taiwan)*	**[7OEN-23]** Effect of Residual Antibiotics on Biodiesel Yield of Microalgae Treating Livestock Excreta *Sangjun JEONG (Jeonbuk National University, Korea)*	**[7OMT-28]** Robust Photocatalytic Degradation of Organic Pollutants by MFe_2O_4 Nanoparticles *Nishesh Kumar GUPTA (University of Science and Technology (UST), Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*
15:35-15:50			**[7OEN-24]** Citrus Pressed Cake Drying Technology *Jae Hee LEE (GAIA Corporation, Korea)*	**[7OMT-29]** A New 3D Hierarchical Bi_3O_4Cl/Bi_5O_7I Heterojunction and Its Photocatalytic Degradation Performance over Rhodamine-B and Bisphenol-A *Syed Taj Ud DIN (Dongguk University, Korea)*
15:50-16:05	**[7KBR-13]** Utilization of Biochar in Catalytic Applications *Naomi B. KLINGHOFFER (Western University, Canada)*	**[7OEG-20]** Biodiesel Production of Waste Cooking Oil by via Non-Catalytic Transesterification using Swine Manure Biochar *Minyoung KIM (Sejong University, Korea)*	**[7OEN-25]** Occurrence of Microplastics in South Korea: A Review *Kimberly Ann YANO (Kongju National University, Korea)*	**[7OMT-30]** Tailoring Heterojunction Architecture on IrO_2 Based Dimensionally Stable Anodes for Environmental Applications *Evandi RAHMAN (Korea Institute of Science and Technology, Korea)*
16:05-16:20		**[7OEG-21]** Effects of Pyrolysis Syngas Injection onto Methane Yield from Anaerobic Digestion Process *Jongkeun LEE (Konkuk University, Korea)*	**[7OEN-26]** The Occurrence of Pharmaceuticals and Personal Care Products in Different Environmental Media: A Review *Nash Jett DG. REYES (Kongju National University, Korea)*	**[7OMT-31]** Gradient N-doped Structure of Carbon Quantum Dots as Metal-free Photo-electrocatalyst for Improved Charge Channeling and Associated Water Treatment *Mumtaz ALI (Hanyang University, Korea)*
16:20-16:35	**[7OBR-19]** Process Development for Large-scale Biochar Production by Integration of Pyrolysis and Large Combustion Plant *Seunghan YU (Sungkyunkwan University, Korea)*	**[7OEG-22]** Production of Hydrogen and Carbon Black by Photocatalytic Decomposition of Benzene Using Liquid Plasma *Kyong-Hwan CHUNG (Sunchon National University, Korea)*	**[7OEN-27]** Melting Slag Formation for the Recycling of Automobile Shredder Residues *Ha-Na JANG (Yonsei University, Korea)*	**[7OMT-32]** Exfoliated Magnetic Ti_2AlC Heterostructures Using a Green One-step Hydrothermal Synthesis Process and Their Applications in Radionuclide Sequestration *Asif SHAHZAD (Kyungpook National University, Korea)*
16:35-16:55	Break (20 min)			

Room	ROOM 1	ROOM 2	ROOM 3	ROOM 4
Session	**Energy**	**Bioresources**	**Environment**	**Environment**
16:55-17:10	**[7KEG-15]** Assessing Global Water Sustainability in the Recovery of Unconventional Oil and Gas Resources *Daniel S. ALESSI (University of Alberta, Canada)*	**[7KBR-16]** Mineralization and Nutrient Releasing of Biochar Compound Fertilizer in a Highly Weathering Soil *Shih-Hao JIEN (National Pingtung University of Science and Technology, Taiwan)*	**[7OEN-38]** Experimental Parametric Studies and Effect of Water Matrix on Photocatalytic Degradation of Organic Wastewater using Fe-TiO_2 Nanotubes: Towards Commercial Application *Rida FATIMA (Hanyang University, Korea)*	**[7OEN-43]** Visible Light Photocatalytic Degradation of Thiabendazole with Porous Organic Polymers (POP): Effect of Reaction Conditions *Alireza RANJBARI (Ghent University Global Campus, Korea)*
17:10-17:25			**[7OEN-39]** Sustainable Biopolymers Production Using Red Algae Derived Volatile Fatty Acids: Closed Loop Approach *Naresh Kumar AMRADI (Yonsei University, Korea)*	**[7OEN-44]** Removal of Nitrate from Groundwater through Reduction and Adsorption Using Modified Biochar with Zero-valent Iron *Eun-Yeong HAN (Jeonbuk National University, Korea)*
17:25-17:40	**[7OEG-33]** Constructing Highly Porous Graphitic Carbon Nitride for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction *Maliheh RAZAVI (University of Ulsan, Korea)*	**[7OBR-35]** Life Cycle Greenhouse Gas, Energy and Economic Analysis of an Advanced Sulfidogenic Oxic-settling Anaerobic (SOSA) Process for Wastewater Treatment with in-situ Sludge Reduction *Di WU (Hong Kong University of Science and Technology, Hong Kong, China)*	**[7OEN-40]** The Enhanced Pyrolysis of Crude Oil Sludge Using CO_2 as Reactive Gas Medium *Jung-Hun KIM (Sejong University, Korea)*	**[7OEN-45]** Application of Co_9S_8 Impregnated Porous Carbon Mmaterial Fabricated from Pyrolysis of Lignin-Co Composite *Gihoon KWON (Sejong University, Korea)*
17:40-17:55	**[7OEG-34]** Slow-release Fe^{II} and Persulfate Candle-assisted Oxidation of Acenaphthene: Effect of Anions and Hydroxylamine *Ardie SEPTIAN (Kyungpook National University, Korea)*	**[7OBR-36]** Effect of Forced Ventilation Using a Three-Layer Pipeline during Sewage Sludge High Pile Composting *Guodi ZHENG (Institute of Geographic Sciences and Natural Resources Research, University of Chinese Academy of Sciences, China)*	**[7OEN-41]** Electrochemical Oxidation of Contaminants using Graphite Electrode in Flow-through System *Jong-Gook KIM (Jeonbuk National University, Korea)*	**[7OEN-46]** The Effects of Spartina Anglica Invasion on Depth Profiles of Methane Production and Soil Microbial Community *Jinhyun KIM (Yonsei University, Korea)*
17:55-18:10		**[7OBR-37]** Cocoa Pod Husk Waste as a Potential Bioresource for Preparation of Value-added Biomaterials. An Approach to Pectin Extraction *Bryan M. CÓRDOVA (National University of Engineering, Peru)*	**[7OEN-42]** Simultaneous TOC-TN-TP Oxidation using Base Activation and Improvement of Oxidation Efficiency *Dong-Hun SHIN (Jeonbuk National University, Korea)*	**[7OEN-47]** Treatment of Cesium-Contaminated Soil through Extraction – Selective Adsorption Process *Taesun KIM (Jeonbuk National University, Korea)*

❂ September 8 (Tuesday)

Time	ROOM 1	ROOM 2	ROOM 3	ROOM 4
9:00-9:40	- Plenary Lecture 3 - [Room: ROOM 1] **[8PL-3]** New Dimensions of Porous Coordination Polymers/Metal-Organic Frame works Susumu KITAGAWA (Kyoto University, Japan)			
9:40-10:00	Break (20 min)			
Room	**ROOM 1**	**ROOM 2**	**ROOM 3**	**ROOM 4**
Session	**Environment**	**Materials Technology**	**Bioresources**	**Special Session 1 -Mitigation and Adaptation for Climate Change and Particulate Matter** *Session Organizer: Eui-chan JEON, Hyun-Han KWON (Sejong University, Korea)*
10:00-10:15	**[8KEN-17]** Effect of Microplastics on the Removal of Pollutants from Aqueous Medium by using Carbon Materials *Wei ZHANG (Zhengzhou University, China)*	**[8KMT-20]** Conversion of Biochar to Solid Acids with Sulfonate Groups for Spiramycin Hydrolysis: Insights into the Sulfonation Reaction and the Aromatic Properties of the Feedstock *Xiaomin DOU (Beijing Forestry University, China)*	**[8OBR-07]** Accelerated Aging of Biochar for Assessment of Biochar Stability *Hye-Bin KIM (Jeonbuk National University, Korea)*	**[8SS1-01]** Development of Estimation Method of Consumption-Based National GHG Emissions *Han-Sae KIM (Sejong University, Korea)*
10:15-10:30			**[8OBR-08]** Anaerobic Digestion of Food Waste and Sewage Sludge for Biogas Production *Yun-Hui JEON (Kyungpook National University, Korea)*	**[8SS1-02]** Characteristic of Ammonia Emission from the Open Poultry House System *Seongmin KANG (Sejong University, Korea)*
10:30-10:45	**[8KEN-18]** Geochemical Distribution of Gallium, Indium, and Thallium and Their Availability in Highly Weathered Soils *Zeng-Yei HSEU (National Taiwan University, Taiwan)*	**[8KMT-21]** Utilization of Nanocomposites for Management of Water Contaminants *Sandeep KUMAR (Guru Jambheshwar University of Science and Technology, India)*	**[8OBR-09]** Improved Growth of Chlorella Vulgaris using Silver Nanoparticles Solution as Light Filter Devices *Chang-Hyun JEON (Kyungpook National University, Korea)*	**[8SS1-03]** The Prodecural Rationality of the Korean Policy on Fine Particulate Matter *Sang-Hyeon JIN (Kyungpook National University, Korea)*
10:45-11:00			**[8OBR-10]** Synthesis of Diesel Range Fuel Precursor from Furfuryl Alcohol over Fibrous γ-Al_2O_3 Sphere Supported Nb_2O_5 Catalyst *Mahlet N. GEBRESILLASE (Myongji University Korea)*	**[8SS1-04]** Improvement of Estimation Method for National Ammonia Inventory and Assessment of Mitigation Technologies *Gayoung YOO (Kyung Hee University, Korea)*
11:00-11:15	**[8KEN-19]** A Review of the Health Impacts of WTE Facilities *Marco J. CASTALDI (The City College of New York, City University of New York, USA)*	**[8OMT-03]** Engineering the Photocatalytic Behaviours of g/C_3N_4-based Metal-free Materials for Degradation of a Representative Antibiotic *Jun LIU (Institute of Semiconductors, Chinese Academy of Sciences, China)*	**[8OBR-11]** Bifunctional Catalysis of Cobalt-Nickel Phosphides for the Solvent-Free Hydrogenation of Biomass-Derived Levulinic Acid *Reibelle Q. RAGUINDIN (Myongji University, Korea)*	**[8SS1-05]** Exploring Flash Drought and its Relation to Atmospheric Circulation *Hyun-Han KWON (Sejong University, Korea)*
11:15-11:30		**[8OMT-04]** Zinc Zeolitic Imidazolate Frameworks as Base Catalysts: Tuning Catalytic Properties via Variation of Basicity and Crystal Size *Maria N. TIMOFEEVA (Institute of Catalysis SB RAS, Russia)*	**[8OBR-12]** Food Waste and Its Derivatives as Alternative Carbon Source for Denitrification of Steel Processing Wastewater: Process Performance and Microbial Community Dynamics *Joonyeob LEE (Pukyong National University, Korea)*	**[8SS1-06]** Drought Early Warning System and its Application with Groundwater Data-Based Drought Index *Jeongju LEE (K-water, Korea)*
11:30-11:45	**[8OEN-01]** A Facial and Novel Synthesis of Fe_2O_3/Mn_2O_3 Nanocomposite for a Fast Degradation of Organic Pollutants *Yasaman GHAFFARI (University of Science and Technology (UST), Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*	**[8OMT-05]** Sulfate Radical-induced Degradation of Naproxen with Nanosized Magnetic $CoFe_2O_4$@Mxene as a Heterogeneous Catalyst of Persulfate *Aqsa FAYYAZ (Kyungpook National University, Korea)*	**[8OBR-13]** Understanding Surface Functionality of Mesoporous Biochar in Phase Change Materials Infiltration through Stability and Energy Storage Capacity *Dimberu G. ATINAFU (Yonsei University, Korea)*	
11:45-12:00		**[8OMT-06]** Co-pyrolysis of Coffee-ground with Waste Polystyrene Foam for Upgrading the Coffee-ground Derived Pyrolysis Oil *Quynh Van NGUYEN (University of Science and Technology, Korea)*	**[8OBR-14]** Ru-Re Catalysts Supported on Biochar Engineered in Different Pyrolytic Atmospheres for Converting Furan into Platform Chemicals *Younghyun LEE (Ajou University, Korea)*	
12:00-13:30	Lunch			

13:30-14:20	Poster Session 2			
14:20-15:00	- Plenary Lecture 4 - [Room: ROOM 1] **[8PL-4]** Emergent Materials for Energy, Environment and Health Tejraj M. AMINABHAVI (Rajiv Gandhi Health Science University, India)			
15:00-15:20	Break (20 min)			
Room	**ROOM 1**	**ROOM 2**	**ROOM 3**	**ROOM 4**
Session	**Environment**	**Bioresources**	**Environment**	**Special Session 2-Special Session: Air Quality, Health, and Climate Change (Invited only)** *Co-Sponsored by Prof Jinkyu Hong (Yonsei University) and Prof. Eri Saikawa (Emory University)*
15:20-15:35	**[8KEN-22]** Microalgae-based Wastewater Treatment and Resource Recovery – A Synergistic Approach *Amit BHATNAGAR (LUT University, Finland)*	**[8KBR-24]** Metal-Organic Frameworks (MOF) for Electrochemical and Optical Sensing of Bacteria *Akash DEEP (CSIR-Central Scientific Instruments Organisation, India)*	**[8OEN-19]** Occurrence and Transport of di(2-ethylhexyl) Phthalate (DEHP) in the Drinking Water Treatment Plants from South Korea *Youngkun CHUNG (Korea Advanced Institute of Science and Technology (KAIST), Korea)*	Place to be Announced for Invitees
15:35-15:50			**[8OEN-20]** Impact of Land Use/Land Cover on the Groundwater Quality at Agricultural Region of South Korea *MoonSu KIM (National Institute of Environmental Research, Korea)*	
15:50-16:05	**[8KEN-23]** Designing Clay Minerals for Sustainable Remediation of Per- and Polyfluoroalkyl Contaminants in the Environment *Binoy SARKAR (Lancaster University, UK)*	**[8OBR-16]** Development of Modified Biochar on the Eco-friendly Process for Food Waste and Livestock Manure Composting *Balasubramani RAVINDRAN (Kyonggi University, Korea)*	**[8OEN-21]** Novel Membrane-type Electrode for the Selective Reduction of Co^{2+} from Ca^{2+}-rich Concrete Decommissioning Wastewater *Joosung PARK (Korea Advanced Institute of Science and Technology (KAIST), Korea)*	
16:05-16:20		**[8OBR-17]** Nitrogen and Phosphorus Removal and Recovery from Wastewater with Metal Impregnated Biochar *Dong-Jin KIM (Hallym University, Korea)*	**[8OEN-22]** Effect of Biofouling Layer on the Rejection of Emerging Contaminants in the Forward Osmosis Process *Duksoo JANG (Korea Advanced Institute of Science and Technology (KAIST), Korea)*	
16:20-16:35	**[8OEN-15]** Wastewater Treatment Plants as Sources of Microfibres and Microplastics to Environment: Detection and Treatment *Muhammad Tariq KHAN (The Education University of Hong Kong, Hong Kong, China)*	**[8OBR-18]** Hydrochar Production from Waste Seaweed: Effect of Reaction Conditions *Sepideh SOROUSH (Ghent University Global Campus, Korea)*	**[8OEN-23]** Synergistic Effect of CO_2 and Pt Catalyst on Thermal Disposal of Food Waste *Soosan KIM (Ajou University, Korea)*	

16:35-16:55	Break (20 min)		
Room	**ROOM 1**	**ROOM 2**	**ROOM 3**
Session	**Environment**	**Environment**	**Materials Technology**
16:55-17:10	**[8KEN-25]** Challenges in Translational Research from Concepts of Proof to Innovative Environmental Technologies: System Complexity, Critical Barriers, and Adaptive Research Methodology *Longbin HUANG (The University of Queensland, Australia)*	**[8KEN-26]** Distributed Waste-to-Resource Development in Glasgow *Siming YOU (University of Glasgow, UK)*	**[8OMT-30]** Copper Segregated Nickel Foam and Its Dichalcogenide for Chemical Assisted overall Water Splitting *Bezawit. Z DESALEGN (Myongji University, Korea)*
17:10-17:25			**[8OMT-31]** Encapsulated Phase-Changing Eutectic Salts in Magnesium Oxide Fibers for Capture: Beyond the Capacity-Stability Trade-off *Monica Louise T. TRIVIÑO (Myongji University, Korea)*
17:25-17:40	**[8OEN-24]** Adsorptive Removal of Ammonium and Sulfonamides Antibiotics from Livestock Burial Leachate using Low-grade Charcoal and Zeolite *Jung-yeol JO (Jeonbuk National University, Korea)*	**[8OEN-27]** Synoptic Circulation Pattern Modulates co-occurring Surface Ozone and PM2.5 Compound Pollutions during Summertime in Eastern China *Lian ZONG (Nanjing University of Information Science & Technology, China)*	**[8OMT-32]** Study Calcination Effect of MoS_2 and WS_2 Nanosheets on the W/WO_3 for Improving Photoelectrochemical Performance *Meysam TAYEBI (University of Ulsan, Korea)*
17:40-17:55	**[8OEN-25]** Soil Trace Gas Fluxes in Living Mulch and Conventional Agricultural Systems *Eri SAIKAWA (Emory University, USA)*	**[8OEN-28]** Application of on Campus Low-Cost Air Quality Sensors in the Monitoring of Real-Time $PM_{2.5}$ Concentrations in Southeast United States *Haoran CHENG (Emory University, USA)*	**[8OMT-33]** $ZnO/CdS/MoS_2$ Photoanode with Multi-heterojunctions for Highly Efficient Photoelectrochemical Hydrogen Evolution *Morteza KOLAEI (University of Ulsan, Korea)*
17:55-18:10	**[8OEN-26]** Emerging Endocrine Disrupting Chemicals: A Challenge to Children's Health in Hong Kong *Ziying LI (The Education University of Hong Kong, Hong Kong, China)*	**[8OEN-29]** Removal of Microfibres and Microplastics in Sewage Treatment Works: Implications to Environmental Risk *Yuguang WANG (The Education University of Hong Kong, Hong Kong, China)*	**[8OMT-34]** Platform Chemicals from Sugar: Experimental Study with MOF Catalysts *Noor ALJAMMAL (Ghent University Global Campus, Korea)*

Plenary Speakers

7PL-1 | September 7 (Monday) 14:20-15:00 >> ROOM 1

Yong-Chil SEO | Yonsei University, Korea

Title | Role of Waste to Energy (WtE) in Waste Management by Reviewing Korean Practices and Recent Activities

Prof. Yong-Chil Seo is Former President of Korea Waste Management Society. As a professor of Yonsei University he is now directing two national programs to support graduate student research and fellowship in the fields of "Waste to Energy and Environmental Engineering". His main research areas are Waste and Biomass to Energy, Waste Recycling and Air Pollution Controls, especially Heavy Metals including Mercury. He has been working as an expert working group member for UNEP to develop the implementation guidance of Minamata Mercury Convention last several years (UNEP Mercury Global Assessment Report 2013 & 2018, UNEP Emission BAT Guideline, Partnership members in Coal Emission and Waste Management).

7PL-2 | **September 7 (Monday) 9:30-10:10** >> **ROOM 1**

Ki-Hyun KIM | Hanyang University, Korea

Title | In Search of Practical Options for the Treatment of Gaseous Indoor Air Pollutants: Adsorption and Catalysis –based Techniques

HYU Distinguished Prof. Ki-Hyun Kim was at Florida State University for an M.S. (1984-1986) and at University of South Florida for a Ph.D. (1988-1992). He was a Research Associate at ORNL, USA (1992 to 1994). He moved to Sang Ji University, Korea in 1995. In 1999, he joined Sejong University. In 2014, he moved to the Department of Civil and Environmental Engineering at Hanyang University. His research areas broadly cover the various aspects in the interfacing field of "Air Quality & Environmental Engineering" in connection with "Material Engineering" with emphasis on advanced novel materials like Coordination Polymers, especially Metal-Organic Frameworks (MOFs). He was awarded as one of the top **10 National Star Faculties in Korea in 2006** and became an **academician** (Korean Academy of Science and Technology) in 2018. He has been recognized as **'Highly Cited Researcher (HCR)' for 2019 in Environment & Ecology field** from Clarivate Analytics. He is serving as associate editor of 'Environmental Research' and Critical Reviews in Environmental Science & Technology' while being a board member in several other journals (e.g., 'Atmospheric Pollution Research' and 'Sensors'). He has published more than 680 articles many of which are in leading scientific journals including '**Chemical Society Reviews', 'Progress in Material Science', 'Progress in Polymer Science', 'Progress in Energy and Combustion Science', 'Chem', 'Nano Energy', and 'Coordination Chemistry Reviews**'.

8PL-3 | September 8 (Tuesday) 9:00-9:40 >> ROOM 1

Susumu KITAGAWA | Kyoto University, Japan

Title | New Dimensions of Porous Coordination Polymers / Metal-Organic Frameworks

Research Fields

Inorganic and Material Chemistry, Chemistry of Coordination Space

Research Overview

Kitagawa's main research field is inorganic and material chemistry, in particular, chemistry of coordination space, and his current research interests are centered on synthesis and properties of porous coordination polymers/metal-organic frameworks.

He was the first to discover and to demonstrate "porosity" for metal complexes with gas sorption experiments (1997), whose materials are called porous coordination polymers (PCPs) or metal-organic frameworks (MOFs). To date, MOFs are classified as a new category of porous materials, as opposed to the conventional classifications of inorganic and carbon materials. Kitagawa pioneered the functional chemistry of MOFs, and discovered flexible MOFs, dissimilar to those of conventional porous materials. Today several hundred different MOFs are known, and over 7,000 articles on this class of materials have been published annually worldwide. The research developments built on his discoveries are anticipated to lead to radical innovations in materials science, with wide-ranging implications for both academia and industry. Chemical industry firms are producing MOF materials for use in purification, storage, and transportation of gases, among other applications. Kitagawa's achievement has blazed a trail to a new era for porous materials, vital to addressing energy and environmental issues and contributing to human welfare.

8PL-4 | **September 8 (Tuesday) 14:20-15:00** >> **ROOM 1**

Tejraj AMINABHAVI | Soniya College of Pharmacy, India

Title | Emergent Materials for Energy, Environment and Health

Dr. Tejraj Aminabhavi obtained his PhD from the University of Texas at Austin, Texas, USA in 1979. He has 45 years of experiences in academia and industries. His areas of expertise are in polymer science, membranes, and environmental engineering. Aminabhavi published 800 scientific papers in highly cited journals, three US patents, and 60 review articles. His work received 33000 citations with an H Index of 85. His text book on “Introduction to Macromolecular Science”, published by Wiley is widely read. Currently, he is serving as Professor Emeritus and Research Director at the College of Pharmacy, India and is the editor of Chemical Engineering Journal. He is the founder editor-in-chief of Materials Science for Energy Technologies (KeAi Publishers, China) in addition to advisory board memberships on several international journals. He is the visiting professor to several universities in the US and other countries. Aminabhavi received international awards from Japan, Iran and India.

Keynote Speakers

6KEN-01 | **September 6 (Sunday) 15:00-15:30** >> **Room: 1**

- Session: Environment

Shicheng ZHANG | Fudan University, China

Title | Preparation of Aromatic Compounds by Catalytic Hydrogenation of Lignin in Biphasic System

Dr. Shicheng Zhang is a Full Professor and a Vice Chair at the Department of Environmental Science and Engineering, Fudan University, Shanghai, China. His research group is focusing on the biofuel, biochemical and bio-based materials production from biomass wastes by chemical, biological and biochemical methods, especially hydrothermal conversion of biomass waste to high value-added products. He has been involved in more than 30 research projects as PI or Co-PI. Has published more than 120 journal papers, 30 patents, and has more than 3200 ISI citations with H index 29. He has served as Guest Editor of Bioresource Technology (2017) and Green Chemistry (2019). Dr. Zhang has been an active member of numerous national and international commissions and committees, and regularly serves as external judge for national and international funding institutions.

6KEN-02 | **September 6 (Sunday) 15:30-16:00** >> **ROOM 1**

- Session: Environment

Keat Teong LEE | Universiti Sains Malaysia, Malaysia

Title | The Role of Renewable Energy in Global Transformation for a Sustainable Energy Future?

Dr. Lee Keat Teong obtained his Ph.D in Chemical Engineering from Universiti Sains Malaysia (USM) in 2004 and upon graduating he joined the School of Chemical Engineering, USM as a faculty staff. He was promoted to full professorship in 2014 and is currently holding the position; Director of Research Creativity & Management Office, since 2013. Prior to that, he was the Deputy Dean (Research & Postgraduate Studies) for School of Chemical Engineering from 2010 to 2012. Dr. Lee has co-authored 2 books, 10 book chapters, 30 review articles and more than 150 technical research articles in peer reviewed international journals with Scopus bibliographic database recorded H–Index of 57 and total citation of more than 10,000 (access on 21 Aug 2019). He has also graduated more than 10 PhD students as main supervisor and many more Master's and PhD students as co-supervisor. Dr. Lee is currently the Co-Editor for Energy Conversion and Management (Elsevier) and Editorial Board Member for Bioresource Technology (Elsevier), Biotechnology for Biofuels (BioMed Central) and Energy Science & Engineering (Wiley). He has also won numerous awards including Young Scientist Award 2011 by The International Forum on Industrial Bioprocess and 2012 Top Research Scientists Malaysia by the Academy Sciences of Malaysia. He is one of the four Malaysian researchers that was recognized as the most cited researchers in the Shanghai Academic Ranking of World Universities 2016 by Subjects (Energy Science & Engineering). Dr. Lee is now working on the production of biofuels (biodiesel and bioethanol) from biomass (including macro and microalgae) using various technologies. Apart from that, he also has special interest on the social and sustainability aspects of biofuels.

6KEN-03 | September 6 (Sunday) 15:00-15:30 >> Room 2

- Session: Environment

Su Shiung LAM | Universiti Malaysia Terengganu, Malaysia

Title | Microwave Vacuum Pyrolysis Conversion of Biomass Waste into Cleaner Biofuel, Bioplastic Feedstock and Value-added Carbon

Dr. Su Shiung Lam holds a PhD in Chemical Engineering from Cambridge University, and is currently a tenured Associate Professor at Universiti Malaysia Terengganu. He leads a 12-member research group working mainly on Chemical & Environmental Engineering, focusing on Waste Management, Thermal Process (Pyrolysis, Gasification, Microwave Heating), Waste & Biomass Utilization, and Clean Technology. He has collaborations and is active on the research, development, optimization, and application of thermal technology (especially pyrolysis) in many aspects, currently ranked No. 4 in the world in microwave pyrolysis and No. 1 in Malaysia for pyrolysis with respect to the number of SCI-indexed publication. He is also active in servicing as Associate Editor for Energy & Environment and Frontiers in Energy Research, and Guest Editor for Journal of Hazardous Materials, Bioresource Technology, Environmental Research, Environmental Pollution. He has secured 20 research grants, both international and in Malaysia, worth nearly RM 2.5 million (~USD 600,000), publishing about 87 articles in journals, file patent and commercialize inventions from his research team.

6KEN-04 | **September 6 (Sunday) 15:30-16:00** >> **ROOM 2**

- Session: Environment

Meisam TABATABAEI | University Technology Mara (UiTM), Malaysia

Title | The 2019 Report of The Lancet Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today is not Defined by a Changing Climate

Meisam Tabatabaei is an Associate Professor of Environmental Biotechnology (Universiti Teknologi MARA-UiTM, Malaysia) and is the founding Editor-in-Chief of Biofuel Research Journal (BRJ) in Canada. Meisam has been working closely with the United Nation Development Program (UNDP) to promote waste-oriented biofuels in the developing world. Since 2016, he has been the lead collaborator of the Lancet Commission on Public Health and Climate Change (UCL, UK) and has published over 250 publications including original research papers and reviews in journals such as *The Lancet* (Impact Factor: 59.102), *Progress in Energy and Combustion Sciences* (Impact Factor: 26.467), *etc*. (Citations: >6600, h-index: 42, i10 index: 136; November 2019, Google Scholar). The Cumulative Impact Factor of Meisam's publications stands at over 1000. He is currently also a Guest Professor at the Ho Chi Minh City University of Transport (Vietnam). Dr. Tabatabaei has been listed on the Web of Science Highly Cited Researchers List (Top 1% scientists in the world) in Engineering Category since 2017. He is the Editor of the Book Volumes *"Biogas: Fundamentals, Process, and Operation" and "Biodiesel: from Production to Combustion"* which have been published by Springer Nature in 2018 and is on the Editorial/Advisory Board of International Journal of Life Cycle Assessment (Springer), Data In Brief (Elsevier), MethodsX (Elsevier), and Energy Sources, Part A: Recovery, Utilization and Environmental Effects (Taylor & Francis). Meisam is the Associate Editor of Frontiers in Energy Research. Dr. Tabatabaei is also the Guest Editor of Special Issues in Renewable & Sustainable Energy Reviews (Elsevier) and Energies (MDPI). Meisam is the Editor-in-Chief of the Elsevier Book Series on Biomass and Biofuels.

6KEN-05 | **September 6 (Sunday) 16:35-17:05** >> **ROOM 1**

- Session: Environment

Buyan CHULUUN | National University of Mongolia, Mongolia

Title | Oil Field Contamination and Remediation in Mongolia

Dr. Buyan Chuluun is currently working as associate professor at Department of Chemistry, School of Arts and Sciences in National University of Mongolia. She received my PhD in Environmental Engineering (2013) from University of Science and Technology, South Korea. She was working as a research associate in Asian Institute of Technology, Thailand and Korea Institute of Science and Technology, South Korea. She was awarded "Outstanding Young Teacher" a gold medal from The Mongolian Youth Federation in 2017. Her main research areas are biological remediation of organic pollutants and heavy metals in soil and water and environmental microbiology and toxicology.

6KEN-06 | September 6 (Sunday) 17:05-17:35 >> ROOM 1

- Session: Environment

Ajit Kumar SARMAH | The University of Auckland, New Zealand

Title | Mechanical, Durability and X-ray Micro-computed Tomography Investigation of Biochar-admixtured Cement-mortars

Ajit K Sarmah is an Associate Professor in the Civil & Environmental Engineering Department at the University of Auckland, New Zealand. He has a multidisciplinary background with training in both science and engineering disciplines and obtained his PhD (Soil and Water) from the University of Adelaide, Australia. Prior to joining The University of Auckland, he was a Senior Research Scientist at Landcare Research, a Crown Research Institute in Hamilton, New Zealand for nearly 10 years. Earlier he worked in the School of Civil Engineering and School of Agronomy of Purdue University, West Lafayette, Indiana, USA as a Visiting Scientist, as a Research Officer in University of Western Australia, and as a Research Associate at the Asian Institute of Technology, Bangkok, Thailand. He currently leads projects on: production of biochar and characterisation using novel techniques; development of novel adsorbents using biochar to remove contaminants from aqueous and soil systems; design, development and testing of wood plastic biochar composite and testing their mechanical, and thermal properties; development of sustainable green concrete using waste-derived carbon material; fate and transport behaviour of endocrine disrupting chemicals, veterinary medicines and personal care products in terrestrial and aquatic ecosystems. He served as Associate Editor for Science of the Total Environment (Elsevier) and currently is an Associate Editor for Environmental Management (Springer) and Editorial Board Member for two Springer Journals: Nanotechnology for Environmental Engineers and BIOCHAR.

6KBR-07 | **September 6 (Sunday) 16:35-17:05** >> **ROOM 2**

- Session: Bioresources

Haiping YANG | Huazhong University of Science and Technology, China

Title | Recent Developments of Biomass Catalytic Fast Pyrolysis: Strategies for the Optimization of Bio-oil Quality and Yield

Prof Yang' research is focused on Biomass pyrolysis/gasification for H2 enriched gas fuel, liquid fuel and carbon contained materials and chemicals. So far she has published over 100 SCI papers, and 5 were cited in ESI, and the highest SCI cite for 1 paper is over 2000. Now she owns Newton Advanced Fellowships (2018) and the Most Cited Chinese Researchers (Elsevier, 2014-2018). She gained the National Science Fund for Excellent Young Scholars program in 2016 (China). She is a member of the editor board of Fuel and Journal of Analytical and Applied Pyrolysis, also managing guest editor of Fuel and guest editor of Journal of Analytical and Applied Pyrolysis, Science of Total Environment.

6KBR-08 | **September 6 (Sunday) 17:05-17:35** >> **ROOM 2**

- Session: Bioresources

Daniel CW TSANG | The Hong Kong Polytechnic University, Hong Kong, China

Title | Effective Dispersion of MgO Nanostructure on Biochar Support for Glucose Isomerization

Prof. Daniel CW Tsang is currently an Associate Professor and Programme Leader (EOSH) in the Department of Civil and Environmental Engineering at the Hong Kong Polytechnic University. He was an IMETE Visiting Scholar at Ghent University in Belgium, Visiting Scholar at Stanford University in the US, Senior Lecturer and Lecturer at the University of Canterbury in New Zealand, and Post-doctoral Fellow at Imperial College London in the UK and the Hong Kong University of Science and Technology. With a strong link to real-world environmental challenges, Dan's research group strives to develop low-impact solutions to ensure sustainable development and foster new ways in which we utilize biomass waste, contaminated land, and urban water. Dan has published over 300 SCI journal papers, and currently serves as Editor of Journal of Hazardous Materials, Associate Editor of Science of the Total Environment, Critical Reviews in Environmental Science and Technology, Environmental Geochemistry and Health, and Journal of Soils and Sediments, as well as Editorial Board Member of Bioresource Technology, Environmental Pollution, and Chemosphere. Dan has also served as Guest Editor of 20+ Special Issues at Environment International, Chemical Engineering Journal, Journal of Hazardous Materials, Journal of Cleaner Production, Bioresource Technology, etc., and received the Young Scientist Award (International Bioprocessing Association) and Excellence in Review Award (Environmental Science and Technology, Resources, Conservation & Recycling, and Chemosphere). Dan is the Chair and Organizer of 2nd Biological Waste as Resource Conference (BWR2017), 4th Contaminated Land, Ecological Assessment and Remediation Conference (CLEAR2018), 3rd International Conference on Bioresources, Energy, Environment, and Materials Technology 2018 (BEEM2019), and 5th Asia Pacific Biochar Conference (APBC2020).

7KEN-09 | September 7 (Monday) 10:30-11:00 >> ROOM 1

- Session: Environment

Jörg RINKLEBE | University of Wuppertal, Germany

Title | Can Biochar's a Solution to Remediate Contaminated Paddy Soils?

Dr. Jörg Rinklebe is a Professor for Soil- and Groundwater-Management at the University of Wuppertal, Germany. His academic background covers environmental science, bioavailability of emerging contaminants, and remediation of contaminated soils. He works at various scales, ecosystems, and spheres including pedosphere, hydrosphere lithosphere, biosphere, and atmosphere and has a certain experience in fundamental soil science. His main research is on soils, sediments, waters, plants, and their pollutions (trace elements and nutrients) and linked biogeochemical issues with a special focus in redox chemistry. He also has a certain expertise in soil microbiology. Professor Rinklebe is internationally recognized particularly for his research in the areas of biogeochemistry of trace elements in wetland soils. He published plenty of scientific papers in leading international and national journals. Professor Rinklebe is nominated as Highly Cited Researcher. According to SCOPUS (Sep-17-2019) he published over 195 research papers, 20 were nominated as "Highly Cited Papers" and 3 were nominated as "Hot Papers"). His h-index is 36. Also, he published two books entitled "*Trace Elements in Waterlogged Soils and Sediments*" (2016) and "*Nickel in Soils and Plants*" (2018) as well as numerous book chapters. He is serving as Editor of the international journal Critical Reviews in Environmental Science and Technology (CREST) and Special Issue Editor for Environmental Pollution and Journal of Hazardous Materials, and as guest editor of the international journals Environment International, Chemical Engineering Journal, Science of the Total Environment, Chemosphere, Journal of Environmental Management, Applied Geochemistry, and Environmental Geochemistry and Health. Also, he is member on serval editorial boards (e.g., Ecotoxicology, Geoderma, Water, Air, & Soil Pollution, Archive of Agronomy and Soil Science) and reviewer for many leading international journals. He organized many special symposia at various international conferences such as "Biogeochemistry of Trace Elements" (ICOBTE) and "International Conference on Heavy Metals in the Environment" (ICHMET). He was an invited speaker (plenary and keynote) at a plenty of international conferences. In 2016 he got an appointment as Honorable Ambassador for Gangwon Province, South-Korea which was renewed in June-2018. Also, he got an appointment as Visiting Professor at Sejong University, Seoul, South Korea, Adjunct Professor at the University of Southern Queensland, Australia, and Guest Professor at the China Jiliang University, Hangzhou, Zhejiang, China. Recently, Professor Rinklebe was elected as Vice President of the International Society of Trace Element Biogeochemistry (ISTEB).

7KEN-10 | **September 7 (Monday) 11:00-11:30** >> **ROOM 1**

- Session: Environment

Eakalak KHAN | University of Nevada, Las Vegas, USA

Title | Fate of (E)- and (Z)-Endoxifen in Water and Secondary Treated Wastewater under Sunlight

Eakalak Khan is a Professor in Civil and Environmental Engineering and Construction Department and the Director of Water Resources Research Program, University of Nevada, Las Vegas. From 2002 to 2017, he was a Professor in Civil and Environmental Engineering Department, North Dakota State University (NDSU). He also served as the Chair of Civil Engineering Department, NDSU from 2010 to 2013. Prior to NDSU, he was an Assistant Professor in the Department of Civil Engineering, Polytechnic University, New York from 1999 to 2002. He received his Bachelor of Engineering in Environmental Engineering from Chiang Mai University, Thailand in 1990, M.S. in Agricultural Engineering from University of Hawaii in 1993, and Ph.D. in Civil Engineering from University of California, Los Angeles (UCLA) in 1997. In 1998, he was a Postdoctoral Research Associate at the Institute of Environment, UCLA. Eakalak has published more than 115 refereed journal articles. He was awarded a CAREER grant from NSF in 2005. His honors include the NDSU Odney Award for Excellence in Teaching in 2008, Researcher of the Year, College of Engineering, NDSU, 2005, and Water B. Booth Endowed Distinguished Professorship, NDSU, 2017.

7KBR-11 | **September 7 (Monday) 10:30-11:00** >> **ROOM 2**

- Session: Bioresources

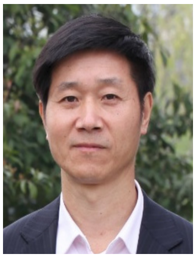
Aijie WANG | Chinese Academy of Sciences, China

Title | Coupled Sulfur and Iron (II) Carbonate-driven Autotrophic Denitrification Nitrogen Removal

Aijie Wang obtained her doctoral degree from Harbin Institute of Technology (HIT) in environmental engineering in 2000. Currently, she is a professor at Harbin Institute of Technology (HIT) and the Research Center for Eco-environmental Sciences (RCEES), CAS. She served as the Deputy Director of National Engineering Laboratory for Wastewater Treatment and Head of Key Laboratory of Environmental Biotechnology at RCEES, CAS. Dr. Wang is specialized in water pollution control and resource recovery, which includes bio-based technology for highly efficient wastewater treatment and water reclamation, augmented bioremediation of polluted aquatic environment and waste organic recycling and resource recovery. A well-recognized feature of her researches is the effective integration of fundamental (interdisciplinary) and practically applicable research. Her work on anaerobic acidogenic of recalcitrant organic compounds based on the concept of biological phase separation has been proved to bring substantial benefits to the Chinese industries, which suffer from heavy pollution for a long time. She has published more than 300 papers in reputed journals and authorized more than 80 invention patents. Her research has been recognized with numerous awards, which included Distinguished Professor of Yangtze River Scholar by Ministry of Education in 2011, the prestigious National Outstanding Youth Science Fund Award in 2012, the Ten-Thousand People Program: Leading Talent Award in 2016, and the National Science & Technology Progress Awards in 2004 and 2010. She was awarded as a member of the IWA Fellows in 2015 and a member of the China Invention Association (CIA) Fellows in 2018. She was elected as the chairman of the Management Committee of AD-SG in IWA in 2018, as a Core Group member of the IWA Resource Recovery Cluster, Vice Chairman of the IWA AD China Chapter, the Adjunct Professor of the University of Oklahoma. She serves as Co-Editor in Chief of *Environmental Research*, and as the associate editor or editorial board member of 5 international academic journals.

7KBR-12 | **September 7 (Monday) 15:20-15:50** >> **ROOM 1**

- Session: Bioresources



Hailong WANG | Foshan University, China

Title | Responses of Plant and Soil to Iron-Modified Biochar in a Paddy Soil Contaminated with Heavy Metals

Hailong Wang is a distinguished professor in environmental science at School of Environmental and Chemical Engineering, Foshan University, China. He is also an adjunct professor at Zhejiang University and Zhejiang A&F University. His research program focuses mainly on environmental functions of biochar and environmental remediation. He has published >200 papers in SCI journals, including 18 ESI highly cited papers. Prof. Wang is the Director of Biochar Engineering Technology Research Center of Guangdong Province, China, a director of the Biochar Industry Technology Innovation Strategic Alliance of China, a member of the International Biochar Initiative (IBI) Advisory Committee, and an editor of "Environmental Science and Pollution Research", "Journal of Soils and Sediments" and "Biochar".

7KBR-13 | September 7 (Monday) 15:50-16:20 >> ROOM 1

- Session: Bioresources

Naomi KLINGHOFFER | Western University, Canada

Title | Utilization of Biochar in Catalytic Applications

Dr. Naomi Klinghoffer is an Assistant Professor in the Department of Chemical and Biochemical Engineering at Western University in London, Canada, with an appointment at Western's Institute for Chemicals and Fuels from Alternative Resources (ICFAR). Her research focuses on catalytic and thermochemical conversion of biomass, waste, and CO_2 into chemicals and fuels. Research projects include activation of char derived from biomass gasification and pyrolysis for catalytic or adsorption applications, enhanced gasification processes, and CO_2 activation. Prior to her academic appointment, Dr. Klinghoffer worked at the Gas Technology Institute (GTI), developing a catalytic membrane reactor for production of dimethyl ether from CO_2, and on design and testing of a pilot plant for CO_2 capture from flue gas using a hollow fiber membrane contactor. Dr. Klinghoffer received her PhD from the Department of Earth and Environmental Engineering at Columbia University.

7KEG-14 | **September 7 (Monday) 15:20-15:50** >> **ROOM 2**

- Session: Energy

Wei-Hsin CHEN | National Cheng Kung University, Taiwan

Title | Advances in Biofuel Production from Microalgal Biomass

Professor Wei-Hsin Chen received his Ph.D. degree from the Institute of Aeronautics and Astronautics, National Cheng Kung University in 1993. After receiving his Ph.D. degree, Dr. Chen worked in an iron and steel corporation as a process engineer (1994-1995). He joined the Department of Environmental Engineering and Science, Fooyin University in 1995 and was promoted to a full professor in 2001. In 2005, he moved to the Department of Marine Engineering, National Taiwan Ocean University. Two years later (2007), he moved to the Department of Greenergy, National University of Tainan. Now he is a faculty member and distinguished professor at the Department of Aeronautics and Astronautics, National Cheng Kung University, Taiwan. Professor Chen visited the Princeton University, USA, from 2004 to 2005, the University of New South Wales, Australia, in 2007, the University of Edinburg, UK, in 2009, the University of British Columbia, Canada, from 2012 to 2013, and the University of Lorraine, France, in 2017 as a visiting professor. He was also an invited lecturer at the University of Lorraine in 2019 and 2020. His research topics include bioenergy, hydrogen energy, clean energy, carbon capture, and atmospheric science. He has published around 550 papers in international and domestic journals and conferences. He is the associated editor of *International Journal of Energy Research*, and the editorial members of *Applied Energy, Energies, BMC Energy, Energy, Ecology and Environment*, etc. He is also the author of several books concerning energy science and air pollution. In recent years, his important awards include 2015 and 2018 Outstanding Research Award (Ministry of Science and Technology, Taiwan), 2015 Highly Cited Paper Award (*Applied Energy*, Elsevier), 2017 Outstanding Engineering Professor Award (Chinese Institute of Engineers), 2019 Highly Cited Review Article Award (*Bioresource Technology*), and 2016-2019 (4 consecutive years) Web of Science Highly Cited Researcher Awards.

7KEG-15 | September 7 (Monday) 16:55-17:25 >> ROOM 1

- Session: Energy

Daniel ALESSI | University of Alberta, Canada

Title | Assessing Global Water Sustainability in the Recovery of Unconventional Oil and Gas Resources

Daniel S. Alessi is an Associate Professor in the Department of Earth and Atmospheric Sciences at the University of Alberta, who specializes in environmental geochemistry and geomicrobiology. Since 2013, his research group has focused on understanding the surface chemistry and reactivity of environmental materials such as iron oxides, bacteria, and biochar, on lithium extraction from oilfield brines, and on improving our knowledge of the water cycle in unconventional oil and gas operations. Dr. Alessi holds the Encana Chair in Water Resources at the University of Alberta, and was named a 2017-2018 Petro-Canada Young Innovator. He sits on the editorial boards of peer-reviewed journals including Marine and Petroleum Geology, Geobiology, Environmental Geochemistry and Health, *Critical Reviews in Environmental Science and Technology and Chemical Geology.*

7KBR-16 | **September 7 (Monday) 16:55-17:25** >> **ROOM 2**

- Session: Bioresources

Shih-Hao JIEN | National Pingtung University of Science and Technology, Taiwan

Title | Mineralization and Nutrient Releasing of Biochar Compound Fertilizer in a Highly Weathering Soil

Prof. Jien now is a full professor of soil sciences, and served in Department of Soil and Water Conservation, National Pingtung University of Science and Technology (NPUST). Prof. Jien also hosts Circular Material Research Center and Multi-modal Disaster Prevention Technology Research Center in NPUST. During Dr. Jien's academic career at NPUST, Prof. Jien has supervised over 60 undergraduate students, 20 postgraduate students, and 2 Ph.D. students. He has published more than 70 peer-reviewed journal articles until now and has awarded the NPUST Excellent Researcher Reward in 2014, 2015, 2016, 2017, 2018 and 2019. Dr. Jien now is focusing on researches regarding soil quality improvement for sustainable soil environments by using innovative methods such as biochar techniques. He also conducted 20 projects associated biochar application from Ministry of Science and Technology (MOST) and other Taiwan governmental units. Now, Dr. Jien devotes to the research associated with soil erosion prevention and soil organic carbon sequestration. Dr. Jien now also hosts the Soil Survey and Conservation Laboratory in NPUST and he has played an important leadership role in establishing teaching, research and conservation programs in his laboratory.

8KEN-17 | September 8 (Tuesday) 10:00-10:30 >> ROOM 1

- Session: Environment

Wei ZHANG | Zhengzhou University, China

Title | Effect of Microplastics on the Removal of Pollutants from Aqueous Medium by using Carbon Materials

Dr. Wei Zhang is associate professor from Zhengzhou University. He is currently served as Executive deputy director of Zhengzhou key laboratory of water resources and environment, Deputy secretary-general of the first high level forum about "Yellow River Protection and Development". He is also the member of IWA-China YWP and member of water resources committee from China Natural Resources Association. His research covers design of complex materials, recycling of WEEE and removal of heavy metal from polluted water or soil. He is also emphasizing on removal of Microplastics from natural water. During recent years, Dr. Wei Zhang has made much scientific progress in the field of environmental materials and water restoration. As first author or corresponding author, he has already published 8 SCI papers, 1 EI paper and 6 Chinese core papers. He has published one monograph about environmental materials as second chief editor. Dr. Wei Zhang has served as chairman of some conferences, such as the Battery Session of the Sustainable Industrial Processing Summit, and Solid Waste Session of the National Doctoral Academic Conference in 2015 and 2016, and also won the "best thesis award" of the 10th National Doctoral Academic Conference.

8KEN-18 | **September 8 (Tuesday) 10:30-11:00** >> **ROOM 1**

- Session: Environment

Zeng-Yei HSEU | Nation Taiwan University, Taiwan

Title | Geochemical Distribution of Gallium, Indium, and Thallium and Their Availability in Highly Weathered Soils

Professor Hseu is a professor of soil quality and environmental sciences in the Department of Agricultural Chemistry, National Taiwan University (NTU), Taipei, Taiwan. He had been employed as a guest professor at Kyoto University in 2010 and at Meiji University in 2011, Japan. He had also been a visiting scholar at Hong Kong Polytechnic University in 2018. Professor Hseu has been the president of the Chinese Society of Soil and Fertilizer Sciences (Taiwan) in 2016-2019 and the president of East and Southeast Asian Federation of Soil Science Societies (ESAFS) in 2018-2019. His major topics of interest are heavy metal dynamics and mineralogy of serpentine soil, morphology and genesis of wetland soil, soil chronosequences on river and marine terraces, and soil heavy metal contamination and remediation. Professor Hseu is the author or coauthor of approximate 100 scientific papers and book chapters.

8KEN-19 | **September 8 (Tuesday) 11:00-11:30** >> **ROOM 1**

- Session: Environment

Marco J. CASTALDI | The City College of New York, City University of New York, USA

Title | A Review of the Health Impacts of WTE Facilities

Dr. Castaldi is the Director of the Waste-to-Energy Research and Technology Council (WTERT) in the United States, an international organization that supports several students and post doctoral researchers; also, his group is recognized by the American Society of Mechanical Engineers as the foremost research group on chemical kinetics of converting wastes to energy. Dr. Castaldi's research will lead to the development of advanced waste-to-energy processes and in particular the high-efficiency recovery of energy from biomass processes using catalysis. Understanding the fundamental reaction sequences and their associated kinetic parameters is the sure way to provide the requisite capability to explore and develop new technologies while improving existing ones for converting "waste" resources into renewable energy. Currently Dr. Castaldi has established the Earth Engineering Center at City College, City University of New York. The goal of EEC|CCNY is to bring to bear rigorous engineering solutions that enable responsible use of energy and materials for the advancement of society. Through industry collaborations and research sponsorship EEC|CCNY develops novel solutions to some of the world's most pressing problems. EEC|CCNY routinely engages students with industry professionals enabling a holistic approach to creative realistic, forward-looking applications. The reach of EEC|CCNY is international in scope with many projects connecting international students and companies with a global presence.

8KMT-20 | September 8 (Tuesday) 10:00-10:30 >> ROOM 2

- Session: Materials Technology

Xiaomin DOU | Beijing Forestry University, China

Title | Conversion of Biochar to Solid Acids with Sulfonate Groups for Spiramycin Hydrolysis: Insights into the Sulfonation Reaction and the Aromatic Properties of the Feedstock

Dr. Xiaomin Dou received his Ph.D. degree from the Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China in 2006. He is presently an associate professor at the College of Environmental Science and Engineering, Beijing Forestry University, China. His recent research interests include pretreating pharmaceutical wastewater through physical-chemical methods, converting biomass to value-added functional materials, and mitigating hazardous ions (As, F and Sb, etc.) from water. He has published 47 scientific papers on the above-mentioned fields with more than 1900 citations.

8KMT-21 | **September 8 (Tuesday) 10:30-11:00** >> **ROOM 2**

- Session: Materials Technology

Sandeep KUMAR | Guru Jambheshwar University of Science & Technology, India

Title | Utilization of Nanocomposites for Management of Water Contaminants

Dr. Sandeep Kumar is working as Associate Professor at the Department of Bio and Nano Technology, Guru Jambheshwar University of Science and Technology, Hisar, Haryana, India. Dr. Kumar did his PhD from Panjab University, Chandigarh. His research interests include synthesis of nanomaterials, nanocarriers for healthcare applications, nanomaterials-based sensors, biomaterials, and nanotoxicology. He has one patent and published more than 100 research papers in many reputed SCI journals. Dr. Kumar runs both international and national sponsored research projects from different funding agencies. Dr. Kumar visited Hanyang University, Seoul, South Korea as a visiting Professor and University of Nebraska, Lincoln, USA as Water Advanced Research and Innovation (WARI) fellow. Dr. Kumar also visited Australia, UK, Scotland, Germany, Spain, Belgium, France under different supporting schemes (DST) of Govt of India. Dr. Kumar received the Haryana Yuva Vigyan Ratna Award in 2017.

8KEN-22 | **September 8 (Tuesday) 15:20-15:50** >> **ROOM 1**

- Session: Environment

Amit BHATNAGAR | LUT University, Finland

Title | Microalgae-based Wastewater Treatment and Resource Recovery – A Synergistic Approach

Amit Bhatnagar is working as Full Professor in University of Eastern Finland, Kuopio Campus, Finland. He obtained his PhD from Indian Institute of Technology (IIT) Roorkee, in 2003. He has conducted postdoc research in various international universities/institutes such as Linnaeus University, Sweden; University of Porto, Portugal; Hamburg University of Technology (TUHH), Germany; University of Kuopio, Finland; Yonsei University, South Korea; Swiss Federal Institute of Environmental Science and Technology (EAWAG), Switzerland; Central Building Research Institute (CBRI)/CSIR, India. He has published 170 research/review articles in peer-reviewed journals so far and few book chapters. His current H-index is 53 (Google Scholar) with over 12,000 citations. He is serving as an *Associate Editor* for *Critical Reviews in Environmental Science and Technology*, and included in the Editorial Board of *Nature Scientific Reports* and *PLOS ONE* journals. He has also served as special issue guest editor for Journal of Hazardous Materials and Bioresource Technology. He has been identified as one of the **2018 Highly Cited Researchers** from *Clarivate Analytics (Web of Science)*.

8KEN-23 | **September 8 (Tuesday) 15:50-16:20** >> **ROOM 1**

- Session: Environment

Binoy SARKAR | Lancaster University, UK

Title | Designing Clay Minerals for Sustainable Remediation of Per- and Polyfluoroalkyl Contaminants in the Environment

Prior to commencing at Lancaster University, Dr Binoy SARKAR was a Research Associate at the Leverhulme Centre for Climate Change Mitigation, University of Sheffield (2017 – 2019). He also worked at the Future Industries Institute, University of South Australia, as a Research Associate and then Research Fellow (2011 – 2016). He was an honorary Adjunct Research Fellow of University of South Australia during 2016 – 2019.

Dr Binoy SARKAR was awarded the Australian Government sponsored Endeavour Research Fellowship to visit and conduct research at Indiana University, Bloomington, USA (2016). He is also a recipient of the Geof Proudfoot Award from the Australasian Soil and Plant Analysis Council, and Desai-Biswas Medal from ICAR-Indian Agricultural Research Institute.

8KBR-24 | September 8 (Tuesday) 15:20-15:50 >> ROOM 2

- Session: Bioresources

Akash DEEP | Nanoscience and Nanotechnology Lab, India

Title | Metal-Organic Frameworks (MOF) for Electrochemical and Optical Sensing of Bacteria

Dr. Akash Deep is working as a Senior Scientist at the Nanoscience and Nanotechnology lab (H-1) of CSIR-Central Scientific Instruments Organisation (CSIR-CSIO), Chandigarh. He has more than 20 years of research experience in the areas of material science and analytical chemistry. His current areas of research include advanced functional materials (graphene, 2-D dichalcogenides, MOFs, conducting polymers), molecular sensors, energy harvesting and storage systems, and environmental sciences. He has published more than 150 research papers in international journals and also transferred technologies to industrial partners. He has so far guided 8 Ph.D students, while 8 more are pursuing their experimental work. Dr. Akash Deep has also been awarded with CSIR India's Raman Research Fellowship. He has active collaboration with a number of universities and research labs.

8KEN-25 | **September 8 (Tuesday) 16:55-17:25** >> **ROOM 1**

- Session: Environment

Longbin HUANG | The University of Queensland, Australia

Title | Challenges in Translational Research from Concepts of Proof to Innovative Environmental Technologies: System Complexity, Critical Barriers, and Adaptive Research Methodology

Longbin Huang is currently a full professor and the Program Leader of Ecological Engineering of Mine Wastes, in Sustainable Minerals Institute (SMI), University of Queensland, Brisbane, Australia. Prof Huang has been leading many large industry projects (worth > $15 million) directly/jointly funded by governments and large mining and minerals companies, to develop game-changing technologies for cost-effective and sustainable tailings rehabilitation. From research background in soil-plant relations and plant environmental physiology, Prof Huang has been focusing on developing new technologies of ecological engineering of mine wastes, for rehabilitating ferrous and base metal mine tailings (e.g., magnetite tailings, bauxite residues (or red mud), Cu/Pb-Zn tailings). His translational research achievements were recognized in the 2019 UQ's Partners in Research Excellence Award in the "Resilient Environments" (together with Rio Tinto and Queensland Alumina Ltd). He also serves as Section/Coordination editors for Plant and Soil, and Environmental Geochemistry and Health. Longbin graduated with Bachelor's Degrees in Agronomy (with Soil Science & Plant Physiology double major) and Computer Studies, and a PhD in Plant Environmental Physiology.

8KEN-26 | **September 8 (Tuesday) 16:55-17:25** >> **ROOM 2**

- Session: Environment

Siming YOU | University of Glasgow, UK

Title | Distributed Waste-to-Resource Development in Glasgow

Dr. Siming You is a lecturer in the James Watt School of Engineering of Glasgow University. Before joining the School, he worked as a Research Fellow at NUS (National University of Singapore) Environmental Research Institute. He also served as a Postdoctoral Fellow at Nanyang Technological University and the Massachusetts Institute of Technology in 2014 and 2015, respectively. Dr. You received his Ph.D. in Thermo-fluids from Nanyang Technological University in 2014. He has an area of expertise in the design and analysis of waste management and waste-to-resource generation, and the valorization of waste-derived products like biochar and hydrogen. Dr. You was awarded the Outstanding Young Researcher Award by the American Institute of Chemical Engineering, Singapore Local Section in 2018. He serves as a guest editor for various special issues in prestigious journals including "Waste-to-Hydrogen and Related Technologies", 2019 in Applied Energy, "Waste Lignin to Resources", 2019 in Bioresource Technology, and "Sustainable Energy Technologies for Energy Saving and Carbon Emission Reduction", 2017 in Applied Energy. He also sits in the Editorial Board of a leading journal on waste management - Journal of Hazardous Materials (IF=7.650).

BEEM 2020 | 4th International Conference on Bioresources, Energy, Environment, and Materials Technology

Special Sessions

*Special Sessions - September 8, 2020 (Tuesday)

Special Session 1- Mitigation and Adaptation for Climate Change and Particulate Matter / ROOM 4

Time	Title
	Session Organizer: Eui-chan JEON, Hyun-Han KWON (Sejong University, Korea)
10:00-10:15	**[8SS1-01]** Development of Estimation Method of Consumption-Based National GHG Emissions *Han-Sae KIM, Eui-Chan JEON* (Sejong University, Korea)*
10:15-10:30	**[8SS1-02]** Characteristic of Ammonia Emission from the Open Poultry House System *Seongmin KANG, Joonyoung, ROH, Eui-Chan JEON* (Sejong University, Korea)*
10:30-10:45	**[8SS1-03]** The Procedural Rationality of the Korean Policy on Fine Particulate Matter *Sang-Hyeon JIN* (Kyungpook National University, Korea)*
10:45-11:00	**[8SS1-04]** Improvement of Estimation Method for National Ammonia Inventory and Assessment of Mitigation Technologies *Gayoung YOO[1]*, Min Seop JEONG[1], Wanseop JUNG[1], Jeong-hun WOO[2] ([1]Kyung Hee University, [2]Konkuk University, Korea)*
11:00-11:15	**[8SS1-05]** Exploring Flash Drought and Its Relation to Atmospheric Circulation *S.S.K.CHANDRASEKARA, Hojun KIM, Hyun-Han KWON* (Sejong University, Korea)*
11:15-11:30	**[8SS1-06]** Drought Early Warning System and Its Application with Groundwater Data-based Drought Index *Jeong-Ju LEE[1], Shin-Uk KANG[1], Gun-Il CHUN[1], Hyun-Han KWON[2]* ([1]K-water, [2]Sejong University, Korea)*

Special Session 2-Special Session: Air Quality, Health, and Climate Change (Invited only) / ROOM 4

Time	Title
	Co-Sponsored by Prof Jinkyu Hong (Yonsei University) and Prof. Eri Saikawa (Emory University)
15:20-16:35	Place to be announced for invitees

BEEM 2020 | 4th International Conference on Bioresources, Energy, Environment, and Materials Technology

Oral Sessions

*Oral Sessions - Day 1 (September 6, 2020, Sunday)

[Environment / Room 1]

Time	Title
15:00-15:30	**[6KEN-01]** Preparation of Aromatic Compounds by Catalytic Hydrogenation of Lignin in Biphasic System *Cheng ZHANG[1], Hongfei LIN[2]*, Shicheng ZHANG[1,3]* ([1]Fudan University, China, [2]Washington State University, USA, [3]Shanghai Institute of Pollution Control and Ecological Security, China)*
15:30-16:00	**[6KEN-02]** The Role of Renewable Energy in Global Transformation for a Sustainable Energy Future *Keat Teong LEE* (Universiti Sains Malaysia, Malaysia)*
16:00-16:15	**[6OEN-01]** Abundant Biogenic Oxygenated Organic Aerosol in Atmospheric Coarse Particles: Plausible Sources and Atmospheric Implications *Qiao ZHU[1,2]* ([1]Peking University Shenzhen Graduate School, China, [2]Emory University, USA)*

[Environment / Room 1]

Time	Title
16:35-17:05	**[6KEN-05]** Oil Field Contamination and Remediation in Mongolia *Buyan CHULUUN[1]*, Ninjbadgar BATKHUYAG[1], Saranzaya BATTSENGEL[1], Sodtsetseg ENKHTAIVAN[1], Galdmaa DAVAAJAV[1], Urantulkhuur BATTUMUR[2], Seong Pil JEONG[3] ([1]National University of Mongolia, Mongolia, [2]Mongolian University of Life Sciences, Mongolia, [3]Korea Institute of Science and Technology (KIST), Korea)*
17:05-17:35	**[6KEN-06]** Mechanical, Durability and X-ray Micro-computed Tomography Investigation of Biochar-admixtured Cement-mortars *Sai PRANEETH, Ajit K. SARMAH* (The University of Auckland, New Zealand)*
17:35-17:50	**[6OEN-08]** Community-Engaged Assessment of Soil Heavy Metal and Metalloid Contamination in Atlanta *Samuel J. W. PETERS[1], Wanyi YANG[1], Gil FNK[2], Priya D'SOUZA[1], Dana BARR[1], P. Barry RYAN[1], Tim FREDERICK[3], Sydney CHAN[3], Rosario HERNANDEZ[2], Taranji ALVARADO[2], Arthur HINES[2], Chris THEAL[2], Eri SAIKAWA[1]* ([1]Emory University, [2]Historic Westside Gardens Atlanta, [3]Environmental Protection Agency, USA)*

[Environment / Room 2]

Time	Title
15:00-15:30	**[6KEN-03]** Microwave Vacuum Pyrolysis Conversion of Biomass Waste into Cleaner Biofuel, Bioplastic Feedstock and Value-added Carbon *Su Shiung LAM[1]*, Shin Ying FOONG[1], Peter Nai Yuh YEK[2], Wan Adibah WAN MAHARI[1], Wanxi PENG[3], Christian SONNE[4] ([1]Universiti Malaysia Terengganu, Malaysia, [2]University College of Technology Sarawak, Sarawak, [3]Henan Agricultural University, China, [4]Aarhus University, Denmark)*
15:30-16:00	**[6KEN-04]** The 2019 Report of The Lancet Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today is not Defined by a Changing Climate *Meisam TABATABAEI* (Universiti Teknologi MARA (UiTM), Malaysia)*
16:00-16:15	**[6OEN-02]** Characterization and Biogas Production Potentials of Aqueous Phase Produced from Hydrothermal Carbonization of Biomass - Major Components and their Binary Mixtures *Muhammad USMAN[1], Gang LUO[1,2]*, Shicheng ZHANG[1,2]* ([1]Fudan University, [2]Shanghai Institute of Pollution Control and Ecological Security, China)*

[Bioresources / Room 2]

Time	Title
16:35-17:05	**[6KBR-07]** Recent Developments of Biomass Catalytic Fast Pyrolysis: Strategies for the Optimization of Bio-oil Quality and Yield *Haiping YANG*, Xu CHEN, Qingfeng CHE, Shujuan LI, Zihao LIU, Yingquan CHEN, Xianhua WANG, Jingai SHAO and Hanping CHEN (Huazhong University of Science and Technology, China)*
17:05-17:35	**[6KBR-08]** Effective Dispersion of MgO Nanostructure on Biochar Support for Glucose Isomerization *Daniel C.W. TSANG* (The Hong Kong Polytechnic University, Hong Kong, China)*
17:35-17:50	**[6OBR-09]** Investigate the Effect of GAC on Anaerobic Digestion of Waste Water from Hydrothermal Liquefaction of Biomass *Muhammad USMAN[1], Gang LUO[1,2*], Shicheng ZHANG[1,2]* ([1]Fudan University, [2]Shanghai Institute of Pollution Control and Ecological Security, China)*

[Environment / Room 3]

Time	Title
15:00-15:15	**[6OEN-03]** Graphene Quantum Dots Decorated BiS Nano-flowers for Improved Photoelectrocatalytic Water Treatment *Aima Sameen ANJUM[1], Mumtaz ALI[1], Muhammad ZEESHAN[2], Rabia RIAZ[1], Kyung Chul SUN[1]*, Sung Hoon JEONG[1]* ([1]Hanyang University, Korea, [2]National Textile University, Pakistan)*
15:15-15:30	**[6OEN-04]** Catalytic Pyrolysis of Fishing Net Waste using a CO_2 as a Reaction Medium *Dongho CHOI, Sungyup JUNG, Eilhann E. KWON* (Sejong University, Korea)*
15:30-15:45	**[6OEN-05]** CO_2-Cofeeding Pyrolysis of Pine Sawdust with Utilization of Steel Slag as a Catalyst *Sangyoon LEE, Dohee KWON, Eilhann E. KWON* (Sejong University, Korea)*
15:45-16:00	**[6OEN-06]** Relation Formula(R2) between Energy Efficiency Method(R1) and GHG Mitigation at Korean MSW to Energy Facility. *Hyeok Young KWON, Jae Young, KIM* (Seoul National University, Korea)*
16:00-16:15	**[6OEN-07]** Estimation of Ammonia Emission During Growing Seasons of Perilla in Plastic House *Sae-Nun SONG, Sung-Chang HONG*, Seon-Young YU, Gyu-Hyun LEE, Kyeong-Sik KIM (National Institute of Agricultural Sciences, Korea)*

[Environment / Room 3]

Time	Title
16:35-16:50	**[6OEN-10]** Structural Variations and Generation of Binding Sites in Fe-loaded ZSM-5 and Silica under the Effect of UV-irradiation and their Role in Enhanced BTEX Abatement from Gas Streams *Nishesh Kumar GUPTA[1,2], Suho KIM[1,2], Kwang Soo KIM[1,2]* ([1]University of Science and Technology (UST), [2]Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*
16:50-17:05	**[6OEN-11]** Reversible and Irreversible Foulings Associated with Membrane Photobioreactor for Wastewater Treatment *Jungmin KIM, Sengbin OH, and Hyun-woo KIM* (Jeonbuk National University, Korea)*
17:05-17:20	**[6OEN-12]** Characterization of Submicron Aerosols over the Yellow Sea Measured Onboard the Gisang 1 Research Vessel in Spring 2018 and 2019 *Minsu PARK[1]*, Seong Soo YUM[1], Minju JEONG[1], Najin KIM[2], Sang-Boom RYOO[3], Sang-Sam LEE[3] ([1]Yonsei University, Korea, [2]Max Planck Institute for Chemistry, Germany, [3]National Institute of Meteorological Sciences, Korea)*
17:20-17:35	**[6OEN-13]** Evaluating the Role of Ballast Surface Charge for Floc Development in Ballasted Flocculation *Muhammad QASIM, Seongjun PARK, Jong-Oh KIM* (Hanyang University, Korea)*

*Oral Sessions - Day 2 (September 7, 2020, Monday)

[Plenary Lecture / Room 1]

Time	Title
09:30-10:10	**[7PL-1]** Role of Waste to Energy (WtE) in Waste Management with Reviewing Korean Practices and Recent Activities *Yong-Chil SEO* (Yonsei University, Korea)*

[Environment / Room 1]

Time	Title
10:30-11:00	**[7KEN-09]** Can Biochar's be a Solution to Remediate Contaminated Paddy Soils? *Jörg RINKLEBE * (University of Wuppertal, Germany)*
11:00-11:30	**[7KEN-10]** Fate of (E)- and (Z)-Endoxifen in Water and Secondary Treated Wastewater under Sunlight *Marina Ariño MARTIN[1,2], Jayaraman SIVAGURU[3], John MCEVOY[1], Prinpida SONTHIPHAND[4], Eakalak KHAN[5]* ([1]North Dakota State University, USA, [2]Chulalongkorn University, Thailand, [3]Bowling Green State University, USA, [4]Mahidol University, Thailand, [5]University of Nevada, USA)*
11:30-11:45	**[7OEN-01]** Responses of Fine Particulate Matter and Ozone to Local Emission Reductions in the Sichuan Basin, Southwestern China *Xue QIAO[1,2], Lu LIU[1], Chun YANG[1], Yanping YUAN[1], Mengyuan ZHANG[3], Hao GUO[2], Ya TANG[1], Qi YING[4], Shengqiang ZHU[3], Hongliang ZHANG[2,3,5]* ([1]Sichuan University, China, [2]Louisiana State University, USA, [3]Fudan University, China, [4]Texas A&M University, USA, [5]Institute of Eco-Chongming (SIEC), China)*
11:45-12:00	**[7OEN-02]** Convergence of Submerged Membrane Filtration and Cold Plasma for Enhanced Livestock Excreta Treatment *Hyeonmin AN, Jae-Cheol LEE, Sojeong CHEON, and Hyun-Woo KIM* (Jeonbuk National University, Korea)*

[Plenary Lecture / Room 1]

Time	Title
14:20-15:00	**[7PL-2]** In Search of Practical Options for the Treatment of Gaseous Indoor Air Pollutants: Adsorption and Catalysis –based Techniques *Ki-Hyun KIM* (Hanyang University, Korea)*

[Bioresources / Room 1]

Time	Title
15:20-15:50	**[7KBR-12]** Responses of Plant and Soil to Iron-Modified Biochar in a Paddy Soil Contaminated with Heavy Metals *Ergang WEN[1,2], Xing YANG[1,3], Hanbo CHEN[1,4], Hailong WANG[1,2]* ([1]Foshan University, China [2]Zhejiang A&F University, China, [3]University of Wuppertal, Germany, [4]Shenyang Agricultural University, China)*
15:50-16:20	**[7KBR-13]** Utilization of Biochar in Catalytic Applications *Naomi B. KLINGHOFFER* (Western University, Canada)*
16:20-16:35	**[7OBR-19]** Process Development for Large-scale Biochar Production by Integration of Pyrolysis and Large Combustion Plant *Seunghan YU[1], Minsu KIM[1,2], Heeyoon KIM[1], Changkook RYU[1]* ([1]Sungkyunkwan University, [2]Korea Institute of Machinery & Materials(KIMM), Korea)*

[Energy / Room 1]

Time	Title
16:55-17:25	**[7KEG-15]** Assessing Global Water Sustainability in the Recovery of Unconventional Oil and Gas Resources *Daniel S. ALESSI*, Ashkan ZOLFAGHARI (University of Alberta, Canada)*
17:25-17:55	**[7OEG-33]** Constructing Highly Porous Graphitic Carbon Nitride for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction *Maliheh RAZAVI, Tahereh MAHVELATI-SHAMSABADI, Hossein FATTAHIMOGHADDAM, Byeong-Kyu LEE* (University of Ulsan, Korea)*
17:55-18:10	**[7OEG-34]** Slow-release Fe^{II} and Persulfate Candle-assisted Oxidation of Acenaphthene: Effect of Anions and Hydroxylamine *Ardie SEPTIAN, Won Sik SHIN* (Kyungpook National University, Korea)*

[Bioresources / Room 2]

Time	Title
10:30-11:00	**[7KBR-11]** Coupled Sulfur and Iron (II) Carbonate-driven Autotrophic Denitrification Nitrogen Removal *Aijie WANG*, Haoyi CHENG, Tingting ZHU, Yilu SUN (Chinese Academy of Sciences, China)*
11:00-11:15	**[7OBR-03]** Efficient Production of 2-methyltetrahydrofuran and 1,4-pentanediol from Biomass-derived Levulinic Acid *Shinje LEE, Wangyun WON* (Kyung Hee University, Korea)*
11:15-11:30	**[7OBR-04]** The Role of Biochar in Alleviating Soil Drought Stress in Urban Roadside Greenery *You Jin KIM, Junge HYUN, Hanmin CHOI, Gayoung YOO* (Kyung Hee University, Korea)*
11:30-11:45	**[7OBR-05]** Biomass Waste Valorization to Generate Modified Biochar to Recover Phosphorus from Animal Manure Wastewater *Tao ZHANG* (China Agricultural University, China)*
11:45-12:00	**[7OBR-06]** Magnetic Ball-milled FeS@Biochar as Persulfate Activator for Degradation of Tetracycline *Jingchun TANG*, Juan HE (Nankai University, China)*

[Energy / Room 2]

Time	Title
15:20-15:50	**[7KEG-14]** Advances in Biofuel Production from Microalgal Biomass *Wei-Hsin CHEN* (National Cheng Kung University, Taiwan)*
15:50-16:05	**[7OEG-20]** Biodiesel Production of Waste Cooking Oil by via Non-Catalytic Transesterification using Swine Manure Biochar *Minyoung KIM, Sungyup JUNG, Taewoo LEE, Eilhann E. KWON* (Sejong University, Korea)*
16:05-16:20	**[7OEG-21]** Effects of Pyrolysis Syngas Injection onto Methane Yield from Anaerobic Digestion Process *Jongkeun LEE, Youngho PARK, Ki Young PARK* (Konkuk University, Korea)*
16:20-16:35	**[7OEG-22]** Production of Hydrogen and Carbon Black by Photocatalytic Decomposition of Benzene Using Liquid Plasma *Kyong-Hwan CHUNG, Sang-Chul JUNG* (Sunchon National University, Korea)*

[Bioresources / Room 2]

Time	Title
16:55-17:25	**[7KBR-16]** Mineralization and Nutrient Releasing of Biochar Compound Fertilizer in a Highly Weathering Soil *Cheng-Han XIE, Shih-Hao JIEN* (National Pingtung University of Science and Technology, Taiwan)*
17:25-17:40	**[7OBR-35]** Life Cycle Greenhouse Gas, Energy and Economic Analysis of an Advanced Sulfidogenic Oxic-settling Anaerobic (SOSA) Process for Wastewater Treatment with in-situ Sludge Reduction *Di WU*, Xiaoming LIU, Guang-Hao CHEN (Hong Kong University of Science and Technology, Hong Kong, China)*
17:40-17:55	**[7OBR-36]** Effect of Forced Ventilation Using a Three-Layer Pipeline during Sewage Sludge High Pile Composting *Guodi ZHENG[1, 2]*, Tongbin CHEN[1, 2] ([1]Institute of Geographic Sciences and Natural Resources Research, [2]University of Chinese Academy of Sciences, China)*
17:55-18:10	**[7OBR-37]** Cocoa Pod Husk Waste as a Potential Bioresource for Preparation of Value-added Biomaterials. An Approach to Pectin Extraction *Bryan M. CÓRDOVA[1]*, Ronny G. HUAMANI-PALOMINO[1], Tiago VENÂNCIO[2], Glenda SANTOS[2], Raquel MEDINA[1], Pedro RAMOS M[1] ([1]National University of Engineering, Peru, [2]Universidade Federal de São Carlos, Brazil)*

[Materials Technology / Energy / Room 3]

Time	Title
10:30-10:45	**[7OMT-07]** Evaluation of Thermal Performance of PCM Based Electrically Conductive Heat Storage Concrete using Biochar *Young Uk KIM, Seunghwan WI, Sumin KIM* (Yonsei University, Korea)*
10:45-11:00	**[7OMT-08]** Oxidation of Oxytetracycline by Oxygen-doped Graphitic Carbon Nitride and Peroxymonosulfate *Do Gun KIM, Nguyen Thanh TUAN, Seok Oh KO* (Kyung Hee University, Korea)*
11:00-11:15	**[7OMT-09]** Enhanced Acetaminophen Degradation by Fe and N Co-doped Multi-walled Carbon Nanotubes *Do Gun KIM, Tae Hoon KIM, Seok Oh KO* (Kyung Hee University, Korea)*
11:15-11:30	**[7OMT-10]** Exceptionally Porous g-C_3N_4 Nanosheets for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction *Hossein FATTAHIMOGHADDAM, Tahereh MAHVELATI-SHAMSABADI, Byeong-Kyu LEE* (University of Ulsan, Korea)*
11:30-11:45	**[7OEG-11]** W Doped α-Fe_2O_3 Heterojunction with MoS_2 Nanosheet for Improving Photoelectrochemical Performance *Zohreh MASOUMI, Meysam TAYEBI, Byeong-Kyu LEE* (University of Ulsan, Korea)*
11:45-12:00	**[7OMT-12]** Synthesis of Cosmetic Grade TiO_2-SiO_2 and TiO_2-stearic Acid Core-shell Powder Comparison with Commonly used TiO_2 *Jay Ryang PARK[1,2], Kyung Soo PARK[1], Chan Gi LEE[1], Basudev SWAIN[1,]* ([1]Institute for Advanced Engineering (IAE), [2]Ajou University, Korea)*

[Environment / Room 3]

Time	Title
15:20-15:35	**[7OEN-23]** Effect of Residual Antibiotics on Biodiesel Yield of Microalgae Treating Livestock Excreta *Sangjun JEONG, Sol YANG, Sooyoung SUNG, Soyeon PARK, Gerardo Oswaldo ORTIZ VANEGAS, and Hyun-Woo KIM* (Jeonbuk National University, Korea)*
15:35-15:50	**[7OEN-24]** Citrus Pressed Cake Drying Technology *Jae Hee LEE[1]*, Jang Wook CHOI[1], Yong Hwan JUNG[2], Jong Chul LEE[2] ([1]GAIA Corporation, [2]Biodiversity Research Institute, Korea)*
15:50-16:05	**[7OEN-25]** Occurrence of Microplastics in South Korea: A Review *Kimberly Ann YANO, Nash Jett REYES, Lee Hyung KIM* (Kongju National University, Korea)*
16:05-16:20	**[7OEN-26]** The Occurrence of Pharmaceuticals and Personal Care Products in Different Environmental Media: A Review *Nash Jett DG. REYES, Franz Kevin F. GERONIMO, Hyeseon CHOI, Minsu JEON, Lee-Hyung KIM* (Kongju National University, Korea)*
16:20-16:35	**[7OEN-27]** Melting Slag Formation for the Recycling of Automobile Shredder Residues *Heung-Min YOO[1], Yong-Chil SEO[2], Ha-Na JANG[2]* ([1]Wonju Regional Environmental Office, [2]Yonsei University, Korea)*

[Environment / Room 3]

Time	Title
16:55-17:10	**[7OEN-38]** Experimental Parametric Studies and Effect of Water Matrix on Photocatalytic Degradation of Organic Wastewater using Fe-TiO_2 Nanotubes: Towards Commercial Application *Rida FATIMA, Zulakha ZAFAR, Jong-Oh KIM* (Hanyang University, Korea)*
17:10-17:25	**[7OEN-39]** Sustainable Biopolymers Production Using Red Algae Derived Volatile Fatty Acids: Closed Loop Approach *Naresh Kumar AMRADI, Alice MUHORAKEYE, Ju-Hyeong JUNG, Young-Bo SIM, Sang-Hyoun KIM* (Yonsei University, Korea)*
17:25-17:40	**[7OEN-40]** The Enhanced Pyrolysis of Crude Oil Sludge Using CO_2 as Reactive Gas Medium *Jung-Hun KIM, Eilhann E. KWON* (Sejong University, Korea)*
17:40-17:55	**[7OEN-41]** Electrochemical Oxidation of Contaminants using Graphite Electrode in Flow-through System *Jong-Gook KIM, Kitae BAEK* (Jeonbuk National University, Korea)*
17:55-18:10	**[7OEN-42]** Simultaneous TOC-TN-TP Oxidation using Base Activation and Improvement of Oxidation Efficiency *Dong-Hun SHIN, Jong-Gook KiIM, Kitae BAEK* (Jeonbuk National University, Korea)*

[Environment / Room 4]

Time	Title
10:30-10:45	**[7OEN-13]** Biofouling Mitigation by Modified Polypropylene Feed Spacer using Polydopamine-vanillin *Chansoo PARK, Hyunseo SHIN, Jong-Oh KIM* (Hanyang University, Korea)*
10:45-11:00	**[7OEN-14]** Shaping Reactor Microbiome to Optimize Caproate Productivity : Application of Design-Build-Test-Learn Framework *Byung-Chul KIM, Changyu MOON, Yongju CHOI, Kyoungphile NAM* (Seoul National University, Korea)*
11:00-11:15	**[7OEN-15]** Colloidal Activated Carbon as Highly Efficient Bifunctional Catalyst: Implications in Activation of Persulfate for Phenol Degradation *Alam Venugopal Narendra KUMAR, Jiyeon CHOI, Ardie SEPTIAN, Annamalai SIVASANKAR, Won Sik SHIN* (Kyungpook National University, Korea)*
11:15-11:30	**[7OEN-16]** Implication of Microbial Community to the Overall Performance of Tree-box Filter Treating Parking Lot Runoff *Franz Kevin GERONIMO, Hyeseon CHOI, Minsu JEON, Nash Jett REYES, Yookyung LEE, Kimberly Ann YANO, Lee-Hyung KIM* (Kongju National University, Korea)*
11:30-11:45	**[7OEN-17]** Understanding the Difference in Performance between High and Low Infiltration Systems for Urban Stormwater Runoff Management *Heidi B. GUERRA, Youngchul KIM* (Hanseo University, Korea)*
11:45-12:00	**[7OEN-18]** Synergetic Collaboration of Graphitic Carbon Nitride With an Insulator for Enhanced Visible-light Photocatalytic Activity *Milad JOURSHABANI, Byeong-Kyu LEE* (University of Ulsan, Korea)*

[Materials Technology / Room 4]

Time	Title
15:20-15:35	**[7OMT-28]** Robust Photocatalytic Degradation of Organic Pollutants by MFe_2O_4 Nanoparticles *Nishesh Kumar GUPTA[1,2], Yasaman GHAFFARI[1,2], Kwang Soo KIM[1,2]* ([1]University of Science and Technology (UST), [2]Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*
15:35-15:50	**[7OMT-29]** A New 3D Hierarchical Bi_3O_4Cl/Bi_5O_7I Heterojunction and Its Photocatalytic Degradation Performance over Rhodamine-B and Bisphenol-A *Syed Taj Ud DIN, Woonchul SEO, Changchang MA, Woochul YANG* (Dongguk University, Korea)*
15:50-16:05	**[7OMT-30]** Tailoring Heterojunction Architecture on IrO_2 Based Dimensionally Stable Anodes for Environmental Applications *Evandi RAHMAN[1], Jieun SHIN[2], Kangwoo CHO[3]*, Seok Won HONG[1] ([1]Korea Institute of Science and Technology, Korea, [2]California Institute of Technology, USA, [3]Pohang University of Science and Technology (POSTECH), Korea)*
16:05-16:20	**[7OMT-31]** Gradient N-doped Structure of Carbon Quantum Dots as Metal-free Photo-electrocatalyst for Improved Charge Channeling and Associated Water Treatment *Mumtaz ALI[1], Aima Sameen ANJUM[1], Hassan ANWER[2], Rabia RIAZ[1], Sung Hoon JEONG[1]*, Kyung Chul SUN[1]* ([1]Hanyang University, Korea, [2]National Textile University, Pakistan)*
16:20-16:35	**[7OMT-32]** Exfoliated Magnetic Ti_2AlC Heterostructures Using a Green One-step Hydrothermal Synthesis Process and Their Applications in Radionuclide Sequestration *Asif SHAHZAD, Mokrema MOZTAHIDA, Khurram TAHIR, Bolam KIM, Ahsan Abdul GHANI, Nagesh MAILE, Hyeji JEON, Dae Sung LEE* (Kyungpook National University, Korea)*

[Environment / Room 4]

Time	Title
16:55-17:10	**[7OEN-43]** Visible Light Photocatalytic Degradation of Thiabendazole with Porous Organic Polymers (POP): Effect of Reaction Conditions *Alireza RANJBARI[1,2], Kristof DEMEESTERE[2], Francis VERPOORT[1,3], Philippe M. HEYNDERICKX[1,2]* ([1]Ghent University Global Campus, Korea, [2]Ghent University, Belgium, [3]Wuhan University of Technology, China)*
17:10-17:25	**[7OEN-44]** Removal of Nitrate from Groundwater through Reduction and Adsorption Using Modified Biochar with Zero-valent Iron *Eun-Yeong HAN, Dong-Hun SHIN, Hye-Bin KIM, Jong-Gook KIM, Kitae BAEK* (Jeonbuk National University, Korea)*
17:25-17:40	**[7OEN-45]** Application of Co_9S_8 Impregnated Porous Carbon Mmaterial Fabricated from Pyrolysis of Lignin-Co Composite *Gihoon KWON, Kwangsuk YOON, Hocheol SONG* (Sejong University, Korea)*
17:40-17:55	**[7OEN-46]** The Effects of *Spartina Anglica* Invasion on Depth Profiles of Methane Production and Soil Microbial Community *Jinhyun KIM[1], Hanbyul LEE[2], Jae-Jin KIM[2], Hojeong KANG[1]* ([1]Yonsei University, [2]Korea University, Korea)*
17:55-18:10	**[7OEN-47]** Treatment of Cesium-Contaminated Soil through Extraction – Selective Adsorption Process *Taesun KIM, Hye-Bin KIM, Jin PARK, Sumin LEE, Kitae BAEK* (Jeonbuk National University, Korea)*

*Oral Sessions - Day 3 (September 8, 2020, Tuesday)

[Plenary Lecture / Room 1]

Time	Title
09:00-09:40	**[8PL-3]** New Dimensions of Porous Coordination Polymers/Metal-Organic Frameworks *Susumu KITAGAWA* (Kyoto University, Japan)*

[Environment / Room 1]

Time	Title
10:00-10:30	**[8KEN-17]** Effect of Microplastics on the Removal of Pollutants from Aqueous Medium by using Carbon Materials *Wei ZHANG, Peihuan HUANG, Xiang GU, Qiting ZUO* (Zhengzhou University, China)*
10:30-11:00	**[8KEN-18]** Geochemical Distribution of Gallium, Indium, and Thallium and Their Availability in Highly Weathered Soils *Zeng-Yei HSEU*, Yu-Hsi LIU (National Taiwan University, Taiwan)*
11:00-11:30	**[8KEN-19]** A Review of the Health Impacts of WTE Facilities *Marco J. CASTALDI* (The City College of New York, City University of New York, USA)*
11:30-11:45	**[8OEN-01]** A Facial and Novel Synthesis of Fe_2O_3/Mn_2O_3 Nanocomposite for a Fast Degradation of Organic Pollutants *Yasaman GHAFFARI[1,2], Nishesh Kumar GUPTA[1,2], Jiyeol BAE[2], Kwang Soo KIM[1,2]* ([1]University of Science and Technology (UST), [2]Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*

[Plenary Lecture / Room 1]

Time	Title
14:20-15:00	**[8PL-4]** Emergent Materials for Energy, Environment and Health *Tejraj M. AMINABHAVI* (Rajiv Gandhi Health Science University, India)*

[Environment / Room 1]

Time	Title
15:20-15:50	**[8KEN-22]** Microalgae-based Wastewater Treatment and Resource Recovery – A Synergistic Approach *Amit BHATNAGAR* (LUT University, Finland)*
15:50-16:20	**[8KEN-23]** Designing Clay Minerals for Sustainable Remediation of Per- and Polyfluoroalkyl Contaminants in the Environment *Binoy SARKAR[1]*, Raj MUKHOPADHYAY[2], Jaffer YOUSUF[2], Nanthi BOLAN[3] ([1]Lancaster University, UK, [2]ICAR-Central Soil Salinity Research Institute, India, [3]The University of Newcastle, Australia)*
16:20-16:35	**[8OEN-15]** Wastewater Treatment Plants as Sources of Microfibres and Microplastics to Environment: Detection and Treatment *Muhammad Tariq KHAN, Yan Laam CHENG, Yuguang WANG, Yiu Fai TSANG* (The Education University of Hong Kong, Hong Kong, China)*

[Environment / Room 1]

Time	Title
16:55-17:25	**[8KEN-25]** Challenges in Translational Research from Concepts of Proof to Innovative Environmental Technologies: System Complexity, Critical Barriers, and Adaptive Research Methodology *Longbin HUANG* (The University of Queensland, Australia)*
17:25-17:40	**[8OEN-24]** Adsorptive Removal of Ammonium and Sulfonamides Antibiotics from Livestock Burial Leachate using Low-grade Charcoal and Zeolite *Jung-yeol JO, Kitae BAEK* (Jeonbuk National University, Korea)*
17:40-17:55	**[8OEN-25]** Soil Trace Gas Fluxes in Living Mulch and Conventional Agricultural Systems *Samuel J. W. PETERS[1], Eri SAIKAWA[1]*, Daniel MARKEWITZ[2], Lori SUTTER[2], Alexander AVRAMOV[1], Zachary P. SANDERS[2], Benjamin YOSEN[1], Ken WAKABAYASHI[1], Geoffrey MARTIN[1], Joshua S. ANDREWS[2], Nicholas S. HILL[2] ([1]Emory University, [2]University of Georgia, USA)*
17:55-18:10	**[8OEN-26]** Emerging Endocrine Disrupting Chemicals: A Challenge to Children's Health in Hong Kong *Ziying LI, Yu Bon MAN, Rudolf Shiu Sun WU, Yiu Fai TSANG* (The Education University of Hong Kong, Hong Kong, China)*

[Materials Technology / Room 2]

Time	Title
10:00-10:30	**[8KMT-20]** Conversion of Biochar to Solid Acids with Sulfonate Groups for Spiramycin Hydrolysis: Insights into the Sulfonation Reaction and the Aromatic Properties of the Feedstock *Qianqian XIE[1], Xiaomin DOU[1]*, Yongsik OK[2], Zhen CHEN[1] ([1]Beijing Forestry University, China, [2]Korea University, Korea)*
10:30-11:00	**[8KMT-21]** Utilization of Nanocomposites for Management of Water Contaminants *Sandeep KUMAR[1]*, Monika NEHRA[1], Jyotsana MEHTA[1], Neeraj DILBAGHI[2], Ki-Hyun KIM[2] ([1]Guru Jambheshwar University of Science and Technology, India, [2]Hanyang University, Korea)*
11:00-11:15	**[8OMT-03]** Engineering the Photocatalytic Behaviours of g/C_3N_4-based Metal-free Materials for Degradation of a Representative Antibiotic *Jun LIU[1], Yanchun DENG[2], Xiaomin DOU[2], Zhijie WANG[1]*, Shengchun QU[1], Zhanguo WANG[1] ([1]Institute of Semiconductors, Chinese Academy of Sciences, [2]Beijing Forestry University, China)*
11:15-11:30	**[8OMT-04]** Zinc Zeolitic Imidazolate Frameworks as Base Catalysts: Tuning Catalytic Properties via Variation of Basicity and Crystal Size *Maria N. TIMOFEEVA[1]*, Valentina N. PANCHENKO[1], Ivan A. LUKOYUNOV[1], Sung Hwa JHUNG[2] ([1]Institute of Catalysis SB RAS, Russia, [2]Kyungpook National University, Korea)*
11:30-11:45	**[8OMT-05]** Sulfate Radical-induced Degradation of Naproxen with Nanosized Magnetic $CoFe_2O_4$@Mxene as a Heterogeneous Catalyst of Persulfate *Aqsa FAYYAZ, Yejin KIM, Kristy TALUKDAR, S.SD. ELANCHEZHIAYN, Chang Min PARK* (Kyungpook National University, Korea)*
11:45-12:00	**[8OMT-06]** Co-pyrolysis of Coffee-ground with Waste Polystyrene Foam for Upgrading the Coffee-ground Derived Pyrolysis Oil *Quynh Van NGUYEN[1,2], Yeon-Seok CHOI[1,2]*, Sang-Kyu CHOI[1,2], Yeon-Woo JEONG[1] ([1]Korea Institute of Machinery and Materials, [2]University of Science and Technology, Korea)*

[Bioresources/ Room 2]

Time	Title
15:20-15:50	**[8KBR-24]** Metal-Organic Frameworks (MOF) for Electrochemical and Optical Sensing of Bacteria *Akash DEEP* (CSIR-Central Scientific Instruments Organisation, India)*
15:50-16:05	**[8OBR-16]** Development of Modified Biochar on the Eco-friendly Process for Food Waste and Livestock Manure Composting *Balasubramani RAVINDRAN*, Woo Jin CHUNG, Soon Woong CHANG, SeokJoo CHUNG (Kyonggi University, Korea)*
16:05-16:20	**[8OBR-17]** Nitrogen and Phosphorus Removal and Recovery from Wastewater with Metal Impregnated Biochar *Moh Moh Thant ZIN, Dong-Jin KIM* (Hallym University, Korea)*
16:20-16:35	**[8OBR-18]** Hydrochar Production from Waste Seaweed: Effect of Reaction Conditions *Sepideh SOROUSH[1,2], Frederik RONSSE[2], Stef GHYSELS[2], An VERBERCKMOES[2], Francis VERPOORT[1,3], Philippe M. HEYNDERICKX[1,2]* ([1]Ghent University Global Campus, Korea, [2]Ghent University, Belgium, [3]Wuhan University of Technology, China)*

[Environment / Room 2]

Time	Title
16:55-17:25	**[8KEN-26]** Distributed Waste-to-Resource Development in Glasgow *Simon ASCHER, Siming YOU* (University of Glasgow, UK)*
17:25-17:40	**[8OEN-27]** Synoptic Circulation Pattern Modulates co-occurring Surface Ozone and PM2.5 Compound Pollutions during Summertime in Eastern China *Lian ZONG[1], Hong WANG[1], Guicai NING[2], Yubin LI[1], Zhiqiu GAO[1], Chao LIU[1], Linlin WANG[2]*, Yuanjian Yang[1]* ([1]Nanjing University of Information Science & Technology, [2]Institute of Atmospheric Physics, China)*
17:40-17:55	**[8OEN-28]** Application of on Campus Low-Cost Air Quality Sensors in the Monitoring of Real-Time $PM_{2.5}$ Concentrations in Southeast United States *Haoran CHENG, Eleanor PARTINGTON, Momo RUTKIN, Anna MUNSLOW, Alexander AVRAMOV, Eri SAIKAWA* (Emory University, USA)*
17:55-18:10	**[8OEN-29]** Removal of Microfibres and Microplastics in Sewage Treatment Works: Implications to Environmental Risk *Yuguang WANG, Yan Laam CHENG, Kai XU, Yiu Fai TSANG* (The Education University of Hong Kong, Hong Kong, China)*

[Bioresources / Room 3]

Time	Title
10:00-10:15	**[8OBR-07]** Accelerated Aging of Biochar for Assessment of Biochar Stability *Hye-Bin KIM, Kitae BAEK* (Jeonbuk National University, Korea)*
10:15-10:30	**[8OBR-08]** Anaerobic Digestion of Food Waste and Sewage Sludge for Biogas Production *Yun-Hui JEON, M. GOVARTHANAN, Chang-Hyun JEON, June LEE, Woong KIM* (Kyungpook National University, Korea)*
10:30-10:45	**[8OBR-09]** Improved Growth of *Chlorella Vulgaris* using Silver Nanoparticles Solution as Light Filter Devices *Chang-Hyun JEON, Yun-Hwi JEON, June LEE, M. GOVARTHANAN, Woong KIM* (Kyungpook National University, Korea)*
10:45-11:00	**[8OBR-10]** Synthesis of Diesel Range Fuel Precursor from Furfuryl Alcohol over Fibrous γ -Al_2O_3 Sphere Supported Nb_2O_5 Catalyst *Mahlet N. GEBRESILLASE[1], Reibelle Q. RAGUINDIN[1], Jeong Gil SEO[2]* ([1]Myongji University, [2]Hanyang University, Korea)*
11:00-11:15	**[8OBR-11]** Bifunctional Catalysis of Cobalt-Nickel Phosphides for the Solvent-Free Hydrogenation of Biomass-Derived Levulinic Acid *Reibelle Q. RAGUINDIN[1], Mahlet N. GEBRESILLASE[1], Jeong Gil SEO[2]* ([1]Myongji University, [2]Hanyang University, Korea)*
11:15-11:30	**[8OBR-12]** Food Waste and Its Derivatives as Alternative Carbon Source for Denitrification of Steel Processing Wastewater: Process Performance and Microbial Community Dynamics *Joonyeob LEE[1], Eunji KIM[2], Seung Gu SHIN[3] and Seokhwan HWANG[2]* ([1]Pukyong National University, [2]Pohang University of Science and Technology, [3]Gyeongnam National University of Science and Technology, Korea)*
11:30-11:45	**[8OBR-13]** Understanding Surface Functionality of Mesoporous Biochar in Phase Change Materials Infiltration through Stability and Energy Storage Capacity *Dimberu G. ATINAFU, Seong Jin CHANG, Beom Yeol YUN, Sumin KIM* (Yonsei University, Korea)*
11:45-12:00	**[8OBR-14]** Ru-Re Catalysts Supported on Biochar Engineered in Different Pyrolytic Atmospheres for Converting Furan into Platform Chemicals *Younghyun LEE, Jechan LEE* (Ajou university, Korea)*

[Environment / Room 3]

Time	Title
15:20-15:35	**[8OEN-19]** Occurrence and Transport of di(2-ethylhexyl) Phthalate (DEHP) in the Drinking Water Treatment Plants from South Korea *Youngkun CHUNG[1], Hyelyeon TAK[1], Duksoo JANG[1], Hyojeon KIM[1], Seon-Ha CHAE[2], Youngmin HONG[3], and Seoktae KANG[1]* ([1]Korea Advanced Institute of Science and Technology (KAIST), [2]K-water Institute, [3]Technical Research Center, Shimadzu Scientific Korea, Korea)*
15:35-15:50	**[8OEN-20]** Impact of Land Use/Land Cover on the Groundwater Quality at Agricultural Region of South Korea *HyunKoo KIM[1], MoonSu KIM[1]*, Minjung GO[1], Sunhwa PARK[1], Dohwan JUNG[1], Inkyu SHIN[1], MinKyeong LEE[1], JaeHa YANG[2] ([1]National Institute of Environmental Research, [2]EGICONSULTING Co.Ltd., Korea)*
15:50-16:05	**[8OEN-21]** Novel Membrane-type Electrode for the Selective Reduction of Co^{2+} from Ca^{2+}-rich Concrete Decommissioning Wastewater *Joosung PARK[1], Keunyoung LEE[2] and Seoktae KANG[1]* ([1]Korea Advanced Institute of Science and Technology (KAIST), [2]Korea Atomic Energy Research Institute, Korea)*
16:05-16:20	**[8OEN-22]** Effect of Biofouling Layer on the Rejection of Emerging Contaminants in the Forward Osmosis Process *Duksoo JANG, Seungju CHOI, Seoktae KANG* (Korea Advanced Institute of Science and Technology (KAIST), Korea)*
16:20-16:35	**[8OEN-23]** Synergistic Effect of CO_2 and Pt Catalyst on Thermal Disposal of Food Waste *Soosan KIM, Jechan LEE* (Ajou University, Korea)*

[Materials Technology / Room 3]

Time	Title
16:55-17:10	**[8OMT-30]** Copper Segregated Nickel Foam and Its Dichalcogenide for Chemical Assisted overall Water Splitting *Bezawit. Z DESALEGN, Jeong Gil SEO* (Myongji University, Korea)*
17:10-17:25	**[8OMT-31]** Encapsulated Phase-Changing Eutectic Salts in Magnesium Oxide Fibers for Capture: Beyond the Capacity-Stability Trade-off *Monica Louise T. TRIVIÑO[1], Jeong Gil SEO[2]* ([1]Myongji University, [2]Hanyang University, Korea)*
17:25-17:40	**[8OMT-32]** Study Calcination Effect of MoS_2 and WS_2 Nanosheets on the W/WO_3 for Improving Photoelectrochemical Performance *Meysam TAYEBI, Byeong-Kyu LEE* (University of Ulsan, Korea)*
17:40-17:55	**[8OMT-33]** $ZnO/CdS/MoS_2$ Photoanode with Multi-heterojunctions for Highly Efficient Photoelectrochemical Hydrogen Evolution *Morteza KOLAEI, Meysam TAYEBI, Byeong-Kyu LEE* (University of Ulsan, Korea)*
17:55-18:10	**[8OMT-34]** Platform Chemicals from Sugar: Experimental Study with MOF Catalysts *Noor ALJAMMAL[1,2,], Alexandra LENSSENS[1,2], An VERBERCKMOES[2], Joris W. THYBAUT[2], Francis VERPOORT[1,3], Philippe M. HEYNDERICKX[1,2]* ([1]Ghent University Global Campus, Korea, [2]Ghent University, Belgium, [3]Wuhan University of Technology, China)*

*Special Sessions

Special Session 1- Mitigation and Adaptation for Climate Change and Particulate Matter / ROOM 4

Time	Title
	Session Organizer: Eui-chan JEON, Hyun-Han KWON (Sejong University, Korea)
10:00-10:15	**[8SS1-01]** Development of Estimation Method of Consumption-Based National GHG Emissions *Han-Sae KIM, Eui-Chan JEON* (Sejong University, Korea)*
10:15-10:30	**[8SS1-02]** Characteristic of Ammonia Emission from the Open Poultry House System *Seongmin KANG, Joonyoung, ROH, Eui-Chan JEON* (Sejong University, Korea)*
10:30-10:45	**[8SS1-03]** The Procedural Rationality of the Korean Policy on Fine Particulate Matter *Sang-Hyeon JIN* (Kyungpook National University, Korea)*
10:45-11:00	**[8SS1-04]** Improvement of Estimation Method for National Ammonia Inventory and Assessment of Mitigation Technologies *Gayoung YOO[1]*, Min Seop JEONG[1], Wanseop JUNG[1], Jeong-hun WOO[2] ([1]Kyung Hee University, [2]Konkuk University, Korea)*
11:00-11:15	**[8SS1-05]** Exploring Flash Drought and Its Relation to Atmospheric Circulation *S.S.K.CHANDRASEKARA, Hojun KIM, Hyun-Han KWON* (Sejong University, Korea)*
11:15-11:30	**[8SS1-06]** Drought Early Warning System and Its Application with Groundwater Data-based Drought Index *Jeong-Ju LEE[1], Shin-Uk KANG[1], Gun-Il CHUN[1], Hyun-Han KWON[2]* ([1]K-water, [2]Sejong University, Korea)*

Special Session 2-Special Session: Air Quality, Health, and Climate Change (Invited only) / ROOM 4

Time	Title
	Co-Sponsored by Prof Jinkyu Hong (Yonsei University) and Prof. Eri Saikawa (Emory University)
15:20-16:35	Place to be Announced for Invitees

BEEM 2020 | 4th International Conference on Bioresources, Energy, Environment, and Materials Technology

Poster Sessions

Poster Sessions 1 - September 7, 2020, Monday

Presentation No.	BR. Bioresources
7PBR-01	Production of Pellet Amendment using Biochar and Its Application in Paddy Condition for Preservation of Agricultural Environment *Se-Won KANG[1,2], Jin-Ju YUN[2], Jae-Hyuk PARK[2], Ju-Sik CHO[2]* ([1]Louisiana State University, USA, [2]Sunchon National University, Korea)*
7PBR-02	A Novel Z-scheme Ag_3PO_4/Fe_3O_4/BAB Photocatalyst with Enhanced Visible-light Catalytic Performance toward the Degradation of Bisphenol A *Kristy TALUKDAR, Yejin KIM, Aqsa FAYYAZ, Yeon Ji YEA, Yeon Ji YEA, Chang Min PARK* (Kyungpook National University, Korea)*
7PBR-03	Evaluation of Deicer Impact on Growth of Winter Crops and Annual Herbaceous Plants *Chan-Young LEE* (Korea Expressway Corporation Research Institute, Korea)*
7PBR-04	Evaluation of Deicer Impact on Growth of Woody Plants *Chan-Young LEE* (Korea Expressway Corporation Research Institute, Korea)*
7PBR-05	Seasonal Monitoring of Bacterial Community in Full-scale Anaerobic Digestion Treating Food Waste *Michal SPOSOB[1], Gwang-Sue YUN[1]*, Byung-Kyu AHN[1], Tae-Hoon KIM[1], Dongjin LEE[2], Hee-Sung MOON[2], Yeo-Myeong YUN[1]* ([1]Chungbuk National University, [2]National Institute of Environmental Research, Korea)*
7PBR-06	Combustion Characteristics of the Livestock Manure Pellets and the Pyrolysis Gases Generated from Livestock Manure Pellets *Kwang Hwa JEONG*, Dong Jun LEE, Sung Hyoun LEE, Dong Hyun LEE (National Institute of Animal Science, Korea)*
7PBR-07	The Lifecycle and Management Strategy of Plastics in Korea *Sora YI* (Korea Environmental Institute, Korea)*
7PBR-08	Hydrothermal Method Preparation Of Nanohexagon And Nanopentagon-like ZnS:Morphological Control And Antibacterial Applications *Antony ANANTH, Jin-Hyo BOO* (Sungkyunkwan University, Korea)*
7PBR-09	Effects of Voltage on Anaerobic Digestion of Digested Sludge *A In CHEON, Hyeon Myeong YANG, Hang Bae JUN* (Chungbuk National University, Korea)*
7PBR-10	Effect of Free Ammonia for High Protein Production in Chlorella Vulgaris. *Changyu MOON, Byung-Chul KIM, Kyoungphile NAM* (Seoul National University, Korea)*
7PBR-11	Factors Affecting Anaerobic Dry Fermentation for Food Waste Management *Kyu Won SEO[1,2], Kyung-il KIM[3], Jaeshik CHUNG[1]* ([1]Korea Institute of Science and Technology, [2]Korea University, [3]Seoul National University, Korea)*

7PBR-12 Heavy Metal Removal in Contaminated Wastewater Using Starfish Biochar

Deok Hyun MOON (Chosun University, Korea)*

7PBR-13 Adsorption of Cd(Ⅱ) by Encapsulated Spent Mushroom Substrate Biochar: Batch and Fixed-bed Column Systems

Hyeji JEON[1], Youngsu LIM[2], Jihyeon SONG[1], Jiseon JANG[3], Dae Sung LEE[1] ([1]Kyungpook National University, [2]Pohang Institute of Metal Industry Advancement, [3]Korea Radioactive Waste Agency, Korea)*

7PBR-14 Production of Biodiesel Synthesized from the Black Soldier Fly Larvae and Its Fuel Property Characterization as a Potential Transportation Fuel in Korea

Jo-Yong PARK[1], Yong-Gyu NA[1], Cheol-Hwan JEON[1], Hwa-Yeon CHEON[1], Eun-Young YOON[2], Sang-hoon LEE[3], Eilhann E. KWON[2], and Jae-Kon KIM[1] ([1]Korea Petroleum Quality & Distribution Authority, [2]Sejong University, [3]GreenTeko, Inc., Korea)*

7PBR-15 Bio Jet Fuel Production and Quality Control Review

Yong-Gyu NA, Jae-Kon KIM (Korea Petroleum Quality & Distribution Authority, Korea)*

7PBR-16 Removal of Ammonia, Zinc and Copper from Rainwater Runoff Using Sulfonated Biochar

Jingyan LIU[1], Min ZHENG[2], Xianghui WANG[3], Linlin WANG[1], Xiaomin DOU[1], Kangning XU[1] ([1]Beijing Forestry University, China, [2]University of Queensland, Australia, [3]Shanghai SUS Environmental Co. Ltd., China)*

Presentation No.	EG. Energy

7PEG-17 Renewable Energy Capacity Selection Considering the Annual Load Properties of Office Building

Gi-Hoon, KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEG-18 Pavement Acceleration Test Results for Road Pavement Durability Evaluation of Piezoelectric Harvester for Road

Gi-Hoon, KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEG-19 Test Road Installation and Demonstration Test Result of Piezoelectric

Gi-Hoon, KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEG-20 Rest Area Experimental Installation and Effect Analysis of Piezoelectric Harvester

Gi-Hoon, KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEG-21 Catalytic Pyrolysis of Pine Sawdust over a Ni/SiO_2 Catalyst using CO_2 as Reaction Medium

Seong-Heon CHO, Jong-Min JUNG, Eilhann E. KWON (Sejong University, Korea)*

7PEG-22 Catalytic Pyrolysis of Rice Husk with CH_4

Young-Kwon PARK (University of Seoul, Korea)*

7PEG-23 Catalytic Co-pyrolysis of Biomass Waste and Oil Sludge Waste

Young-Kwon PARK (University of Seoul, Korea)*

7PEG-24 CO_2 Effects for Syngas and Biochar Production in the Catalytic Pyrolysis of Peat Moss from the North Polar Region

Taewoo LEE, Jong-Min JUNG, Sungyup JUNG, and Eilhann E. KWON (Sejong University, Korea)*

7PEG-25 Analysis on Environmental Effects of Electric Vehicles for Korea Electricity Mix Based on LCA

Sora YI (Korea Environmental Institute, Korea)*

Presentation No.	EN. Environment

7PEN-26 Degradation of Organic Pollutants using Fe-based Photocatalysts

Yasaman GHAFFARI [1,2], Nishesh Kumar GUPTA[1,2], Jiyeol BAE[2], Kwang Soo KIM[1,2] ([1]University of Science and Technology (UST), [2]Korea Institute of Civil Engineering and Building Technology (KICT), Korea)*

7PEN-27 A Study on the Underground of Highway and Its Implications with Environmental Change

Jiho PARK, Yongwon KIM (Korea Expressway Corporation, Korea)*

7PEN-28 The Change of Highway from a Cultural, Economic, and Ecological Perspective through Healing Way Promotion

Jiho PARK, Yongwon KIM (Korea Expressway Corporation, Korea)*

7PEN-29 The Potential of Pt/TiO_2 as Thermal Catalyst for Gaseous Formaldehyde: Effects of Concentration Levels and Flow Rates of Formaldehyde at Room Temperature

Young-Jae LEE, Ki-Hyun KIM (Hanyang University, Korea)*

7PEN-30 Effect of Palladium on the SBM Catalyst Prepared from Spent Zn/Mn Alkaline Battery for Catalytic Combustion of VOCs

Sang Chai KIM (Mokpo National University, Korea)*

7PEN-31 The Establishment of Environmental Governance in Public Institutions for Realizing Social Values

Yongwon KIM, Jiho PARK (Korea Expressway Corporation, Korea)*

7PEN-32 Policy Implications of Creating Environmental, Social and Economic Shared Value in Roadside Public Institutions

Yongwon KIM, Jiho PARK (Korea Expressway Corporation, Korea)*

7PEN-33 A Comparative Study Report on the Annual Differences in Revegetation Methods for Expressway Slopes

Gi Seong JEON[1], Kyung Hoon KIM[2] ([1]Korea Expressway Corporation Research Institute, [2]Illim Inc., Korea)*

7PEN-34 Introduction to the Quality Evaluation Standards for Expressway Slope Revegetation Methods

Gi Seong JEON[1], Kyung Hoon KIM[2] ([1]Korea Expressway Corporation Research Institute, [2]Illim Inc., Korea)*

7PEN-35 Temporal and Spatial Differences of Atmospheric Ammonia Concentraton in Agricultural Area

Sung-Chang HONG, Sae-Nun SONG, Seon-Young YU, Gyu-Hyun LEE, Kyeong-Sik KIM (National Institute of Agricultural Scences, RDA, Korea)*

7PEN-36 Up-Regulated Temperature Inducing Change of Nutrient Output in Upland Runoff

Kyeong-Sik KIM, Sung-Chang HONG, Seon-Young YU, Gyu-Hyun LEE, Soon-Kun CHIO, Seung-Oh HUR (National Institute of Agricultural Scences, RDA, Korea)*

7PEN-37 Ammonium Concentration of Precipitation in Agricultural Area

Gyu-Hyun LEE, Sung-Chang HONG, Seon-Young YU, Kyeong-Sik KIM, Sae-Nun SONG (National Institute of Agricultural Scences, RDA, Korea)*

7PEN-38 Up-Regulated Temperature Inducing Change of Nutrient Output in Rice Paddy Runoff

Seon-Young YU, Sung-Chang HONG, Gyu-Hyun LEE, Kyeong-Sik KIM, Soon-Kun CHIO, Seung-Oh HUR (National Institute of Agricultural Scences, RDA, Korea)*

7PEN-39 Degradation of Naproxen by Plasma in Liquid Process with Hydrogen peroxide and TiO_2 Photocatslysts

Heon LEE, Hye-Jin BANG, Sang-Chul JUNG (Sunchon National University, Korea)*

7PEN-40 Estimating Reduced Nonpoint Pollution Load of Highways by Road Sweeping

Hee Man KANG[1], Hye Jin KANG[1], Jang Won SON[2], Han Phil RHEE[2] ([1]Korea Expressway Corporation, [2]ETwaters Inc., Korea)*

7PEN-41 Estimating Particle Matter and Nonpoint Source Pollution Removal Effect of Road Sweeping by Water Quality Modeling

Hee Man KANG[1], Hye Jin KANG[1], Jang Won SON[2], Han Phil RHEE[2] ([1]Korea Expressway Corporation, [2]ETwaters Inc., Korea)*

7PEN-42 Survey on Maintenance of Nonpoint Pollution Treatment Facilities

Hee Man KANG[1], Hye Jin KANG[1], Jang Won SON[2], Han Phil RHEE[2] ([1]Korea Expressway Corporation, [2]ETwaters Inc., Korea)*

7PEN-43 Evaluation of Particle Size Distribution of Road Deposited Sediments Collected by Expressway Sweeping

Hee Man KANG, Hye Jin KANG (Korea Expressway Corporation, Korea)*

7PEN-44 Development of GIS-based Highway Climate Change Impact Analysis Tool

Ju Goang LEE (Korea Expressway Corporation Research Institute(KECRI), Korea)*

7PEN-45 Introduction to Evaluation Indicators for Climate Change Projects

Ju Goang LEE (Korea Expressway Corporation Research Institute(KECRI), Korea)*

7PEN-46 Derivation of Highway Facility Design Standards considering Climate Change

Ju Goang LEE (Korea Expressway Corporation Research Institute(KECRI), Korea)*

7PEN-47 A Study on Optimal Pore Range for High Adsorption Behaviors by Activated Carbon Fiber Prepared from a Various Precursor

Hye-Min LEE[1], Ju-Hwan KIM[2], Young-Kwon PARK[3], Byung-Joo KIM[1] ([1]Korea Institute of Carbon Convergence Technology, [2]Chonbuk National University, [3]University of Seoul, Korea)*

7PEN-48 Effects of Electron Beam Irradiation on DMMP Adsorption Behaviors of Activated Carbon Fibers

Hye-Min LEE[1], Ju-Hwan KIM[2], Sang-Chul JUNG[3], Byung-Joo KIM[1] ([1]Korea Institute of Carbon Convergence Technology, [2]Chonbuk National University, [3]Sunchon National University, Korea)*

7PEN-49 Correlation Analysis of Fine Dust Concentration btween Highway Tunnels and Government Measuring Posts nearby

Chulhwan KIM, Hyejin KANG (Korea Expressway Corporation Research Institute, Korea)*

7PEN-50 Case Considerations of Highway Noise Abatement with Low-noise Pavements

Chulhwan KIM, Hyejin KANG (Korea Expressway Corporation Research Institute, Korea)*

7PEN-51 Noise Reduction Performance Estimation of Surface Modified Concrete Pavements

Chulhwan KIM, Hyejin KANG (Korea Expressway Corporation Research Institute, Korea)*

7PEN-52 Measurement Position Consideration at Highway Roadside for Noise Measurments

Chulhwan KIM, Hyejin KANG, Taesun CHANG (Korea Expressway Corporation Research Institute, Korea)*

7PEN-53 The Effects of 3 Different Kinds of De-icing Salt on Physiological Response of Tree Species by using Infra-red Camera

Kunhyo KIM[1], Yukyeong SEO[1], Jihyeon JEON[1], Gi-Seong JEON[2], Hyun Seok KIM[1,,3,] ([1]Seoul National University, [2]Korea Expressway Corporation Research Institute, [3]National Center for Agro Meteorology, Korea)*

7PEN-54 An Analysis of the Visual Preferences of the Driver for Bird Deterrent Patterns in Transparent Noise Barriers using Driving Simulator

Taesun CHANG, Chulhwan KIM, Hyunjin PARK, Kiyoung LEE, Haeyeon HWANG (Korea Expressway Corporation, Korea)*

7PEN-55 Acoustic Performance Estimation of Noise Reducing Devices Considering with Source Charateristics

Chulhwan KIM[1], Taesun CHANG[1], Junho CHO[2] ([1]Korea Expressway Corporation Research Institute, [2]Railway Transportation Department of Woosong College, Korea)*

7PEN-56 Analysis of Air Pollutants Concentration Variation in the Operation of Ventilation System in Tunnel

Hyejin KANG, Chul Hwan KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEN-57 Scope and Methodology for Calculating Air Pollutant Emissions on Expressway

Hyejin KANG, Chul Hwan KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEN-58 Sensitivity Analysis of CALINE4 through Actual Measurement to Determine the Impact of Air Pollution on Highways

Hyejin KANG, Chul Hwan KIM (Korea Expressway Corporation Research Institute, Korea)*

7PEN-59 Development of Eco-friendly Soil Restoration Assessment System for Surface Soil Failure

Jong Cheol LEE, Dash DARINCHULUUN, Sang Soo LEE (Yonsei University, Korea)*

7PEN-60 Evaluation the Risk of Soil Erosion against Climate Change

Min Woo KANG, Young Hyun KIM, Sang Soo LEE (Yonsei University, Korea)*

7PEN-61 Capping Efficiency of Ca-Rich Mineral Under Nonwoven Fabric Mats and Sand Armour for Interrupting Nutrient Release from Liver Sediments

Seung-Hee HONG[1], Chang-Gu LEE[2] and Seong-Jik PARK[1] ([1]Hankyong National University, [2]Ajou University, Korea)*

7PEN-62 Field Test of Stormwater Treatemtn Devices for Improving Heavy Metals Removal in Expressway

Hee Man Kang, Hye Jin Kang (Korea Expressway Corporation Research Institute, Korea)*

7PEN-63 Potential Impacts of Large-Scale Climate Variabilities on Transpacific Transport of Springtime Asian Aerosols

Ja-Ho KOO[1], Jaemin KIM[2], Yun Gon LEE[2] ([1]Yonsei University, [2]Chungnam National University, Korea)*

7PEN-64 Spatiotemporal Characteristics of PMs and Satellite-based AOD in the Korean Peninsula

Kwang Nyun KIM[1], Seung Hee KIM[2], Ja-Ho KOO[3], Yun Gon LEE[1] ([1]Chungnam National University, Korea, [2]Chapman University, USA, [3]Yonsei University, Korea)*

7PEN-65 Effective Applying of Noise Reducing Devices for Traffic Noise Abatements

Chulhwan KIM[1], Taesun CHANG[1], Junho CHO[2] ([1]Korea Expressway Corporation Research Institute, [2]Woosong College, Korea)*

7PEN-66 Contribution to Thermal Comfort and CO_2 Mitigation of Urban Park with Complex and Heterogeneous Landscape in Seoul

Keunmin LEE[1], Je-Woo HONG[2], Jeongwon KIM[1] and Jinkyu HONG[1] ([1]Yonsei University, [2]Korea Environment Institute, Korea)*

7PEN-67 Estimation of Surface CO_2 Flux over Asia using Inverse Modeling with CO_2 Observations in the Korean Peninsula

Hyun Mee KIlM, Minkwang CHO (Yonsei University, Korea)*

7PEN-68 Oxidative Degradation of 1,2-dichloroethane in Groundwater

Won-Gune JEONG, Jong-Gook KIM, Kitae BAEK (Jeonbuk National University, Korea)*

7PEN-69 A Development of Reconstruction and Temporal Extension Model for Fine Dust in Korea

Sumiya URANCHIMEG, Jin-Guk KIM, Dinh Huy NGUYEN, Hyun-Han KWON (Sejong University, Korea)*

7PEN-70 Fe(III)-based Washing Process for Remediation of Multi Metals-contaminated Soil

Su Yeon KIM, Hye-Bin KIM, Jong-Gook KIM, Kitae BAEK (Jeonbuk National University, Korea)*

7PEN-71 A Bivariate Frequency Analysis of Fine Dust using Copula Function

Jin-Young KIM, Sumiya URANCHIMEG, Byung-Jin SO, Hyun-Han KWON (Sejong University, Korea)*

7PEN-72 Water Quality Estimation Using Hydrometeorological Factors within the Hierarchical Bayesian Framework

Minkyu JUNG, Yong-Tak KiIM, Hong-Geun CHOI, Hyun-Han KWON (Sejong University, Korea)*

7PEN-73 Latent Markov Processes for Identifying Spatio-temporal Pattern of Water Quality

Jae-Ung YU, Hemie CHO, Hojun KIM, Hyun-Han KWON (Sejong University, Korea)*

7PEN-74 The Relationship of the Price Movements of Raw Materials and Recyclable Materials in South Korea

Hye-Sook LIM[1,2] ([1]Korea Environment Institute, [2]Seoul National University, Korea)*

7PEN-75 Analysis of the Harmful Algal Blooms in the Upstream of the New Dam

Saeromi LEE[1], Chang-Hyuk AHN[1,2], Eun-Ju KIM[1], Tae-Mun HWANG[1] ([1]Korea Institute of Civil Engineering and Building Technology, [2]Seoul National University, Korea)*

7PEN-76 Analysis of Quality Characteristics of Soil Ameliorant using Microalgal Sludge

Chang Hyuk AHN[1,2], Saeromi LEE[1], Jae Roh PARK[1], Tae-Mun HWANG[1] ([1]Korea Institute of Civil Engineering and Building Technology, [2]Seoul National University, Korea)*

7PEN-77 Analysis of Operational Status of Hog Barns using Closed Composting Equipment

Dong-Hyun LEE, Kwang-Hwa JEONG, Dong-Jun LEE and Hoe man PARK (National Institute of Animal Science (NIAS), Korea)*

7PEN-78 Comparison of Two Odor Evaluating Parameters, Sensory and Instrumental, to Estimate Odor Strength in Livestock Facilities

Saem-ee WOO, Yu Na JANG, Si Young SEO, Okhwa HWANG, Sojin LEE, Gwanggon JO, Taehwan HA, Min Woong JUNG, and Deug-Woo HAN (National Institute of Animal Science (NIAS), Korea)*

7PEN-79 Applying Negative Pressurizing Technique May Contribute to The Homogenous Air Supply in Statically Composted Manure Piles

Dong-Hyun LEE, Saem-ee WOO, Yu Na JANG, Okhwa HWANG, Min Woong JUNG, Jung-Hoon KWAG, and Deug-Woo HAN (National Institute of Animal Science (NIAS), Korea)*

7PEN-80 Enhanced Redox Chemical Reactions in Ice and the Role of Freeze Concentration Effect

Kitae KIM (Korea Polar Research Institute (KOPRI), Korea)*

7PEN-81 Development of Eco-efficient and Cost-effective Critical Metal Extraction Process from Waste LCD through Mechano-chemical Treatment

Jay Ryang PARK[1,2], Eun Duck PARK[2], Chan Gi LEE[1], Basudev SWAIN[1] ([1]Institute for Advanced Engineering (IAE), [2]Ajou University, Korea)*

7PEN-82 Decreased Odorous Compounds in Response to Evolution of a New Microbial Community in a Full-scale Swine Manure Pit Recharge System with Recirculation of Aerobic Treated Liquid Fertilizer

Gwang-Sue YUN[1], Ha-Eun OH[1], Tae-Hoon KIM[1], Michidmaa ENKHTSOG[1], Yu-Na JANG[2], Min-Woong JUNG[2], Okhwa HWANG[2], Yeo-Myeong YUN[1] ([1]Chungbuk National University, [2]National Institute of Animal Science, Korea)*

7PEN-83 Relationship between Increased Solubilization and Biogas Productivity of Pretreated Microalgae Waste

Byung-Kyu AHN, Tae-Hoon KIM, Hui-Jin KIM, Yeo-Myeong YUN (Chungbuk National University, Korea)*

7PEN-84 Evaluation of Maximum of Hopping Distance of Adjacent Humic Substances Molecules as Electron Shuttle

Jingtao DUAN[1], Zhen YANG[2], Andreas KAPPLER[2], Jie JIANG[1] ([1]Beijing Forestry University, China, [2]Center for Applied Geoscience, Germany)*

7PEN-85 Assessing of Impact of Redox Properties of Natural Organic Matter on Transformation of Pollutants in Groundwater.

Zhiyuan XU[1], Zhen YANG[2], Jie JIANG[1] ([1]Beijing Forestry University, China, [2]Center for Applied Geoscience, Germany)*

7PEN-86 The Hybrid of Soil Exposure and Land Use Model to Access Lead Exposure among Children in North Taiwan

Chi Sian KAO[1], Ying Lin WANG[2], Ting Wu CHUANG[1], Ling Chu CHIEN[1] ([1]Taipei Medical University, [2]National Taiwan University, Taiwan)*

7PEN-87 Effects of Particle Diameter on the Accumulation and Phytotoxicity of Platinum Nanoparticles in Hydroponic Rice Plant

Xin LIU[1], Yuan YANG[1], Sen HE[1], Dan ZHI[1], Daniel C.W. TSANG[2], Yaoyu ZHOU[1] ([1]Hunan Agricultural University, China, [2]The Hong Kong Polytechnic University, Hong Kong, China)*

7PEN-88 Ammonia Emission Characteristics in Mechanically Ventilated Fattening Pig Farm in Spring

Minwoong JUNG, Taehwan HA, Yuna JANG, Ae Jeong KWON, Junyong PARK, Siyoung SEO, Saem Ee WOO, Gwanggon JO (National Institute of Animal Science (NIAS), Korea)*

7PEN-89 Effects of Loading Change and Promoters on V/MPTiO_2 for Selective Catalytic Reduction of NO with NH_3

Se Won JEON, Inhak SONG, Hwangho LEE and Do Heui KIM (Seoul National University, Korea)*

Poster Sessions 2 - September 8, 2020, Tuesday

Presentation No.	EN. Environment
8PEN-01	Catalytic Co-pyrolysis of Lignocellulosic Biomass and Food Waste for Reducing the Formation of Benzene Derivatives *Chanyeong PARK, Jechan LEE* (Ajou University, Korea)*
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8PEN-08	Assessment of Microplastic Removal in Drinking Water Treatment Process *Sang Heon NA[1,2], Jaeshik CHUNG[1], Eun-Ju KIM[1,2]* ([1]Korea Institute of Science and Technology (KIST), [2]University of Science and Technology, Korea)*
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Min Su JEON, Hye Seon CHOI, Nash Jett REYES, Lee Hyung KIM (Kongju National University, Korea)*

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Jaeyoung SEON, Yuhoon HWANG (Seoul National University of Science and Technology, Korea)*

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Min Wook KIM, Soon-Ik KWON, Jin-Ho KIM, Sung-Chang HONG, Soon-Kun CHOI, So-Jin YEOB (National Institute of Agricultural Science, Korea)*

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Yoo Kyung LEE, Hye Seon CHOI, Min Su JEON, Nash Jett REYES, Lee Hyung KIM (Kongju National University, Korea)*

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Hye Seon CHOI, Minsu JEON, Nash Jett REYES, Lee Hyung KIM (Kongju National University, Korea)*

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Younggyo SEO, Yuhoon HWANG (Seoul National University of Science and Technology, Korea)*

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Sok KIM, Yun Hwan PARK, Ho Seon KIM, Yoon-E CHOI (Korea University, Korea)*

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Yoonah JEONG, Ye-Eun LEE, I-Tae KIM (Korea Institute of Civil Engineering and Building Technology, Korea)*

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Soonyoung YU, Seok-Hee KIM, Han-Suk KIM, Seong-Taek YUN (Korea University, Korea)*

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Soonyoung YU[1], Gitak CHAE[2], Seong-Wook KIM[3] ([1]Korea University, [2]Korea Institute of Geoscience and Mineral Resources, [3]GI Co. Ltd., Korea)*

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Hui Jae YUN[1], Jeong Yong LEE[1], Chang Yeon WON[1], Lee Hyung KIM[2] ([1]Shingu College, [2]Kongju National University, Korea)*

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Yoora CHO[1], Avanthi Deshani IGALAVITHANA[1], Pavani Dulanja DISSANAYAKE[1], Ondřej MASˇEK[2], Mee Kyung SANG[3], Yong Sik OK[1] ([1]Korea University, Korea, [2]University of Edinburgh, UK, [3]National Institute of Agricultural Science, Korea)*

8PEN-30 Estimation of the Available Energy Potential from Woody Biomass and Policy Suggestion

Ji Hye JO (Korea Environment Institute, Korea)*

8PEN-31 Impact of Endospore Forming Bacteria on Treatment Performance in Food-waste Recycling Wastewater Treatment Process

Kyu Won SEO[1,2], Jaeshik CHUNG[1], Yong Su CHOI[1], Man Bock GU[2] ([1]Korea Institute of Science and Technology, [2]Korea University, Korea)*

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8PEN-33 Dos and Don'Ts in the Design of Indoor Air Quality Studies on Smoke-free Products

Catherine GOUJON GINGLINGER[1], Maya I. MITOVA[1], Michel ROTACH[1], Jae Hyun KIM[2], Serge MAEDER[1] ([1]Philip Morris Products S.A., Switzerland, [2]Philip Morris Korea Inc. Korea)*

8PEN-34 Human Chemical Signature — Investigating the Influence of Human Presence and Selected Activities on Concentrations of Airborne Constituents

Catherine GOUJON GINGLINGER[1], Maya I. MITOVA[1], Michel ROTACH[1], Jae Hyun KIM[2], Serge MAEDER[1] ([1]Philip Morris Products S.A., Switzerland, [2]Philip Morris Korea Inc. Korea)*

8PEN-35 Magnetically Separable Bismuth Oxyiodide/Magnetite Photocatalyst for Bisphenol A Removal under Solar Light

Bolam KIM[1], Jiseon JANG[2], Dae Sung LEE[1] ([1]Kyungpook National University, [2]Korea Radioactive Waste Agency, Korea)*

8PEN-36 Stabilization of Mercury and Arsenic Contaminated Soil Using a Combination of Hydrated Lime, Steel Slag and Calcium Sulfide (CaS) Fertilizer

Deok Hyun MOON (Chosun University, Korea)*

8PEN-37 Catalytic Oxidation of VOCs with Ozone over Waste Alkaline Battery

Young-Kwon PARK (University of Seoul, Korea)*

8PEN-38 Effect of Surfactants in Waters on Plants

Eun Hea JHO, Han Sol PARK, Young Ho YOON (Hankuk University of Foreign Studies, Korea)*

8PEN-39 Recovery and Utilization of Aluminum from Water Sludge as Adsorbent and Precipitant for Phosphate Removal

Truong Van TUAN, Dong-Jin KIM (Hallym University, Korea)*

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Duksoo JANG[1], Kwanyoung KO[2], Sanghyun PARK[3], Seoktae KANG[1] ([1]Korea Advanced Institute of Science and Technology (KAIST), [2]Konkuk University, [3]3M R&D Center, Korea)*

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Shakya ABEYSINGHE, KiTae BAEK (Jeonbuk National University, Korea)*

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Young Hyun KIM, Sang Soo LEE (Yonsei University, Korea)*

8PEN-43 Effect of Static Magnetic Field on H_2O_2 Production in Bioelectrochemical Systems

Hyunji EOM[1,2], Eunjin JWA[1], Young Sun MOK[2], Joo-Youn NAM[1] ([1]Korea Institute of Energy Research, [2]Jeju National University, Korea)*

8PEN-44 Changes in Ammonia Generation according to Pig Manure Composting Period in Machine-Stirred Composting Facility

Kwang Hwa JEONG, Dong Jun LEE, Dong Hyun LEE, Hoe Man PARK, Jung Kon KIM (National Institute of Animal Science, Korea)*

8PEN-45 Sustainable Energy Recovery via Catalytic Pyrolysis of Swine Manure using CO_2 and Steel slag

Dong-Jun LEE[1,2], Kwang-Hwa JEONG[2], Dong-Hyun LEE[2], Hoeman PARK[2], Jung-Kon KIM[2], and Eilhann E. KWON[1] ([1]Sejong University, [2]National Institute of Animal Science (NIAS), Korea)*

8PEN-46 Animal Manure Valorization for Bioethanol Production: A Case Study of Horse Manure

Dong-Jun LEE[1,2], Jun Ho YIM[3], Sungyup JUNG[1], Mi-Sun JANG[3], Kwang-Hwa JEONG[2], Dong-Hyun LEE[2], Hoeman PARK[2], Young Jae JEON[3] ([1]Sejong University, [2]National Institute of Animal Science (NIAS), [3]Pukyong National University, Korea)*

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Yu Na JANG, Saem-ee WOO, Si Young SEO, Taehwan HA, Gwanggon JO, Okhwa HWANG, Deug-Woo HAN, Sojin LEE, Min woong JUNG (National Institute of Animal Science (NIAS), Korea)*

8PEN-48 Effective Medium for Black Solider Fly Applied in Food Waste Treatment

Chul-Hwan KIM, Kwanyoung KO, Haegeun CHUNG (Konkuk University, Korea)*

8PEN-49 Experiment on the Evaluation of Particulate Matter Reduction Capacity of Tree Species

Kunhyo KIM[1], Jihyeon JEON[1], Hee Jin JUNG[1], Yukyeong SEO[1], Gi-Seong JEON[2], Hyun Seok KIM[1,3] ([1]Seoul National University, [2]Korea Expressway Corporation Research Institute, [3]National Center for Agro Meteorology, Korea)*

8PEN-50 Thermal Catalyst Performance Evaluation Synthesized using Metal Oxide (MeOx)

Won-Ki KIM, Ki-Hyun KIM (Hanyang University, Korea)*

8PEN-51 Analysis of Volatile Organic Compounds in Mainstream Smoke of Tobacco Cigarette and Heat-not-burn Cigarette

Dae-Hwan LIM, Ki-Hyun KIM (Hanyang University, Korea)*

8PEN-52 Analysis of Carbonyl Compounds Released from Diverse Commercial Cigarette Products: Flavored Cigarettes vs. Heat-not-burn Cigarettes

Sol HAN, Ki-Hyun KIM (Hanyang University, Korea)*

8PEN-53 The Effects of Particle Size of Carbon Materials on the Adsorption Performance against Gaseous Benzene

Seung-Ho HA, Ki-Hyun KIM (Hanyang University, Korea)*

8PEN-54 Changes in Net Ecosystem Productivity in Temperate Forests in Northern China Depend on the Form and Level of Simulate Nitrogen Addition

Yun LI, Chunmei WANG (Beijing Forestry University, China)*

8PEN-55 Climate Change Undermines the Reliability of Hydropower Plants: Evidence from China

Weiyi GU, Beibei LIU (Nanjing University, China)*

8PEN-56 Transformation Kinetics and Products Identification of Aqueous Chlorination of Progesterone and Norgestrel

Hong CHANG, Tianhao WU (Beijing Forestry University, China)*

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8PMT-62	Low Temperature Synthesis of Urea-assisted NiOx Thin Films as a Hole Transport Layer for Inverted $CH_3NH_3PbI_3$ Perovskite Solar Cells *Sang-Hun NAM*, Jung-Hoon YU, and Jin-Hyo BOO* (Sungkyunkwan University, Korea)*
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8PMT-64	Construction of $BiVO_4$ co-deposited with Plasmonic Ag and N-doped Graphene Quantum Dots for Enhancing Photocatalytic Activity *Changchang MA, Syed Taj Ud DIN, Woochul YANG* (Dongguk University, Korea)*
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8PMT-68 Preparation of Surface Fluorinated TiO_2 Hollow Structures with Enhanced Photocatalytic Performance by Facile Solution Route

Duk-Hee LEE, Jae-Ryang PARK, Chan-Gi LEE, Kyung-Soo PARK (Institute for Advanced Engineering, Korea)*

8PMT-69 Post-Modification of Mesoporous MIL-101 with Brønsted Acid for Removing Radioactive Gas

Ga-Young CHA[1,2], Do-Young HONG[1], Young Kyu HWANG[1,2] ([1]Korea Research Institute of Chemical Technology (KRICT), [2]University of Science and Technology (UST), Korea)*

8PMT-70 Solar-to-Hydrogen Peroxide Conversion of TiO_2@Graphite-derived Carbon Dot Nanocomposites

Hoang Tran BUI, Yoonsang PARK, Woosung KWON and Wooyul KIM (Sookmyung Women's University, Korea)*

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8PMT-71 Synthesis, Characterization, and Electrochemical Studies of Iron Sulfide Modified TiO_2 NPs Decorated Carbon Nanofibers

Bishweshwar PANT, Mira PARK (Woosuk University, Korea)*

8PMT-72 Ag NPs Embedded Spider-web-like Polyurethane Nanofiber Membrane as An Efficient Antibacterial Medium

Bishweshwar PANT, Mira PARK (Woosuk University, Korea)*

8PMT-73 Three-dimensionally Assembled MnO_2 Nanowires as Efficient Supercapacitor Electrode

Gunendra Prasad OJHA, Mira PARK (Woosuk University, Korea)*

8PMT-74 TiO_2 / Carbon Nanofiber Composite for Supercapacitor Applications

Gunendra Prasad OJHA, Mira PARK (Woosuk University, Korea)*

8PMT-75 A Strategic Approach to Forming Advanced Porous Carbon for Electric Double Layer Capacitors: Sophisticated Nanospace Management from Transgenic Hybrid Poplars

Hyeonji JANG, Yeon Hu PARK, Jae-Heung KO, Jung Tae LEE (Kyung Hee University, Korea)*

8PMT-76 Effect of Sulfate Doping on the Antibacterial Activity of Ag_3PO_4 Nanoparticles Loaded on Polymer Electrospun Nanofiber

Ji Yeon KIM[1], Gopal PANTHI[2], Gunendra Prasad OJHA[1], Mira PARK[1] ([1]Woosuk University, [2]Jeonbuk National University Medical School, Korea)*

8PMT-77 Anion Doping: A New Strategy for Enhancing Antibacterial Activity of Ag_3PO_4 Nanoparticles Anchored on Polymer Electrospun Nanofibers

Ji Yeon KIM[1], Gopal PANTHI[2], Yun-Su KUK[3], Oh Hoon KWON[4], Seung-Geun KIM[5], Yong Wan PARK[4], Mira PARK[1] ([1]Woosuk University, [2]Jeonbuk National University Medical School, [3]Korea Institute of Carbon Convergence Technology (KCTECH), [3]Korea Institute of Convergence Textile, [4]Research and Development Jirisan Hanji, Korea)*

8PMT-78 Ag_3VO_4 NPs Decorated Polyacrylonitrile Nanofibers: Synthesis, Characterization, and Photocatalytic Activities

Eun-Jung LEE[1], Bishweshwar PANT[2], Mira PARK[2] ([1]Research and Development Jirisan Hanji, [2]Woosuk University, Korea)*

8PMT-79 Carbon Quantum Dots Incorporated Keratin/PVA Nanofiber Membrane for Multifaceted Applications

Da Woon JEONG[1], Eun-Jung LEE[2], Hye Kyoung SHIN[3], Bishweshwar PANT[1], Mira PARK[1] ([1]Woosuk University, [2]Research and Development Jirisan Hanji, [3]Jeonju University, Korea)*

8PMT-80 Thermally Stable Polymer Binders for Hybrid Separators in Lithium Ion Battery

Chulyeon LEE, Sooyong LEE, Woongki LEE, Hwajeong KIM, Youngkyoo KIM* (Kyungpook National University, Korea)*

8PMT-81 Organic Transistor Sensors with Quercetin-Embedded Polymer Nanolayers for Detecting Reactive Oxygen Species

Woongki LEE, Chulyeon LEE, Hwajeong KIM, Youngkyoo KIM* (Kyungpook National University, Korea)*

8PMT-82 Kinetics of Oxytetracycline Degradation by Oxygen-doped Graphitic Carbon and Peroxymonosulfate

Tae Hoon KIM, Ga Hyun KIM, Young Hoon KIM, Do Gun KIM, Seok Oh KO (Kyung Hee University, Korea)*

8PMT-83 Bimetallic V_2O_5-TiO_2Catalyst Coupled with Ceramic Membranes for the Facile Oxidation of di(2-ethylhexyl) Phthalate

Hyelyeon TAK, Youngkun CHUNG, Hyojeon KIM, and Seoktae KANG (Korea Advanced Institute of Science and Technology (KAIST), Korea)*

8PMT-84 Waste Resource Flow Analysis of End-of-Life Vehicles in Korea

Sora YI (Korea Environmental Institute, Korea)*

8PMT-85 The Relationship of the Materials Consumption and Economic Growth in OECD Countries

Hye-Sook LIM[1,2] ([1]Korea Environment Institute, [2]Seoul National University, Korea)*

8PMT-86 Evaluation of Correlation between Air Resistance Coefficient and Optical Porosity of Windbreak Tree, *American Arborvitae*

Taehwan HA, Siyoung, SEO, Sojin LEE (National Institute of Animal Science (NIAS), Korea)*

8PMT-87 Aqueous Mercury Removal by Sulfurized Magnetic Activated Carbon Derived from Simultaneous Activation, Magnetization, and Sulfurization of Bamboo

Che-Jung HSU[1], Ying-Pin HUANG[2], Ying-Lin WANG[1], Hsing-Cheng HSI[1] ([1]National Taiwan University, [2]Industrial Technology Research Institute, Taiwan)*

8PMT-88 Insights into Adsorption of Diclofenac on Metal-Organic Frameworks

Maria N. TIMOFEEVA[1,2], Alina V. Schvydko[1,2], Pavel A. SIMONOV[1], Sung Hwa JHUNG[3] ([1]Institute of Catalysis SB RAS, Russia, [2]Novosibirsk State Technical University, Russia, [3]Kyungpook National University, Korea)*

Abstracts

Plenary Lectures

Role of Waste to Energy (WtE) in Waste Management with Reviewing Korean Practices and Recent Activities

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In the history of waste management in Korea, systematic and integrated management has been started in the middle of 1980s with the establishment of Waste Control Law. By enforcing several specialized and discrete acts under this basic law and imposing an extended producer responsibility and a volume-based garbage charge system by the concept of polluter payment, waste management has become more effective for both general household waste and industrial hazardous/massive waste. The management has involved not only minimization of waste generation but also maximization of waste recycling with appropriate treatment options such as waste to energy (WtE) and sanitary landfill. The policy trends last several decades have focused on converting wastes into resources, and these have led to the implementation of "waste to energy and resources" and a "sustainable and circulation society" in the present and future plans for waste management. A new law called "Fundamental Law of Resource Circulation" enforced in January 2018, to create a platform of resource circulation, has played to manage wastes properly as resources. However, last several years WtE has not been dealt with renewable energy by public objections on WtE and by the national policy promoting other energy resources such as solar, wind, and hydrogen energies. A movement to vital utilization of WtE technologies was needed and a forum so called "WtE Policy & Technology Forum" endorsed by related groups of societies was established. The forum members are now working on the review of history and status of WtE in waste management, in view points of policy, technology, and public awareness, to reset an appropriate role of WtE.

The historical review of Korean waste management with pointing out some policies and technologies adopted effectively, including WtE, especially for combustible wastes, is going to be presented. Then the role of WtE in waste management practices could be identified and the necessity of related policies and technologies could be understood. Also the recent problems facing by political changes in the state of WtE, and the Forum activities which have been just started to revise such situation, will be introduced.

Keywords: Waste management, Waste to energy (WtE), Policy and technology, Forum activities, combustible wastes.

In Search of Practical Options for the Treatment of Gaseous Indoor Air Pollutants: Adsorption and Catalysis –based Techniques

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For the proper control of air quality in indoor environment, a good number of advanced technologies have been built based on catalysis and adsorption. To meet such goal, the removal of both particulate matter (PM) and gaseous pollutants (such as volatile organic compounds (VOCs)) is important. To date, the methodologies for the control of PM are well established based on advanced filtration method. However, it is not yet easy to find one good techniques to control diverse VOCs. For instance, activated carbon is superior material to effectively treat aromatic hydrocarbons (like benzene and toluene), while its adsorption suffers badly from light molecular weight species like formaldehyde (FA). To efficiently and effectively control various target species, it is desirable to learn more about the basic aspects of key treatment methodologies.

In an effort to develop novel techniques for proper air quality management (AQM), we have investigated several key methodologies for the treatment of gaseous VOCs such as photocatalysis, thermocatalysis, adsorption, and reactive adsorption. In this research, we have tested each treatment approach toward a list of target VOCs on parallel basis. Based on this research, we are aiming to deliver a new path for developing advanced methodologies to properly control air pollutants in indoor environment. As such, the results of this study are expected to help construct highly effective air purification system with enhanced upscalability for practical applications.

Key words: Photocatalysis; Thermocatalysis, Adsorption, Reactive adsorption; VOCs

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New Dimensions of Porous Coordination Polymers/Metal-Organic Frameworks

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The recent advent of porous coordination polymers (PCPs) or metal-organic frameworks (MOFs) as new functional microporous materials, have attracted the attention of chemists and physicists due to highly efficient capacity of storage, separation and conversion of gaseous substances[1]. We have found unique porous properties of porous coordination polymers (PCPs) or metal-organic frameworks (MOFs), which respond to specific guests, dissimilar to the conventional porous materials. The 3rd generation PCPs (Soft porous crystals) possess flexible or dynamic porous frameworks[2], which reversibly respond to external stimuli, not only chemical but also physical, unlike the 2nd generation compounds (Robust PCPs). Besides normal storage, soft PCPs have vast potential for separation with an extremely high selectivity[3,4] highly efficient storage, and catalysis, as well as sensing and actuator functions. For these reasons, many studies investigate these materials. Here, I discuss porous materials with capabilities that exceed current ones, which we call the 4th generation PCPs, for current environment and energy issues [5,6]. It would be fabulous if novel porous materials possessed more features than just the 3rd generation's excellent characteristics (flexibility, collectivity, and diversity). These additional features include 1) Hierarchy and Hybrid (double-H), which means to combine different functions and pursue the dynamic development of combined functions, (2) Anisotropy and Asymmetry (double-A), which means to learn from living organisms and then go beyond such organisms' capabilities, and (3) Disorder and Defect (double-D), which may lead to excellent catalytic reactivities and electronic functions. Hereinafter these three characteristics are referred to collectively as "HAD" characteristics.

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Emergent Materials for Energy, Environment and Health

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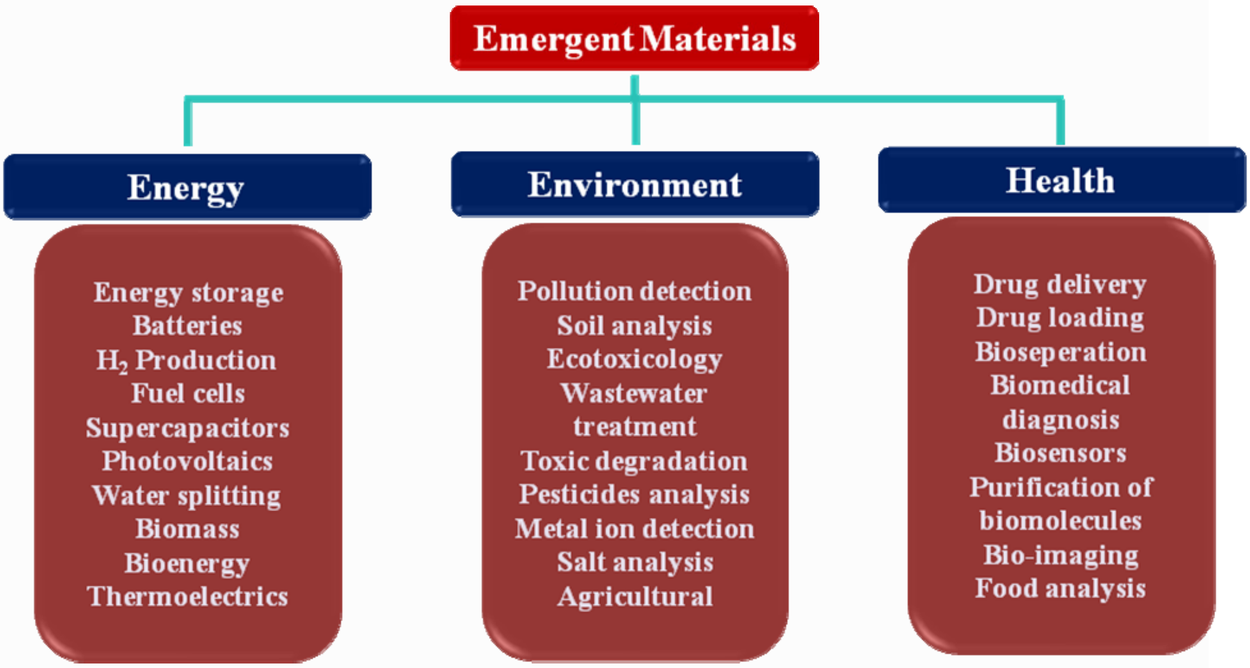
Recent years have witnessed renewed activities in developing emergent advanced materials in areas of chemistry, physics, biology, medicine, pharmacy and engineering. For over the past years, our activities on the development of advanced **Emergent Materials** that focus on the environment, energy and health reflecting to bring the best of research results to the international research community. Our focus has been to design, synthesize, and characterize the advanced hierarchical nano-structured materials, self assembly of materials, polymers, composites, membranes, green and sustainable materials, micro and nano materials, carbon-based functional materials for H_2 production for greener environment as alternative to fossil fuels and nanodevices in drug delivery area. Representative examples of the following topics will be discussed.



Keywords: Energy, Health, Environment, Materials, Applications

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Abstracts

Keynote Lectures

Preparation of Aromatic Compounds by Catalytic Hydrogenation of Lignin in Biphasic System

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Faced with the current dual pressures of energy shortage and environmental protection, the development and utilization of lignocellulose biomass have been paid attentions in the world [1]. Valorization of lignin towards valuable chemicals and biofuels has increasing economic viability of integrated bio-refineries [2]. Due to the complexity of its molecular and aggregate structure and the heterogeneity of physicochemical properties, a green and efficient method of utilization has not yet been found. Therefore, the effective use of lignin and reducing environmental pollution has become a hot and difficult issue in current research. Based on the current research and development trend of high-efficient utilization of lignin, this abstract introduced the preparation of aromatic compounds by catalytic depolymerization of lignin (and its model compounds) in biphasic system. The main contents are as follows:
1) The amphiphilic nano-catalyst Ru/xNb_2O_5-yMC, Ru supported on niobium-carbon composite support (hydrothermal method), was prepared by incipient wetness impregnation. 2) The amphiphilic catalyst (Ru/40Nb_2O_5-60MC) high-selectivity on cleaving the C-O bond while retaining the C=C bond of the benzene ring in the probe experiments of lignin monomer and dimer model compound in a biphasic catalytic system [3]. 3) The preparation of phenolic compounds by the biphasic catalysis was carried out using native lignin from birch wood. 14.0% of aromatic monomers were obtained in the water/decalin biphasic system under mild reaction conditions (1% Ru/40Nb_2O_5-60MC, 200 ^oC, 4h). In addition, the biphase catalytic system achieves a higher material flow and energy flow, which more than 80% of the carbon flows to the liquid phase product, and 14% of them flows to the small molecule compounds (i.e., the aromatic compounds). In the meantime, more than 50% of the energy flows into the bio-oil (i.e., large molecular compound).

Keywords: Lignin, aromatic compounds, catalytic hydrogenation, biphasic system

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The Role of Renewable Energy in Global Transformation for a Sustainable Energy Future

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Renewable energy has a very crucial role in meeting the sustainability of energy demands in the future. It was reported that renewable energy, primarily biomass, solar PV and wind can meet at least two-thirds of the global energy demand. Although the cost of renewables have considerably been on the decline due to intensive research and development activities, but it is still relatively expensive for many developing and less developed countries. In this regard, enabling policy and regulatory framework has a very crucial role and especially support from developed countries can further mobilize and accelerate the utilization of renewable energy. Nevertheless, the recent decision by European Union to gradually ban the use of biofuels derived from palm oil may be seen by many as a step backward in the development of renewable energy. Although having access to affordable and sustainable energy is one of The Sustainable Development Goals (SDGs), one has to remember that another equally important goal is to end extreme global poverty. The palm oil industries primarily in Malaysia and Indonesia has lifted millions of people out from the poverty bracket and this fact should not be ignored for future decisions on the fate of oil palm utilization as feedstock for biofuels. On the other hand, a truly sustainable energy future can only be achieved with a shift in societal mind-set and life-style change to go hand-in-hand with technological and economical advancement in renewable energy development.

Keywords: Life-style change; Societal mind-set; SDGs; Sustainable; Palm Oil

Microwave Vacuum Pyrolysis Conversion of Biomass Waste into Cleaner Biofuel, Bioplastic Feedstock and Value-added Carbon

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Microwave vacuum pyrolysis is a thermal process performed using microwave heating and vacuum condition in an inert environment that can break down and convert biomass to produce useful liquid oil, gases, and char products. This technique has been applied for recovering the energy and chemical value of various types of biomass waste, comprising forestry waste, furniture waste, fruit waste, waste cooking oil, agricultural waste, and palm oil waste. The pyrolysis showed advantages in providing a fast heating (up to 80 °C/min), relatively shorter process time and lower energy consumption, representing a method that is potentially faster and more energy efficient compared to that shown by the method commonly performed using conventional heating source. The pyrolysis produces liquid oil products for potential use as cleaner biofuels and feedstock for bioplastic production, and also solid products such as biochar and activated carbon that can be refined for use in waste treatment. Our findings show that microwave vacuum pyrolysis shows potential as a promising pyrolysis approach with improved heating performance and generation of useful products with desirable properties. These have led to outputs such as joint research with international partners, patent filing, company licensing, journal publications, awards and industrial partnership for prototype development, distribution and application.

Keywords: Pyrolysis, Microwave, Biomass, Waste, Biofuel

The 2019 Report of The Lancet Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today is not Defined by a Changing Climate

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Climate change is already damaging the health of the world's children and is set to shape the wellbeing of an entire generation unless the world meets Paris Agreement targets to limit warming to well below 2˚C. The 2019 report of the Lancet Countdown on Health and Climate Change published in *The LANCET* comprehensively tracks progress across 41 key indicators, demonstrating what action to meet Paris Agreement targets—or business as usual—means for human health. The project is a collaboration between 120 experts from 35 institutions including the World Health Organisation (WHO), World Bank, University College London, and Tsinghua University. For the world to meet its UN climate goals and protect the health of the next generation, the energy landscape will have to change drastically, and soon, the report warns. Nothing short of a 7.4% year-on-year cut in fossil CO_2 emissions from 2019 to 2050 will limit global warming to the more ambitious goal of 1.5°C.

Lifelong health impacts of business as usual: If the world follows a business-as-usual pathway, with high carbon emissions and climate change continuing at the current rate, a child born today will face a world on average over 4˚C warmer by their 71st birthday, threatening their health at every stage of their lives.

Infants will be among the worst affected by crop failures: As temperatures rise, harvests will shrink—threatening food security and driving up food prices. When grain prices spiked in 2007–2008, for example, Egypt's bread prices rose 37%. Over the past 30 years, global yield potential of maize (-4%), winter wheat (-6%), soybean (-3%), and rice (-4%) has fallen. Infants and small children are among the worst affected by malnutrition and related health problems such as stunted growth, weak immune systems, and long-term developmental problems.

Children will be particularly susceptible to infectious disease outbreaks: Children will be particularly susceptible to infectious diseases that rising temperatures and changing rainfall patterns will leave in their wake. Over the past 30 years, the number of climatically suitable days for *Vibrio* bacteria (that cause much of diarrhoeal disease globally) have doubled. The threat is particularly high in the Baltic (with a record high of 107 suitable days in 2018) and in Northeast USA where the sea has been warming rapidly.

Similarly, changing weather patterns are creating favourable environments for Vibrio cholerae bacteria, with global suitability rising almost 10% since the early 1980s—increasing the likelihood of cholera outbreaks in countries where the disease does not regularly occur.

Spurred on by climate change, dengue is the most rapidly spreading mosquito-borne viral disease in the world. Nine of the 10 most hospitable years for dengue transmission have occurred since 2000, allowing mosquitoes to invade new territories across Europe. Around half of the world's population are now at risk.

Air quality will worsen—further damaging heart and lung health: Through adolescence and into adulthood, a child born today will be breathing more toxic air, driven by fossil fuels and made worse by rising temperatures. This is especially damaging to young people as their lungs are still developing, so polluted air takes a great toll, contributing to reduced lung function, worsening asthma, and increasing the risk of heart attacks and stroke.

As global CO_2 emissions from fossil fuels continue to rise (up 2.6% from 2016-2018), energy supply from coal is increasing (up 1.7% from 2016-2018), reversing a previous downward trend, while premature deaths related to PM2.5 remain stagnant at 2.9 million worldwide. Coal contributed to over 440,000 premature deaths from PM 2.5 in 2016, and likely over 1 million deaths when all pollutants are considered.

This might only be the tip of the iceberg, researchers say. If Europe were to experience PM2.5 at 2016 levels over the lifetime of the current population, economic losses and health costs of air pollution-related disease and premature death could reach €129 billion a year.

Watts, N., et al., 2019. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. **The Lancet**, 394(10211), pp.1836-1878.

Throughout their adult lives, extreme weather events will intensify: Later in life, a child born today will face increased risk from severe floods, prolonged droughts, and wildfires. 152 out of 196 countries have experienced an increase in people exposed to wildfires since_2001-2004—with a financial toll per person 48 times larger than flooding. India alone saw an increase of more than 21 million exposures, and China around 17 million, resulting in direct deaths and respiratory illness as well as loss of homes.

As the fourth hottest year on record, 2018 saw a record-breaking 220 million more over 65s exposed to heatwaves than in 2000 (63 million more than in 2017)—with older city dwellers with chronic health conditions in Europe and the Eastern Mediterranean most vulnerable to heat-related illness such as stroke and kidney disease. Last year, Japan had 32 million heatwave exposures, equivalent to almost every person over 65 experiencing a heatwave.

More frequent and longer heatwaves will redefine global labour capacity, the report warns. In 2018, a potential 45 billion additional hours of work were lost due to extreme heat globally compared to 2000. Amid last year's prolonged heatwaves, outdoor agricultural and construction workers in southern parts of the USA lost as much as 20% of potential daylight hours during the hottest month.

Urgent action needed to protect the health of the next generation: If the world's actions match the ambition of the Paris Agreement pathway, that limits global warming to well below 2˚C, a child born in the UK today could see an end to coal use by their 6th birthday, with the growth of solar and wind energy resulting in cleaner air across the country.

In France, the last petrol and diesel cars will be sold by the time they turn 21, with cycle ways and green spaces supporting healthier more liveable cities. By their 31st birthday, a child born today could see the world reach net-zero emissions, ensuring a healthier future for coming generations from cleaner air, safer drinking water, and more nutritious food.

Despite the scale of the challenge, the report offers some reason for cautious optimism—growth in renewables accounted for 45% of total growth in power generation in 2018 (27% from wind and solar power); while use of electricity as a fuel for road transport grew by almost 21% globally from 2015 to 2016; and low-carbon electricity accounted for a third of total electricity generation in 2016.

Watts, N., et al., 2019. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. **The Lancet**, 394(10211), pp.1836-1878.

Oil Field Contamination and Remediation in Mongolia

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Since 1940s thirty two prospective blocks of oil deposits were identified in Mongolia for petroleum exploration. Currently two petroleum blocks, namely, the Toson-Uul XIX with reserve of 179 million tons and Tamsag XXI with reserve of 127 million tons has been under oil exploration and extraction by Petro China Daqing Tamsag LLC in Matad and Khalkhgol soums of Dornod province. In the Toson-Uul XIX block 10,192 barrels (1350 tons) of oil per day is produced from 381 wells with direct exports of crude oil to China, whilst 12,054 barrels (1600 tons) of oil is produced from 218 wells in the Tamsag XXI block and crude oil is exported to China as well. During drilling, transportation, storage and export related operations soil and groundwater in Menen steppe have been considerably polluted by crude oil, salts which are used in drilling, and heavy metals. In order to achieve sustainable development goal of country and comply with the Petroleum Law of Mongolia and the Law on Prohibition of Mineral Exploration and Mining Activities in Mongolia a detailed survey for defining pollution sources and selecting remediation methods has to be carried out in Tamsagbulag oil field. Up till now only physical reclamation method has been employed in Mongolia. Since 2014 a suitable remediation method for oil-contaminated soil have been tested in both oil-spilt and intentionally-contaminated soils at laboratory and outdoor condition. Bioaugmentation method was proved to be a good remediation method in batch test in controllable condition. However, biostimulation method has been a better remediation method in pilot test under ambient condition.

Keywords: crude oil, Tamsagbulag oil field, bioaugmentation, biostimulation, bio-waste

Mechanical, Durability and X-ray Micro-Computed Tomography Investigation of Biochar-Admixtured Cement-Mortars

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The cement industry is a major CO_2 emitter worldwide accounting for nearly 7-8% of global carbon dioxide emissions. The number is expected to grow in the near future given the demand for cement world-wide. Additionally, the excessive extraction/usage of sand results in the erosion of the land, destruction of riverine and coastal environment which ultimately affects ecosystem health. Therefore in an effort to reduce CO_2 emissions and seeking alternative materials for mortar, we investigated the use of sand and biochar as fillers in construction materials. The carbon-rich biochar addition in the construction activities results in an effective way of carbon sequestration in the ecosystem and provides an effective replacement for the fine aggregates.The use of biochar as an admixture in the cement-mortars has potential to sequester CO_2 in the process. As part of this study, we used poultry litter derived biochar to replace sand in the range of 10-40% of the total weight in cement mortars. A total of four mix designs (with 10%, 20%, and 40% replacement with sand and control) were used to cast the blocks and tested for their mechanical strength, durability, thermal conductivity and water adsorption. X-ray micro computed tomography analysis was performed on mortars to gain insights into the relationship between overall porosity of the block and biochar particles. The flexural strength of the composites at 20% biochar replacement of sand was improved by 26% as compared to control. Biochar addition lowered the thermal conductivity of the cement mortars and was optimised at 10% addition. The density of the mortars decreased approximately by 20% with 40% biochar addition. Micro-CT analysis showed nearly a five-fold increase in the 2-dimensional porosity of the sample, however, no marked changes were observed for samples which contained 20% biochar. An estimation of using mortar plastering as an example for 100 m^2 area with standard thickness of 12 mm revealed that CO_2 emissions could be decreased by 20% when sand is replaced with 40% biochar.

Keywords: Biochar, thermal conductivity, density, porosity, tomography, compressive strength

Recent Developments of Biomass Catalytic Fast Pyrolysis: Strategies for the Optimization of Bio-oil Quality and Yield

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Abstract

Catalytic fast pyrolysis (CFP) has been seen as an attractive route to convert biomass to high-quality of bio-oil through deoxygenation of pyrolysis vapors in the form of H_2O, CO and CO_2. However, the deoxygenation process always comes at the expense of bio-oil yield drop. In this paper, the catalytic effects of various catalysts, focusing on the recent improvements on the design of advanced catalysts are summarized. Evidence is given that basic metal oxides (e.g. MgO and CaO) are promising alternative catalysts to zeolites (such as ZSM-5) regarding the preferred decarboxylation reaction. However, in spite of some interesting results reported in literature, it is impossible to obtain a clear understanding on catalysts or system design principles in terms of producing bio-oil with both high quality and high yield, since most studies have reported their results in different forms. Hence, a uniform data exhibition form is necessary for the further development of biomass CFP technology. Additionally, the integration strategies of CFP with pre-upgrading of pyrolysis volatiles, which aims at increasing the yield of high-quality bio-oil, are also discussed. The system complexity and economy are the main challenge of this process.

Keywords: biomass, catalytic fast pyrolysis, bio-oil, quality, yield

Effective Dispersion of MgO Nanostructure on Biochar Support for Glucose Isomerization

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Abstract

Glucose isomerization to fructose is one of the most important reactions in the field of biomass valorization. We demonstrate wood waste valorization with MgCl2 salt to synthesize an environment-friendly catalyst (i.e., MgO-biochar), which exhibits effective glucose-to-fructose isomerization with over 30% fructose yield and 80% selectivity at only 100 °C for 30 min in water as a green medium. This study highlights that one-step synthesis can effectively disperse and tether MgO nanostructures to the biochar matrix, which displays a significant reduction of Mg leaching compared to MgO-biochars produced by two-step synthesis and pure MgO. The MgCl2 acts as a porogen that facilitates the formation of a porous biochar structure and dispersion of nanostructured MgO. We identify key parameters of impregnation media (ethylene glycol, ethanol, and water) and pyrolysis conditions (600/750 ^{o}C in N2/CO2 atmosphere) that are responsible for adjusting the reactivity and stability of MgO, which enable the design of more effective and recyclable biochar catalysts. Weak interactions between MgCl2 and biomass in the presence of aqueous miscible organic solvents as shape-directing agents are accountable for fast leaching of Mg from the MgO-biochar surface. The FTIR spectra confirm the existence of various coordinations on the hydroxylated surfaces of MgO-biochar surfaces. The mesoporous structures of the biochar support enhance the stability of MgO moieties as revealed by BET, XRD, and Raman analyses. Given the benefits of effective MgO dispersion on the biochar support, we can reduce the amount of MgO active species involved in each reaction run, which mitigates over-reaction compared to pure MgO catalysts and achieves high fructose yield and selectivity for three consecutive cycles.

Keywords
heterogeneous basic catalysts; engineered biochar; waste management; sustainable biorefinery; metal-biomass interaction.

Can Biochar's be a Solution to Remediate Contaminated Paddy Soils?

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Healthy food production is imperative for human health. However, many wetland soils are polluted with toxic elements such as arsenic, cadmium, mercury, antimony and others. In particular, paddy soil are very vulnerable since they serve as producer of food, including rice. Paddy soils are regularly flooded and thus, they underlie large fluctuations of redox conditions. Those changes of redox conditions have considerable impacts on the biogeochemical behavior of toxic elements as well as on pH, carbonate, and carbon solubility, chemistry of iron, manganese, and sulfur as well as on microbial community, which control the mobilization of toxic elements.

Doubtless, the redox potential and pH are master variables in governing those mobilization processes. We are able to conduct experiment in the laboratory to study mechanistically the release dynamics of toxic elements. Also, we are seek for suitable amendments to stabilize those toxic metals in the soil which should be stabile even under dynamic redox conditions. Biochar is considered as one option to fulfill this purpose. Results gained at various scales (laboratory and field scale) will be presented.

Keywords: biochar, toxic element, soil contamination

Fate of (E)- and (Z)-Endoxifen in Water and Secondary Treated Wastewater Under Sunlight

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Endoxifen is the main metabolite of tamoxifen, a common cytostatic drug. Endoxifen has been recently detected in the final effluent of wastewater treatment plants (WWTPs). The antiestrogenic activity of endoxifen could bring negative effects to aquatic lives if released to the water environment. This study determined the fate of endoxifen isomers (E and Z) in secondary treated wastewater and receiving surface water under sunlight. It focused on photodegradation efficiency and kinetics, and potential phototransformation by-products (PBPs) and their toxicity. Based on laboratory-scale experiments, the concentrations of endoxifen isomers in wastewater were reduced by at least 83% after 150 minutes of solar radiation whereas in surface water samples, endoxifen was photodegraded by 61% after 150 minutes of irradiation. Eight PBPs were identified and toxicity analysis via modelling revealed that seven of these PBPs are potentially more toxic than endoxifen itself. Therefore, highly toxic PBPs are potentially generated at WWTPs if endoxifen is present in the wastewater exposed to sunlight. Endoxifen remaining in the effluent could be a source of toxic by-products in receiving surface water under sunlight. The findings from this study suggest that treatment methods to effectively mineralize endoxifen and/or degrade the toxic PBPs further to non-harmful by-products should be investigated.

Keywords: By-products, endoxifen, photodegradation, toxicity, and sunlight

Coupled Sulfur and Iron (II) Carbonate-driven Autotrophic Denitrification Nitrogen Removal

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Abstract: Very recently, new sewage discharge standards have ben launches at national and local levels in China, which are featured by stricter limitations for pollutants discharge including total nitrogen. Sulfur driven autotrophic denitrification (SAD) technologies is receiving increasing attentions, owe to its cost-effective and independent on the adding of organic carbon, a factor may result in the unexpected increase of COD concentration in the effluent when using traditional heterotrophic denitrification (HD) process. However, SAD suffers from acidification and relative low denitrification rate, which, to a certain extent, limits its engineering application. Here, we propose a novel sulfur-based denitrification process, which introducing siderite ($FeCO_3$) as a co-electron donor and buffer agent (sulfur-iron (II) carbonate driven autotrophic denitrification, SICAD). Compared to the SAD, the denitrification rate in SICAD was found to be 132% higher. By employing multiple characterization and analysis approaches, we revealed the synergistic mechanism of sulfur and siderite in terms of pH stabilization, biomass promotion and reaction zone extension. Towards engineering application, we developed a new type of reactive composite carrier (RCC). In addition, a manufacture line of RCC was developed with the capability of fast producing RCC with controlled the sizes. By testing the RCC in a pilot-scale reactor (400 m^3/d), the results showed SICAD process is a highly efficient nitrogen removal technology and hold great potential of engineering application. A demonstration plant with capacity of 10000 m^3/d is under construction.

Keywords: autotrophic denitrification; Sulfur driven autotrophic denitrification; sulfur-iron (II) carbonate driven autotrophic denitrification; reactive composite carrier

Responses of Plant and Soil to Iron-Modified Biochar in a Paddy Soil Contaminated with Heavy Metals

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A pot experiment was conducted to evaluate the effect of raw (RawBC) and iron-modified (FeBC) biochars derived from oriental plane (*Platanus orientalis* Linn) branches on the bioavailability and uptake of arsenic (As), cadmium (Cd) and lead (Pb) by rice in a paddy soil under different water regimes (continuously flooded (CF) and alternately wet and dry (AWD). Application of RawBC (3%, w/w) significantly (P<0.05) increased the soil pH, while the Fe-modified biochar (FeBC) noticeably decreased the pH value. Both biochars increased the soil organic carbon content. The concentrations of soil available As, Cd, and Pb significantly (P<0.05) decreased after biochar amendments. The FeBC had better effect in reducing the availability of As and Pb in the soil, particularly under the AWD water regime, while RawBC was more conducive in reducing the content of soil available Cd, particularly under the CF water regime. The FeBC decreased As concentration, while it increased the concentration of Cd and Pb in the straw and brown rice as compared to the untreated soil. Soil catalase and urease activities were enhanced by the RawBC but decreased by FeBC treatment. The FeBC had more advantages in increasing the yield of rice, which increased the grain yield by 60 and 32% in CF and AWD treatments, respectively. In conclusion, the FeBC was more suitable for remediation of As contaminated soil but increased the uptake and translocation of Cd and Pb to the brown rice, and decreased the soil catalase and urease activities. Our findings suggest that the FeBC can be recommended for immobilization of As; however, a potential human risk of Cd and Pb in FeBC-treated paddy soils should be considered due to increases in their uptake and translocation of the metals to brown rice.

Keywords: Metal(loid)s; bioavailability; water management; soil enzyme; wetland soils.

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Utilization of Biochar in Catalytic Applications

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Our work investigates the utilization of biochar in catalytic applications, where biochar presents a low cost alternative to conventional catalysts. Biochar produced from waste biomass has been demonstrated to have catalytic activity that is attributed to its high surface area and inorganics, which are highly dispersed the surface of the char. In order to produce effective catalysts from biochar, it is critical to understand how its properties influence its catalytic activity.

Forestry or agricultural residues are used as feedstocks in order to produce biochar via thermochemical conversion methods such as pyrolysis and gasification. The feedstocks were selected in order to represent biomass materials that are of low value, and have limited alternative uses. Biochar was produced at temperatures between 400-950 °C under N_2, CO_2, and H_2O. Biochar properties were characterized via BET, SEM/EDX, and TPD. Catalytic decomposition of methane was applied in order to quantify the catalytic activity of the biochar.

The biochar was analysed for a variety of properties that influence its catalytic activity, such as surface area, porosity, composition, and surface chemistry. Biochar from gasification had very high surface areas, ranging from 450 – 680 m^2 g^{-1}, which is higher than that of biochar generated from most pyrolysis processes. Micropores were observed in the biochar produced from gasification, and porosity was dependent on the gasification conditions. Both acidic and basic C-O functional groups were identified on the biochar surface. Our work showed that when biochar is used as a catalyst, the methane decomposition reaction has a lower light off temperature and higher overall conversion compared to conventional catalysts, such as alumina and platinum. Higher surface area resulted in increased catalytic activity. However, diffusion limitations were observed in the micro pores of the char. Inorganic metals were highly dispersed on the biochar surface, and the conditions under which the char is made influence the dispersion of inorganics. Biochar made under CO_2 had highly dispersed inorganics which resulted in improved catalyst performance, indicating that gasification under CO_2 is beneficial due to the ability to preserve the catalytic sites.

In order to develop effective biochar catalysts, it is critical to understand its surface properties. This will enable us to tune the biochar properties in order to produce specialized catalysts.

Keywords: Biochar, catalyst, gasification, biomass

Advances in Biofuel Production from Microalgal Biomass

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The development of renewable energy technology has attracted a great deal of attention and has a remarkable progress over the past several decades. To date, bioenergy accounts for the largest share among the developed renewable energies, and it has been widely employed in developed, developing, and under developed countries. The prime purpose of bioenergy is to produce biofuels as alternatives to fossil fuels. Because biofuels derived from biomass pertain to carbon-neutral fuels, the applications of biofuels can lessen the fossil fuel consumption, abate greenhouse gas emissions, and mitigate atmospheric greenhouse effect and climate change. Compared to terrestrial plants, microalgal biomass cultivation uses much less land to produce an equivalent amount of biomass. Microalgae are characterized by their rapid growth and high photosynthesis and carbon fixing efficiencies; accordingly, better carbon capture and storage are achieved while they grow and are harvested. From the aspect of biofuels, microalgae can be converted to solid, liquid, and gas biofuels, depending on the thermochemical conversion processes. In this study, the advances in microalgae torrefaction for biochar production, pyrolysis for bio-oil production, and gasification for syngas production are addressed. The advanced kinetic models accounting for the thermal degradation of microalgae will also be underlined to show the potential of microalgae as feedstocks for biofuel production.

Keywords: Biomass, microalage, biofuel, thermochemical conversion, kinetics.

Assessing Global Water Sustainability in the Recovery of Unconventional Oil and Gas Resources

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Hydraulic fracturing is a widespread technology for the recovery of hydrocarbons trapped in low permeability geologic formations, and the process has led to a global energy revolution over the past decade. However, fracturing is a water-intensive process and concerns have arisen from the public, governmental agencies, and other stakeholders about the sustainability of the hydraulic fracturing water cycle with regards to both water sourcing and the handling, treatment and disposal of produced water that returns to the surface. Water represents one of the largest components of fracturing field activities, and optimizing the water cycle promises to generate cost savings. Numerous factors control the sustainability of the fracturing water cycle in a particular region, including the availability of freshwater resources, options for the treatment and reuse of produced water, and whether the region is permanently or periodically water-short.

In this study, we extracted data for millions of hydrocarbon wells in North America to create a massive database of water use practices in conventional and unconventional oil and gas production. Focusing on the handling, treatment and disposal of produced water, we combined two key parameters – the volume of water produced and its total dissolved solids (TDS) – we developed a new parameter called total produced salts (TPS) which better describes the combined impacts of volume and salinity. TPS represents a new and more sophisticated tool to advance and improve the overall sustainability of produced water handling, treatment and disposal in the hydraulic fracturing water cycle at regional to national scales.

Keywords: hydraulic fracturing, water cycle, sustainability, shale gas

Mineralization and Nutrient Releasing Of Biochar Compound Fertilizer in A Highly Weathering Soil

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Biochar has been considered as a useful amendment for soil physical properties. Due to fertility deficient of the biochar, it's a better way to combine extra fertilizers with the biochar in soils. In this study, we produced a granular compound biochar fertilizer (gCBF) by combiming the biochar with bagasse compost, and then applied it into a degraded red soil (Ultisol) to evaluate its effects on nutrient releasing in the soil. This study produced four gCBFs composed by different ratio of the biochar and the compost, which are biochar-compost (1:3, w/w) (BC3), biochar-compost (1:1) (BC1), biochar only (B), and compost only (C), respectively. The four gBCFs were put in tea bags and then be buried into the soil for incubation of 180 days. The tea bags were collected and weighted at 1, 3, 7, 15, 30, 60 and 180 days, respectively, to evaluate the decomposition rate of the BCFs. We also collected soil solution from gBCF-amended soils by using zero tension lysimeter to assess dynamic variation of nutrient releasing during incubation. The results indicated that the highest decomposition rate (45%) of gBCFs was found in C-treated soil, and followed by treatments of BC3 (30%), BC1 (28%) and B (19%) after 180 days. Regarding nutrient releasing dynamics, all treatments were almost beginning to level off after 7 days incubation and the BC3 treatment could still maintain high concentration of nutrients including NO_3^-, Ava. P and Exc. K until the end of incubation. The pot experiments were also carried out by plaiting of *Brassica rapa chinensis*, the highest crop productions ($p < 0.05$) were found in the BC3 treatment for the 1st and 2nd crop planting during 2 months.

Keywords: Biochar, decomposition, nutrient releasing.

Effect of Microplastics on the Removal of Pollutants from Aqueous Medium by using Carbon Materials

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This study evaluated the effect of polyethylene (PE) microplastics on the removal of Cr(VI) by activated carbon (AC) in aqueous media. Different influences of PE on the removal of Cr(VI) by AC could be attributed to variable adsorption of Cr species on PE under lower AC dosage condition, and formation of AC coating on PE surface at high AC dosage. What's more, the effect of PE microplastics on the removal of norfloxacin by Carbon Nanotubes (MCNT) has also been investigated. The addition of PE microplastics will reduce the adsorption capacity of MCNTs on NOR. The agglomeration between PE and MCNT would reduce the effective adsorption sites for MCNTs.

Keywords: Microplastics, activated carbon (AC), Cr(VI), norfloxacin

Geochemical Distribution of Gallium, Indium, and Thallium and Their Availability in Highly Weathered Soils

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Emerging contamination elements (ECEs) attracted great public due to their potential risks to the environment and human health. Among ECEs, gallium (Ga), indium (In), and thallium (Tl) are ones of the key elements used in the critical technologies including wireless, optoelectronics, and liquid-crystal display industry. Ga, In, and Tl naturally exist in soils and their contents vary with soil types derived from different parent materials. Taiwan, highly developed in the critical-technologies, is the largest producer of wafer foundry and integrated circuit ackaging and testing in the world. Ultisols and Oxisols, well known as highly-weathered soils, are common soil types on the river terraces of tablelands in Taiwan which contain over one thousand factories for the ECE-containing equipment production. Hence, the aims of this study were to (i) determine the range of concentrations of Ga, In, and Tl in the soils (n=53) by using total element analysis and EDTA extraction, (ii) evaluate the potential availability of these ECEs in the soils, and (iii) illustrate relationships among and between element and general soil properties controlling distributions and amounts of elements. Ga in the soil ranged from 9.47 to 23.4 mg kg^{-1}. In ranged from 4.77 to 37.1 μg kg^{-1}, with a mean of approximate 17.0 μg kg^{-1}; Tl ranged from 55.7 to 206 μg kg^{-1} in all samples. However, Ga, In, and Tl showed irregular trend with soil depth. The EDTA-extractable amounts of Ga, In, and Tl accounted less than 50% of their total contents in all cases. The EDTA-extracted ECEs significantly correlated with soil total ECEs, CEC, DCB-extractable Fe, and clay. We used a multivariate regression to predict the availability of elements (EDTA extraction) as a function of general soil properties. The equations of multivariate regression were only at a significant level of confidence using the following equations: available Ga = 0.073×(total Ga) + 0.014×(clay) – 0.43 (R^2 = 0.27, n=53, $p < 0.01$); available Tl = 0.22×(total Tl) + 0.56×(clay) – 22.5 (R^2 = 0.74, n=53, $p < 0.001$). However, the prediction of In availability by these attributes was invalid because of poor correlations between EDTA-extractable In and total In and other soil properties.

Keywords: Emerging contamination element, soil contamination, technology-critical element, bioavailability

A Review of the Health Impacts of WTE Facilities

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There has been considerable progress made with waste to energy (WTE) facilities over the past several years. Many countries that previously did not have WTE facilities have begun to construct them as they recognize the benefit of WTE for sustainable waste management. Those newly constructed facilities have created visibility for the WTE industry locally and worldwide. Some of that visibility has resulted in public concern over health impacts of WTE facilities based on outdated or incorrect information. There is a large body of scientific and engineering literature in the public domain that quantitatively documents the performance of WTE facilities and impacts of adhering to a sustainable waste management strategy. The longstanding and well-documented scientific consensus is that human health is not adversely impacted by WTE. As far back as 20 years ago, a National Research Council report in 2000 stated that pollutants such as particulate matter, lead, mercury, and dioxins and furans from well-run WTE facilities are expected to contribute little to environmental concentrations or to health risks. The presentation will cover the latest information in the peer-reviewed literature on health impacts of WTE facilities.

Conversion of biochar to solid acids with sulfonate groups for spiramycin hydrolysis: Insights into the sulfonation reaction and the aromatic properties of the feedstock

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Biochar has been recognized as a sustainable platform for developing functional materials including catalysts. This work demonstrated a method of converting biochar to sulfonated solid-acid catalysts for spiramycin hydrolysis, and intensively investigated the effects of sulfonation reaction and the aromatic properties of the feedstock during the conversion. Initially, two biochar samples (H and X) were sulfonated with three reagents (concentrated H_2SO_4, $ClSO_3H$ and p-toluenesulfonic acid (TsOH)) under hydrothermal, simple heating, ambient temperature, and $CHCl_3$-assisted treatments. The effect of elemental compositions and structural characteristics of the feeding materials (H and X) on the acidic properties of the sulfonated biochars were investigated. The results showed that the sulfonation ability of the three reagents was in the order of $ClSO_3H$ > H_2SO_4 > TsOH, while hydrothermal treatment provided the highest total acidity, and largest number of acidic groups (e.g., SO_3H, COOH and Ar-OH). Biochar X with higher O/C and N contents, and less graphitic features showed superior acidic properties than biochar H under all the employed treatments. The hydrolytic efficiencies of the sulfonated biochars under 200 W of microwave irradiation increased with increasing total acidity, and the amount of SO_3H and COOH groups. After sulfonation, the O/C of biochars increased, while H/C decreased, and the aromatic and graphitic features did not change. The electromagnetic energy absorbed by the sulfonated biochars did not notably contribute to spiramycin hydrolysis. Further, biochars were prepared under 300-650 ^{o}C, and the effect of aromaticity and degree of condensation of these biochars on the sulfonation conversion were examined. The results indicated that low aromaticity and degree of condensation facilitate the sulfonation and promote the reaction to achieve high amounts of acidic groups. The H/C values dropped with increasing numbers of benzene rings in the condensed polyaromatic carbon clusters by a topological analysis, which made the total available sulfonation sites decreased. Thus, this work demonstrated an effective and promising method for maneuvering biochar-based functional solid-acid catalysts for antibiotic remediation in contaminated water.

Keywords: biochar, sulfonation, solid acids, hydrolysis, spiramycin

Utilization of Nanocomposites for Management of Water Contaminants

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The contamination of water resources has increased many fold with advancement in technology. The organic and inorganic micropollutants with toxic and carcinogenic nature are contaminating the water bodies that ultimately cause numerous health-related issues. The long persistence nature of these contaminants in the environment make the situation more critical. The access to potable water demands simplified and cost-effective procedures for monitoring the quality of water on regular basis. Nanomaterials exhibiting novel physical and chemical properties offer great promise to combat environmental pollution. The ability to modify surface properties of nanomaterials in controlled fashion provide unique opportunities to design and develop efficient devices with improved features. The physiochemical properties of nanomaterials are dominated mainly due to their structure that make these novel materials and their composites suitable for variety of applications in different research domains. In particular, organic and inorganic hybrid nanomaterials are among the most promising developments for wastewater management. The functionality of these hybrid nanomaterials is based on the interfacial interactions between nanometric scale inorganic nanoparticles and bio-based organic polymers. The present work focuses on impregnation of nanomaterials in porous support for management of microbial contamination and sensing of emerging pollutants. Different physical and chemical routes were adopted to synthesize the nanocomposites and various process steps were characterized through spectroscopic and microscopic methods. The developed nanocomposites were evaluated for field samples as well and produced encouraging results that favorably promote the use of such hybrid materials in technological applications.

Keywords: Nanocomposites, Water contaminants, Impregnation, Pollutants, Materials.

Microalgae-based Wastewater Treatment and Resource Recovery – A Synergistic Approach

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Biological wastewater treatment using microalgae has gained considerable interest in the last few decades. Microalgal biomass, produced from a variety of wastewaters, offers a potential feedstock for a wide spectrum of industrial bioproducts from biofuels to nutraceuticals, thus contributing towards circular bioeconomy.

In this study, the potential of different microalgal (MA) species (freshwater and marine water) as well as microalgal consortia (MC), cultivated in local wastewaters in Finland, was explored. The effect of different cultivation conditions of MA and MC was examined in terms of (i) biomass production, (ii) removal efficiency of different pollutants from wastewater and (iii) the biochemical composition of biomass. After wastewater treatment, lipids were extracted from MA biomasses, which showed a variety of fatty acids from C14 to C18.

The findings of this study showed that wastewater can serve as a good source of macro- and micronutrients for the cultivation of MA and MC, while at the same time, MA and MC effectively remove pollutants from the wastewater. Further, the produced biomass can be used for the production of valuable bioproducts. The latest findings of the ongoing research at the Algal Biotechnology lab at the University of Eastern Finland will be presented and discussed in the presentation.

Keywords: Microalgae, wastewater treatment, cultivation conditions, bioproducts.

Designing Clay Minerals for Sustainable Remediation of Per- and Polyfluoroalkyl Contaminants in the Environment

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Per- and polyfluoroalkyl substances (PFAS) are extremely persistent and bio-accumulative contaminants of emerging concern. Defence activities involving aqueous firefighting foam are considered as the major point-source of PFAS contamination in the environment in addition to non-point inputs from industrial wastewater, municipal landfills and biosolids. PFAS are considered toxic to humans causing cancer, and harmful to other diverse range of organisms. Owing to high chemical, thermal and biological stability of PFAS compounds, their remediation in the environment is challenging. As one of the inexpensive and sustainable PFAS remediation strategies, this presentation aims to highlight advances in clay-based materials for removing PFAS from contaminated water.

Clay minerals with or without modification have been shown to remove PFAS compounds from water, or to immobilize the contaminants in soils. High PFAS removal performances were obtained when clay minerals were modified with different organic agents such as surfactants, polymers and amines. Some researchers employed combined inorganic-organic clay modification routes to obtain enhanced PFAS removal performance. Clay-based materials have mostly been shown to sorb PFAS compounds through both hydrophobic interaction and electrostatic attraction because of the organophilic and anionic nature of the contaminant chemicals. Environmental factors such as solution pH, presence of natural organic matter, background ion types, and ionic strength could influence the sorption efficiency of PFAS on clay-based materials. Advanced clay modification approaches such as preparation of clay-carbon composites and clay-anchored nano-photocatalysts hold potential to further improve PFAS removal from contaminated water via enhanced sorption and combined sorption-transformation mechanisms, in environmentally friendly manner. Synthesising currently available information on clay-based materials for PFAS remediation, this talk will also discuss some future research directions.

Keywords: Clay minerals; Clay modification; Removal mechanisms; PFAS; Wastewater treatment

Metal-Organic Frameworks (MOF) for Electrochemical and Optical Sensing of Bacteria

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The detection and sensitive quantification of bacteria is of great significance to ensure general health safety. The convenient, rapid, and portable detection of bacteria can be achieved with the aid of advanced functional nanomaterials. Metal-organic frameworks (MOFs) are the class of porous coordination polymers that are characterized with interesting material properties, including stable luminescence and electrocatalytic activity. The electrocatalytic activity of MOFs can be further augmented by forming their composites with other nanomaterials. We have explored various MOFs and their composites to develop simple and sensitive sensing platforms for different bacteria. Fluorescent MOFs, e.g., Tb- and Fe-based MOFs have been utilized for the fluorescence quenching based detection of dipicolinic acid, E. coli, S. aureus, etc. These sensing techniques have been based on the use of MOF as such (without modification) or preparing their bioconjugates with bacteriophages or antibodies. MOFs have also been utilized in developing electrochemical sensing platforms with amperometry or impedance spectroscopy measurement protocols. In order to improve electrochemical signals, Cu- and Fe- based MOFs have been grown-over or mixed with other nanomaterials, such as polyaniline and graphene. All the above optical and electrochemical sensing set-ups have been assessed for different quality assurance parameters like material stability, range of detection, limit of detection, etc. MOFs based sensors have successfully yielded high detection sensitivities. The MOF based platforms can be translated into paper type detection kits, simple fluorescent strips, and disposable electrodes.

Keywords: Metal-organic frameworks, bacteria, detection, optical, electrochemical

Challenges in Translational Research from Concepts of Proof to Innovative Environmental Technologies: System Complexity, Critical Barriers, and Adaptive Research Methodology

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Environmental research scientists have published tremendous amounts of findings in literature, with many plausible and innovative concepts of proof from elaborately designed and well controlled experiments. However, few of them have found ways into robust technologies and solutions for resolving real world environmental problems, despite clear-cut effects demonstrated under well controlled experimental conditions in laboratories. This is because many laboratory-scale processes lack its scalability and operability, in the real world without precisely controlled conditions and highly trained researchers. In some cases, operational risks have not been well understood or overlooked for the sake of simplicity and rapid publication purposes, which would require unrealistic control measures and sophisticated engineering once being implemented under field conditions. In many cases, expensive and unrealistic infrastructure is needed to implement the delicate technology born out of laboratory studies, leading to poor cost-effectiveness and insignificant improvements in overall advantages and benefits, and sometimes, even elevated operational risks under field conditions. These outcomes are unacceptable to end-users and investors. The present talk will illustrate the journey to translate concepts into operationally feasible technologies, by introducing the methodology of (1) system analysis of the perceived technology in complex systems, (2) the assessment of potential scalability, adaptability, operability and transferability, and (3) top-down approach to demonstrate robust effects (i.e., phenotypes) under field conditions. A system analysis method from one to multiple-dimension will be introduced for pre-assessment of the translational research needs. The importance of industry (or end-user) engagement and continual funding will be highlighted, which is critical to the success of translational research and environmental technology development. In the present talk, I would like to share my experience in the development of environmental remediation methods/techniques (such as tailings, contaminated soils) to illustrate the journey of translational research in environmental science and technologies.

Keywords: translational research, concept of proof, environmental technology, industry end-users, operability.

Distributed Waste-to-Resource Development in Glasgow

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Sustainable waste management is critical to achieving the United Nations Sustainable Development Goals. Distributed waste management systems have the advantages of shortening waste transportation distance and emissions, as well as bringing the public closer to the concept of sustainable waste management. This work will present the environmental impacts (i.e. global warming potential, eutrophication potential, and acidification potential) and economic feasibility of distributed bioenergy systems in Glasgow based on anaerobic digestion and gasification technologies. Monte Carlo simulation was used to take account of the effects of potential uncertainties in the input parameters. The distributed bioenergy systems could save over 300 kg of CO_2 per tonne of municipal solid waste treated and have profitability chances ranging from 68 to 98%, when the sale of digestate and biochar is considered. The bioenergy systems can satisfy 20–23% of electricity demands and 4–5% of heat demands of each area served.

Food waste management has been recognised as a priority waste stream that can be used to generate renewable energy and resources. The Glasgow city was divided into 23 wards each one of which was considered to have a mesophilic anaerobic digestion-based food waste treatment system with a combined heat and power unit to generate heat and electricity. The life cycle assessment and economic analysis showed that the distributed development could save 92.27 kg $CO_{2\text{-eq}}$. per tonne of food waste treated and have a net-present worth of £ 3.187 million considering a carbon tax of 50 £ $tonne^{-1}$ and a biogas yield of 190 m^3 $tonne^{-1}$.

Keywords: Distributed systems; Waste-to-Energy; Environmental Impacts; Economic Feasibility

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Development of Estimation Method of Consumption-Based National GHG Emissions

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Greenhouse gas emissions are estimated on the basis of territories, but as the global value chain changes, production bases within the territories are being moved overseas. And as a result, Carbon Leakage is occurred which greenhouse gas is leaking to outside the territory. To compensate for this, the 'Consumption-Based Emissions (CBE)' is based on the 'User Pays Principle', which shifts responsibility for GHG emissions to product users, and is mainly estimated by the Multi-Regional Input-Output method (MRIO). Estimation of GHG emissions based on CBE on the MRIO method has a problem in that the accuracy of estimation is deteriorated because data transformation occurs in the process of converting the supply-use table to the input-output table, the process of integrating commodity or industry classification, adjusting the exchange rate and etc. In this study, we review the limitations of the CBE by the MRIO method, and developed a method to estimation of the CBE by using the industry linkage table by countries (input-output table or supply-use table) to supplement this. And we estimated CBE of Korea by the developed method.

Keywords: Consumption-Based Emissions, Carbon Leakage, Multi-Regional Input-Output, Eora

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Characteristic of Ammonia Emission from the Open Poultry House System

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The annual mean concentration of PM-2.5 in Korea was 24 μg/m3 in 2018, which ranked 27th highest among the 73 countries surveyed by AirVisual. One of the causes of the increased concentration of PM-2.5 is an increase in secondary products contributing to the generation of fine dust. Substances involved in the secondary generation of fine dust include NH_3, NOx, SOx, and VOCs. Korea policies focus on controlling the amounts of NOx and SOx among those substances contributing to the secondary generation of PM-2.5. There have been few studies related to the identification of the sources of ammonia (NH_3) emissions or the application of emission factors when adequately considering the environment in Korea.

NH_3 emissions in Korea totalled 301,303 tons as of 2016, of which NH_3 from the agricultural sector accounted for approximately 78.7%. In the agricultural sector, the NH_3 emissions in the livestock sector amounted to 217,464 tons, accounting for approximately 92% of the NH_3 emissions in this sector, and thus an accurate estimation and management of such emissions is important Regarding the estimation of NH_3 emissions in Korea, the emission factors developed by the US EPA and CORINAIR in Europe have mainly been applied. In the case of Korea, there are several limitations to using the emission factor as it is because there are differences in climate and farming methods between foreign agricultural methods such as the United States and domestic livestock methods. Therefore, in order to identify and manage reliable sources of ammonia emissions and emissions, it is necessary to develop emission factors suitable for country specific, such as the type of livestock and the treatment process of livestock manure, and calculate emissions.

This study aims to proactively investigate ammonia emission characteristics through the ammonia measurement method and actual measurement for the development of emission factors and emission calculations, open poultry house system.

Keywords:PM-2.5 Secondary sources, Ammonia emission, open poultry house system, Ammonia measurement method,

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The Procedural Rationality of the Korean Policy on Fine Particulate Matter

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The government of South Korea recently introduced strong policies to solve the problem of fine particulate matter. Owing to these strict regulations, most Koreans have suffered from face masks and indoor activities. However, some researchers criticize that the policy of Seoul, which is the biggest city in Korea, has failed. In addition, others analyze the policy process from the viewpoint of ‘path dependency,’ which is a typical kind of irrational theories. In other words, they conclude that the central government has just shown unreasonable behaviors. Among this controversy, this study attempts to prove that the Korea government has thoroughly prepared the policy on fine particulate matter. Also, this study insists that the policy scheme has been successfully established. To attain this research goal, the theory of ‘procedural rationality’ is adopted and utilized. In conclusion, the results of this analysis could provide helpful policy implications related to fine particulate matter, especially in the age of the COVID virus.

Keywords: Bounded rationality, Satisficing model, Substantive rationality, Irrational decision-making

Improvement of Estimation Method for National Ammonia Inventory and Assessment of Mitigation Technologies

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Even though ammonia concentration in the atmosphere is very important to understand particulate matter dynamics, there is high uncertainty in the current ammonia emission inventory in Korea. Here, we aimed to improve precision of the current ammonia inventory by the CAPSS (Clean Air Policy Support System) and assess the potentials of existing mitigation technologies. The present CAPSS estimated national ammonia emission by multiplying the amount of chemical fertilizer usage with the emission factors (EF) of fertilizers. The amounts of chemical fertilizer usage are assumed to be equal to the amount of sales record by local farmers' association, which does not represent the actual amount of fertilizer usage in the field. Although this method uses the country specific emission factors of three types fertilizers (urea, complex fertilizer, sulfuric ammonium), there is a need to confirm the reliability of these factors. To make the fertilizer usage data more accurate, we investigated the amount of fertilizer sales from the private market and added this amount to the existing statistics. The accuracy of the EFs was confirmed by conducing the field experiment and the former EF of complex fertilizer was adjusted, which is very similar to the EEA(European Environment Agency) guidebook value. As a result, the amount of fertilizer usage was increased by 56% and total ammonia emission inventory was increased by 2% compared to the old inventory. The low percentage of increase was due to the fact that the EF of complex fertilizer was reduced by 50%. We also improved the temporal resolution of ammonia emission data by considering the cultivation patterns of different crops. We assumed that fertilizer nitrogen is volatilized as ammonia within 1 month after fertilization. As a result, there were two seasonal peaks in May and September, which was greatly improved by the old method which assumed the equal monthly emission during April to October. Current technologies for ammonia abatement in the livestock facilities are absorption (scrubbing), adsorption, condensation, biolfiltration, oxidation, and combustion, all of which are post hoc treatment after emission. However, an emerging technology focuses on production reduction by using diverse microbiological/chemical treatment. Removal efficiency, advantage and limitation of each technology will be compared using a scoring method.

Keyword: Ammonia emission, agriculture, ammonia mitigation technology, scrubbing, ammonia emission factors

Exploring Flash Drought and Its Relation to Atmospheric Circulation

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The investigating the occurrence of flash drought is vital due to its rapid intensification compared to other conventional droughts. The Evaporative Demand Drought Index (EDDI) indicates the potential onset of flash droughts and estimation of EDDI solemnly depends on the atmospheric evaporative demand (E_0). Hence, this study aims to identify distribution of the heat wave flash droughts in South Korea using EDDI. Initially the surrogate model using Hargreaves Equation is developed to estimate reference evapotranspiration (ET_0) over the 60 stations in South Korea. The Hargreaves Equation requires the limited amount of data such as extra-terrestrial solar radiation, maximum and minimum temperature compared to FAO 56 model to estimate ET_0. The previously derived ET_0 using FAO 56 method is applied to evaluate the temporal distribution of Hargreaves coefficient (c_H). Further the compatibility of the modelled ET_0 with the FAO 56 ET_0 is analysed. The derived ET_0 using surrogate model-Hargreaves Equation is then applied to the EDDI to identify the onset of historical flash droughts in Korea. The applicability of developed Bayesian approach to understand the behaviour of the Hargreaves Equation and then using the modelled ET_0 to understand the onset of drought is very important because the method uses the limited number of variables and it is advantageous for the countries which have data limitation.

Keywords: Flash drought, EDDI, Hargreaves Equation, evapotranspiration

Acknowledgement

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Drought Early Warning System and Its Application with Groundwater Data-based Drought Index

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This study aims to develop a drought monitoring and forecasting technique based on groundwater data-based drought index and data-driven modelling. For drought monitoring, kernel density estimator is presented in the daily groundwater level over the 253 national groundwater stations. The estimated cumulative distribution function is then utilized to map the present groundwater level into the percentile. The current drought declaration status is divided into warning, caution and severe based on 20, 10, and 5 percentile of groundwater level, and the areas with severe intake problems among the severe drought areas are classified as very severe. For drought forecasting, we explored the lagged relationships between regionalized SGI (standardized groundwater level index) and SPI (standardized precipitation index) in perspective of the drought propagation. The 167 regional prediction models were constructed using a NARX (nonlinear autoregressive exogenous) artificial neural network model which can effectively capture nonlinear relationships with the lagged independent variable. SGI forecasts along with rainfall forecasts provided by the Korea Meteorological Administration are converted to groundwater level percentile values and used for 1~3 months drought forecasting. The data up to 2018 were used for training the NARX artificial neural networks, and it was applied to the period of 2019 to evaluate the errors of models and rainfall forecasts.

Keywords: groundwater supply area, SPI, SGI, NARX, drought early warning

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Abstracts

Oral Sessions

Abundant Biogenic Oxygenated Organic Aerosol in Atmospheric Coarse Particles: Plausible Sources and Atmospheric Implications

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Secondary organic aerosol (SOA) is a key component in atmospheric aerosols, strongly influencing air quality and climate. Most previous studies focused on SOA formation in the fine aerosol mode, and little is known about SOA formation across a broader size range, especially for the coarse aerosol mode. In this study, we coupled radiocarbon analysis and the offline aerosol mass spectrometric method to characterize water-soluble organic matter in size-segregated samples between 0.056 and 18 μm collected in urban Shenzhen, China. For the first time, detailed size distributions of different types of oxygenated organic aerosols (OOAs) are obtained. Fossil fuel OOA was mostly distributed in fine particles, and biogenic OOA occurred mostly in coarse particles. Organic composition and correlation analyses suggested that the major source of the coarse-mode OOA was more plausible to be heterogeneous reactions of biogenic volatile organic compounds (VOCs) on soil dust rather than primary biological materials. If so, this mechanism would complement the missing sinks of biogenic VOCs, significantly influence the regional and global organic aerosol budgets, and thus should be considered in air quality and climate models. This study highlights the urgent need for laboratory simulations of heterogeneous reactions of various VOCs on soil dust.

Keywords: SOA, coarse particles, biogenic VOCs, soil dust, heterogeneous reactions

Characterization and Biogas Production Potentials of Aqueous Phase Produced from Hydrothermal Carbonization of Biomass - Major Components and their Binary Mixtures

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Abstract

Hydrothermal carbonization aqueous phase (HTC-AP) can be used for methane production by anaerobic digestion (AD). However, it generally had low conversion efficiency due to the formation of complex dissolved organic matters, which depends upon the components of biomass. The present study investigated the characteristics, methane potentials, and recalcitrant chemicals of HTC-AP produced from the different combinations of model carbohydrate (α-cellulose, C) and protein (bovine serum albumin, BSA) compounds with mass ratios of 1:0, 0.75:0.25, 0.5:0.5, 0.75:0.25 and 0:1. The methane yields of samples 1:0 (pure C) and 0:1 (pure BSA) were 192 mL/g COD and 187 mL/g COD, respectively, while it was decreased to 105.5 CH4 mL/g COD for sample 0.75:0.25 (C/BSA), indicating more recalcitrant organics were produced with the combination of C and BSA. It was found that the mean MW (209157) of sample 0.75:0.25 was much higher than the other samples (<7000 Da). While the highest percentage (51 %) of hard bio-degradable hydrophobic DOC, humics, and building blocks organics were also observed in this sample by LC-OCD-OND analysis. Furthermore, a high value of SUVA index 2.56 was noted, indicating the presence of a large number of aromatic compounds. In addition, fluorescent compounds mainly relating to humic-like substances were also detected by 3D-EEM. GC-MS analysis showed a higher concentration of pyrazine, and its derivatives were produced in sample 0.75:0.25, which indicated the occurrence of a serious Maillard reaction. The continuous experiment further verified the lower biodegradability of sample 0.75:0.25 with a methane yield of 108 mL/g COD. It also showed that only 18.9 % of the fluorescent components were degraded and 13 recalcitrant chemicals were identified to be hard bio-degradable during the AD process.

Keywords: Wastewater treatment; Hydrothermal carbonization; Carbohydrates and Protein; Anaerobic digestion; LC-OCD-OND; Recalcitrant organics

Graphene Quantum Dots Decorated BiS Nano-flowers for Improved Photoelectrocatalytic Water Treatment

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On the performance to cost scale, the catalytic activity of bismuth sulfide (BiS) competes with other metal dichalcogenides. However, the polymeric binders inclusion used for BiS coating hampers the directly exposed surface of the BiS for catalysis. To avoid this issue we proposed a highly dense seeded growth of BiS nano-flowers on carbon cloth (CC). In addition, visible light active and gram scale producible graphene quantum dots (GQDs) were coupled with the BiS nano-flowers in different modes. For example, BiS doped GQDs, BiS grown GQDs, BiS crosslinked GQDs, and their hybrid structures were tested. As a result, the binder-free coating of BiS on CC showed 50 % higher photo-electrocatalytic degradation of methylene blue dye, compared to binder assisted attachment. GQDs doped BiS showed superior photo-electrocatalytic activity as compared to other coupling modes. Conclusively, the micro-quantum scale interfaces of BiS were optimized to achieve enhanced catalytic performance. Also, the stability of the electrode was confirmed under harsh chemical environments, bending cycles, and repeated photo-electrocatalytic cycles.

Keywords: photocatalysis, electrocatalysis, dye degradation, binder-free, electrodes.

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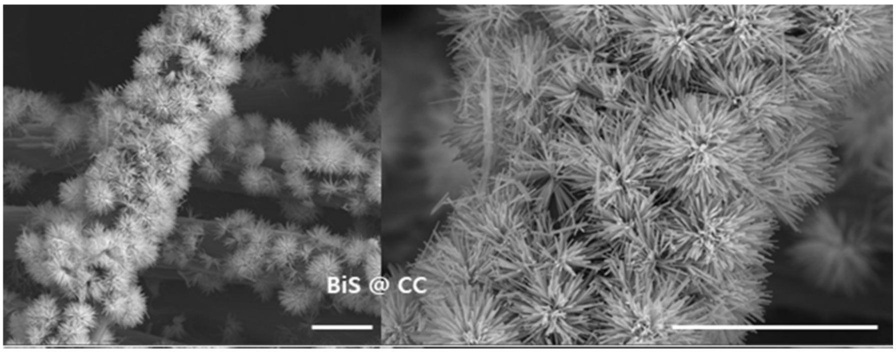
Graphical Abstract



Dense growth of BiS nanoflowers on carbon cloth (scale bar 10 μm).

Catalytic Pyrolysis of Fishing Net Waste using a CO_2 as a Reaction Medium

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Plastic wastes generation has been globally attributed to the environmental issues. Recycling of plastic wastes is a practical way for waste disposal. However, contamination and partial decomposition of plastic wastes from the seas and oceans should be eliminate prior to recycling of it. Here, we provide the viable option to converts plastic wastes into value-added product (*e.g.*, syngas) without pre-treatment. In detail, the thermo-chemical conversion of fishing net waste (FNW) was examined for syngas production. In addition, CO_2 was adopted as a reaction medium in pyrolysis of FNW to enhance the production of syngas (H_2 and CO). In addition, catalytic pyrolysis of FNW was investigated to enhance the reaction kinetics for formation of syngas, which is induced by the CO_2. The result shows that the CO_2 did significantly increase the CO production, which could not be observed in the N_2 environment. CO and H_2 formation were due to gas phase reactions (*i.e.*, homogeneous reactions) between CO_2 and volatile pyrolysates. This study suggests that the catalytic pyrolysis of FNW using CO_2 can be an option for conversion of plastic waste to energy as a form of syngas.

Keywords: Waste-to-energy, catalytic pyrolysis, plastic, CO_2, syngas

CO_2-Cofeeding Pyrolysis of Pine Sawdust with Utilization of Steel Slag as a Catalyst

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To find an innovative way for managing waste and recovering energy simultaneously, two materials, pine sawdust (carbonaceous material) and steel slag (catalyst), were used in the pyrolysis process. Also, a viable use of carbon dioxide (CO_2) as a reactive material in the non-catalytic/catalytic pyrolysis process was evaluated to perform a more sustainable conversion system. Hence, the present study laid great emphasis on the CO_2 effects. The present study pointed the optimistic technical features in line with the use of CO_2 in the pyrolysis process. Using CO_2 in pyrolysis of pine sawdust offered a strategic way to control carbon reallocation from liquid to gaseous pyrolysates by the gas phase reactions. Due to the slow reaction kinetics of the gas phase reactions, enhancement of CO gas by the reaction of CO_2 in pyrolysis process only observed at ≥ 600 ˚C. Such the slow reaction kinetics was expedited remarkably when steel slag was acted as a catalyst. Moreover, CO_2 expedited thermal cracking of volatile pyrolysates including dehydrogenation, which led to the enhanced formation of CH_4 and H_2.

Keywords: Lignocellulosic biomass; catalytic pyrolysis; carbon dioxide; steel slag; waste-to-energy

Relation Formula(R2) between Energy Efficiency Method(R1) and GHG Mitigation at Korean MSW to Energy Facility.

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In korea, about 300 waste incineration plant was built during last 30 years. To meet GHG mitigation, energy recovery efficiency factor was adopted to all waste to energy facilities from 2019 year by Korean EPA.

It's same methodology of EU R1 system as the formula WFD(2008/98/EC)

$R1 = \dfrac{(E_p - (E_f + E_i))}{0.97 \cdot (E_w + W_f)}$	Ew = Total energy of waste, W_f = Additional fuel energy
	Ep = Production of energy (sum of electricity and heat)
	Ef = Fuel from outside, Ei = Energy from outside.

Remarkable factor would be EF(equation factor) of energy, classified by electricity and heat as 2.6 times of electricity, 1.1 times of heat, which was based on "The first & second law of thermodynamics".

In the meantime, indirect GHG emission factor of energy in korean mitigation methodology shows

Electricity : 0.466TCO2/MWh, Heat : 0.1226 TCO2/Gcal

There is discordance between R1 and indirect emission factor of incineration plant. It was made by

R1			Indirect emission factor		
EF / electricity	EF / Heat	Elec./Heat	Electricity	Heat	Elec./Heat
Coal fired power plant	Boiler	2.36	Avg. of power plant	All fuel	3.80

To match GHG mitigation by energy recovery efficiency in Korean waste to energy plant

$$Energy\ Efficiency = [EP-(Ef+Ei)]/[0.97*(Ew+Ef)] \quad ---(1)$$

$$R1 = Ep / 0.97 \times Ew = 2.6\ Eel\ gross + 1.1\ Qth = 2.6\ \eta el\ gross + 1.1\ \eta th \quad ---(2)$$

We can develop new Relation formula R2(Korean energy recovery factor) as

$$\begin{aligned} R2 &= [EP-(Ef+Ei)]/[0.97(Ew+Ef)\} \\ &= Ep / 0.97 \times Ew \\ &= 4.18\ Eel\ gross + 1.1\ Qth = 4.18\ \eta el\ gross + 1.1\ \eta th \quad ---(3) \end{aligned}$$

This relation formula can be used in every country derived by indirect emission factor.

Keywords: R1, GHG mitigation, waste to energy, relation formula, heat efficiency

Estimation of Ammonia Emission During Growing Seasons of Perilla in Plastic House

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Concerns have been raised about the impact on human health of recent high concentrations of fine dust. Particulate matter is categorized into PM_{10}, with a particle size less than 10 μm, and $PM_{2.5}$, with a particulate size less than 2.5 μm. Primary particulate matter directly generated from a source is mainly PM_{10}, and secondary particulate matter produced by a chemical reaction with harmful substances emitted in the form of atmospheric gas is mainly $PM_{2.5}$. Ammonia reacts with sulfur oxides and nitrogen compounds in the atmosphere to form ultrafine ammonium sulfate and ammonium nitrate. Ammonia is mainly generated by livestock manure and fertilizer use on farmland. The Ministry of Environment estimates the annual emissions of eight air pollutants, including ammonia, and uses the estimates as data for establishing a reduction policy. Accordingly, there is a growing need for accurate estimates of the amount of ammonia emitted during agricultural production. Therefore, in this study, ammonia emissions generated from the cultivation of leafy perilla in plastic houses were determined. The ammonia discharged from the surface of soil growing leafy perilla was collected using a wind tunnel chamber with a height of 150 cm and a width of 100 cm. The ammonia was then captured by the acid trap method and analyzed with the indophenol blue method. A poultry compost of 34 $ton \cdot ha^{-1}$, the amount commonly used by farmers in the field, was sprayed on the soil surface. The compost and soil were stirred three times using a tractor to prevent damage to perilla seed germination by ammonia gas generation. From July to November, just after spraying poultry manure, the ammonia was periodically measured and analyzed to be 77.8 kg ha^{-1} (21% of the nitrogen containing poultry compost). Most ammonia was released in the two weeks after application of the poultry manure and then the amount released gradually decreased. Ammonia concentration tended to increase immediately after additional nitrogen fertilizer application for growth control during cultivation of leafy perilla.

It can be concluded that in order to estimate the exact ammonia emission from important protected cultivation, it is necessary to estimate the emissions through field empirical studies that consider the environmental factors and characteristics of various types of protected cultivation such as plastic houses and glasshouses.

Keywords: Ammonia, Poultry Compost, Perilla, Particulate Matter, Plastic House

Acknowledgements. This study was carried out with the support of the "Research Program for Agricultural Science & Technology Development (Project No. PJ014206)" of the National Institute of Agricultural Sciences, Rural Development Administration, Republic of Korea.

Community-Engaged Assessment of Soil Heavy Metal and Metalloid Contamination in Atlanta

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Urban agriculture is emerging as a method to improve food security and public health in cities across the United States. However, there is potentially an increased risk of exposure to heavy metals and metalloids (HMM) through consumption of contaminated soil, especially for children. There is also debate on what concentrations of HMM in soil constitute a low risk for those engaged in urban agricultural activities. This community-engaged study measured the concentrations of lead (Pb) and 24 other metals with X-ray Fluorescence (XRF) in 19 urban agricultural and residential sites in West Atlanta and compared them to three rural background sites. This study found strong positive correlations between observational data, using XRF and Inductively-Coupled Plasma Mass Spectrometry (ICP-MS) for Pb and zinc (Zn), but XRF overestimated cadmium (Cd) and chromium (Cr). HMM concentrations were compared in the context of the Environmental Protection Agency's (EPA) regional screening levels (RSLs) and University of Georgia's (UGA) extension service low risk levels (LRLs). The majority of sites were below EPA RSLs for Pb. There were, however, several sites that were above the UGA LRL but below the EPA RSL. A subset of samples was also assessed for gastrointestinal bioavailability to provide a better estimate of potential exposure. This study showed that growing in raised beds can lower heavy metal concentrations, highlighting a low-cost practice for reducing exposure. However, some beds were still above UGA LRLs, indicating the need to assess soils in raised beds to determine potential sources of contamination.

Keywords: Soil heavy metals and metalloids, Community-engaged research, lead, urban agriculture

Investigate the Effect of GAC on Anaerobic Digestion of Waste Water from Hydrothermal Liquefaction of Biomass

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Abstract

Hydrothermal liquefaction (HTL) of biomass produced bio oil and hydro-char along with wastewater (HTL-WW) with limited energy contents which could be used for methane production through anaerobic digestion. However, generally the composition of HTLWW and nature of recalcitrant organics depend upon the types of biomass, which has not been well study. The present study explore the granular activated carbon (GAC) in anaerobic digestion at 2, 4, 6 and 8 g/L COD of HTLWW from corn straw and sludge. It was found GAC promoted the significant methane production 145 and 172 mL CH_4/g COD from corn straw and sludge HTLWW respectively at 8 g/L COD. It was also suggested, firstly GAC absorbed the organics to reach the saturation point and then prompted the methane production. Therefore, GAC could not achieve the saturation condition at low concentration and in resulted in low methane yield. This study will develop new understanding associated with HTLWW degradation and will contribute to improve the anaerobic digestion process.

Table 1 Characteristics of corn straw and sludge HTLWW

Items	Sludge HTLWW	Corn straw HTLWW
pH	8.7±0.5	4.02±0.2
COD (g/L)	60.5±0.2	44.7±0.3
TN (g/L)	8.9±0.8	0.92±0.1
NH_4^+-N (g/L)	7.8±0.1	0.595±0.1
TOC (g/L)	17.8±0.1	13.28±0.1
Acetic acid (mg/L)	5035±146	5818±100
Propionic acid (mg/L)	1653±49	991±50
i-butyric acid (mg/L)	926±35	527±35
n-butyric acid (mg/L)	1638±62	105±23
i-valeric acid (mg/L)	1648±65	120±10
n-valeric acid (mg/L)	720±25	100±7.5

Keywords: HTLWW; Characterization; methane production; granular activated carbon; anaerobic digestion

Structural Variations and Generation of Binding Sites in Fe-loaded ZSM-5 and Silica under the Effect of UV-irradiation and their Role in Enhanced BTEX Abatement from Gas Streams

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In the present work, we have investigated the role of UV-irradiation on the structural and functional properties of Fe-ZSM-5 and Fe-silica by spectroscopic and experimental analysis. The UV-irradiated Fe-ZSM-5 showed structural and chemical variations due to the cleaving of framework bonds which in turn decreased the crystallinity of Fe-ZSM-5. For UV-irradiated Fe-silica, increased hydroxyl density, silica-network reconfiguration, and change in the Fe coordination were predicted by spectroscopic techniques. These structural and functional changes significantly contributed towards the adsorption of benzene, toluene, ethylbenzene, and xylene (BTEX) via diffusion and hydrogen bonding. At the same time, these adsorbents behaved as an efficient catalyst and showed remarkable photo-oxidation of adsorbed BTEX. As large as 80% of increment in the BTEX removal performances were recorded after UV-pretreatment for Fe-silica. Both the adsorbents were found effective for more than 10 cycles proving their economic application for pollutant removal from indoor air.

Keywords: BTEX, Fe/SiO_2, Fe-ZSM-5, Spectroscopy, UV-irradiation

Reversible and Irreversible Foulings Associated with Membrane Photobioreactor for Wastewater Treatment

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As technology advances, factories and livestock are concentrated, and the resulting emissions of water pollutants are increasing. As a result, wastewater treatment technology is also being studied a lot, and many new technologies are being developed. Core feature of membrane photobioreactors (MPBR) is almost complete rejection of solid particles from the effluent. The membrane-based water treatment technology can be more eco-friendly than the chemical and physical water treatment technologies and can withstand shorter processing times and higher organic loads compared to conventional PBR processing techniques, thus minimizing microalgae losses and increasing the organic removal efficiency.. However, inevitable membrane fouling makes separation efficiency decreased accompanying operation cost increase. To remove foulants on the membrane surface effectively, much research has been conducted but the control of membrane fouling is still being regarded as a main obstacle. In this study, therefore, MPBR inoculated with *chlorella sorokiniana* was operated to verify how reversible and irreversible membrane fouling progress according to HRT variation while treating wastewater. In addition, we test how the difference of cleaning methods affect irreversible fouling. Results indicate that HRT decrease from 3-d to 1-d did not reduce N-removal (~85%) and P-removal (97%). The increase in TMP was observed up to 12kPa during the operation of the reactor. In addition, the membrane surface before and after washing was analysed by scanning electron microscope (SEM) and the surface properties were analysed by energy-dispersive X-ray spectroscopy (EDX) to observe irreversible membrane fouling and reversible membrane fouling. This study provides useful information that can contribute to cost-effective operation of MPBR with the control over irreversible membrane fouling.

Keywords: Microalgae, membrane photobioreactor , TMP, cleaning, irreversible fouling

Characterization of Submicron Aerosols over the Yellow Sea Measured Onboard the Gisang 1 Research Vessel in Spring 2018 and 2019

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Aerosols are known to exert significant effects on visibility and human health. Poor air quality due to aerosols over the Korean Peninsula is becoming a big social issue. East Asia has been known as one of the largest source regions of aerosols, and the aerosol concentration in East Asia is very high. The Yellow Sea, located between the Chinese continent and the Korean Peninsula, is an ideal place for investigating continental influence from both sites.

As an effort to investigate such influence, submicron aerosol measurements were carried out over the Yellow Sea on board the Gisang 1 research vessel in spring 2018 and 2019. Two condensation particle counters (CPC; TSI 3776 and TSI 3772) measured the total number concentration of aerosols larger than 3 nm and 10 nm (N_{CN3} and N_{CN10}, respectively). A scanning mobility particle sizer (SMPS) measured the aerosol size distribution with a range of 10-500 nm in mobility diameter. A cloud condensation nuclei (CCN) counter (CCNC; DMT CCN-100) measured CCN number concentration at several supersaturations.

On average, N_{CN10} over the Yellow Sea in spring 2018 and 2019 were 6053 cm^{-3} and 7312 cm^{-3}, respectively. Such relatively high aerosol number concentrations suggest severe continental influence over the Yellow Sea. Aerosol number concentration and size distribution showed clear temporal and spatial variation. Aerosol number concentration and size distribution were influenced by meteorological conditions, such as wind direction and relative humidity. Aerosol number concentration was generally low under southerly wind or high RH conditions. New particle formation (NPF), nucleation of condensable vapors to the solid or liquid phase, occurred occasionally during the measurement period and the spatial extent of the NPF covered a large area over the Yellow Sea. Aerosol hygroscopicity and CCN activity over the Yellow Sea were similar to those of aged continental aerosols. Comprehensive analysis results will be shown at the conference.

Keywords: aerosol number concentration, aerosol size distribution, ship measurement, Yellow Sea, Gisang 1

Evaluating the Role of Ballast Surface Charge for Floc Development in Ballasted Flocculation

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Ballasted Flocculation (BF) (injection of ballast media to increase the size and density of flocs accelerating its settling velocity) is rapidly gaining attention in water industry due to its potential of achieving high superficial velocities (100m/h) which leads to quick HRT intervals, highly compact footprints of system and stable removal efficiency. The two important factors that control the settling performance of ballasted flocs are size and density of aggregated flocs which directly depends upon the characteristics of ballast material and rate of ballast induction in aggregated flocs. The ballast size, ballast specific gravity, and surface charge of ballast are important factors that influence the floc development phenomenon in ballasted flocculation. Over the last decade, remarkable progress has been made to evaluate the impact of ballast size and ballast specific gravity in ballasted flocculation. However, the literature lacks the evaluation of ballast surface charge and its implications at floc development phenomenon. Therefore, the 30 and 80um commercially available magnetite ballasts with equivalent specific gravity and various surface charges ranging from positive to negative were evaluated in this study. The purpose was to quantify the role of ballast surface charge at turbidity removal and floc development in ballasted flocculation. The size and settling velocity of aggregated flocs was directly determined using image analysis. A model was used to determine ballast induction rate at varied ballast surface charges and the ratio of un-ballasted flocs in each case were also determined. It was observed that the ballasts with highly positive and negative charge disrupt the coagulation chemistry and ballasts with closely neutral surface charge exhibit mature floc development. An optimization of ballasted flocculation process based on ballast surface charge can lead to efficient BF facility

Key Words: Ballasted flocculation, Surface charge, Settling velocity, Ballast incorporation

Responses of Fine Particulate Matter and Ozone to Local Emission Reductions in the Sichuan Basin, Southwestern China

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Abstract: The Sichuan Basin (SCB; including the Chongqing Municipality and 17 prefectural cities from the Sichuan Province) is one of the areas largely affected by air pollution in China. Understanding the responses of air pollutant concentrations to emission changes is key for designing and evaluating control strategies. Thus, this study uses the Community Multi-scale Air Quality (CMAQ) model to simulate $PM_{2.5}$ (i.e., particulate matter with an aerodynamic diameter ≤2.5 μm) in winter (January 2015) and ozone (O_3) in summer (July 2015) under nine emission reduction scenarios. For each scenario, the anthropogenic emissions of air pollutants from each SCB grid cell in the simulation domains are reduced by the same ratio ranging from 10% to 90%. The results show that ~30-70% reductions of emissions are needed to make the monthly $PM_{2.5}$ concentrations less than the Chinese standard for 24-h $PM_{2.5}$ (75 μg m^{-3}) in all the SCB urban centers. However, the monthly $PM_{2.5}$ concentrations under 90% reductions of emissions still exceed the World Health Organization (WHO) guideline for 24-h $PM_{2.5}$ (25 μg m^{-3}) in 16 urban centers. To completely prevent 8-h O_3 pollution events in all the urban centers, ~80% reductions of emissions are needed. Under 90% reductions, ~35% of the SCB areas still have the monthly 8-h O_3 concentrations exceeding the WHO guideline for 8-h O_3 (47 ppb). Although emissions of different air pollutants cannot be reduced by the same ratio in real situation, the results of this study can suggest that (1) compared with the present governmental targets, greater emission reductions are needed to completely prevent air pollution events and meet the WHO guidelines for the entire SCB, (2) both SCB and non-SCB emissions should be greatly reduced, and (3) the reduction ratios of SO_4^{2-} and its precursors should be higher than that of other pollutants to mitigate $PM_{2.5}$ pollution.

Keywords: air pollution; $PM_{2.5}$; O_3; air quality; Chengdu; Chongqing

Convergence of Submerged Membrane Filtration and Cold Plasma for Enhanced Livestock Excreta Treatment

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Industrialization and population growth have increased meat consumption leading to non-point source pollution by the livestock excreta. If the excreta are not properly managed, its discharge into receiving water will cause serious eutrophication. To address this environmental problem, various treatment techniques have been tested but they clearly have shown their limitations. Biological treatment requires a longer time for better treatment efficiency and chemical treatment accompanies cost issues associated with chemicals. To overcome such limitations, this study proposes a novel physicochemical process integrating membrane filtration (MF) and cold plasma (CP). The purpose of this study is to verify the synergistic effect of integration and to demonstrate how CP reduces the fouling of MF. Using statistical analysis, this study also identifies the correlations between operating conditions and contaminants. Submerged hollow-fiber microfiltration made of polyvinylidene fluoride (PVDF) was installed inside the CP reactor (working volume of 3 L). Flowrate was set to 1.0, 1.5, and 3.0 L/d according to experimental design. Results show that the highest removal efficiencies of T-N (72.4%), T-P (57.8%), NH_4-N (73.3%), DOC (71.3%), SS (98.7%), and turbidity (99.1%) were obtained at hydraulic retention time (HRT) 3 d, respectively. Decreased membrane resistance (0.4×10^{14} m^{-1}) compared to the control (1.5×10^{14} m^{-1}) support reduced transmembrane pressure (TMP, 85.0 kPa to 45.6 kPa) and inclined flux (2.2×10^{-3} $m^3/m^2{\cdot}h$ to 4.4×10^{-3} $m^3/m^2{\cdot}h$) due to CP application in HRT 1 d. Reactive chemical species generated from the CP must have degraded organic foulants actively nearby the membrane surface. Scanning electron microscope (SEM) and energy-dispersive X-ray spectroscopy (EDX) analysis evidences the contribution of CP on membrane fouling reduction. In addition, statistical analysis reveals that HRT had a strong negative correlation with flux increase and TMP decrease in the integrated process. These findings provide useful information that can contribute to enhancing livestock excreta treatment and membrane fouling reduction simultaneously.

Keywords : Livestock excreta, cold plasma, membrane filtration, membrane fouling, TMP

Efficient Production of 2-Methyltetrahydrofuran and 1,4-Pentanediol from Biomass-derived Levulinic Acid

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In conventional biomass-to-biofuel processes, cellulose and hemicellulose are converted into biofuels. However, to improve the economics of the process, it is desirable that some fractions of biomass be produced as fuels and other fractions as chemicals. The coproduction of fuels and chemicals additionally enables a flexible response to the market conditions of bioproducts. We propose a new strategy for the coproduction of fuels and chemicals from lignocellulosic biomass. After pretreatment of biomass, cellulose is converted directly into levulinic acid (LA) and hemicellulose is converted into LA via intermediates of furfural and furfuryl alcohol. Then, LA is converted into 2-methyltetrahydrofuran (MTHF) and 1,4-pentanediol (1,4-PeD). The spilt ratio of LA is controlled to efficiently produce MTHF and 1,4-PeD according to the market situations of final products. We present an alternative configuration where LA is converted into γ-valerolactone (GVL) which can be also adjusted to produce MTHF and 1,4-PeD and compare the two designs. Heat integration is performed to form a heat exchange network in the process, thereby a significant amount of utility requirements is reduced. The minimum selling price of MTHF is calculated based on the proposed strategy. Additionally, key cost drivers for the process are identified from sensitivity and uncertainty analysis.

Keywords: 2-methyltetrahydrofuran, 1,4-pentanediol, lignocellulosic biomass, process design, techno-economic analysis

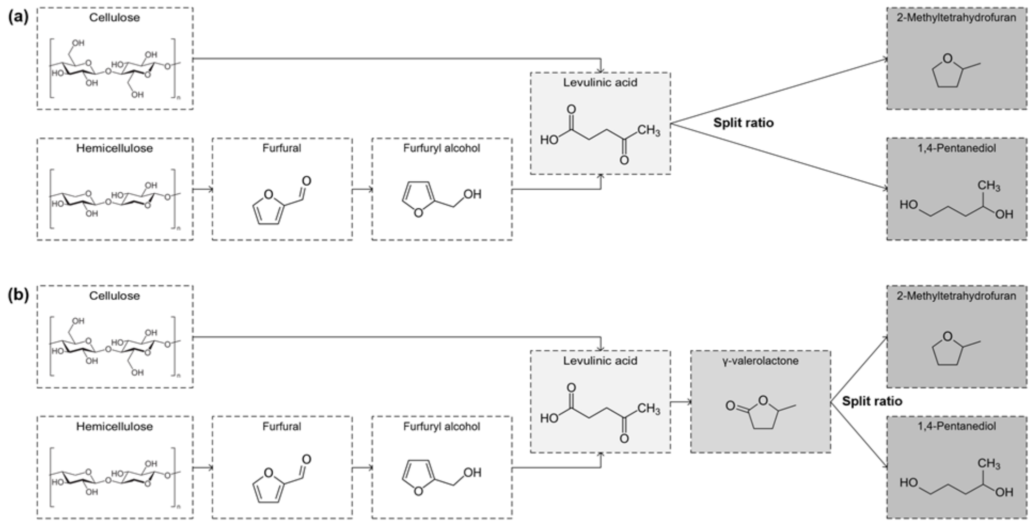

Figure 1. Reaction pathway: (a) LA to MTHF and 1,4-PeD and (b) LA to GVL to MTHF and 1,4-PeD

The Role of Biochar in Alleviating Soil Drought Stress in Urban Roadside Greenery

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Biochar can improve soil structure and increase water use efficiency. In this study, the objective is to determine the role of biochar in improving soil physical structure and water retention under water-shortage conditions in urban roadside greenery. In the field study, the experimental plots (2 m x 2 m) were established on the roadside greenery in Suwon, Korea. The biochar treatment (BC) was prepared by mixing on-site soil in a 10-cm depth and biochar at 2.5% (wt). During the study period, there was no anthropogenic irrigation. After 8 months, soil bulk density significantly decreased by 10% in the BC compared to the CON (1.39 g cm^{-3}). Continuous monitoring of soil moisture showed that 98% of the data points had higher soil water contents in the BC than in the CON. Soil drainage was investigated based on the differences in soil water content right after precipitation and before the next rainfall, which was 15% slower in the BC than in the CON. The greenhouse experiment was conducted to understand the process of biochar's soil structural changes. A compacted-sandy soil (1.39 g cm^{-3}) and the wood biochar were prepared. The incubation pots (18 L) were filled with the biochar-added soil at 4% (wt) and with no-added soil (control). For drought simulation, soil water content was adjusted at 15-25% water-holding capacity. After 100 days, soil samples were collected to analyze bulk density and pore images of X-ray computed tomography. These results indicate that biochar can be lower soil compaction and better overall soil porosity. Soil aggregates were separated by a wet-sieving method and pore size distribution (PSD) was measured using the sandbox and Hyrud-1d model. The proportion of micro-aggregates (53-250 μm) and meso-pores (15-90 μm) was increased in the biochar treatment compared to the control. These results indicate that the macro-sized biochar (1 mm) can interact with the small-sized aggregates, and thereby enhancing the pore proportion with the size corresponding to the pore diameter plant available water (2-90 μm). Plant and microbial activities were increased in the biochar treatment compared to the control. In conclusion, our results imply that biochar could be a strategy for management of urban roadside greenery to alleviate soil drought stress.

Keywords: biochar, urban roadside greenery, drought stress, soil structure, pore distribution

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Biomass Waste Valorization to Generate Modified Biochar to Recover Phosphorus from Animal Manure Wastewater

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One of the reality before us today is the increasingly exhausted of phosphorus (P) resource. Animal manure, produced from livestock and poultry production, contains large amount of P. The treatment of P recovery from animal manure is regarding as a promising technical for food security. Recently, numbers methods to treat waste agricultural biomass have been considered. Amongst, pyrolysis to generate biochar has attracted attention. Biochar, has a rich surface chemistry, interesting nanostructures, abundant oxygen-containing functional groups, and a large porous structure, regarded as a potential sorbent. Due to the limitation of P-solubilization and selectivity recovery processes caused by the existing of organic phosphorus, sparingly soluble P, and many other kinds of substances, we have conducted a series of explorations on phosphorus solubilization and selectivity adsorption. For P solubilization, organic phosphorus and sparingly soluble P can be decomposed, dissolved, and released under thermal conversion (ultrasound, hydrothermal process, microwaves digestion). Coupling degradation and oxidation process, such as microwaves digestion and NaOH (or H_2O_2-HCl), ultrasound/H_2O_2, and hydrothermal assisted process have been developed. For P fixation, cation loaded biochar, such as magnesium modified corn biochar, ferric oxide hydrate modified biochar, calcium modified biochar, can be synthesized to enhance P adsorption selectivity. The adsorption isotherm, adsorption kinetics, thermodynamics have been investigated. The P saturated adsorbed modified biochar could continually release P in soil environment and its fertilizer property has been analysis.

Keywords: Phosphorus sorption, Animal manure wastewater, Biomass, Engineered biochar, Nutrient recovery

Magnetic Ball-milled FeS@biochar as Persulfate Activator for Degradation of Tetracycline

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In this study, FeS@BC was synthesized successfully by physical ball milling and applied for the oxidative removal of tetracycline (TC) with the presence of persulfate (PS). The effects of pH, dosage of FeS@BC and PS and co-existing anions on TC degradation were investigated. Our results showed that higher TC degradation efficiency was obtained at low pH and at high dosages of PS and FeS@BC. Under the optimal conditions (pH=3.6, [FeS@BC]=0.3g/L and [PS]=10mM) in our research, the removal efficiency of TC was 87.4% after 30 min treatment. Besides, the TC removal rate was inhibited slightly by inorganic anions with the following order of CO_3^{2-} > Cl^- > NO_3^-. The surface-bound Fe(Ⅱ) and S(Ⅱ) acted as electron donors in the catalytic process and generated the SO4・－ and ・OH at the surface of FeS@BC. In addition, S(Ⅱ) also participated in reduction of Fe(Ⅲ). The introduction of BC not only reduced the agglomeration of FeS for a continuous-releasing source of dissolved Fe^{2+}, but also it can be acted as an electron shuttle and a good adsorption carbon-based material to facilitate the fast electron transfer among PS, electron donors and pollutant. Moreover, we found both of radical and non-radical degradation processes were involved in the FeS@BC/PS/TC system. The proposed FeS@BC catalyst could be a promising effective catalyst for the remediation of other emerging organic contaminants.

Key words: Ball milling, FeS@BC, Persulfate (PS), Tetracycline (TC), Reaction mechanism.

Evaluation of Thermal Performance of PCM based Electrically Conductive Heat Storage Concrete using Biochar

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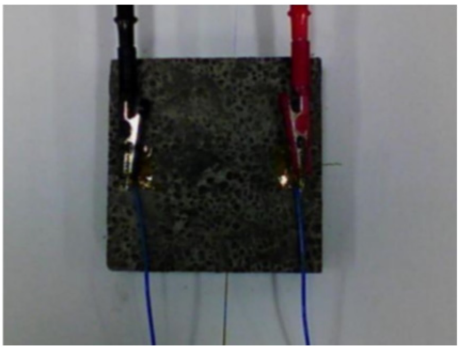
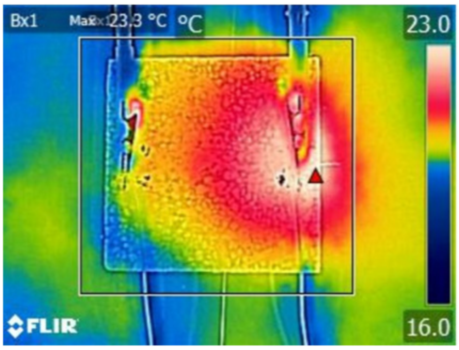
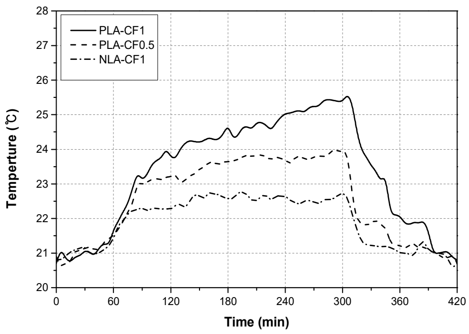
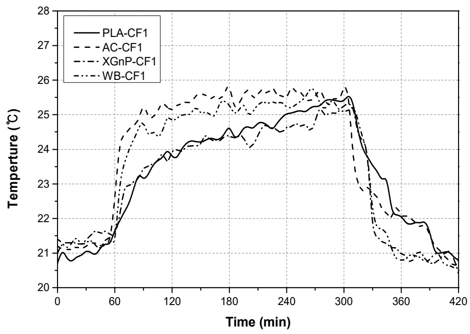
Due to the recent rapid growth of the building industry, the increase in energy demand for buildings will be particularly severe. Electroconductive concrete (ECC) can exhibit uniform temperature distribution, low maintenance and reimbursement costs through electrical heating. Biochar is produced as one of the by-products of pyrolysis, and the yield and carbon stability of biochar depend on the feedstock and pyrolysis conditions. The purpose of this study was to conduct conductive mortar experiments using PCM and carbon materials to improve the thermal performance of ECC. The carbon material used was wood biochar, activated carbon, and XGnP. As the carbon material was used, the electrical resistance was low and could be converted into a conductive mortar. Among them, wood biochar and activated carbon showed excellent conductivity. In the electric heating test, a time delay effect was observed through PCM, and the time to reach the peak temperature and the temperature rise were the fastest in Wood Biochar.

Keywords: Biochar, Carbon material, PCM, Thermal performance, Mortar









Oxidation of Oxytetracycline by Oxygen-doped Graphitic Carbon Nitride and Peroxymonosulfate

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Carbon based catalysts have gain a great interest because of their high activity, enhanced electron transfer, thermal stability, and chemical stability. Graphitic carbon nitride (g-CN) is one of the carbon based catalysts which can be prepared by simple single-step polycondensation, is cheap, and non-toxic. The g-CN acts as a photocatalyst but does not activated peroxydisulfate (PDS) or peroxymonosulfate (PMS). However, recently, it has been found that the oxygen-doped g-CN (O-g-CN) could activated PMS due to less electron density and more unpaired electrons. Therefore, the catalytic oxidation of oxytetracycline (OTC) using O-g-CN and PMS was investigated in depth. OTC is one of the most widely used antibiotics worldwide, posing a great threat to aquatic ecosystem. The results of a series of batch experiments showed that the O-g-CN was successfully prepared by one-pot thermal process and that OTC removal was excellent with 0.1 g/L O-g-CN and 1 mM PMS (37.5 mg/g·h). The OTC removal was enhanced with the increases in O-g-CN dose and pH. The electron paramagnetic spectra showed strong signals of 5,5-dimethylpyrroline-(2)-oxyl-(1) (DMPOX) generated by DMPO oxidation, indicating that $SO_4^{\bullet-}$ contributed dominantly to the OTC removal. The OTC degradation rate was decreased and the characteristics of the O-g-CN were altered as the O-g-CN was repeatedly used. The results of Raman spectroscopy, X-ray diffraction patterns, Fourier-transform infrared spectroscopy, zeta potential analysis, X-ray photoelectron spectroscopy showed the decrease in crystallinity, graphitic carbons, and the degree of structural disorder of graphitic structures, while it was shown that the oxygen content and the number of graphene layers were increased. The findings in this study suggest that O-g-CN can be a cost-effective catalyst for the degradation of refractory organic compounds and that a g-CN with a more rigid crystalline structure and a proper oxygen content would provide the g-CN structure with an improved catalytic activity.

Keywords: catalyst, graphitic carbon nitride, peroxymonosulfate, oxytetracycline, radicals

Acknowledgement: This work was supported by Korea Environment Industry & Technology Institute(KEITI) through Subsurface Environmental Management(SEM) Projects, funded by Korea Ministry of Environment(MOE)(2019002480005).

Oxidation of Oxytetracycline by Oxygen-doped Graphitic Carbon Nitride and Peroxymonosulfate

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Carbon based catalysts have gain a great interest because of their high activity, enhanced electron transfer, thermal stability, and chemical stability. Graphitic carbon nitride (g-CN) is one of the carbon based catalysts which can be prepared by simple single-step polycondensation, is cheap, and non-toxic. The g-CN acts as a photocatalyst but does not activated peroxydisulfate (PDS) or peroxymonosulfate (PMS). However, recently, it has been found that the oxygen-doped g-CN (O-g-CN) could activated PMS due to less electron density and more unpaired electrons. Therefore, the catalytic oxidation of oxytetracycline (OTC) using O-g-CN and PMS was investigated in depth. OTC is one of the most widely used antibiotics worldwide, posing a great threat to aquatic ecosystem. The results of a series of batch experiments showed that the O-g-CN was successfully prepared by one-pot thermal process and that OTC removal was excellent with 0.1 g/L O-g-CN and 1 mM PMS (37.5 mg/g·h). The OTC removal was enhanced with the increases in O-g-CN dose and pH. The electron paramagnetic spectra showed strong signals of 5,5-dimethylpyrroline-(2)-oxyl-(1) (DMPOX) generated by DMPO oxidation, indicating that $SO_4^{\bullet-}$ contributed dominantly to the OTC removal. The OTC degradation rate was decreased and the characteristics of the O-g-CN were altered as the O-g-CN was repeatedly used. The results of Raman spectroscopy, X-ray diffraction patterns, Fourier-transform infrared spectroscopy, zeta potential analysis, X-ray photoelectron spectroscopy showed the decrease in crystallinity, graphitic carbons, and the degree of structural disorder of graphitic structures, while it was shown that the oxygen content and the number of graphene layers were increased. The findings in this study suggest that O-g-CN can be a cost-effective catalyst for the degradation of refractory organic compounds and that a g-CN with a more rigid crystalline structure and a proper oxygen content would provide the g-CN structure with an improved catalytic activity.

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Enhanced Acetaminophen Degradation by Fe and N Co-doped Multi-walled Carbon Nanotubes

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A new co-doped composite of Fe and N on multi-walled carbon nanotube (Fe-N-CNT) was fabricated via a simple hydrothermal method and characterized using scanning electron microscopy (SEM), Raman spectroscopy, X-ray diffraction patterns, Fourier-transform infrared spectroscopy, zeta potential analysis, X-ray photoelectron spectroscopy (XPS), and cyclic voltammetry. Further, the degradation of acetaminophens (ACT) was investigated to demonstrate the catalytic capability of Fe-N-CNT via activating persulfate (PS). The doping of Fe and/or N was confirmed by SEM and XPS. The ACT degradation was 99.8% after a reaction time of 30 min with 0.05 g/L Fe-N-CNT and 0.08 mM PS and it was not significantly influenced in the initial pH of 20-8.2. The ACT removal rate was in the order of: CNT < Fe-CNT < N-CNT < Fe-N-CNT. The optimum doped amount of Fe and N was 42 and 320.1 mg/g-CNT, respectively, based on the ACT removal rate. A non-radical mechanism of Fe-N-CNT/PS system was verified in the results of the scavenger study, PS decomposition, as well as cyclic voltammetry. A remarkably enhanced electron transfer was observed for Fe/N-CNT probably sue to the electro deficiency and/or Fe^{3+}/Fe^{2+} redox cycle. The change in ACT removal and the leaching of Fe were negligible when Fe-N-CNT was used ten (10) times. It is suggested based on results in this study, that the co-doping of Fe and N on carbon based materials would greatly enhance the electron transfer leading to a better oxidation of organic compounds in water.

Keywords: Fe-N-carbon nanotube, carbon-catalyst, acetaminophen, non-radical, persulfate

Acknowledgement: This work was supported by Korea Environment Industry & Technology Institute(KEITI) through Subsurface Environmental Management(SEM) Projects, funded by Korea Ministry of Environment(MOE)(2019002480005).

Enhanced Acetaminophen Degradation by Fe and N Co-doped Multi-walled Carbon Nanotubes

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A new co-doped composite of Fe and N on multi-walled carbon nanotube (Fe-N-CNT) was fabricated via a simple hydrothermal method and characterized using scanning electron microscopy (SEM), Raman spectroscopy, X-ray diffraction patterns, Fourier-transform infrared spectroscopy, zeta potential analysis, X-ray photoelectron spectroscopy (XPS), and cyclic voltammetry. Further, the degradation of acetaminophens (ACT) was investigated to demonstrate the catalytic capability of Fe-N-CNT via activating persulfate (PS). The doping of Fe and/or N was confirmed by SEM and XPS. The ACT degradation was 99.8% after a reaction time of 30 min with 0.05 g/L Fe-N-CNT and 0.08 mM PS and it was not significantly influenced in the initial pH of 20-8.2. The ACT removal rate was in the order of: CNT < Fe-CNT < N-CNT < Fe-N-CNT. The optimum doped amount of Fe and N was 42 and 320.1 mg/g-CNT, respectively, based on the ACT removal rate. A non-radical mechanism of Fe-N-CNT/PS system was verified in the results of the scavenger study, PS decomposition, as well as cyclic voltammetry. A remarkably enhanced electron transfer was observed for Fe/N-CNT probably sue to the electro deficiency and/or Fe^{3+}/Fe^{2+} redox cycle. The change in ACT removal and the leaching of Fe were negligible when Fe-N-CNT was used ten (10) times. It is suggested based on results in this study, that the co-doping of Fe and N on carbon based materials would greatly enhance the electron transfer leading to a better oxidation of organic compounds in water.

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Exceptionally Porous g-C_3N_4 Nanosheets for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction

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Conventional methods for hydrogen peroxide production are suffering from several unavoidable challenges such as abundant energy and organic solvents consumption as well as potential explosion hazard of the mixture of oxygen and hydrogen. Photocatalytic oxygen reduction reaction has been recently introduced as an energy saving, environmentally friendly, facile, and safe method for such a purpose. As a metal-free photocatalyst with unique optical, chemical and economical characteristics, graphitic carbon nitride (g-C_3N_4) has been widely investigated for different applications over the past few years. A suitable band gap (about −2.7 eV) as well as a conduction band potential of almost −1.3 eV make g-C_3N_4 a promising candidate for photocatalytic H_2O_2 production under visible light. As a result, in this study we investigated the utilization of highly porous g-C_3N_4 nanosheets synthesized by cyanuric acid-melamine (CM) complex as a starting material for obtaining a significant enhancement in H_2O_2 production rate. The experimental results indicated a high hydrogen peroxide production rate of approximately 285 $\mu mol.g^{-1}.h^{-1}$ under visible light irradiation (λ>420 nm) for the optimized conditions compared with that of almost 135 $\mu mol.g^{-1}.h^{-1}$ for the bulk g-C_3N_4

Keywords: hydrogen peroxide production, Photocatalysis, g-C_3N_4, supramolecular structure

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MIST: Ministry of Science and ICT) (No. 2019R1A2C2085250).

W Doped α-Fe_2O_3 Heterojunction with MoS_2 Nanosheet for Improving Photoelectrochemical Performance

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Photoelectrochemical (PEC) water splitting is one of the most promising approaches for such renewable and sustainable energy of hydrogen. Hematite (α-Fe_2O_3) is a n-type semiconducting material which can absorb visible light (band-gap energy: 2.1 eV) with cheap, non-toxic, and earth-abundant elements. However, the efficiency of α-Fe_2O_3-based photoanode is still limited by some intrinsic drawbacks, such as short hole diffusion lengths and the high electron-hole recombination. Recently, MoS_2 has been demonstrated to be able to act as a proper 2D material for heterojunction with well-aligned band edges when it is combined with α-Fe_2O_3 to development of effective charge extraction. In this study, first we optimized percentage of W doping on α-Fe_2O_3 photoanode, deposited on the FTO as a conductor substrate and then modified by MoS_2 prepared via the liquid exfoliation method. Figure 1a shows typical linear scan voltammetry (LSV) of pure α-Fe_2O_3, 0.25-1.0 % of W on α-Fe_2O_3 and 0.5%W-α-Fe_2O_3/MoS_2 electrodes between -0.6-0.6 V *vs.* Ag/AgCl. After constructing the heterojunction of MoS_2 with pure α-Fe_2O_3 and 0.5% W-α-Fe_2O_3, the photocurrent density significantly increased. The 0.5% W-α-Fe_2O_3/MoS_2 electrode shows the photocurrent density of 2.1 mA.cm^{-2} at 0.6 V vs. Ag/AgCl, which is 10 and 2.5 times higher that of the pure α-Fe_2O_3 and 0.5% W-α-Fe_2O_3, respectively. Figure 1b shows chopped LSV scans in which photocurrent shows prompt response and is in a good agreement with the photocurrent density of LSV.

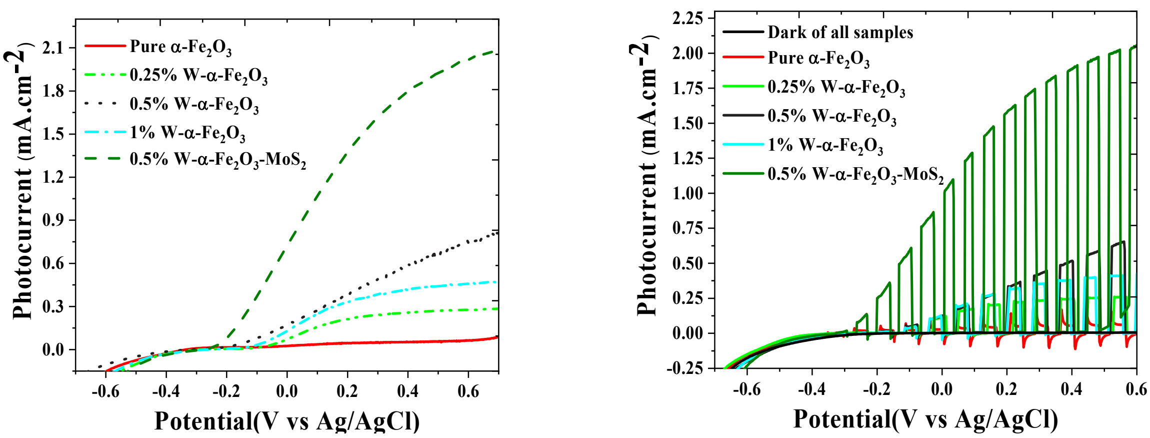

Fig.1:(a) LSV and (b) chopped LSV of photoanodes, under 100mW/cm^2, in NaOH as the electrolyte.

Keywords: liquid phase exfoliation, α-Fe_2O_3, doping tungsten (W), MoS_2 nanosheets.

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MIST: Ministry of Science and ICT) (No. 2019R1A2C2085250).

Synthesis of Cosmetic Grade TiO_2-SiO_2 and TiO_2-stearic acid Core-shell Powder Comparison with Commonly used TiO_2

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TiO_2 nanoparticles are generally used as a base constituent in the commercial production sunscreen and several other cosmetics. TiO_2 nanoparticles known to generate reactive oxygen species (ROS) upon UV irradiation which has cytotoxicity, genotoxicity characteristics even damages the DNA. The cytotoxicity, genotoxicity concern can be mitigated by shielding the TiO_2 nanoparticles particles through the suitable coating. Considering the advantages of SiO_2 and stearic acid, SiO_2 and stearic acid coated TiO_2 nanoparticles were synthesized for cosmetic application purpose and their UVB protection factor and sun protection factors were compared with bare TiO_2 nanoparticles. A suitable optimum condition was explored for cosmetic grade TiO_2-SiO_2 and TiO_2-stearic acid core-shell nanopowder synthesis and various physical properties and optical properties were also analyzed. Cosmetic grade 100 nm-sized TiO_2-SiO_2 core-shell nanopowder exhibited better sun protection factor (SPF) whereas TiO_2-stearic acid core-shell nanopowder exhibited reduced photocatalytic activity which could provide better protection against cytotoxicity, genotoxicity.

Keywords: Cosmetic Grade TiO_2-SiO_2; Sunscreen; UVA protection; Nanopowder

Biofouling Mitigation by Modified Polypropylene Feed Spacer using Polydopamine-vanillin

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Feed spacer shows a significant role in spiral-wound reverse osmosis (RO) membrane module. The feed spacer maintains the gap between the membranes which prevents the membrane from joining and improves the mass transfer during the operation. Despite these advantages, long-term operation can occur biofouling on the spacer surfaces, affected on the RO membrane filtration process. In this study, biofouling mitigation was verified by modifying the polypropylene (PP) feed spacer surface using vanillin which is an environmentally friendly and hydrophilic material. A mussel-inspired material, polydopamine (PDA), was also used for the spacer modification to improve the adhesive strength of vanillin from the spacer surface. Two ways of coating method were applied: the PDA was pre-coated on the surface of the PP, then the vanillin coated feed spacer (PDA-V spacer). Another method was to co-deposit vanillin and PDA (PCV spacer). PDA-V and PCV spacers were coated by immersion and then analysed for various surface analysis. In addition, bacterial adhesion and detach experiments were carried out to evaluate the coating performance of the spacer for biofouling reduction. Experimental results showed that the PCV spacer was more effective in inhibiting the biofilm formation than the PDA-V spacer by delaying the formation of the bacterial colonies.

Keywords: anti-biofouling, polypropylene, immersion, vanillin, polydopamine

Shaping Reactor Microbiome to Optimize Caproate Productivity : Application of Design-Build-Test-Learn Framework

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Medium chain length carboxylate (MCC) is a versatile platform chemical which can be processed into renewable diesel, fragrances, food additives, and so on. Despite of its high potential to ease the existing energy crisis, MCC is hardly utilized in a large scale. Conventionally, MCC is produced from longer chain length carboxylate derived from plant and animal oils or petroleum and the production cost is high. Recently, chain elongation based on reverse-β-oxidation is getting more attention, which enables MCC production from various waste streams and lowers the production cost. Open cultures of anaerobic microbial consortia have the ability to efficiently handle the complexity of organic wastes due to their broad genetic and metabolic diversity.

The reactor for shaping a caproate-producing microbiome consisted of two steps. In the first step, the reactor pH was adjusted to 5.6 and glucose was provided as a substrate to enrich microbes which could grow well under the mild acidic condition. In the second step, shaping of caproate-producing microbiome was carried out. In the second step of SBR, lactate and short chain length carboxylates were added in the reactor, they were used as an electron donor and an acceptor of chain elongation, respectively. Our result indicate that the presence of acetate can promote butyrate fermentation but impeditive to further chain elongation to caproate. Adversely, addition of butyrate was beneficial to shaping caproate producing microbiome. Activity of hydrogenotrophic homoacetogen was identified which could produce acetate from H_2 and CO_2. Therefore, CO_2 capturing system was introduced in the second step of shaping process to prohibit acetate production, and conversion ratio of lactate to caproate could be enhanced over 70%. An optimum shaping condition was determined (i.e., injection of lactate 50 mM, butyrate 10 mM with CO_2 capturing) and by repeating the shaping condition, conversion ratio of lactate to caproate could be enhanced to 90%. As a result of microbiome analysis, solvent producing isolate, *C. carboxidivorans*, were abundantly enriched. In the batch reactor operation using selected microbiome under optimum shaping condition showed high (i.e., 10.03 gCOD/L/day) and predictable (i.e., 60% of selectivity calculated in lactate eq. bases) caproic acid productivity in exceptionally short start-up time (i.e., 84 h). To optimize the productivity of caproic acid, operation of caproic acid producing anaerobic membrane bioreactor system will be conducted.

Keywords: Chain elongation, Caproic acid, Open culture fermentation, Microbiome shaping

Colloidal Activated Carbon as Highly Efficient Bifunctional Catalyst: Implications in Activation of Persulfate for Phenol Degradation

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A scalable approach for the preparation of colloidal activated carbon (CAC) for groundwater remediation application was presented. The CAC showed excellent suspension stability under laboratory conditions. Dynamic light scattering analysis of CAC revealed that particles size (d_{50}) of carbon is ~0.4 μm. X-ray photo electron spectroscopy (XPS) confirms the total composition of N and S atoms in CAC was less than 1%. CAC catalyst showed excellent phenol degradation in the presence of persulfate (PS). The total phenol removal efficiency of CAC/PS was much better than the classical Fe^{2+}/PS system. The effect of initial pH, CAC dosage and anions on the phenol degradation rate was also systematically investigated. Anion species and CAC dosage affected phenol degradation rate. In the CAC/PS system, 250 mg/L of CAC was the optimum loading for the complete removal of 0.5 mM phenol within 30 min. Screening of reactive species through electron paramagnetic resonance (EPR) revealed that the phenol degradation in the CAC/PS system is taking place with the involvement of radicals ($SO_4^{\bullet-}$, $^{\bullet}OH$ and $O_2^{\bullet-}$). Phenol oxidation in the presence of radical scavengers (methanol, ter-butyl alcohol and NaN_3) suggests that the phenol degradation in the CAC/PS system follows adsorption–decomposition mechanism. Various physico-chemical properties of CAC such as high suspension stability, sorption capacity, PS activation and scalable production showed that CAC can be used as a low-cost metal-free catalyst for groundwater remediation application.

Keywords: Activated carbon, colloidal activated carbon, heteroatom doped carbon, persulfate and groundwater treatment, phenol degradation

Implication of Microbial Community to the Overall Performance of Tree-box Filter Treating Parking Lot Runoff

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This study determined the mechanisms affecting the pollutant removal of a 9-year old tree box filter, an example of a low impact development technique, in treating parking lot runoff. Specifically, the implications of microbial community to the overall performance of the tree-box filter was investigated. Based on the findings, it was found that hydrologic and hydraulic factors including volume, average flow, peak flow, HRT and runoff duration significantly affected the pollutant reduction efficiency of the tree box filter suggesting that infiltration and retention in the facility plays an important role in reducing the organic and nutrient loads from the parking lot catchment. Summer season was found to be the most suitable season for microorganism growth since more microorganism were found during this season. Least microorganism count was found in spring because of the plant growth during this season since plant penology influences the seasonal dynamics of soil microorganisms. Litterfall during fall season might have affected the microorganism count during winter since, during this season, the compositional variety of soil organic matter changes affecting growth of soil microbial communities. Microbial analyses of sediment samples collected in the system revealed that the most dominant microorganism phylum is *Proteobacteria* in all the seasons in both inlet and outlet comprising 37% to 47% of the total microorganism count. *Proteobacteria* was followed by *Acidobacteria, Actinobacteria* and *Chloroflexi* which comprises 6% to 20%, 9% to 20% and 2% to 27%, respectively of the total microorganism count for each season. These findings were useful in optimizing the design and performance of tree box filters considering physical, chemical and biological pollutant removal mechanisms.

Keywords: Low impact development, microorganism, stormwater management, tree box filter

Acknowledgements

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Understanding the Difference in Performance between High and Low Infiltration Systems for Urban Stormwater Runoff Management

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The increasing effect of urbanization has been more apparent through flooding and decline in downstream water quality especially from heavy rainfalls. In response, stormwater runoff management solutions have focused on runoff volume reduction and treatment through infiltration. However, there are areas with low infiltration soils or experiencing more dry days and even drought. In this study, a lab-scale infiltration system was used to compare the applicability of two types of soil as base layer in gravel-filled infiltration systems with emphasis on runoff capture and suspended solids removal. The two types of soils used were sandy soil representing a high infiltration system and clayey soil representing a low infiltration system. Findings showed that infiltration rates increased with the water depth above the gravel-soil interface indicating that the available depth for water storage affects this parameter. Runoff capture in the high infiltration system is more affected by rainfall depth and inflow rates as compared to that in the low infiltration system. Based on runoff capture and pollutant removal analysis, a media depth of at least 0.4 m for high infiltration systems and 1 m for low infiltration systems is required to capture and treat a 10-mm rainfall in Korea. A maximum infiltration rate of 200 mm/h was also found to be ideal to provide enough retention time for pollutant removal. Moreover, it was revealed that low infiltration systems are more susceptible to horizontal flow and that the length of the structure may be more critical than depth in this condition.

Keywords: design, infiltration, low impact development, reuse, stormwater runoff management

Synergetic Collaboration of Graphitic carbon nitride With an Insulator for Enhanced Visible-light Photocatalytic Activity

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Recently, graphitic carbon nitride g-C_3N_4 as a fascinating conjugated polymer has been attracted interdisciplinary attention in the scientific community. It can harvest clean energy i.e., solar energy and convert it to chemical energy which is considered as a green technology. The g-C_3N_4 is a non-toxic, metal-free, as well as cheap photocatalyst. It has been approved that g-C_3N_4 has a good light response at around 450 nm, which is related to its narrow bandgap of 2.7 eV. Of particular note is that the surface chemistry of g-C_3N_4 can be easily manipulated to improve its band structures, electronic properties, optical absorption, and interfacial charge transfer.

In this study, thiourea is well grown up on the silica oxide surface as the insulator (g-C_3N_4/SiO_2) by thermal polymerization method. Then, the best composite is obtained by an acid etching process in which an HF solution is used. The obtained g-C_3N_4/SiO_2 hybrid shows the dramatically photocatalytic activity in degradation of rhodamine b (12 mg/L) under 300 W, Xenon lamp with 420 nm cut off filter. The X-ray diffraction (XRD) results obviously show that g-C_3N_4 is successfully intercalated between SiO_2 particles, indicating a strong interaction between g-C_3N_4 and SiO_2 components. Moreover, the scanning electron spectroscopy (SEM) clearly confirms the bulk morphology of g-C_3N_4 becomes spherical shapes as the same as SiO_2 particles. On the other hand, silica based material can provide more active sites and a homogeneous environment for g-C_3N_4 photocatalyst to improve it in terms of visible light performance. More importantly, it also decreases the length of photoinduced electron-hole transportation and leads to depressing the recombination rate of electron-hole pairs, endowing the enhanced photocatalytic activity.

Keywords: Photocatalysis, Green technology, g-C_3N_4, Insulator, Visible light performance

Acknowledgements

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Process Development for Large-scale Biochar Production by Integration of Pyrolysis and Large Combustion Plant

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Due to favourable material properties, biochar from biomass pyrolysis has been attracting great interests for various energy and environmental applications. For realization of its potentials, it is required to produce biochar on a large scale using a clean and energy-efficient process. During pyrolysis, solid biomass is thermally decomposed and converted to carbonaceous biochar while a significant proportion of mass and chemical energy is released as tar and gases. Fully recovering the energy contained in the by-products is often not possible and requires complicated process with difficulties in operation control and maintenance.

This study presents a new process for large-scale biochar production with a high energy efficiency and simple process layout, which can overcome the limitation of existing pyrolysis processes. The process integrated the pyrolysis reactor with a large combustion plant that can provide combustion gas at a moderate temperature as heat source for pyrolysis and burn the by-products for efficient heat recovery. This process concept was applied to a biochar production plant at a 50 ton/day capacity integrated with a 125 MWe power plant burning wood pellets. To design the actual process, detailed numerical modelling was developed for reactions and heat transfer involved in drying and pyrolysis of biomass in rotary kiln reactors based on fundamental experiments. The model was then applied to determine the target design parameters such as process layout, reactor dimension, and additional heat supply. The target biomass for biochar production is wood pellet which is available at the plant, but several domestic biomass types are being considered for feedstock in the future. The equipment required for process integration has been installed and the process is currently under troubleshooting and operation tests.

Keywords: biochar production, pyrolysis, process integration, energy recovery, wood pellet

Biodiesel Production of Waste Cooking Oil by via Non-Catalytic Transesterification using Swine Manure Biochar

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Livestock manure has gained considerable attention due to its massive generation and environmental hazards. Especially, the generation of manure from swine is superior. In a previous study, a pyrolysis process was conducted to the management of swine manure. The results proved that it can experimentally recover energy while managing swine manure. However, possible valorization of pyrolysis by-products such as biochar has not been proposed. Hence, the present study laid great stress on the possible valorization of biochar in the production of biodiesel since swine manure biochar (SMB) is a carbon rich material containing several inorganic species. SMB was generated from three different operating temperatures (350, 500, 600 ° C). The surface morphologies of SMB were characterized by the biodiesel yield in line with the Physico-chemical properties of SMB. In addition, the pore size of the SMB was confirmed by Brunauer-Emmett-Teller (BET) analysis. For example, SMB generated at 350 ° C has a high yield of over 93% compared to other temperatures. Also, biodiesel yields according to the experimental temperature have higher than silica in general. Therefore, SMB was used as a substitute for silica as a porous material to synthesize waste cooking oil into biodiesel.

Keywords: Livestock manure, Biodiesel, Biochar, Non-Catalytic Transesterification, waste-to-energy

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Effects of Pyrolysis Syngas Injection onto Methane Yield from Anaerobic Digestion Process

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Anaerobic digestion has been recognized as a promising technology for recent decades due to increase of interest in clean energy source. The anaerobic digestion may have benefit in terms of mitigating odor generation, reducing greenhouse gas production, and converting abandoned biomass to useful end product (*i.e.*, biogas). However, the limited biomass conversion efficiency during biochemical process (40-60% of CH_4 in biogas) remains as a hurdle for wide application of the anaerobic digestion. To overcome the low CH_4 yield and improve economic feasibility of anaerobic digestion process, various biogas upgrading technologies have been introduced. Among the biogas upgrading technologies, direct H_2 addition method supply additional H_2 into anaerobic digester and the injected H_2 act as electron donor to produce CH_4 via hydrogentrophic methanogenesis. Despite the advantage of direct H_2 addition method for better CH_4 yield, high price of pure H_2 and concern about a rise of pH in anaerobic digester when H_2 injection exceeds stoichiometric equilibrium between H_2 and CO_2 are pointed out as the major drawback for expanding use of the method. The main objective of this study was to investigate effects of pyrolysis syngas, containing H_2 gas, addition to anaerobic digester for upgrading CH_4 yield. To this end, pyrolysis of digested sludge and anaerobic digestion of thickened sludge with injection of pyrolysis syngas were conducted. During the anaerobic digestion of thickened sludge with injection of pyrolysis syngas, H_2-rich characteristic of syngas promoted CH_4 yield when it compared to the equivalent value of control test. However, existence of C_2H_4 in syngas showed reversible inhibition onto CH_4 production even when syngas contains balanced H_2 to CO_2 for stoichiometric ratio of hydrogentrophic methanogenesis. Furthermore, the results of TCOD, VS, and TOC analyses revealed that the observed difference in CH_4 yield was attributed to the H_2 richness by syngas injection, not discrepancy in substrate degradation.

Keywords: Anaerobic digestion, Biogas upgrading, Methane yield, Pyrolysis, Syngas injection

Acknowledgements

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Production of Hydrogen and Carbon Black by Photocatalytic Decomposition of Benzene Using Liquid Plasma

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Volatile organic compounds released as wastes cause serious environmental problems. Of these substances, benzene is the largest amount. In this study, a photocatalytic decomposition of spent benzene using liquid phase plasma and photocatalyst is proposed. This reaction produced hydrogen as a gaseous product and simultaneously produced carbon black. Liquid benzene was decomposed by photocatalytic reaction using liquid phase plasma. The irradiation effect of the liquid plasma applied as a light source in relation to the decomposition of benzene and hydrogen generation was investigated. Hydrogen production and benzene removal have been characterized from photocatalytic decomposition of liquid benzene on TiO_2 and metal-loaded TiO_2 photocatalysts. Zeolite beads were applied as photocatalyst support. In the photocatalytic decomposition reaction using liquid phase plasma, some hydrogen was generated by decomposition of benzene by irradiation of liquid plasma only without photocatalyst. This is due to the decomposition of benzene by active species produced by liquid phase plasma irradiation. Photocatalytic decomposition of benzene was enhanced by the addition of metal-loaded TiO_2 photocatalysts in the photocatalytic reaction. Metal loading on TiO_2 improved the generation of hydrogen and the decomposition of benzene due to improved photosensitivity. Zeolite beads served as an efficient photocatalyst support for the fixation of TiO_2. Photocatalytic decomposition reaction of benzene using liquid phase plasma was efficient to produce carbon black simultaneously with hydrogen production.

Keywords: Hydrogen, Liquid phase plasma, Benzene, Carbon black, TiO_2

Effect of Residual Antibiotics on Biodiesel Yield of Microalgae Treating Livestock Excreta

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Livestock industry has supplied essential protein sources to society. Its quantitative and qualitative growth along with the industrial development made the total number of livestock increased rapidly thus the amounts of livestock excreta (LE) inclined as well. Due to high levels of pollutants such as nitrogen, phosphorus, and organics, eutrophication became a severe social and environmental problem. Moreover, emerging contaminants, e.g. antibiotics for livestock's disease prevention, were revealed as potential threats to human society. However, some microalgae have been known to absorb and/or degrade the antibiotics during photoautotrophic or heterotrophic growth. By harvesting the biomass, therefore, microalgae can improve water quality and become a useful source of renewable energy, biodiesel. Relatively little information, however, is available about how residual antibiotics affect the yield of biodiesel production. To verify the relationship, this study investigates the variation of biodiesel yield according to different antibiotics concentrations ranging from 0.01 to 20 mg/L in LE. *Chlorella sorokiniana* was grown under mixotroph condition (16 hr light–8 hr dark cycle) and amoxicillin was the main antibiotic in this study. Results indicate that the biodiesel yield of the control (LE, no antibiotic) was found to be ~0.07 g FAME/g biomass. It was evidenced that amoxicillin might reduce the yield down to ~70% (~0.02 g FAME/g biomass). These results support that frequent abuse of antibiotics for livestock may harm the eco-friendly conversion of waste-to-energy strategy.

Keywords: Livestock excreta, Antibiotics, Microalgae, Biodiesel, waste to energy

Citrus Pressed Cake Drying Technology

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In 2017, the amount of citrus pressed cake generated by a citrus juice extractor was 72,460 tons per year on Jeju Island, South Korea, and the final treatment method is storage on site. There are also physiological activities of flavonoids, but pectin and free sugars reduce the drying rate (kg of water/m^2-hr) and drying performance (SMER, Specific Moisture Evaporation Rate, kg of water/Mcal), which also delays operating time. The citrus pressed cake treatment process to dry was carried out under the "cooking oil" added conditions (0wt.%, 1wt.%, 3wt.% and 5wt.%) to shorten the operating time. The operating conditions of the electric heat source dryer were set as follows: heating temperature 170^{o}C, cooling time 1 h, 50 Hz fan inverter, and vapor temperature difference calculated by moving average 2.0^{o}C/10 min. The design conditions of the electric heat source dryer derived from using operating parameters such as operating time (hr), power consumption (kWh), drying rate (kg of water/m^2-hr), drying performance (SMER, Specific Moisture Evaporation Rate, kg of water/Mcal).

Keywords: Citrus pressed cake, Cooking oil, Drying rate, Drying performance

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Occurrence of Microplastics in South Korea: A Review

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Abstract:
Microplastics have been drawing attention due to its persistence and its potential detrimental effects to human health and environment. The size of microplastics can range from 0.1 to 5mm, but most recent studies defined microplastics as plastics smaller than 5mm. A collection of published literatures were reviewed and summarized to evaluate the occurrence and sources of microplastics in South Korea. The data regarding the amount of microplastics from municipal wastewater treatment plants (WWTP) in big cities and regions, Han river, Anyang stream, Jinhae bay, Geoje coast and eight coastal waters in South Korea were obtained from scientific databases and publications. Microplastics in WWTP influent and effluent ranged from 31 to 270 particles/L and 0.01 to 0.25 particles/L, respectively. Among the different WWTPs studied, the WWTP in Busan provided the largest concentration of microplastics. The microplastics in surface water bodies ranged from 0.001 to 88 particles/L. Among the surface water bodies, the greatest amount of microplastics was found on Jinhae bay. Busan and Jinhae bay were both located in the southeastern tip of Korean peninsula. Jinhae bay receives discharge from Nakdong River which passes through Daegu and Busan. Polypropelene (PP) and polyethylene (PE) were the dominant polymers found in WWTPs and Jinhae bay. These polymers were commonly found in packaging materials and bottles. Abundance of microplastics varies in different parts of South Korea. The ubiquity of microplastics is considered as a major challenge in establishing control measures in preventing microplastic pollution. Further studies and standardized methods for identification and quantification of microplastics are recommended to analyze the impact of microplastics in the environment.

Keywords: microplastic, polymers, South Korea

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The Occurrence of Pharmaceuticals and Personal Care Products in Different Environmental Media: A Review

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Pharmaceuticals and personal care products (PPCPs) are among the most common types of emerging contaminants that are widely investigated due to their persistence in the environment. A collection of 143 papers retrieved from journals and academic publications were reviewed to determine the types of PPCPs found in different environmental media such as surface water, wastewater, groundwater, soil, animal tissues, and plant organs. Among the 139 identified types of PPCPs, Carbamazepine (CBZ), Ibuprofen (IBF), Naproxen (NPX), Caffeine (CAF), Triclosan, (TCL), Galaxolide (GLX), and Tonalide (TNL) were the most commonly-found in the environment. CAF was the most predominant compound found on treated wastewater (207 ng/L to 22000), surface water (2.15 ng/L to 144179 ng/L), and groundwater (<6 ng/L to 16249 ng/L). The primary pathway of PPCPs in the environment is through the discharge of wastewater. Since most wastewater treatment plants were not designed to treat PPCPs, trace concentrations of these compounds can be released in the environment. Moreover, higher environmental concentrations of PPCPs can be detected due to the direct discharge or leakage of raw wastewater from defective sewer systems. Apart from surface water contamination, treated wastewater containing PPCPs can also result aquatic ecosystem risks. IBF (2.5 ng/mL to 3.8 ng/mL), CBZ (0.03 ng/g to 0.06 ng/g), GLX (100 ng/g to 1800 ng/g), TNL (60 ng/g to 240 ng/g), and TCL (11 ng/mL to 110 ng/mL) were found on fish organs and plasma. PPCPs tend to accumulate on animal tissues due to their long-term exposure to these compounds. Concentrations of GLX and TCL ranging from 2.39 ng/g to 52.5 ng/g and 6 ng/g to 80.1 ng/g were also detected on soil and plant samples. Biosolids and reclaimed water may contain trace minerals and nutrients necessary for plant growth; however, PPCPs can reach also reach the terrestrial environment through these practices. Despite the vast array of scientific investigations and environmental assessments, further studies are still necessary to qualitatively and quantitatively assess the ecotoxicological effects of different PPCP compounds.

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Keywords: Emerging contaminants, pharmaceuticals and personal care products

Melting Slag Formation for the Recycling of Automobile Shredder Residues

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The gasification of Automobile Shredder Residue (ASR) was performed using fixed-bed reactor for the recovery as energy resources. The capacity of fixed-bed reactor was 1kg/hr and the experimental temperature was 800, 1,000, and 1,200 ℃. The equivalence ratio(ER) was ranged from 0.1 to 0.5. The syngas yield composed of hydrogen and carbon monoxide was ranged from 40% to 86%. The syngas yield from the process increased as the gasification temperature increased. In addition, the melting experiment of char and ash from the gasification process was performed for the recycle as the clay bricks from the melting slag. The pore number of melting slag increased as the gasification temperature increased. The strength of melting slag was higher than that of the standard clay bricks. As the results, the melting slag content and the gasification temperature were optimized as 10 wt % and 1,300℃, respectively.

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Keywords: Automobile Shredder Residue; Recycling; Gasification; Melting; Slag

Robust Photocatalytic Degradation of Organic Pollutants by MFe_2O_4 Nanoparticles

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Ferrite nanoparticles, MFe_2O_4 (M = Co, Ni, Cu, and Zn) have been synthesized by the surfactant-mediated co-precipitation-oxidation method. The band gap calculated from UV-Visible diffuse reflectance spectra were found in the range of 1.11-1.81 eV. The XRD and TEM analysis confirmed cubic symmetry for $CoFe_2O_4$, $NiFe_2O_4$, and $ZnFe_2O_4$ with crystallite size in the range of 27-36 nm. The $CuFe_2O_4$ nanoparticles were in the tetragonal symmetry with 16 nm as the crystallite size. The photocatalytic activity of ferrites was tested by considering methylene blue dye as the target pollutant using 32 W UV-C/H_2O_2 system. Exceptional degradation rate (k_{app}) in the order: $NiFe_2O_4$ (2.417 min^{-1}) > $CoFe_2O_4$ (2.141 min^{-1}) > $ZnFe_2O_4$ (2.069 min^{-1}) > $CuFe_2O_4$ (2.065 min^{-1}) were recorded at neutral pH. In the optimized condition, NiF was found to degrade 89%, 92%, 93%, and 78% of methylene blue, methyl orange, bromo green, and methyl red, respectively within 1 min of UV-irradiation. Nearly 40% TOC removal was recorded after 5 min of degradation reaction, which increased to 60% after 50 min. Mechanism elucidated by scavenger studies and fluorescence spectroscopy revealed that $^{\bullet}OH$ and holes were the primary reactive radicals responsible for the degradation process. With excellent recyclability, these catalysts showed competitive degradation in contaminated water and could be scaled-up for a cost-effective wastewater remediation process.

Keywords: Ferrites, Kinetics, Organic dyes, Photocatalysis, Surfactant-mediated

A New 3D Hierarchical Bi_3O_4Cl/Bi_5O_7I Heterojunction and Its Photocatalytic Degradation Performance over Rhodamine-B and Bisphenol-A

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Herein, we developed a new 3D-hierarchical Bi_3O_3Cl/Bi_5O_7I heterojunction photocatalyst by an in-situ solvothermal route. The 3D-hierarchical Bi_3O_4Cl/Bi_5O_7I were characterized by Thermogravimetric analysis, X-ray diffraction spectroscopy, Raman spectroscopy, FESEM, EDX, UV-DRS and PL spectroscopy for the investigation of phase, morphology, elemental analysis and optical properties. The generation of $O_2^{\cdot-}$, $^{\cdot}OH$ radicals and holes during photocatlytic reaction was revealed by using Isopropyl alcohol, 1,4-Benzoquinon and potassium Iodide. Based on radical tests the charge transport mechanism was proposed for 3D-hierarchical Bi_3O_4Cl/Bi_5O_7I interface. The photocatalytic performance of our 3D-hierarchical Bi_3O_4Cl/Bi_5O_7I was investigated by Rhodamine-B (RhB) dye and Bisphenol-A (BPA) colourless pollutant. The performance of our newly synthesized 3D Bi_3O_4Cl/Bi_5O_7I heterojunction photocatalyst much enhanced than the pristine Bi_3O_4Cl and Bi_5O_7I photocatalyst due to the formation of type II heterostructure and their unique 3D morphology. The newly developed photocatalyst effectively supress the photo-excited electron hole recombination, but also build a 3D open frame network to harvest more incident light and provide more specific surface area for photo reactions. Benefitting from the 3D-hierarchical nanostructure and type II heterojunction mechanism, RhB and BPA decomposition over Bi_3O_4Cl/Bi_5O_7I reached up to 97% within 90 min and 86% with 20 min using a visible light $(\lambda \geq 420\, nm)$ Xenon lamp as a light source, which was much higher than that achieved over pure Bi_3O_4Cl and Bi_5O_7I photocatalyst. The 3D-hierarchical Bi_3O_4Cl/Bi_5O_7I heterojunction photocatalyst fabricated in this study may be an attractive material for many environmental and energy-related applications.

Keywords: visible light Photocatalyst, Bi_3O_4Cl, Bi_5O_7I, Heterojunction, Bisphenol-A degradation, Rhodamine B degradation

Tailoring Heterojunction Architecture on IrO_2 Based Dimensionally Stable Anodes for Environmental Applications

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Dimensionally stable anodes (DSAs), most often based on IrO_2 as a core component, have been widely deployed for industrial chlorine production (chlor-alkali), energy storage into molecular H_2 (polymer exchange membrane electrolysis), and high-salinity wastewater treatment processes among many other uses. A challenge lies on that the Pt-group metal oxides with the lowest over-potential for oxygen evolution reaction also exhibit outstanding electro-catalytic activities for chlorine generation. The competition between oxygen and chlorine evolution reactions for active surface sites (*e.g.,* surface coordinated reactive oxygen species) intrigues heterojunction architecture over the conventional DSA configuration in order to shift the surface reaction selectivity. In addition, a dual functioning approach of the heterojunction is expected by a proper choice of over-layer in order to prevent the core IrO_2 layer from anodic dissolution. In this study, we present and compare variable strategies on hetero-junction anodes, focusing on an enhanced reactive chlorine species (RCS) generation in dilute aqueous solution in terms of current and energy efficiency. TiO_2 was fabricated as outer layer of $Ir_{0.7}Ta_{0.3}O_x$ anodes. The $Ir_{0.7}Ta_{0.3}O_x$ layer in ohmic contact with the Ti base would serve as electron shuttle by redox cycle of Ir(IV)/Ir(VI) couple. Potentiostatic (anodic potential at 3 V vs NHE) and galvanostatic (30 mA/cm^2) electrolysis in 50 mM NaCl solutions showed that heterojunction anodes, $Ir_{0.7}Ta_{0.3}O_x/TiO_2$ generates RCS with far greater current efficiency than $Ir_{0.7}Ta_{0.3}O_x$ anode. Despite a moderate loss of current through the junctions, an elevated electro-stationary concentration of adsorbed hydroxyl radical would result in the enhancement. TiO_2 as outer layer was found to be beneficial for RCS generation by providing large surface charge for M-O bond strength and minimize corrosive losses of Ir from the underlying ohmic-contact layer.

Keywords: Heterojunction electrode, electrochemical chlorine generation, water treatment

Gradient N-doped Structure of Carbon Quantum Dots as Metal-free Photo-electrocatalyst for Improved Charge Channeling and Associated Water Treatment

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Metal-free electrocatalysts are important to avoid the secondary pollution generated by the metal leaching from the metals-based catalysts in water treatment. In this regard, carbon materials are promising candidates, with competing advantages of low cost, earth-abundant, and sustainable nature. Among different carbon materials, carbon quantum dots (CQDs) show multimodal catalytic activities; for example, both electrocatalytic and photocatalytic activity of CQDs can be utilized simultaneously, for the dye degradation from water. This dual catalytic activity of CQDs is generated from their small size and associated quantum confinement effect. Although small size provides bandgap in CQDs (necessary for photocatalysis); however, extreme confinement of excited electrons in small size of CQDs causes fast electron-hole recombination. This fast recombination limits the overall photocatalytic activity, which can be avoided by suitable electron-hole separation. For the purpose, here we proposed a gradient nitrogen doping and gradient crystallinity in CQDs. The gradient of nitrogen states from the core to the surface serves as a junction for avoiding the electron-hole recombination. This effect is further assisted by the gradient crystallinity difference between core to the surface of CQDs. Apart from the above rational structural design, the *in situ* growth of CQDs on reduced graphene oxide nanosheets supported on carbon fibers provide additional electron mobility to suppress the recombination of excited electrons. Conclusively, by the combined effect of substrate and CQDs structure, a significant enhancement in photo-electrocatalytic activity in the carbon catalyst system was achieved for the dye degradation from water.

Keywords; Gradient crystallinity, surface states, carbon quantum dots, dye degradation,

metal-free catalyst

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Exfoliated Magnetic Ti_2AlC Heterostructures Using a Green One-step Hydrothermal Synthesis Process and Their Applications in Radionuclide Sequestration

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A green approach was adopted to exfoliate a titanium aluminium carbide (Ti_2AlC) MAX phase with additional magnetic properties. The exfoliated magnetic nanostructures (Ti_2Al_xC) with exceptional mechanical, thermal, significant magnetism, and water stability, as well as abundant oxygenated active binding sites, were synthesized via controlled hydrothermal treatment in an alkaline environment. The Ti_2AlC MAX phase exfoliation resulted into nanofibers, nanorods, and nanosheets (Figure 1). FE-SEM, FE-TEM, Raman spectroscopy, BET surface area, zeta-potential analyses, and XPS were utilized to investigate the material's characteristics and its structural changes after radionuclides adsorption. Cs^+ and Sr^{2+} were selected as model monovalent and divalent radioactive cations. The Cs^+ and Sr^{2+} adsorption on the synthesized nanostructures was assessed in batch tests based on the maximum adsorption capacity, adsorption kinetics, pH effect, and effect of co-existing cations and anions. The detailed quantitative investigation confirmed the interaction of hydroxyl groups on the magnetic nanostructure with Cs^+ and Sr^{2+} ions by electrostatic interactions, adsorption-coupled oxidation, and complex formation. Moreover, the synthesized nanostructures were tested for simulated seawater at ppb level. The results suggested that nanostructures synthesized using this route could provide a new approach to prepare and exfoliate additional MAX phases with synergistic properties for the removal of radioactive nuclides and other pollutants in the environment.

Keywords: Nanostructure, MAX phase, radionuclide, titanium aluminium carbide, adsorption

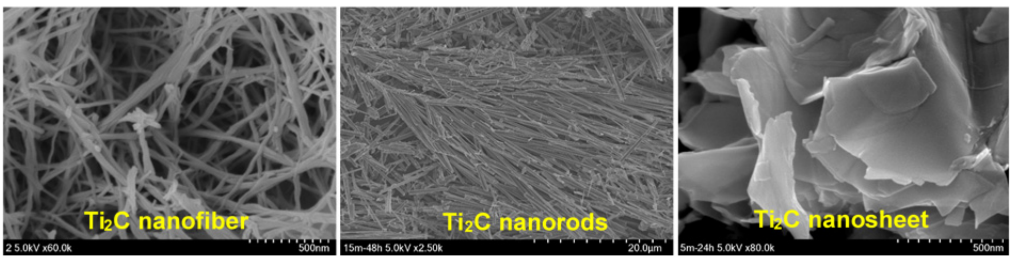

Figure 1

Constructing Highly Porous Graphitic Carbon Nitride for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction

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Hydrogen peroxide (H_2O_2) has received increasing attention because it is not only a mild and environment-friendly oxidant for organic synthesis and environmental remediation but also a promising new liquid fuel. The production of H_2O_2 through photocatalysis is a green, sustainable and promising process, considering it uses water and oxygen as the source materials and solar light as the energy. Among various photocatalysts, graphitic carbon nitride (g-C_3N_4), as a fascinating two-dimensional conjugated polymer consisting of low-cost, earth-abundant elements, has drawn broad attention as a robust, metal-free, and visible-light-active material in various fields. Fine-tuning of catalyst architecture and interface design enables exceptional photocatalytic activity. Herein, we constructed highly porous g-C_3N_4 through a simple thermal condensation method for efficient H_2O_2 production. Melamine powder, which is inexpensive, easy to get and non-poisonous, was used as precursor and, SiO_2 nanospheres in the size of 62 nm synthesized using Stober method, was used as a hard template. According to the experimental results, this highly porous g-C_3N_4 could generate 206 μM hydrogen peroxide after visible light (λ>420 nm) irradiation for 30 minutes which is approximately 2.5 times more than H_2O_2 generation of bulk.

Keywords: Hydrogen peroxide production, Hard template, Porous Graphitic Carbon Nitride

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MIST: Ministry of Science and ICT) (No. 2019R1A2C2085250).

Constructing Highly Porous Graphitic Carbon Nitride for Efficient H_2O_2 Production via Photocatalytic Oxygen Reduction Reaction

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Hydrogen peroxide (H_2O_2) has received increasing attention because it is not only a mild and environment-friendly oxidant for organic synthesis and environmental remediation but also a promising new liquid fuel. The production of H_2O_2 through photocatalysis is a green, sustainable and promising process, considering it uses water and oxygen as the source materials and solar light as the energy. Among various photocatalysts, graphitic carbon nitride (g-C_3N_4), as a fascinating two-dimensional conjugated polymer consisting of low-cost, earth-abundant elements, has drawn broad attention as a robust, metal-free, and visible-light-active material in various fields. Fine-tuning of catalyst architecture and interface design enables exceptional photocatalytic activity. Herein, we constructed highly porous g-C_3N_4 through a simple thermal condensation method for efficient H_2O_2 production. Melamine powder, which is inexpensive, easy to get and non-poisonous, was used as precursor and, SiO_2 nanospheres in the size of 62 nm synthesized using Stober method, was used as a hard template. According to the experimental results, this highly porous g-C_3N_4 could generate 206 μM hydrogen peroxide after visible light (λ>420 nm) irradiation for 30 minutes which is approximately 2.5 times more than H_2O_2 generation of bulk.

Keywords: Hydrogen peroxide production, Hard template, Porous Graphitic Carbon Nitride

Acknowledgement

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Slow-release Fe^{II} and Persulfate Candle-assisted Oxidation of Acenaphthene: Effect of Anions and Hydroxylamine

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Slow-release persulfate candle (PSC) combined with the newly developed slow-release Fe^{II} candle ($Fe^{II}C$) was used for acenaphthene (ANA) oxidation. The ANA oxidation was also conducted with persulfate solution (PS_{aq}) activated with Fe^{II} solution (Fe^{II}_{aq}). The pseudo-first-order rate constant (k_{obs}) and % removal in four systems; PSC/$Fe^{II}C$, PS_{aq}/Fe^{II}_{aq}, PSC/Fe^{II}_{aq}, and PS_{aq}/$Fe^{II}C$, were compared. The k_{obs} and % removal in the PSC/$Fe^{II}C$ system was higher than those in the PS_{aq}/Fe^{II}_{aq}, PSC/Fe^{II}_{aq}, and PS_{aq}/ $Fe^{II}C$ systems. Thermodynamic study showed that ANA oxidation was exothermic and spontaneous. Scavenger experiments confirmed that the $SO_4^{\bullet-}$ has more critical role than the $^{\bullet}OH$ for oxidation and the dominant radical species was affected by the solution pH. The $SO_4^{\bullet-}$ and $^{\bullet}OH$ were elucidated by electron spin resonance (ESR). Anions such as Cl^-, SO_4^{2-}, and HCO_3^- acted as radical scavenger. Hydroxylamine (HA) promoted the removal efficiency owing to Fe^{II} regeneration. Two chlorinated byproducts in the PSC/$Fe^{II}C$ + Cl^- system were identified by LC–MS.

Keywords: Acenaphthene, anions, Fe^{II} candle, hydroxylamine, PS candle

Life Cycle Greenhouse Gas, Energy and Economic Analysis Of An Advanced Sulfidogenic Oxic-settling Anaerobic (SOSA) Process for Wastewater Treatment with in-situ Sludge Reduction

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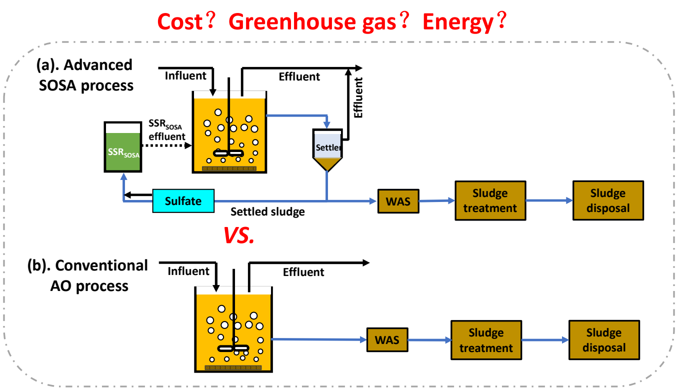
Excess sludge as the by-product of sewage treatment will potentially threat human health and natural environment, while the sufficient treatment of sewage sludge is costly, due to the multi-steps of sludge storage, treatment, and disposal. To solve this burning issue, an advanced sulfidogenic oxic-settling anaerobic (SOSA) process has been newly developed, with commitment effluent quality and over 50% of sludge reduction than the activated sludge process with conventional anoxic/oxic configuration (AO process). However, the life cycle-based environmental assessment and cost of SOSA process and the optimized way of adapting this new in-situ sludge reduction technology in sewage and sludge management infrastructures are yet to be systematically studied. This paper comprehensively evaluated the life cycle greenhouse gas (GHG), energy and economic performances of SOSA by comparing with the conventional AO process. The following sludge treatment and disposal processes including sludge thickening, conditioning, dewatering, anaerobic digestion, landfill disposal, and land application are determined in defined twelve different scenarios. The specific objectives of this study were: to evaluate and assess the life cycle greenhouse gas (GHG) emission, energy and economic implications of the advanced SOSA process scenarios and the baseline CAS process scenarios, and all scenarios are connected by different sludge management schemes; and to discuss options and trade-off of cost, energy consumption and GHG emission among the different system integration. The results indicated that the SOSA involved system could save up to 30% of cost compared to that of AO process related scenarios; and GHG reduction is 16% for sludge management if SOSA installed. The obtained findings also implies involving S-cycle for sewage/sludge management is benefit for low carbon cities.



Keywords: Sludge management, SOSA, life cycle assessment (LCA), life cycle cost (LCC)

Effect of Forced Ventilation Using a Three-Layer Pipeline during Sewage Sludge High Pile Composting

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Plant site selection for sewage sludge compost treatment is difficult because it requires a large area to occupy. Reducing the occupied area is the solution to relieve the difficult site selection of compost plants. The occupied area can be reduced in two ways: one is to shorten the composting period and reduce the residence time in the compost pool, and the other is to increase the compost pile height when the composting period is the same. The composting period cannot be shortened because the sludge needs a certain time for degradation and maturation of organic matter. Therefore, increasing the compost pile height is one of the possible ways to reduce the occupied area and increase the treating capacity of the compost plant.

Oxygen supply is important for forced ventilation compost. The ventilation pipeline should be installed on different layers of the high composting pile to obtain a sufficient oxygen supply. The study was conducted on a sewage sludge composting pile of 4.0 m with an installed three-layer ventilation pipeline. The sewage sludge was mixed with a bulking agent (sawdust) at a ratio of 5:1 (w/w). Results showed that the oxygen content of the pile and the oxygen uptake rate have an obvious spatial difference. The high composting pile with an installed three-layer ventilation pipeline increased the oxygen content to 15% through forced ventilation, thereby meeting the oxygen amount needed for aerobic composting. As the composting continued, the aeration status of the piles was improved, and the oxygen supply was gradually increased. The minimum oxygen content in the pile improved linearly during the ventilation circle. At the end of the sludge composting period, the oxygen content in each of the three layers increased to 18% after ventilation. During composting, the oxygen uptake rate first increased and then decreased, and the peak value appeared at the initial thermophilic period. The thermophilic periods (>50 °C) of the three layers of the pile were maintained for more than five days, which meets the sanitation standard requirements.

Keywords: sewage sludge, compost, oxygen, high pile, forced ventilation

Cocoa Pod Husk Waste as a Potential Bioresource for Preparation of Value-added Biomaterials. An Approach to Pectin Extraction

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The increasing demand of cacao for chocolate manufacturing has contributed enormously for promoting the cacao production in Peru, which is currently the 8th largest exporter of cacao beans with 82 000 metric tons per year. However, the inadequate disposal of cocoa pod husk (CPH) generates serious environmental problems in cacao plantations. Hence, new alternatives related to the utilization of cocoa industry by-product represents a great challenge for innovative industries since ten tons of CPH is generated for each ton of dry cocoa beans. Unfortunately, waste management still represents a critical challenge for low/middle-income countries like Peru, in which exists over 1400 open dumps through the nation with only 29 landfill registered in 2017. For this reason, our groups is working on the preparation of value-added biomaterials derived from CPH in order to provide alternatives for the utilization of this waste. In this regard, the good properties of CPH as raw material for preparation of biochars highly effective in the simultaneous adsorption of brilliant green, rhodamine B and methyl orange as artificial wastewater was recently demonstrated by our group as can be observed in Fig 1. On the other hand, an approach to pectin extraction using citric acid has been performed. According to NMR analysis by HSQC, characteristic groups of pectin such as $-OCH_3$ and $-COCH_3$ groups as well as galacturonic acid residues have been assigned as can be observed in Fig. 2.

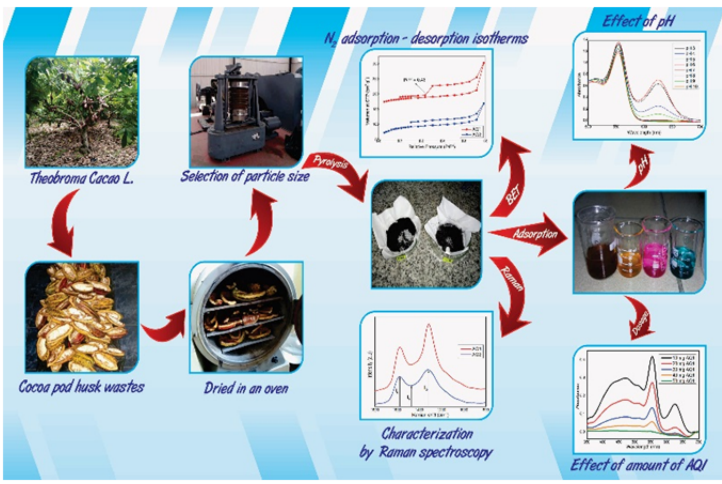

Figure 1. CPH as raw material for biochars

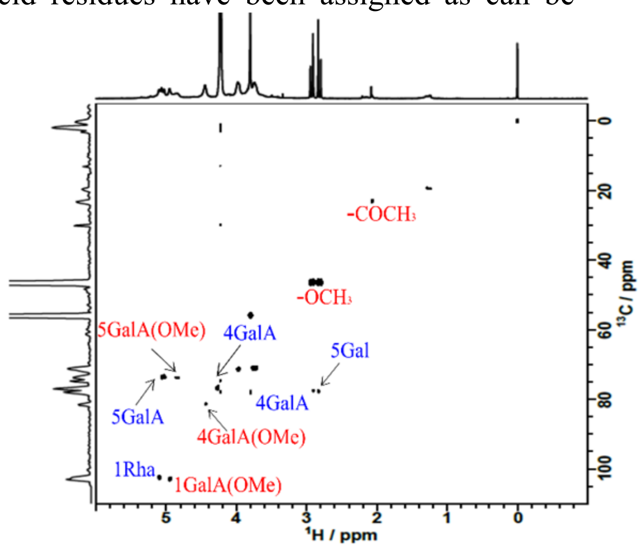

Figure 2: CPH as a resource of pectin

Keywords: Cocoa pod husk, biochar, pectin, value-added biomaterials.

Experimental Parametric Studies and Effect of Water Matrix on Photocatalytic Degradation of Organic Wastewater using Fe-TiO_2 Nanotubes: Towards Commercial Application

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Abstract

Investigation of experimental parameters play a key role to access the viability of any water and wastewater treatment technology towards more practical and field applications. Photocatalysis is one of the such technology in which research is progressing towards green and more practical applications. Extensive literature is available on nanoparticle based photocatalysis and some studies show commercial application but little to no literature is available for near actual or practical application of Titanium nanotube based photocatalyst. Therefore, in this study we aim to investigate effect of experimental parameters and water matrix on photocatalytic degradation of organic material (i.e. Congo red). Hydrothermally synthesized Fe-doped Titanium nanotubes will be used as catalyst. A rectangular batch reactor equipped with 32 W florescent bulb will be used. We aim to investigate the effect of different experimental variables such as pH, and initial concentration of organic pollutant. Our second and most important objective is to evaluate the effect of water matrix. We will be using natural tap water, river water, deionized water (DI) and ultra-pure water. Furthermore, photocatalytic performance will be evaluated in the presence of some inorganic and organic species commonly found in industrial waste water (oxalic acid, sodium chloride, boric acid, and zinc chloride). The inhibition effect is expected to be observed when natural waters are used instead of distilled water. Moreover, results will be critically analyzed to predict conditions at which Fe-TiO_2 nanotubes show high performance under near actual or realistic conditions.

Sustainable Biopolymers Production Using Red Algae Derived Volatile Fatty Acids: Closed Loop Approach

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Abstract

Day to day increment in the single-use fossil derived plastics has led the world to face a mountain of non-biodegradable plastics which are causing ecological imbalance and environmental pollution Alternatively, the use of microbial derived bio-degradable plastics in integration with eco-friendly biohydrogen production could overcome the dilemmas we have encountered with non-degradable plastics while encouraging the biomanufacturing sector as well. However, the production cost of PHA has been a great barrier to extend its application to large scale. Raw material availability, use of pure cultures and polymer extraction constitute the main reasons for its high production cost. In this context, the present study was designed and evaluated the PHA production by integrating with continuous stirred tank reactors (CSTR) biohydrogen process using red algae biomass as feedstock. Initially, red algae biomass derived sugars was fermented for the production of biohydrogen and volatile fatty acids (VFA). Subsequently, the resulting VFA's were used as a substrate for PHA production using mixed culture and mixed culture bioaugmentation with *Acinetobacter junii BP25.* The bioprocess performance was evaluated using feast and famine strategy in sequencing batch reactors (SBR), wherein feast conditions studied with nutrients along with carbon and famine condition evaluated with nutrient depletion only carbon source. Moreover, the biopolymer films and biocomposite of PHA-Lignin was prepared to broader its applications in biomedical field. The study delivers an integrated process for biohydrogen and biopolymers production using algal biomass as feedstock, thus offers a new opportunity for large scale PHA production using waste biomass as a renewable resource in the biorefinery framework.

Keywords: *Biopolymers, Feast and Famine, Biorefinery, Algal Biomass, Closed-Loop*

The Enhanced Pyrolysis of Crude Oil Sludge Using CO_2 as Reactive Gas Medium

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The consumption of petroleum has been increased to fulfill the global energy demand. However, consuming petroleum has been resulted in crude oil sludge (COS) during the refinery process, and the disposal method of COS has not been full achieved. To alleviate its harmful impacts to environment, developing a method for the simultaneous waste disposal and energy recovery is required. For the solution, this study suggests the pyrolysis of COS. Particularly, the carbon dioxide (CO_2) was employed as reactive gas medium to develop sustainable pyrolytic platform. To monitor the thermolytic behaviors of COS in the presence of CO_2, a series of the TGA tests of COS was conducted, and the TGA tests confirmed that CO_2 did not change the thermolytic behaviors, such as onset and end temperature for the thermolysis of COS. However, CO_2 changed thermolytic behaviors via the heterogeneous reactions (*i.e.*, volatilized hydrocarbons and CO_2). The enhanced generation of H2, CH4, C2H6, C2H4, and C2H2 was occurred via expedited thermal cracking and dehydrogenation under CO_2 atmosphere. Despite the fact that the enhanced thermal cracking and dehydrogenation generally enhances the aromaticity in pyrolytic oil, enhanced generation of CO was observed only from pyrolysis of COS in CO_2, of which enhanced generation of CO effectively decreased the aromaticity by restricting the formation of benzene derivatives.

Keywords: crude oil sludge; pyrolysis, energy recovery, carbon dioxide, waste disposal

Electrochemical Oxidation of Contaminants using Graphite Electrode in Flow-through System

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Electrochemical oxidation (EO) is a well-known remediation process in water and soil. Without the additional process and chemicals, EO can detoxify the target via direct and indirect oxidationThe system can generate reactive oxygen species (ROS) such as hydrogen peroxide (H_2O_2) and hydroxyl radical ($OH^{\cdot}$)[1] via anodic reaction as well as cathodic reduction of oxygen generated at the cathodeEven though the effectiveness has been demonstrated in the batch system, the applicability of EO to the field is still in doubt.

In this study, we carried out electrochemical oxidation in a column, a flow-through system, to evaluate the applicability of systemto real fields[2]. The oxidation of sulfanilamide as the target representative contaminants in the system was evaluated in terms of applied current and electrode distance using graphite electrodeTo identify the removal mechanism, we analyzed the oxygen species (H_2O_2 and $OH^{\cdot}$) and intermediates/carboxylic acids.

Acknowledgment

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Simultaneous TOC-TN-TP Oxidation using Base Activation and Improvement of Oxidation Efficiency.

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The Total orgainc carbon(TOC), total nitrogen(TN), and total phosphate(TP) are most common indicators for water quality, and those are required oxidation process of any type of materials to carbon dioxide, nitrate, and phosphate as final products for the detection during the analysis.[1] In the standard test method, persulfate is recommended as an oxidizing agent to achieve the purpose. In this study, one oxidizing reactor has been proposed to carry out the oxidation in the on-line monitoring system of TOC, TN, and TP instead of three individual systems to monitoring. However, the residual persulfate after oxidation in the reactor interfered the spectrophotometric analysis of nitrate and phosphate. Therefore, in the proposed system, the complete consumption of persulfate is a key factor for the monirotring system.

In this study, base activation was proposed to remove residual persulfate.[2] Base activation was performed in the condition of alkaline/UV irradiation. As a result, the residual persulfate was completely removed after UV irradiation for 30 min at basic condition. In the proposed system with one oxidation reactor, TOC, TN, and TP were analyzed continuously within 5% of analytical error range compared to standard test method and individual system.

Keywords: Total Nitrogen, Total Phosphate, Oxidation, Persulfate, Activation

Acknowledgment
This research was supported by R&D Center for Green Patrol Technologies through the R&D for Global Top Environmental Technologies funded by Ministry of Environment, Republic of Korea(MOE) and Korea Ministry of Environment(MOE) as Knowledge-based environmental service(Waste to energy) Human resource development Project .

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Visible Light Photocatalytic Degradation of Thiabendazole with Porous Organic Polymers (POP): Effect of Reaction Conditions

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Thiabendazole has gained a wide application as a fungicide for different plants such as rice, tobacco, sugar cane, tomato, and fruit trees. The residues of this compound have been detected in agricultural run-off or food processing industries' wastewater effluent.

Recently, a new class of materials, which are known as porous organic polymers (POPs) are introduced [1]. These novel POPs are tailored π-conjugated organic networks with nanoporous three-dimensional characteristics that have a high surface area and a great chemical and thermal stability.

In this research, the potential of POP-1 [2] for visible light induced photocatalytic degradation of thiabendazole is investigated at different conditions of pH (3, 5, 7, 9), POP and different thiabendazole concentrations.

Neutral pH is the most favourable for both thiabendazole adsorption and photocatalytic degradation. Adsorption results in a removal of 80% after 90 min, which is increased up to 98% removal after an additional period of 240 min photocatalytic degradation under visible light irradiation. In the blank experiment in presence of visible light and without catalyst, it has been seen that there is almost no photolysis occurs at pH 7 after 4 hours of irradiation.

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Keywords: Thiabendazole, photocatalysis, visible light, porous organic polymers (POP)

Removal of Nitrate from Groundwater through Reduction and Adsorption Using Modified Biochar with Zero-valent Iron

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Nitrate (NO_3^-), one of the groundwater pollutants, is mainly originated from agricultural fertilizers, pesticides, and animal excretion. Exposure of nitrate to the human being can cause methemoglobinemia and carcinoma. Therefore, nitrate contamination of groundwater has become a serious problem for the human being and ecosystem. Zero-valent iron (ZVI)-based materials are effective to reduce NO_3^- to nitrogen and ammonia due to its high reducing power. However, ZVI cannot remove NO_3^- alone due to its cohesive properties and fast oxidation on the surface. Biochar is an electron-rich porous material with a large surface area. In this study, sawdust biochar with ZVI was applied to remove nitrate from groundwater. The reduction and adsorption properties were evaluated.

Keywords: Nitrate; Adsorption; Zero-valent Iron; Biochar; Groundwater

Acknowledgment

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Application of Co_9S_8 Impregnated Porous Carbon Material Fabricated from Pyrolysis of Lignin-Co Composite

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Biochar is a suitable material for environmental remediation due to its carbon fixation capacity and porous structure. In addition, the series of experiments including CO_2-assisted pyrolysis was performed to expand the applicable area, especially, wastewater treatment by using as a catalyst as well as enhancing syngas production and biochar properties. The magnetic and catalytic properties were given by the pre-treatment of impregnation and mixing with cobalt precursors. To investigate the energy production during the pyrolysis of cobalt-biomass composite, the thermo-gravimetric analysis (TGA) was conducted in identical conditions with the biochar fabrication process and produced flammable gases (syngas and CH_4) were monitored during the pyrolysis. The characteristics of cobalt-loaded biochar were analysed by series of experiments using XRD, XPS, Squid, BET, *etc*. The prepared cobalt-loaded biochar was used to catalytic reduction of p-nitrophenol (PNP) and bromate (BrO_3^-), and oxidation of organic wastes by persulfate activation. In the results, the syngas production increased by the effect of CO_2 and cobalt species. In addition, CO_2 has affected to BET surface area and chemical state of cobalt during the pyrolysis. In detail, BET surface area briskly increased from 6.6 $m^2\ g^{-1}$ for N_2 condition to 599 $m^2\ g^{-1}$ for CO_2 condition. Under N_2, cobalt species in the precursors ($CoCl_2$ or Co_3O_4) transformed to metallic Co (Co^0) during pyrolysis with kraft lignin (including 2-3 % of sulfur contents), while it transformed to Co_9S_8 under CO_2 condition. Through the increased BET surface area and forming Co_9S_8, cobalt-loaded biochar fabricated in CO_2 condition revealed better catalytic property to reducing contaminants than that in N_2 condition.

Keywords: Pyrolysis, CO_2 utilization, lignin valorisation, Co_9S_8, engineered biochar,

The Effects of *Spartina Anglica* Invasion on Depth Profiles of Methane Production and Soil Microbial Community

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Invasion of *Spartina* spp. is a notorious ecological disturbance in tidal salt marsh ecosystems, which occurs in East Asia and the Pacific Coast of North America. In Ganghwa Island, the Republic of Korea, the invasion of *Spartina anglica* has been reported since 2015, and the invaded area has rapidly increased. Previous studies found that the invasion has enhanced methane emission through increased primary production and a changed methanogenic pathway, but they did not determine the depth profiles of the changes while the depth in the soil profile to which the disturbance propagates is one of the critical issues to be addressed. In this study, we illustrated the depth profiles of the effect of the invasion of *S. anglica* on the methane production and soil microbial community structure. The invasion of *S. anglica* has increased methane emission in the field and potential methane production in the top 30 cm soil, indicating that the top 30 cm soil layer plays a substantial role in the enhanced methane emission by the invasion of *S. anglica*. The abundance of *mtbA* gene (methylotrophic methanogens) has increased by the invasion of *S. anglica* only in the top 30 cm soil, showing that the invasion of *S. anglica* has increased the contribution of a non-competitive methanogenic pathway. The invasion of *S. anglica* also influenced the soil microbial community. The bacterial diversity decreased in the invaded area, especially in the top 30 cm soil layer. In principal coordinates analysis based on the bray-curtis distance, there was a long distance between the bacterial communities in the top layer, and which was reduced in deeper soil layers (-30 to -100 cm). In contrast, the archaeal community structure showed a different composition depending on soil depth and was not significantly influenced by the invasion of *S. anglica*. Our results demonstrated that the invasion of *S. anglica* significantly affected soil biogeochemistry and microbial community structure only in the top 30 cm soil, which serves as a hotspot for the enhanced methane production. The effects of the invasion of *S. anglica* on deeper soil layers (-30 to -100 cm) were not as substantial as top 30 cm soil because the rooting depth of *S. anglica* was typically limited up to -40 cm.

Keywords: *Spartina anglica*, tidal salt marsh, methane, methanogenesis, microbial community structure

Treatment of Cesium-contaminated Soil through Extraction – Selective Adsorption Process

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Currently, most nuclear power plants around the world are old, and the decommissioning of nuclear power plants is one of the most challenging issues. In decommissioning nuclear power plants, it is required to reduce the volume of radioactive waste for the final disposal in the special facilities. Among the various radioactive materials produced in nuclear power plants, cesium(Cs) has a relatively long half-life(30.2yr) and high water solubility, thus it is highly mobile and remains in the ecosystem for a long time, especially in the soil system due to the high affinity with the clay minerals. Since Cs is adsorbed on the soil surface strongly, it needs huge costs for treatment and final disposal. Extraction is a simple, cost-effective way to separate Cs from the soil and a preponderate step to remediate and reduce the volume of the target. Zeolite is an aluminosilicate mineral and used as an absorbent due to its pore structure. Cesium could be adsorbed onto zeolite through adsorption and cation exchange. However, in the presence of other competitive cations(K^+, Ca^{2+}, $NH4^+$) used in the extraction step, the adsorption selectivity of Cs on zeolite should be secured. Thus, in this study, we propose the "Extraction – Selective adsorption" process as a method treating Cs-contaminated soil at the site remediation stage. Extractants and selectivity on zeolite on various experimental conditions were conducted to minimize the volume of radioactive wastes.

Keywords: Cesium, Extraction, Selective adsorption, Zeolite

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(grant number: 2018R1A2B6004284), and Korea Ministry of Environment(MOE) as Knowledge-based environmental service(Waste to energy) Human resource development Project.

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A Facial and Novel Synthesis of Fe_2O_3/Mn_2O_3 Nanocomposite for a Fast Degradation of Organic Pollutants

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In the last decades, environmental contamination crises become the world's most significant challenge. Organic dyes are classified as the most critical chemicals that induce water/wastewater contamination. Heterogeneous photocatalytic degradation is one of the methods which can be used for dye degradation. However, most of the catalysts can only utilize in the low pH range (2.5–3.5), and high UV intensity which will increase treatment cost in a considerable amount. Therefore, in the present study, simple, fast, and economical fabrication of Fe_2O_3/Mn_2O_3 nanocomposites has been reported.

In this study, Fe_2O_3/Mn_2O_3 was prepared using surfactant-mediated co-precipitation methodology, and the application of this material was demonstrated in a heterogeneous photo-Fenton degradation reaction. The influence of various parameters such as dye concentration, catalyst dosage, UV intensity, and H_2O_2 concentration on the degradation reaction in the presence of Fe_2O_3/Mn_2O_3 was investigated at neutral pH. Finally, the recyclability of the catalyst was evaluated for five consecutive cycles. Moreover, a detailed spectroscopic and microscopic analysis was performed to investigate the characteristics of the catalyst using state-of-the-art techniques such as SEM, TEM, EDS, FTIR, XRD, and XPS.

It was found that, in the optimized experimental conditions, the Fe_2O_3/Mn2O3 nanocomposite can degrade (95%) of Methylene blue within 5 min of UV-irradiation. Moreover, this material showed a slight loss of performance even after five catalytic cycles.

According to reusability studies, Fe2O3/Mn2O3 nanocomposite is a cheap, environmentally friendly, robust, and effective system that is suitable for the treatment of dye-contaminated industrial effluent in large scales.

Keywords: Heterogeneous catalysts; Fe_2O_3/Mn_2O_3; Photo-Fenton

Engineering the Photocatalytic Behaviours of g/C_3N_4-based Metal-free Materials for Degradation of a Representative Antibiotic

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Graphitic carbon nitride (g/C_3N_4) is of promise as a highly efficient metal-free photocatalyst, yet engineering the photocatalytic behaviours for efficiently and selectively degrading complicated molecules is still challenging. Herein, we modify the photocatalytic behaviours of g/C_3N_4 *via* the strategy of tuning the energy band, optimizing the charge extraction and decorating of cocatalyst. The combination shows a synergistic effect for boosting the photocatalytic degradation of a representative antibiotic, lincomycin, both in the degradation rate and the degree of decomposition. In comparison with the intrinsic g/C_3N_4, the structurally optimized photocatalyst shows an enhancement of 10 folds in degradation rate. Interestingly, various methods and experiments have demonstrated the specific catalytic mechanisms for the multiple systems of g/C_3N_4-based photocatalysts. In the degradation, the active species, including $\cdot O_2^-$, $\cdot OH$, and h^+, have different contributions in the different photocatalysts. The intermediate, H_2O_2, plays an important role in the photocatalytic process, and the detailed functions and originations are clarified for the first time. The above work has been received by Advanced Functional Materials (impact factor: 15.621, 10.1002/adfm.202002353) just now.

Keywords: graphitic carbon nitride, photocatalytic behaviours, antibiotic, catalytic mechanisms, active species

Zinc Zeolitic Imidazolate Frameworks as Base Catalysts: Tuning Catalytic Properties Via Variation of Basicity and Crystal Size

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Nowadays, a new subclass of metal-organic frameworks (MOFs), such as zeolitic imidazolate frameworks (ZIFs), have attracted considerable attention as materials for catalysis due to combination of structure od zeolites and physicochemical properties of MOFs in one material. Here we demonstrated investigation of catalytic potential of zinc zeolitic imidazolate frameworks based on 2-methyl- (ZIF-8), 2-ethylimidazolate (MAF-5 and MAF-6) and imidazolate-2-carboxyaldehyde (ZIF-90) linkers in three important catalytic reactions, such as (a) synthesis of 1-methoxy-2-propanol (PGME) from methanol and propylene oxide, (b) synthesis of erythrulose (the monosaccharide) via aldol condensation of formaldehyde and dihydroxyacetone and (c) synthesis of cyclic carbonates from CO_2 and epoxides. Effect of structure and chemical composition on the reaction rate and distribution of products was investigated by a combination of catalytic and physicochemical methods, including X-ray powder diffraction (XRD), scanning electron microscopy (SEM), N_2 adsorption-desorption and Infrared spectroscopy using $CDCl_3$ as probe molecule. It was found that efficiency of ZIFs materials depends on their basicity, structure of solids and crystal size which affects the different localization and accessibility of active sites, and the diffusion of reactants to the active sites.

Keywords: Zinc zeolitic imidazolate frameworks, Basicity, Catalytic properties, Acid-base catalysis

Sulfate Radical-induced Degradation of Naproxen with Nanosized Magnetic $CoFe_2O_4$@Mxene as a Heterogeneous Catalyst of Persulfate

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Naproxen is a nonsteroidal anti-inflammatory drug and found in μg/L to ng/L levels from the aqueous environment, which have detrimental effects on human health and ecosystem. A heterogeneous nanocatalyst composed of 2D Mxene nanosheets functionalized with $CoFe_2O_4$ nanoparticles was fabricated by liquid self-assembly for the activation of persulfate to degrade a model pollutant, naproxen. As prepared material was characterized by XRD, SEM-EDS, TEM, FTIR, and XPS techniques. $CoFe_2O_4$ deposition on Mxene nanosheets increased the interlayer distances and surface area, thus enhancing the degradation capacity of catalyst. Results showed that around 90% of naproxen was degraded within 30 min with addition of 0.5 mmol persulfate at 1 g/L of $CoFe_2O_4$@Mxene dosage. To understand the removal process, different influencing parameters including the solution pH, catalyst dosage, persulfate concentration, initial concentrations of the pollutant, and reaction time on naproxen removal were studied. Radical scavenging experiment confirmed that $SO_4^{\bullet-}$ and $OH^{\bullet}$ were considered dominant species for naproxen degradation. The pH study indicated that the degradation efficiency was enhanced under neutral and acidic conditions. The presence of co-existing ions slowed down the degradation process to a certain degree by following order $HCO_3^- > Cl^- > Cr^{3+} > SO_4^{2-} > NO_3^- > PO_4^{3-}$. Moreover, $CoFe_2O_4$@Mxene exhibited a good recyclability, as it remained stable and efficiently removed naproxen even after 5 adsorption-desorption cycles. These results suggested that $CoFe_2O_4$@Mxene activated persulfate is a promising method for the treatment of water polluted with naproxen.

Keywords: cobalt ferrite, MXene, persulfate, $CoFe_2O_4$@Mxene, naproxen

Co-pyrolysis of Coffee-ground with Waste Polystyrene Foam for Upgrading the Coffee-ground Derived Pyrolysis Oil

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Coffee-ground was pyrolyzed with waste polystyrene foam which was expected to improve the coffee-ground derived pyrolysis oil quality due to high heating value and non-oxygen composition of polystyrene. The co-pyrolysis experiment was conducted in bubbling fluidized bed reactor under the following conditions: temperature of 500^{o}C which was chosen based on results from thermo-gravimetric analyses of coffee-ground and waste polystyrene foam, nitrogen flow rate of 20-25 L/min., and feeding rate of 200 g/hr. Various mixing ratios of coffee-ground/waste polystyrene foam were tested as follows: 100/0, 75/25, 50/50, 25/75, 0/100. The yield and characteristics of the pyrolysis oil were compared at various mixing ratios. This method could be considering as efficient method to upgrade quality of pyrolysis oil from coffee-ground because it can be increasing the heating value and reducing the viscosity of coffee-ground derived pyrolysis oil.

Keywords: Coffee-ground, Waste Polystyrene foam, Pyrolysis oil, Upgrade biomass-derived oil

Accelerated Aging of Biochar for Assessment of Biochar Stability

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Biochar affects significantly the mobility and bioavailability of potentially toxic trace elements in the water and soil media. Therefore, the biochar contributes to the stabilization of harmful heavy metal (-loid) in the soil, and the use of biochar as a soil amendment has increased gradually. However, biochar experiences aging or weathering over time in the field, and the aging changes the properties of biochar greatly, which can affect the mobility of metals[1]. The biochar aging tends to lower the stability of biochar, and more dissolved organic matters (DOMs) can be released from the aged biochar or unstable biochar[2]. In addition, the reaction medium in pyrolysis, N_2 and CO_2, can change the surface properties of biochar such as aromaticity and stability. However, despite lots of researchers have reported the aging of biochars in recent years, few studies have investigated the interactions of the biochar aging and reactive media in point of biochar stability. Therefore, in this study, we hypothesized that the aging process increases the DOM leaching from biochar and the biochar pyrolyzed under the CO_2 condition is more stable than the N_2 condition. To verify the hypothesis, three different biomass, sawdust, rice straw, and spent coffee grounds, were pyrolyzed at 300 and 700°C under the N_2/CO_2 atmosphere, and the biochar was aged under three conditions: wet-dry, freeze-thaw and UV light. In addition, the biochar was incubated to investigate the DOM, an indicator of biochar stability. Furthermore, the mobility of As according to the aging process was also evaluated.

Keywords: Biochar; Dissolved Organic Matter(DOM); Aging; Stability

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (grant number: 2019R1A4A1027795) and partially supported by Korea Ministry of Environment(MOE) as Knowledge-based environmental service(Waste to energy) Human resource development Project(YL-WE-18-002).

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An-aerobic Co-digestion Food Waste and Sewage Sludge for Biogas Production

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Abstract

Biogas is one of the most economically-viable and eco-friendly renewable energy sources. Food waste contains diverse source of nutrients with sugars, fats and peptides can be excellent source for the biogas production. This study, investigated the biomethane potential (BMP) of food waste and sewage sludge. BMP tests were performed at different organic loading rate (OLR) 3 and 20 (g VS/L) for food waste, and 3 and 10 (g VS/L) for sewage sludge respectively. Maximum methane yield (430 mL/g VS) and 76% of biogas content was observed in low and high OLR of FW respectively. However, Sewage sludge showed 284 mL/g VS methane yield and 61% of biogas content was observed in high OLR. These results showed that high organic load of substrate causes acidification, but also contributes to high methane yields.

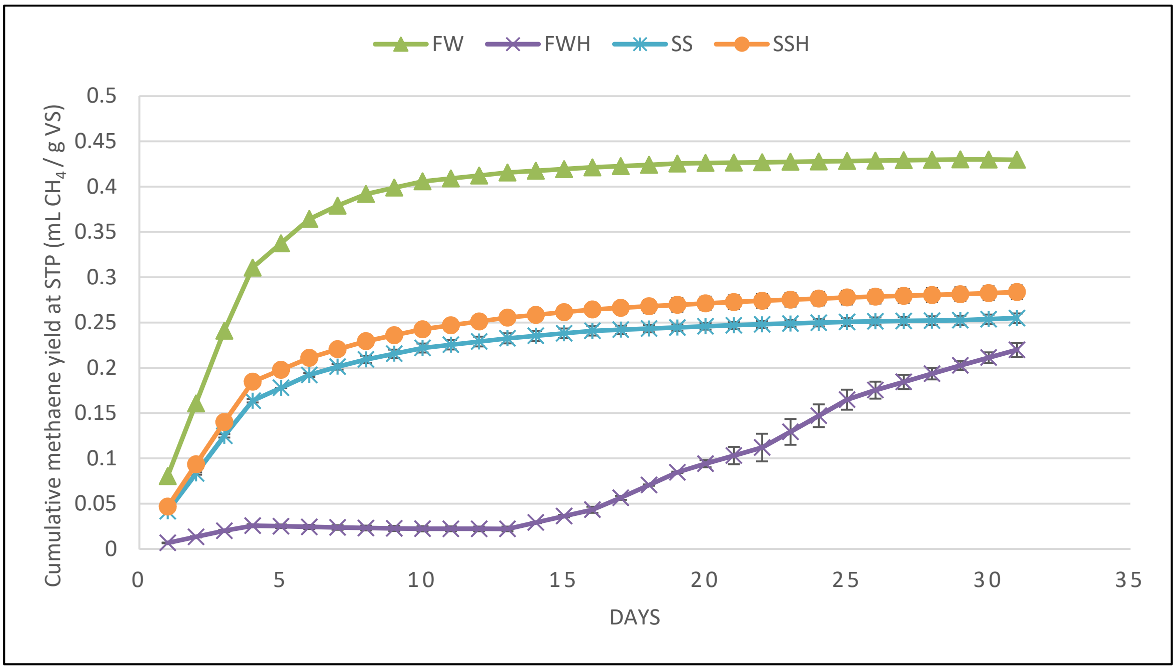

Fig. 1. Cumulative methane yield at STP, FW-food waste, FWH-food waste high load, SS-sewage sludge, SSH-sewage sludge high load.

Keywords: *Anaerobic digestion, biomethane potential (BMP), organic load*

Improved Growth of *Chlorella Vulgaris* using Silver Nanoparticles Solution as Light Filter Devices

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The utilization of microalgal biomass for the energy production has gained worldwide interest because reduction of thermal power and de-nuclear power generation. In addition, the microalgal biomass has been utilized in various chemical and pharmaceutical industries for the production of industrially important value added products. In previous study, the use of Localized Surface Plasmon Resonance (LSPR) on metal nanoparticles significantly improved the growth of the photosynthesis pigment content of algal cultures. LSPR is the effect of the interaction between the conduction band electrons of the metal nanoparticles and electromagnetic field. By this effect, metal nanoparticles backscatter specific wavelengths and deliver them to the microalgae to help pigment synthesis. we derived the optimal conditions 0.24 mM of Silver nanoparticles concentration and 175 $\mu\mathrm{mol}/m^2 \cdot s$ of light intensity from the cultivation results of *Chlorella vulgaris* using silver nanoparticles based on Response Surface Methodology (RSM). In this study, we incubated the Chlorella vulgaris by synthesizing silver nanoparticles to improve the accumulation of microalgal biomass. In this study, we determined how much better *Chlorella vulgaris* grow when cultivation using optimal conditions. Cultivation results for 2 weeks, optical density, dry cell weight (g/L), chlorophyll contents (mg/L), and lipid contents (g/L) of *Chlorella vulgaris* with silver nanoparticles solution were 27%, 26%, 11%, and 31% better than control without silver nanoparticles solution, respectively. The results show promise in gaining access to high value-added pigments for a myriad of applications in medicine through to materials science, and in developing sustainable technologies for the future.

Keywords: Backscattering, LSPR, Microalgae, Nanoparticl

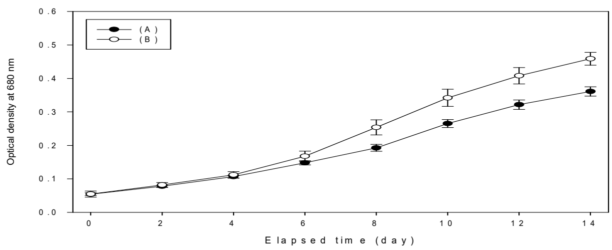

Fig. 1. Optical density of Chlorella vulgaris culture for 2 weeks, (A) is Control and (B) is culture using silver nanoparticles solution

Synthesis of Diesel Range Fuel Precursor from Furfuryl Alcohol over Fibrous γ-Al_2O_3 Sphere Supported Nb_2O_5 Catalyst

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The utilization of furfuryl alcohol directly for the cross-condensation reaction with 2-methylfuran is not possible. Thus, the production of levulinic acid from FOL followed by cross-condensation with 2-MF in one pot process is presented here for the first time. LA is synthesized by the dehydration of xylose to furfural and hydrogenation of furfural to furfuryl alcohol (FOL) followed by the hydrolysis of FOL. however, one of the major challenges of producing LA from FOL is the acid-catalyzed polymerization of FOL into unwanted oligomers resulting in poor selectivity to LA. Mitigating this problem requires the synthesis of heterogeneous catalysts with optimum acidic strength and controllable surface properties. Thus, here in, γ-Al_2O_3 spheres with a unique morphology were synthesized and used as a support for the active sites (acidic Nb_2O_5). Nb_2O_5-γ-Al_2O_3 catalysts with different loading were successfully synthesized by the incipient-wetness impregnation method. γ-Al_2O_3 has Lewis acid sites with different acid strengths and weak Brønsted acid sites, and the reaction between Nb_2O_5 precursor and hydroxyl groups on the surface of γ-Al_2O_3 nanofiber results in strong metal-support interaction, generating Nb_2O_5-γ-Al_2O_3 fibrous spheres with both Lewis acid sites and strong Brønsted acid sites. The fibrous nature of the γ-Al_2O_3 sphere allow high Nb_2O_5 loading thus, increasing the abundance and intensity of Brønsted acid sites. High LA and Diesel fuel precursor yield from FOL (91% and 96% respectively) over Nb_2O_5-γ-Al_2O_3 nanofiber with a loading of 35wt% Nb_2O_5 were obtained. The unique morphology of the catalyst has promising industrial application since it allows higher active site loading and increased accessibility to the active sites.

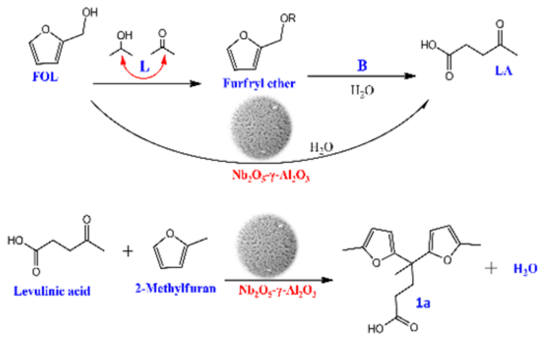

Figure 1. schematic representation of LA synthesis from FOL and cross-condensation of LA and 2-MF.

Keywords: Furfuryl Alcohol, Levulinic acid, Hydrolysis, Condensation, Nb_2O_5-γ-Al_2O_3

Bifunctional Catalysis of Cobalt-Nickel Phosphides for the Solvent-Free Hydrogenation of Biomass-Derived Levulinic Acid

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Nowadays, the catalytic transformation of renewable biomass-derived levulinic acid (LA) to gamma-valerolactone (GVL) and 2-methyltetrahydrofuran (2-MTHF) has gained attention due to attainability of LA as a feedstock and the potential usability of GVL and 2-MTHF as drop-in fuels. Transition metal phosphides (TMPs) are a class of evolving materials which are considered to be ideal catalysts due to their cheap cost, wide availability, and high activity. To date, however, the utilization of transition metal phosphides in biomass transformation reactions has not been much explored. In this work, cobalt (Co)-nickel (Ni) phosphides (Co_xNi_yP) with varying Co:Ni molar ratio were prepared via a facile hydrothermal and phosphorization method and were explored, for the first time, as a catalyst in the solvent-free hydrogenation of LA to GVL and 2-MTHF.

For the initial experiments, the cobalt-nickel phosphides were investigated in the hydrogenation of LA to GVL under a solvent-free system. Among the phosphides, Co_1Ni_2P exhibited the highest catalytic performance among all the examined catalysts, obtaining a full conversion of LA to GVL. Moreover, monometallic Co and Ni phosphides and the physical mixture of these two monometallic phosphides provided poor conversion of LA to GVL, therefore implying the synergistic effect between Ni and Co which could be generated in the catalyst preparation.

The catalytic conversion of Levulinic acid enhances the broad spectrum of chemicals that can be derived from renewable biomass and this successful exploitation of cobalt-nickel phosphides in the solvent-free hydrogenation of LA to GVL and 2-MTHF opens a new avenue towards the potential application of transition metal phosphides in biomass transformation reactions.

Keywords: Biomass, Drop-in Fuels, Levulinic Acid, Hydrogenation, Phosphides

Food waste and Its Derivatives as Alternative Carbon Source for Denitrification of Steel Processing Wastewater: Process Performance and Microbial Community Dynamics

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Biological denitrification of steel processing wastewater requires an external carbon source. Commercial carbon sources such as methanol and mixtures of alcohols are commonly used in industrial-scale denitrification processes but it is economically disadvantageous. Therefore, in this study, feasibility of use of food waste (FW) and its derivatives as carbon sources were investigated in denitrification process of steel processing wastewater, and microbial community dynamics were analysed to give insight for microbial optimization of the process with such different carbon source. The denitrification batch tests were conducted with various carbon sources: (1) different types of FW (FW, suspended-solids-fraction of FW and fermented FW (AFW); (2) their derivatives (butyrate, propionate, acetate and ethanol); (3) commercial carbon sources (RCS45 and methanol). FW showed the shortest specific denitrification rate (q_m) and highest lag time except acetate. FW showed 1.19 times higher q_m than AFW, which contains 43% higher volatiles fatty acids (56% higher acetate) and alcohols than FW. Thus, FW needs to be re-evaluated as a potential carbon source for biological denitrification, and it may provide better process resilience in perturbing conditions of reactor with multi-metabolic microbes. Moreover, active microbial communities were distinctively differentiated by external carbon sources. *Azoarcus*, *Pseudomonas*, *Aeromonas* and *Duganella* were dominant with FW and its derivatives; *Sulfuricella* were dominant with RCS45 and methanol. The findings of the research could be useful theoretical basis for microbial optimization of the denitrification process with different carbon source.

Keywords: biological denitrification, food waste, external carbon source, denitrifying bacteria, steel processing wastewater

Understanding Surface Functionality of Mesoporous Biochar in Phase Change Materials Infiltration through Stability and Energy Storage Capacity

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Biochar, a product of commercially available feedstock pyrolysis, were designed to infiltrate organic phase change materials (PCMs) for energy storage applications. PCMs are effective in thermal energy storage applications owing to their high heating enthalpy, durability, and capability of maintaining the working temperature during the phase change process. Despite such remarkable advantageous, low shape stability and intrinsically low heat transform performance restricted their practical performances. In this study, shape/thermal stable composite PCMs were systematically designed via the vacuum impregnation method. Typically, four different functional organic PCMs (dodecane, tetradecane, octadecane, and octadecanol) were introduced into the pores of the supporting media (such as carbofex biochar natural). The biochars (feedstock pyrolysis temperature 600 and 700 °C) showed a high specific surface area (~550 m^2/g) and suitable pore characteristics, micro/mesopore, for PCM loading. Various characterization techniques (e.g. differential scanning calorimetry, Fourier transform infrared spectra, thermogravimetric analysis, etc.) were analyzed. The active surface functionality of biochar played a vital role in enhancing the thermal stability via intermolecular interaction/hydrogen bonding between the polar PCMs, whereas biochars supporting non-polar PCMs revealed high energy storage capacity and infiltration ratio. Moreover, the as-prepared composite PCMs exhibited high chemical compatibility, shape stability, and moderate heat transfer performance. Thus, the biochar-based organic PCM composite is an encouraging candidate for thermal energy management systems. In general, this investigation is expected to provide start-up insight for the development of multi-disciplinary biochar-based composite PCMs in latent heat thermal energy storage and environmental fields.

Keywords: Biochars, organic phase change materials, thermal energy storage, surface functionality

Ru-Re Catalysts Supported on Biochar Engineered in Different Pyrolytic Atmospheres for Converting Furan into Platform Chemicals

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Rice straw biochar was engineered by varying pyrolysis medium (i.e., N_2 and CO_2) and used as support of Ru-Re catalyst for the transformation of furan to platform chemicals such as tetrahydrofuran (THF) and 1,4-butanediol (1,4-BD). Change in pyrolysis medium affects surface area and porosity of biochar. The biochar-supported Ru–Re catalysts (Ru–Re/BN and Ru-Re/BCO) were compared to activated carbon-supported Ru–Re catalyst (Ru–Re/AC). The presence of alkali metal such as potassium led to changing reducibility and the form of Re species on the catalyst surface. Pyrolysis medium (N_2 or CO_2) also affected metal dispersion and reducibility. Ru–Re/BN was three times more active than Ru–Re/AC and two times more active than Ru–Re/BCO for the production of THF and 1,4-BD. Based on the results, it could be suggested a simple way of modifying physicochemical properties of biochar-supported catalyst and new application of biochar to catalyse the production of value-added platform chemicals from biomass and waste.

Keywords: biorefinery, biochar, bifunctional catalyst, biochemicals

Wastewater Treatment Plants as Sources of Microfibres and Microplastics to Environment: Detection and Treatment

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Microfibres (MFs) and microplastics (MPs) released by wastewater treatment plants (WWTPs) to the environment is of great concern due to its impacts on human and ecosystem health. Detection and removal of MFs and MPs in aquatic environment is a key challenge for the researchers due to the lack of standard protocol and elimination technologies. MFs and MPs (50-99%) are removed during WWTPs processess. However, <2% of the MPs and MFs are still discharged in the effluent. MFs and MPs passes through WWTPs due to their broad nature, small size and lack of particular design of the treatment plants. Furthermore, the role of cougulation/flocoulation and chemicals in removal of MFs and MPs at WWTPs has been rarely investiagted. Therefore, proper assessment and improved removal efficiencies could help to protect the aquatic environment from the contamination of MFs and MPs. This study is designed to assess removal efficiencies of MFs and MPs in WWTPs. MFs and MPs concentration was assessed through a novel developed methodology in the assigned treatment units as well in sludge samples. The initial results showed that significant amounts of MFs and MPs were removed during the various treatment processes, however in spite of good removal rate, still a fair amount of MFs and MPs were found in the treated effluent discharging to the receiving water bodies. In order to reduce the amounts of MFs and MPs entering the aquatic environment, early precautions measures are need to be placed as per according to international understanding and agreements.

Keywords: Microfibres, microplastics, coagulant, wastewater, sludge

Development of Modified Biochar on the Eco-friendly Process for Food Waste and Livestock Manure Composting

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Abstract

Poor food waste(FW) and livestock manure management generates huge amount of greenhouse gases(GHG), harmful pathogens, odor and eutrophication; hence, it has public health and environmental concern. In this study, the modified biochar(MBC) was prepared through physico- chemical process and investigated the effect of the MBC amendment on the combination of Food waste(FW) and swine manure(SM) composting efficiency through physical, physio-chemical, gaseous emissions, microbiological, and phytotoxic analysis during the 50 day process of in-vessel composting. The composting treatments were set-up of modified biochar amendment with three different ratios of FW and SM mixed with sawdust(SD), while treatment without modified biochar amendment was used as a control.The results showed that, compared to the control, modified biochar amended compost mixtures had significantly reduced ($p \leq 0.05$) C:N ratio, NH_3 emission, bulk density, organic matter(OM) and pathogenic microorganisms. On the other hand, modified biochar amendment mixtures had increased total porosity(TP), water holding capacity(WHC), rapid thermophilic temperature, and nitrate nitrogen through the in -vessel composting process.

Keywords: modified biochar; swine manure; food waste: greenhouse emissions; nutrient quality

Nitrogen and Phosphorus Removal and Recovery from Wastewater with Metal Impregnated Biochar

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Struvite crystallization (phosphate fertilizer) has been an effective method in recovering ammonium nitrogen (N) and phosphate phosphorus (P). In this study, struvite crystal was produced by combining of P from incinerated sewage sludge ash (SSA) and N from food wastewater with Mg impregnated biochar. Acid pre-treated alkaline leaching extracted P from SSA removing of most of the undesirable heavy metals in the SSA. Mg impregnated biochar provides active sites for struvite precipitation and promotes struvite production. Moreover, a quadratic statistical model of Response Surface Methodology (RSM) was applied at pH of 8-11, Mg/P ratio of 1-2, N/P ratio of 0.6-2 to predict the optimum struvite precipitation process and 99.9 % of P and 79.6 % of N was recovered at pH 9.38, Mg/P ratio of 2, and N/P ratio of 0.6. XRD and XRF confirmed struvite formation as a major mineral precipitate with a halite (NaCl) impurity. High P bioavailability (98.4%) of precipitated struvite showed that it is an effective fertilizer. Thereafter, three different waste types of SSA, food waste, and biochar from organic waste provided as rich alternative source and combined as sustainable method for eco-friendly fertilizer.

Keywords: biochar, food wastewater, nitrogen and phosphorus recovery, sewage sludge ash, struvite

Hydrochar Production from Waste Seaweed: Effect of Reaction Conditions

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It is reported that (waste) seaweed is a good source to produce hydrochar, because of its availability and high in nutrient content. This hydrochar can be used as adsorbent for pollutants and it can be applied as soil fertilizer or for carbon sequestration. Hydrothermal carbonization (HTC) was carried in an autoclave reactor for *Sargassum* and *Ulva Pertusa* with reaction temperatures going from 180°C to 400°C with different water to dry material ratios (1:1 to 12:1) and residence times ranging from 2 or 4 hr.

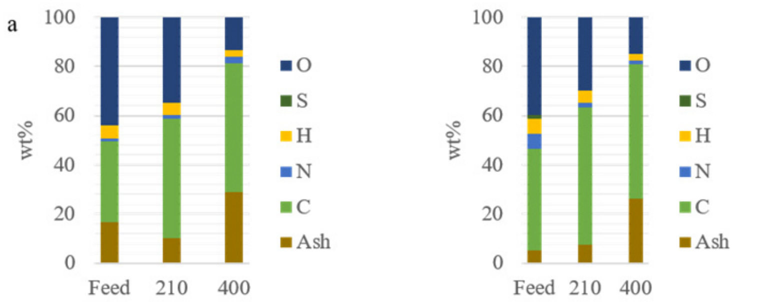

Figure 1: Effect of HTC temperature on composition for (a) *Ulva Pertusa* (b) *Sargassum*.

The effects of residence time and amount of water on the HTC yield, and hydrochar composition, see Figure 1, was analysed. In addition, specific surface area and pore sizes was obtained: as to be expected, increasing residence time and temperature resulted in an increase of the porosity and surface area, while the amount of HTC char decreased.

Keywords: waste seaweed, hydrochar, experimental conditions

Occurrence and Transport of di(2-ethylhexyl) Phthalate (DEHP) in the Drinking Water Treatment Plants from South Korea

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Currently, a toxic plasticizer, di(2-ethylhexyl) phthalate (DEHP), has been recognized as a ubiquitous pollutant in the aquatic environment due to the massive utilization during the production of plastic materials. In this study, the occurrence, transport, and fate of DEHP have been investigated from samples taken from six full-scale water treatment plants located in South Korea. The samples were taken from July to December 2019 at every treatment stage of the six WTPs, which located at three river basins. The DEHP was extracted by liquid-liquid extraction methods, and analyzed by gas chromatography-mass spectrometry. The concentration of dissolved organic carbon (DOC) was also measured in all samples at each sampling site. As expected, DEHP was found in all samples at the concentration ranging from 0.02 μg/L to 4.41 μg/L. The removal efficiency of DEHP was higher in the conventional water treatment process (coagulation/flocculation-sedimentation, sand filtration, microfiltration (MF) membrane) than advanced water treatment processes (ozonation and granular activated carbon (GAC) adsorption). Interestingly, removal of DOC was positively correlated with DEHP removal in the ozonation process (r=0.61), while the strong negative correlation was observed between UV and DEHP removal with r=-0.81. The negative correlation of DEHP with DOC by UV-based AOP system explained that UV process might generate additional DEHP from plastic equipment or microplastics but could not effectively oxidize DEHP compared to the ozonation process due to the significantly less generation of hydroxyl radical. Consequently, special attention and monitoring are required on the fate and removal of DEHP in WTPs, especially consist of UV process, which is not efficient at selectively removing DEHP, since the potential risks of DEHP on human health still exist in surface water of South Korea for drinking water supplies.

Keywords: Plasticizer, Phthalate esters, di(2-ethylhexyl) phthalate (DEHP), water treatment process, mass spectrometry

Impact of Land Use/Land Cover on the Groundwater Quality at Agricultural Region of South Korea

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Though there were many previous researches on land use / land cover (LULC) on the hydrogeochemical characteristics of groundwater in other countries, not many studies were done on this topic in South Korea despite of its importance as essential resource for mankind. We investigated the relationship between hydrogeochemical characteristics of groundwater and land use / land cover by delivering several different statistical analysis including Principal cluster analysis and Hierarchical cluster analysis. Groundwater sources whose dominant LULC is crop field showed higher vulnerability on concentration of contaminant compared to those whose dominant LULC is rice paddy. 5 groups classified by hierarchical cluster analysis indicated that composition of LULCs around groundwater sources may influence on the differentiation of hydrogeochemical properties of groundwater samples. According to results of several analysis methods, more detailed control on the agricultural activity applying additional nutrients to field is required for crop field than rice paddy for better quality of groundwater.

Keywords: Agricultural activity, South Korea, Groundwater contamination, Land use/Land cover, Principal cluster analysis, Hierarchical cluster analysis

Novel Membrane-type Electrode for the Selective Reduction of Co^{2+} from Ca^{2+}-rich Concrete Decommissioning Wastewater

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During the decommission of nuclear power plants, more than 60% of produced wastes are from surface contaminated or radio-activated concretes. For the decontamination of activated concrete wastes, the pulverized concrete wastes are washed with strong acids, thus, radioactive isotopes such as $^{60}Co^{2+}$ and $^{152}Eu^{3+}$ are transferred to Ca^{2+}-rich acidic solutions. Among physico-chemical separation processes, the electrochemical reduction and deposition process using novel hollow-fiber membrane-type electrode made with carbon nanotube (CNT-HME) is investigated in this study for the selective removal of Co^{2+} from Ca^{2+}-rich acidic leachate. Under the applied voltage of -1.0 V (SCE) and flux of 80 LMH of CNT-HME, removal efficiency of 0.1mM ~ 0.5 mM Co^{2+} was always higher than 99.7 % in the acidic (pH=2) solution containing 0.5 M Ca^{2+}. The maximum removal capacity was 69.1 mg/g with 80 LMH of flux until the pores of CNT-HME were plugged by the deposited Co, while the electrode under the typical surface deposition condition showed only 27 % and 19.6 mg/g of removal efficiency and capacity, respectively. In addition, the removal capacity of CNT-HME was easily restored after the washing of deposited Co by HNO_3. The current results showed that the novel hollow-fiber membrane-type electrode system can selectively remove Co^{2+} from Ca^{2+}-rich acidic leachates generated during decommissioning of radio-activated concrete wastes.

Keywords: Decommissioning, activated concrete, electrodeposition, low and intermediate liquid wastes, volume reduction

Effect of Biofouling Layer on the Rejection of Emerging Contaminants in the Forward Osmosis Process

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In this study, the transport of emerging contaminants (ECs) was implemented at the absence and presence of biofouling layers in the forward osmosis (FO) process. Results revealed that the removal of ECs affected by the solute properties and biodegradation efficiency. All of the negatively charged ECs showed high rejection efficiency in pristine and biofouled FO membranes due to the electrostatic repulsion between negatively charged ECs and negatively charged membrane surfaces. The rejection of ECs after the formation of biofouling layers showed that the biological activity of biofilm was important to the change of ECs removal efficiency in the FO process. Among the tested 12 ECs, TCS and ATT were easily biodegraded by model bacteria (*Pseudomonas aeruginosa* PAO1) from the biodegradability test. The removal efficiencies of biodegradable ECs were increased in the biofouled membrane, but the other ECs showed similar removal efficiency in pristine and biofouled FO membranes. This behavior is attributed to the biodegradation of ECs by biofilm. This effect of ECs resulted in the decrease of MPs concentration nearby membrane surface and thus the concentration polarization phenomenon could be reduced by the biofouling layer.

Keywords: Forward osmosis, Fate of emerging contaminants, Biofouling layer

Synergistic Effect of CO_2 and Pt Catalyst on Thermal Disposal of Food Waste

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CO_2 was applied to thermal treatment of real food waste over a Pt catalyst. CO_2 and the catalyst enhanced evolution of non-condensable gases and inhibited formation of condensable species; however, they did not affect solid content remained after the thermal treatment of food waste. In the condensable species, the content of cyclic compounds was decreased with a use of the catalyst and/or CO_2. The use both of CO_2 and the catalyst more enhanced the evolution of non-condensable gases and more decreased the cyclic compound formation than only CO2 or the catalyst was used. For instance, about 67% less cyclic species (e.g., benzene derivatives) were formed for the thermal treatment of food waste at 700 °C in CO_2 over the catalyst than for non-catalytic thermal treatment of food waste without CO_2. The catalytic thermal treatment in CO_2 could be an environmentally friendly way to dispose food waste.

Keywords: waste treatment, food waste, catalytic pyrolysis, CO_2 utilization

Adsorptive Removal of Ammonium and Sulfonamides Antibiotics from Livestock Burial Leachate using Low-grade Charcoal and Zeolite

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Livestock damage caused by foot-and-mouth disease (FMD) and avian influenza(AI) is a serious issue not only in Korea but worldwide every year. Burial disposal of livestock carcasses is a very simple and popular method in Korea. However, the burial site is considered as one of contamination source of soil and groundwater due to releasing leachate containing high concentration and nitrogen and phosphorous and organics including antibiotics. Ammonium is a key compound causing eutrophication and a potential contaminant to beconverted to nitrate. Among antibiotics, sulfonamides(SAs), sulfamethoxazole(SMX) and sulfathiazole(STZ) have been widely used and non-biodegradable antibiotics[1]. Low-grade charcoal accounts for 10% of total production of charcoal, which has been used for soil improvement or landfill disposal. As a carbon-rich hydrophobic material, it shows good performance in adsorbing organic pollutants. However, ammonium is a hydrophilic inorganic pollutant, thus charcoal shows a limited adsorption capacity for ammonium. Therefore, zeolite was proposed to adsorb ammonium based on electrostatic interaction between ammonium and zeolite. In this study, the performance of the zeolite-charcoal mixture(ZC) to remove ammonium and antibiotics was evaluated.

Keywords: Adsorption, Sulfonamieds, Ammonium, leachate, wood chrcoal

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Soil Trace Gas Fluxes in Living Mulch and Conventional Agricultural Systems

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Row crop agriculture is a significant source of two major greenhouse gases (GHGs) (carbon dioxide [CO_2] and nitrous oxide [N_2O]) and the air pollutant precursor ammonia (NH_3). Fluxes of these naturally occurring trace gases are often augmented by agricultural practices, such as fertilizer application and crop systems management. A living mulch system (LMS) maintains a live cover crop year-round and is an emerging agricultural system that can reduce pesticide and fertilizer use while maintaining yields. Multiple trace gas fluxes of GHGs and NH_3 had not previously been measured together in an LMS of corn (*Zea mays* L.) and white clover (*Trifolium repens* L.). This study compared soil gas fluxes in a white clover LMS with two other cover crop systems and a no-cover-crop system. Infrared and gas chromatography measurements were taken over 2 yr in northern Georgia. Mean soil CO_2 and N_2O fluxes (159.7 kg ha^{-1} d^{-1} and 0.027 kg N ha^{-1} d^{-1}, respectively) observed in LMS plots exceeded those from other treatments. Soil temperature, moisture, potentially mineralizable nitrogen (N), and nitrate partially explained these differences. Mean soil NH_3 emissions were greater in LMS (0.089 kg N ha^{-1} d^{-1}) compared with no cover crop (0.038 kg N ha^{-1} d^{-1}). Increased N_2O and NH_3 fluxes could be from release of N from decomposition of clover and from release of N into the soil as the corn shades the clover. Although LMS plots did not reduce trace gas emissions, labile carbon content was at least 100 mg kg^{-1} greater than other treatments after 2 yr, improving soil health.

Keywords: Soil GHG, Emissions, Living Mulch System, Cover Crop

Emerging Endocrine Disrupting Chemicals: A Challenge to Children's Health in Hong Kong

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Endocrine disrupting chemicals (EDCs) and their metabolites have been studied in children's serum, blood, urine, hair, nails and saliva samples to assess the public health issues. Studies indicated that children exposed to EDCs through various consumer products. Inhalation, ingestion and thermal contact are the three exposure routes of which digestion is the most significant one. This work aims to evaluate the exposure levels and assess the health risks of target EDCs in children in Hong Kong through instrumental analysis by investigating the EDCs and their alternative in different consumer products and questionnaire survey. Five kinds of EDCs, namely polybrominated diphenyl ethers, bisphenol A, triclosan, diethylstilbestrol, and 17α-ethinylestradiol, were identified and quantified in the collected children's and parents' urine samples using gas chromatography-mass spectrometry after liquid-liquid extraction and solid phase extraction. Basic information (e.g., age, gender, and BMI index), lifestyle, dietary habits, and public awareness were collected through survey to compare the urinary EDCs concentrations with the questionnaire data using different statistical analysis (i.e., t-test, ANOVA, and regression). Results showed that most parents have less knowledge about EDCs but still bought consumer products labelled with fewer food additives. Also, dietary habits affected the urinary concentration of EDCs in children. The findings of the proposed study can help to understand the exposure routes of selected EDCs in children and promote public awareness to EDCs in daily life.

Keywords: Children, EDCs, exposure, risk assessment, urine

Synoptic Circulation Pattern Modulates Co-occurring Surface Ozone and PM2.5 Compound Pollutions during Summertime in Eastern China

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Abstract: In recent years, ozone pollution during summertime over eastern China has become more serious, and even surface ozone and PM2.5 compound pollutions co-occurred; however, the synoptic circulation pattern of this compound pollution is still unclear. In this study, we used T-mode principal component analysis (T-PCA) method to objectively classify four synoptic weather patterns (SWPs) over eastern China based on the geopotential height at 500hPa during summertime (June, July and August) from 2015 to 2018. Four SWPs of eastern China are closely related to Western Pacific Subtropical High (WPSH), showing significant intraseasonal and interannual variations. Together with the ground air quality and meteorological observations, the surface ozone and particulate pollution presents the remarkable spatial and temporal disparities under these four different SWPs. In areas controlled by WPSH or the prevailing westerlies, ozone pollution is mainly caused by photochemical reactions of NOx and VOCs under weather conditions of high temperature, moderate humidity and slight precipitation. Particularly, the warm moist flow brought by the WPSH can induced hygroscopic growth of fine particulate matter in some local areas, resulting in the increase of PM2.5 concentrations, which may form co-occurring surface ozone and PM2.5 pollutions. In addition, the low boundary layer height (BLH) and frequency of light wind (<2m/s) day (FLWD) are closely related to the transmission and diffusion of pollutants under different SWPs, modulating the levels of ozone and PM2.5 compound pollution. Our findings demonstrate the different roles of synoptic weather patterns in modulating regional surface ozone and PM2.5 pollutions, in addition to substantial emissions, and may also provide insights into regional co-occurring high PM2.5 and high ozone pollution via the effects of certain meteorological factors.

Keywords: synoptic weather pattern, ozone pollution, PM2.5, compound pollution, Western Pacific Subtropical High (WPSH)

Application of on Campus Low-cost Air Quality Sensors in the Monitoring of Real-time $PM_{2.5}$ Concentrations in Southeast United States

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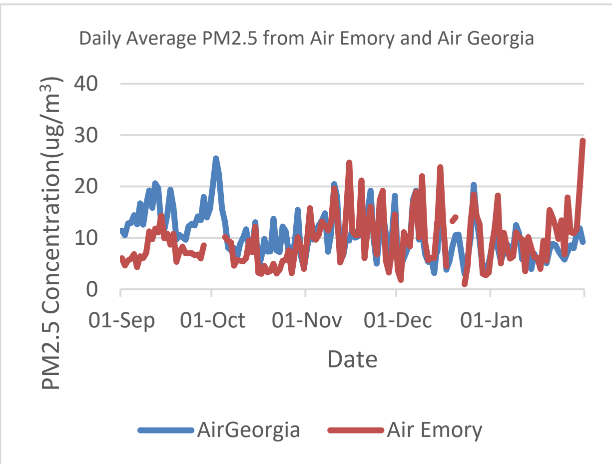
Air Emory is a college student-based environmental research project, with an effort to monitor and report $PM_{2.5}$ concentrations around Emory University's Main Campus in Atlanta, Georgia, United States of America, with self-made low-cost air quality sensor. We integrated Dylos DC 1100 particulate sensor and DHT 22 temperature and humidity sensor and use Raspberry Pi to run Python scripts and receive data. In order to verify the general reliability of our data, we took daily average of data from our sensor and those from sensors set up by the Environmental Protection Division in Georgia (http://airgeorgia.org) in their property (7km away from our location). We selected samples from September 2019 to January 2020 and compared them using R studio by calculating the correlation coefficient and conducting two-sample T-test for difference of means for each month and in aggregate. Results suggest moderate level of correlation among all months surveyed, with a particularly high correlation in December. (Sept: 0.50, Oct: 0.50, Nov: 0.56, Dec: 0.84, Jan: 0.46, All: 0.44) We believe this could be partially explained by local meteorology. In the two most highly correlated months, the monthly average values were also not statistically significantly different, giving us confidence in our measurement. (Sept: < 0.01, Oct: < 0.01, Nov: 0.57, Dec: 0.28, Jan: 0.01, All: 0.08)



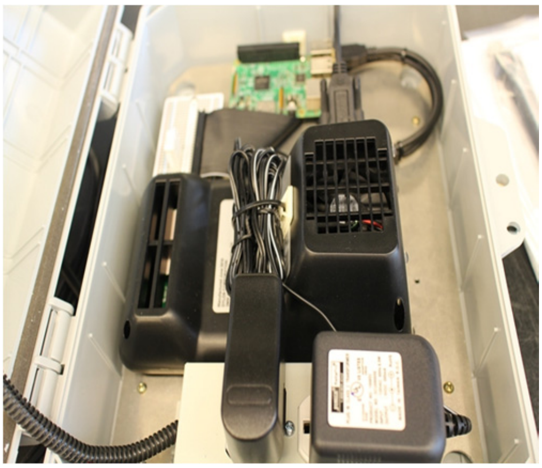


Figure 1 (left): Daily Average Concentrations from Air Georgia and Air Emory data. (right): Our sensor setup.

Keywords: BEEM 2020, $PM_{2.5}$, Low-Cost Sensor, Real-Time Air Quality Monitoring, Data Correlation

Removal of Microfibres and Microplastics in Sewage Treatment Works: Implications to Environmental Risk

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Due to resistant to degrade in aquatic environment, microplastics (MPs) have been considered as an emerging pollutant. Wastewater discharged from sewage treatment works (STWs) is suspected to be a significant contributor of MPs to the aquatic environment, and microfibre (MFs) is the main shape of MPs in wastewater effluent. Concerns associated with MPs, especially ecotoxicological impacts and health risks, have been raised in recent decades. Therefore, in order to reduce the environmental impact of MFs and MPs on the receiving water bodies, the transportation and fate of MFs and MPs during the entire sewage treatment process need to be discovered first to further develop a suitable management plan to reduce the amounts of MFs and MPs discharged from STWs to the receiving water bodies. This study aims to estimate the transportation and fate of MFs and MPs in various processes in the Tai Po Sewage Treatment Works, which is the second largest secondary wastewater treatment plant in Hong Kong, with a capacity of 120,000 m^3/day. The analytical protocols of MFs and MPs in the sewage and sludge were newly developed to reduce the loss of the MFs and MPs during the sample treatment processes. The results showed that significant amounts of MFs and MPs were removed (90.5%) after all the sewage treatment processes. However, in spite of good removal rate, fair amounts of MPs were found in the treated effluent (455.50±29.83 items/L). A sudden increase in MFs and MPs following degritting process needed to be further studied. Based on the initial results, a detail comprehensive study is devised to further investigate the removal mechanisms of various processes in a secondary STWs to reduce the amounts of MFs and MPs discharged from STWs and to evaluate the corresponding environmental risk of the released MPs.

Keywords: Microplastics; microfibres; fate; wastewater treatment plant; effluent.

Copper Segregated Nickel Foam and Its Dichalcogenide for Chemical Assisted overall Water Splitting

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Making headway in carbon-neutral energy is regarded as one of the grand challenges as the environment and energy become the two global issues facing modern society. Herein, urea assisted electrochemical water splitting was studied on a copper segregated nickel foam and its dichalcogenide (CuNF/CuNiS) electrode; catering towards hydrogen production with concurrent environmental treatment and chemical upgrading. The electrodes were synthesized via a galvanic modification of nickel foam with subsequent room temperature sulfurization. The electrodes presented a promising performance for OER and HER with overpotentials of 220 and 140 mV at a current density of 10mA cm^{-2} respectively, in 1 MKOH. In addition, the bifunctional electrode for water electrolysis required a potential of 1.6 V to attain a current density of 10 mA cm^{-2}. Notably, the electrode exhibited excellent urea oxidation activity achieving a current density of 10 mA cm^{-2} at 1.33 V vs. RHE with 0.33M urea in 1MKOH. The urea assisted overall water splitting required a cell voltage of 1.43 V at a current density of 10 mA cm^{-2} ,170 mV less than in the absence of urea. The outstanding performance is attributed to an optimum atomic configuration favouring multifunctionality. Accordingly, these results present a successful avenue towards clean energy along with value addition with the aid of a carefully controlled, simple synthesis route.

Keywords: Dichalcogenide, urea electrolysis, galvanic replacement, multifunctional

Encapsulated Phase-Changing Eutectic Salts in Magnesium Oxide Fibers for Capture: Beyond the Capacity-Stability Trade-off

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Eutectic mixtures (EM) are known to promote the sorption capacity of MgO sorbents for high-temperature CO_2 capture applications. However, EM-MgO sorbents lack cyclic stability and tend to lose their sorption capacity after multiple sorption-regeneration cycles due to sorbent agglomeration and EM melting. Moreover, they are not yet suitable for industrial application due to difficulty in material handling brought about by agglomeration, salt melting, and EM phase changes during reuse. Encapsulation of a pseudoliquid, phase-changing EM promoter inside an MgO shell may thus prevent the loss of active interface. In this work, we successfully encapsulated a K,Li-NO_3 EM in an MgO fiber matrix via core-shell electrospinning. The synthesized sorbent achieved a stable uptake of ~20 wt % after 25 sorption-regeneration cycles, as shown in Figure 1b. This is contrary to conventional EM-MgO sorbents shown in Figure 1a, which evidently lost their sorption capacities only after a few cycles.

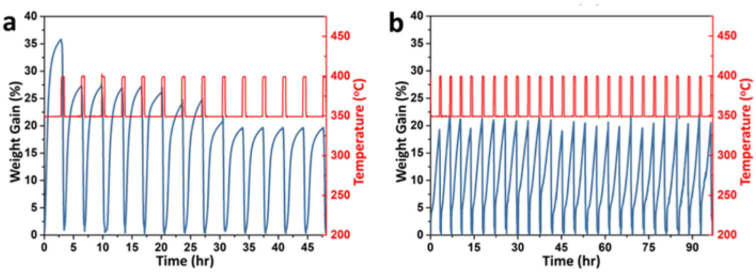

Figure 1. Cyclic sorption-regeneration tests for (a) 20EM-MgO-P and (b) 20EM-MgO-F.

The sorbent was also characterized using various techniques including FIB-SEM and in situ TEM, which confirmed that the EM existed in hollow pockets within the MgO fiber matrix, consequently limiting its movement and redistribution. This allows the sorbent to retain its cyclic stability after multiple cycles, demonstrating its potential for industrial use after further improvement. In summary, the microencapsulation of a phase-changing EM material with pure MgO metal oxide was successfully achieved and may be explored for various material applications. This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Ministry of Science and ICT (MSIT) (No. 2019R1A2C1090304).

Keywords: CO_2 capture, eutectic mixture, magnesium oxide, stable sorption, core-shell fiber

Study Calcination Effect of MoS_2 and WS_2 Nanosheets on the W/WO_3 for Improving Photoelectrochemical Performance

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Abstract

Photoelectrochemical (PEC) water splitting is one of the most promising green approaches for hydrogen generation using solar energy which meets the global energy challenge. WO_3, an n-type semiconductor with a band gap of 2.5–2.8 eV, has attracted considerable attention for photoelectrochemical applications because of its low-cost, non-toxicity, and good charge-carrier transport. On the other hand, WO_3-photoanode has some limitations, such as weak visible light response (<460 nm) and short hole diffusion lengths. Transition-metal dichalcogenides (TMDs) with 5 - 10% of light absorption in the visible range and a valence band maximum, which is more positive than the water oxidation potential, have shown great promise for the production of H_2 or further, to reduce CO_2 to hydrocarbon. The high catalytic activity and excellent stability of TMDs, particularly MoS_2 and WS_2, make them promising 2D materials for energy applications. In this study, MoS_2 and WS_2 nanosheet was prepared using the liquid exfoliation phase method and deposited on WO_3 using a drop casting method. The nanosheets were confirmed by UV-Vis spectroscopy and atomic force microscopy (AFM). Furthermore, XPS, RAMAN and SEM-EDAX analysis indicated that after calcination of the WO_3/MoS_2 and WO_3/WS_2 electrode, the MoS_2 and WS_2 nanosheets were initially transformed to 2D-MoO_3 and 2D-WO_3, respectively. This study examined ways improving the PEC performance of WO_3/MoS_2 and WO_3/WS_2 photoanode before calcination (in Oven at T=90 ^oC) and after calcination (in a furnace at T=450 ^oC). The results revealed a significantly reduced onset potential and increased photocurrent density and N_D compared to pure WO_3. The enhanced PEC performance of the WO_3/MoS_2 and WO_3/WS_2 electrodes was attributed to the following: the role of 2D nanosheets (MoS_2 and WS_2) acting as a photosensitizer by increasing light harvesting in the visible region of the solar spectrum, and a charge separator through suitable energy band alignment.

Keywords: Photoelectrochemical (PEC), liquid phase exfoliation, WO_3, MoS_2 and WS_2 nanosheets.

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MIST: Ministry of Science and ICT) (No. 2019R1A2C2085250).

$ZnO/CdS/MoS_2$ Photoanode with Multi-heterojunctions for Highly Efficient Photoelectrochemical Hydrogen Evolution

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Abstract

The development of photoelectrochemical (PEC) cells as an emerging technology can reduce greenhouse emission burdens and produce renewable energy by harvesting energy directly from sunlight. ZnO has demonstrated many advantages such as chemical inertness, low cost, abundance, and non-toxicity. However, ZnO is only active in the ultraviolet (UV) region of sunlight, which only harvests 3-5% of the total solar energy. Up to date, various strategies have been progressed to alleviate these limitations, which include morphology control, doping, and coupling with other semiconductors for constructing heterojunctions. CdS, as a narrow direct bandgap semiconductor (2.4 eV), has been regarded as a promising semiconductor because of its appropriate bandgap, the proper position of the valence band and conduction band, excellent stability, and easy fabrication. Considering that two-dimensional few-layered molybdenum disulfide (MoS2) nanosheets are a feasible material for heterojunctions, they not only exist suitable band gap energy with a direct Eg of ~1.9 eV to absorb visible light and match with CdS but also exhibit an ultrahigh specific surface area and numerous exposed active edge sites, in contrast with bulk MoS_2. The design of multi-heterojunction photocatalysts for PEC application is one of the most attractive options in recent years. This study investigates improving PEC performance of multi-heterojunction of $ZnO/CdS/MoS_2$ photoanodes were prepared via a three-step process, i.e. hydrothermal treatment, successive ionic layer adsorption reaction (SILAR) and drop casting method. The results shows a remarkable reduced onset potential and increased photocurrent density of $ZnO/CdS/MoS_2$ compared to pure ZnO, CdS and MoS_2. The PEC performance of the $ZnO/CdS/MoS_2$ photoanodes were improved because of the well matched band energy edge of the multi-heterojunction ($ZnO/CdS/MoS_2$) interfaces, which can literally build efficient electron highways to deliver electrons to reaction sites and reduce the recombination of photogenerated charge carriers.

Keywords: Photoelectrochemical (PEC), multi-heterojunction, liquid phase exfoliation, $ZnO/CdS/MoS_2$.

Acknowledgements:
This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MIST) (No. 20190909).

Platform Chemicals from Sugar: Experimental Study with MOF Catalysts

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The conversion of fructose, a sugar derivative from lignocellulosic biomass, into essential platform chemicals, and particularly 5-hydroxymethylfurfural (5-HMF) is studied. This compound has a key status in the production of polymer precursors, liquid biofuels and it is an essential intermediate for the production of fine chemicals [1].

The dehydration of fructose over various acidic MOF was investigated with a microwave reactor at conditions: T = 150°C, reaction time = 5 min, solvent= DMSO/acetone 7:3, 100 mg fructose and 30 mg catalyst.

From the current results, it can be concluded that there is a satisfying fructose conversion, except for ZIF type catalysts (spray dry and room temperature, SP and RT), but the selectivity of this conversion into 5-HMF is negligible for most of the catalysts, except for UiO-66 and sulphonated MIL-101 SO_3H. By means of HPLC analysis and standard comparison, the experimental results reveal that other important chemicals are formed from fructose, such as levulinic acid and formic acid.

Future work consists of more intense screening on the sulphonated MIL-type catalysts, as they currently show the best conversion and selectivity towards HMF.

[1] N. Aljammal, C. Jabbour, J. W. Thybaut, K. Demeestere, F. Verpoort, P. M. Heynderickx. Metal-organic frameworks as catalysts for sugar conversion into platform chemicals : State-of-the-art and prospects, Coord. Chem. Rev., 401, 213064, 2019.

Keywords: MOF catalyst, platform chemicals, 5-hydroxymethylfurfural, experimental

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Abstracts

Poster Sessions

Production of Pellet Amendment using Biochar and Its Application in Paddy Condition for Preservation of Agricultural Environment

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The aim of this study was to assess the effect of biochar pellet blended with condensed molasses soluble (CMS) on rice productivity, soil quality, and methane (CH_4) emission in a paddy condition. This study used a commercial scale pyrolysis system to produce biochar at 600°C from bamboo. The experiment consisted of three different treatments: control, inorganic fertilizer (IF, N-P-K = 90-45-57 kg ha^{-1}), and biochar pellet (BC_PT, 1000 kg ha^{-1}). Compared to other treatments, the biochar pellet decreases annual CH_4 flux by 15.8-18.8%, and also yields stable rice productivity due to high surface area, pH, and CEC of biochar. The rice grain yield using inorganic fertilizer as conventional rice management was slightly more than applied biochar pellets, despite the lower soil chemical properties. However, for long-term paddy management, including environmental protection and rice production, biochar pellets are better suited to maintaining a healthy agricultural ecosystem than conventional practices. We believe that the application of biochar pellets has the potential to reduce CH_4 emission and maintain stable rice productivity through slow release of nutrients for rice cultivation.

Keywords: Condensed molasses soluble, Methane, Agricultural ecosystem, Conventional practices

A Novel Z-scheme Ag_3PO_4/Fe_3O_4/BAB Photocatalyst with Enhanced Visible-light Catalytic Performance toward the Degradation of Bisphenol A

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A novel solid-state Z-scheme heterostructure, Ag_3PO_4 and Fe_3O_4 co-doped activated biochar (Ag-Fe@BAB), was rationally synthesized via a simple co-precipitation method and was used for the first time as a magnetically recoverable photocatalyst for peroxydisulfate activation producing free radical species under visible LED light illumination. Bisphenol A (BPA) was used as a model pollutant to investigate the photocatalytic activities of the Vis/Ag-Fe@BAB/PDS system. The structure of the Ag-Fe@BAB was characterized by XRD, FTIR, SEM-EDS, VSM, BET, UV-Vis, and XPS analysis, which also confirmed the effective deposition of Ag and Fe on the surface of BAB. To manifest the photocatalytic activity of Ag-Fe@BAB composite, the effect of important operating parameters such as the contact time, type of oxidants, concentrations of oxidant, photocatalyst dosage, and pH were scrutinized for the degradation of BPA. The photocatalytic performance of 95.6% was achieved when 1 g/L photocatalyst, 10 mg/L BPA, and 0.5 mM peroxydisulfate (PDS) were used at pH 6.5 under 0.17 mW/cm^2 of visible-light irradiation within 60 min. In addition, the impacts of the presence of several scavengers were investigated in the Vis/Ag-Fe@BAB/PDS system, which proposed a mechanism on the degradation of BPA. The result of this study lays a foundation for highly enhanced photocatalytic technology to treat wastewater contaminated with recalcitrant organic contaminants.

Keywords: activated biochar, nanocomposite, photocatalytic activity, organic pollutants

Evaluation of Deicer Impact on Growth of Winter Crops and Annual Herbaceous Plants

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To investigate the deicer impacts on herbaceous plants, 6 different deicers were applied to the field, where plants were planted in plastic pots, at a range of concentrations, 0, 25, 50, 100, and 200 mM with snowfall. Plots of pooled survival rate and fresh weight for winter crops and annual herbaceous plants against electrical conductivity (EC) of soil showed a typical dose-response. Non-linear regression analysis to fit the observed values to the log-logistic model enabled to estimate GR_{50}, soil EC causing 50% inhibition, and GR_{10}, soil EC causing 10% inhibition. Among the tested winter crops, winter wheat was the most sensitive to deicer with GR_{50} of 19.5 mM, while oilseed rape was the least sensitive with GR_{50} of 44.3 mM. Among the tested annual herbaceous plants, cosmos was the most sensitive to deicer, followed by pea, potato, and Chinese cabbage. Some plants such as turfgrass, winter wheat and garlic were unusually sensitive to non-chloride deicer, SM3. Our findings suggest that even non-chloride deicer can be more phytotoxic to plants than chloride deicer, so the impacts of deicer on plants depend on plant species.

Keywords: Deicer, Winter crop, Annual herbaceous plant, Electrical conductivity

Evaluation of Deicer Impact on Growth of Woody Plants

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To evaluate the effects of deicer on roadside trees, outdoor pot test was conducted for 2 years. For outdoor pot test, 5 tree species, apple, peach, grape, maple and pine were planted in plastic pots. Six different dicers (NaCl, $CaCl_2$, NaCl+$CaCl_2$ 7:3 mixture, PC-10, ES-1, SM-3) were selected and applied at 0, 25, 50, 100 and 200 mM by 6 split application right after snowfall. To quantify the effects of deicer on woody plants, all the data observed were pooled and replotted against direct soil EC measured in March. Non-linear regression analysis was conducted to fit observed growth or yield parameters to the log-logistic model. Two year data of growth responses in bud sprouting and visual growth showed a typical dose-response curve with increasing electrical conductivity (EC) of soil, so non-linear regression analysis to fit the observed values to the log-logistic model enabled to estimate GR_{50}, soil EC causing 50% inhibition, and GR_{10}, soil EC causing 10% inhibition. Maple was the most sensitive to deicer, followed by peach, grape and pine. Apple showed the least sensitivity among woody plants tested, as shown in Table 1.

Table 1 Sensitivity to deicer with tree species

Plant species	Chloride deicers					Non-chloride deicer				
	GR_{50}		GR_{10}		Sensitivity	GR_{50}		GR_{10}		Sensitivity
	EC	mM	EC	mM		EC	mM	EC	mM	
Apple	2.4	37.0	1.1	5.1		0.89	112.94	0.05	NA	
Peach	1.0	3.4	0.3	NA		0.22	14.18	0.06	NA	
Grape	1.7	20.5	0.7	NA		0.67	80.51	0.01	NA	
Maple	0.3	NA	0.1	NA		0.21	13.54	0.09	NA	
Pine	1.7	20.2	0.8	NA		1.02	132.79	0.13	1.87	

Keywords: Deicer, Woody plant, Electrical conductivity, Soil

Seasonal Monitoring of Bacterial Community in Full-Scale Anaerobic Digestion Treating Food Waste

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Anaerobic digestion (AD) is one of the most environmentally friendly ways for treatment of food waste and recovery of energy-rich biogas. In this study, the seasonal changes in microbial communities originating from two full-scale AD treating food waste were analyzed. Studied plants were characterized by stable (C plant, 0.97-1.21 $Nm^3 \cdot CH_4/kg \cdot VS$) and unstable (W plant, 0.38-0.76 $Nm^3 \cdot CH_4/kg \cdot VS$) CH_4 yield and a substantially different effluent ammonium concentration (C plant up to 3,042 mg N/L and W plant 5,369 mg N/L). The obtained results showed the microbial structure difference between stable and unstable performing plant. It was found that a higher bacterial diversity (37 species C plant *vs* 26 species W plant), the number of shared bacteria among all seasons (43% C plant *vs* 35% W plant), the share of dominant species, and balanced acetoclastic and hydrogenotrophic methanogenesis assured the stable performance of the food waste AD. The high ammonium presence (W plant) led to the dominance of class Clostridia while methanogenesis was mostly conducted by hydrogenotrophs (*Methanomassiliicoccus luminyensis*). Additionally, the members belonging to Clostridia (3 species, *Gelria glutamica*, *Ercella succinigenes*, and *Clostridium senegalense*) and Bacteroidia (2 species, *Bacteroides timonensis*, and *Microbacter margulisiae*) were found in both plants at each season (share ≥0.5%) implying their indispensable role during the food waste AD.

Keywords: Anaerobic digestion, Food waste, Microbial community, Biogas

Combustion Characteristics of the Livestock Manure Pellets and the Pyrolysis Gases Generated from Livestock Manure Pellets

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In Korea, more than 90% of livestock manure generated from livestock farms is used as an organic fertilizer. A small amount of livestock manure is used as a raw material for methane production in anaerobic digestion facilities. Recently, as the management of nutrient load in the aquatic environment systems has been strengthened in the country, there has been a demand for developing alternative technologies that can treat livestock manure eco-friendly. Livestock manure is valuable organic resource that can be used as an energy source. Livestock manure has a high value as a fuel for combustion because the low calorific value of dried livestock manure is higher than 3000 kcal/kg. However, current technology levels make it difficult to control air pollutants generated when livestock manure is combusted. The purpose of this study was to reduce the amount of air pollutants generated during burning of livestock manure fuel. In order to perform the combustion experiment precisely, the livestock manure was processed into pellets. The combustion characteristics of the livestock manure pellets and the pyrolysis gases generated from livestock manure pellets were investigated by analyzing the gas components and concentrations of the exhaust fumes generated during combustion. The amount of visible smoke in the exhaust of a test apparatus that burns pyrolysis gas was less than that of direct combustion of livestock manure pellets. The concentrations of H_2 and CO in the exhaust fumes were much lower at the pyrolysis gas combustion treatment compare to direct combustion treatment, but the concentrations of N_2 of pyrolysis gas combustion treatment and direct combustion treatment were similar at 73.49% and 73.95%.

Keywords: combustion, livestock manure, pellets, pyrolysis, solid fuel

The Lifecycle and Management Strategy of Plastics in Korea

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Global plastics production has risen 42% over the last decade to reach 348 million tons as of 2017, of which 72% are disposed of as waste. The production of plastics in Korea has shown consistent growth to record 14.06 million tons in 2017, of which 1.09 million tons are discharged as waste. This study analyzed the current status of plastics in Korea and assesses the linkages and effectiveness of policies through a material flow analysis on the full lifecycle (production, disposal, and treatment) of plastics. Also, based on the investigations, this study suggests useful plastic management strategies for realizing a circular economy. Out of the discharged plastic waste, 51.9% were recycled. Notably, the annual amount of plastic consumption per capita in Korea was found to be 113.3 kg in 2015 and is expected to be 154.2 kg by 2030. According to the material flow analysis of the eight major types of synthetic thermoplastic resins produced in Korea, as of 2017, a total of 9.99 million tons of these major plastics were produced, and 7.70 million tons were collected after disposal and treated (77.1% recovery). It is estimated that 58.9% (4.54 million tons) of the collected waste plastics are recycled, and of the recycled plastics, 69% (3.13 million tons) are used as SRF and supplementary heat sources for cement kilns, and the remaining 1.41 million tons are material recycled. A comparison between the results of the material flow analysis conducted in this study and those of the material flow analysis conducted by the Korea Plastic Recycling Association in 2006 showed that Korea's total generation of waste plastics grew 64.5% from 4.67 million tons to 7.68 million tons over the 11 years from 2006 to 2017. The material flow analysis conducted for the domestic case was compared to the material flow analyses of Japan and Austria in terms of the full lifecycle of production, consumption, and treatment. The analysis showed that Japan's waste management was most effective in terms of overall waste recovery and recycling rates. In particular, while more than 30% of the waste in Korea and Austria is treated by incineration, Japan only sent 8.9% to incineration facilities. By 2030, reduce the generation of disposable plastics by 30%, achieve a 70% plastic waste recycling rate, and achieve zero plastic waste-to-landfill; by 2040, reduce the generation of disposable plastics by 50%, realize a 100% plastic waste recycling rate, and achieve zero plastic waste-to-incinerators. Three proposals are made based on the implications for policy tools for Korea's plastics management, accounting for the total amount of plastic waste generation, the current stagnancy in material recycled waste, and the production of raw materials from recycled waste.

Keywords: Circular Economy, Resource Circulation, Recycling, Plastics, Waste

Hydrothermal Method Preparation Of Nanohexagon And Nanopentagon-like ZnS:Morphological Control And Antibacterial Applications

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Zinc sulphidenanomaterials (ZnS NMs) are primarily used in important technological application such as electrode materials in batteries, photocatalyst, ceramic in optical devices, and recently as an antibacterial materials etc. The microstructure, size and shape of the ZnS NMs determine its performance efficiency thus achieving suitable surface architecture is desired. Hydrothermal method is one of the efficient and cost effective methods which resultin uniform, shape selective and bulk synthesis capability. In this research, ZnS exhibiting different surface structures such as spherical, nanopentagon, and three-dimensional hexagon by changing the concentration and types of surfactants. The prepared materials exhibited cubic sphalerite crystal structure, and high purity as analysed from X-ray diffraction and X-ray photoelectron spectroscopy. The prepared materials were tested for the antibacterial property against human pathogens such as *E.coli, K.pneumoniae* and *S.aureus*. The results showed that the antibacterial action was the strongest against *K.pneumoniae*with minimum inhibitory concentration values as compared to other organisms and showed shape and concentration dependent activity.

Keywords: zinc sulphide, hydrothermal, antibacterial, morphology

Effects of Voltage on Anaerobic Digestion of Digested Sludge

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Recently, bio-electrochemical AD (BEAD) is gaining attention as a technology for managing digested sludge with its high organic removal and methane production capabilities. However, despite high potential of BEAD, only a few paper has reported effects of BEAD on digested sludge treatment performance. Therefore, effects of voltage on organic removal efficiency and methane production rate of digested sludge were quantitatively evaluated in this study through biochemical methane potential (BMP) tests. Total seven reactors were manufactured according to voltage, each reactor was set to control (C-R), control with 0.2 V (C0.2-R), and 0 V (0-R), 0.2 V (0.2-R), 0.4 V (0.4-R), 0.6 V (0.6-R), 0.8 V (0.8-R). Total and working volume of all reactors were 500 and 400 mL, respectively, and all reactors were tested under OLR of 2 kg/m3/d based on soluble COD (SCOD) concentration. As the results, methane yields based on influent total COD (TCOD) and SCOD in 0.4-R were 0.041 L-CH4/g-TCOD and 0.122 L-CH4/g-SCOD, which were approximately 2.7 and 2.6 times higher than those in 0-R. Methane production and biodegradability of 0.4-R were improved for 151 mL and 1.6 % comparing to 0-R. In addition, 0.4-R showed methane production rate of 5.05 mL/hr that was 2.24 mL/hr higher than 0-R (2.81 mL/hr). In contrast, the 0.6-R and 0.8-R showed lower methane production and yield than 0.4-R, It might be because high voltage affects reduction of microbial activity. However, improvement of hydrolysis rate with higher voltage could be confirmed by comparing SCOD/TOCD ratios of each reactor. In conclusion, this study confirmed that voltage could contribute improvement of organic removal efficiency and methane production rate of digested sludge, and this finding would provide application possibility of BEAD as post-treatment process.

Keywords: Bio-electrochemical anaerobic digestion (BEAD), biochemical methane potential (BMP) tests, digested sludge

Effect of Free Ammonia for High Protein Production in *Chlorella Vulgaris.*

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Algae cultivation which is the one of method to treat wastewater has great environmental and economical benefit in that, it can not only remove excess nutrient but also produce valuable bioproducts from the wastewater. N-source in the wastewater is assimilated to amino acid in algae and comprise protein, and this protein has preferable amino acid composition for animal feed and the production cost is much lower than other protein feed. As the contents of the cell change depending on the growth condition, knowing the effect, metabolism, engineering design for algal protein production would be important.
At this point, Free ammonia may be the preferred nitrogen source because energy to assimilate is low and can be penetrated into cell by passive transport. To use the ammonia as nitrogen source, ammonia toxicity which inhibit the cell growth should be considered. The ammonia toxicity can be affected by concentration of ammonia, pH, light intensity. In this study, the effects of free ammonia concentration, light intensity on chlorella vulgaris protein production are studied in batch culture. The difference protein production between nitrate, ammonium and free ammonia for nitrogen source was investigated. *Chlorella vulgaris* cultivated in mixotrophic condition with various pH and nitrogen source was 10 mM nitrate or ammonium. Free ammonia concentration was adjusted by the pH (7.25, 8.25, 9.25). The consumption rate of nitrogen source, Dry cell weight, protein concentration of the cell was investigated. The results demonstrated that higher protein content was obtained in ammonium source medium than nitrate source medium. There is no cell growth in pH 9.25 medium. Next, the effect of free ammonia concentration at fixed pH on production will be investigated. The pH of the medium is 8.5 and the ammonium concentration 10, 20, 30, 40, and 50 mM of which free ammonia concentration is 1, 2, 3, 4, and 5 mM. The result show that as the concentration of free ammonia increase, the growth is inhibited but protein contents of cell is increasing. According to free ammonia toxicity is increasing as light intensity for algae, the effect of light intensity on protein production will be investigated. Finally, the nitrogen assimilation enzyme GS-GOGAT activity and expression level will be investigated in optimal condition for protein production.

Keywords: Protein production; free ammonia; *Chlorella vulgaris*;

Factors Affecting Anaerobic Dry Fermentation for Food Waste Management

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Disposal of food waste has been an emerging and critical issue since ocean dumping of food waste has banned since 2012 in Korea. Anaerobic digestion has been considered as an alternative option for ocean dumping. In this study, anaerobic dry fermentation (below 80 % of water contents) is proposed which could effectively reduce the production of food wastewater with a production of biogas. Anaerobic dry fermentation bioreactors applying two-phase system were investigated with process performance and biogas production at different pretreatment methods, retention time (15, 20, 25 and 30d), and F/M ratio. Constant reduction of solids and stable methane production were achieved at relatively long retention time (25 and 30d), whereas lower biogas production with lower methane composition were observed in the case of short retention time (15 and 20d) due to concentrated VFA and ammonia concentration. Also, too much addition of NaOH (more than 0.2 g/g-TS) for the pretreatment was found to have an adverse effect on the process performance due to the accumulation of the excessive salts. Currently, relative contribution of each parameter is under quantification using response surface methodology (RSM) and our result shows that anaerobic dry fermentation process at proper organic loading rate could be an alternative for food waste treatment.

Keywords: anaerobic digestion, dry fermentation, biogas, organic loading rate

Heavy Metal Removal in Contaminated Wastewater Using Starfish Biochar

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Recently, starfish has been identified as an invasive species in marine ecosystems. It exhibits a high reproductive rate and is known as a bottom feeder, consuming large amount of various benthic invertebrate organisms (shellfish, sea cucumbers, sea urchins, etc.). Moreover, the population of triton shellfish, the starfish's main predator, is limited. Therefore, starfish are an ecological problem for the marine environment and a great number of starfish are captured in the Republic of Korea in order to protect marine ecosystems. However, recycling of captured starfish is scarce and efforts to find a beneficial use application for the starfish are ongoing. In this study, the calcination process was applied to starfish in an oxygen free environment at three different temperatures of 300oC, 500^{o}C and 700^{o}C. The calcined starfish was then used for heavy metal removal in contaminated wastewater. The initial heavy metal concentration of 50 mg/L was treated with starfish biochar in the range of 0.05g – 1g. The treatment results showed that the heavy metal concentrations in the wastewater decreased with increasing starfish biochar dosage. Total heavy metal removal was attained with 0.5g of starfish biochar calcined at 500oC, except for Pb removal. This treatment concentration was outperformed by the starfish biochar calcined at 700oC, where total heavy metal removal was obtained with 0.25g. This indicated that when a higher temperature was applied, the heavy metal removal rate is increased. The findings demonstrated that starfish biochar could be beneficially used to effectively treat heavy metals in contaminated wastewater.

Keywords: starfish, heavy metal, wastewater, biochar

Adsorption of Cd(II) by Encapsulated Spent Mushroom Substrate Biochar: Batch and Fixed-bed Column Systems

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In this study, spent mushroom substrate biochar (SMSB) beads were synthesized to effectively remove cadmium (Cd) from aqueous solutions. The physical and chemical characterization of SMSB beads were conducted by Fourier transform infrared spectroscopy, X-ray diffraction, Thermogravimetric analysis, Scanning electron microscope, and Brunauer-Emmett-Teller methods. The maximum adsorption capacity of SMSB beads was 71.98 mg/g at an initial Cd concentration of 600 mg/L, pH 5, and 305 K, which was superior to the previously reported adsorbents for Cd removal. The performance of Cd adsorption was evaluated under various conditions such as initial Cd solution, pH, contact time, temperature, and competing ions. The adsorption behaviors followed pseudo-second-order kinetics and the Langmuir isotherm. In addition, a fixed-bed column study was conducted under different conditions such as bed heights, flow rates and initial Cd concentrations. The breakthrough curves were best predicted by both Thomas and Yoon-Nelson models at all conditions. These experimental results showed that the synthesized SMSB beads have extensive applicability for the removal Cd from aqueous solutions.

Keywords: Adsorption, Cadmium, Biochar, Spent mushroom substrate, Fixed-bed column

Production of Biodiesel Synthesized from the Black Soldier Fly Larvae and Its Fuel Property Characterization as a Potential Transportation Fuel in Korea

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Insect have a great potential as for a biodiesel raw material. In particular, biodiesel production from black soldier fly larvae (BSFL) is promising because they grow on organic waste. Here, we synthesized biodiesel using lipids extracted from BSFL by the process of esterification by optimizing the conditions: the amount of methanol, reaction temperature, and reaction time under an H_2SO_4 catalyst. Biodiesel was processed through separation/washing processes; vacuum distillation was used to manufacture upgraded biodiesel with a low sulfur content and total acid value. The yield was 86.5% using a 1:8 ratio of lipid and methanol, reaction temperature of 70 °C, and reaction time of 6 h. The fatty acid methyl ester content of BSFL-derived biodiesel was analyzed and comprised lauric acid (23.6%), oleic acid (23.2%), and palmitic acid (20.3%). Quality analysis was conducted following KS M 2965, Korean Standards. All parameters, except oxidation stability, satisfied the quality standards; the oxidation stability quality criterion was met by adding tert-butylhydroquinone (TBHQ). Thus, this study confirms a potential of BSFL biodiesel as a transport fuel.

Keywords: black soldier fly larvae, fatty acids, biodiesel, quality standards, purification

Bio Jet Fuel Production and Quality Control Review

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ICAO(International Civil Aviation Organization) decided to implement CORSIA(Carbon Offsetting and Reduction Scheme for International Aviation) from 2021 as a market-based policy for aviation sector. Accordingly, the importance of using biofuels in the aviation field is being emphasized. Bio jet fuel is produced from biomass raw materials such as oil and fat-based, sugar-based and woody biomass-based. Bio jet fuel produced through synthetic technology can be mixed and used with existing petroleum aviation oil if certain quality standards are met. Quality control is managed according to the international standard ASTM(American Society for Testing and materials) standard. ASTM approval must be obtained according to the raw material and process method, and for approval, the results performed according to the prescribed analysis method must satisfy the criteria. As of 2019, ASTM Permits certification for bio-jet fuels produced through six conversion processes: FT-SPK, HEFA-SPK, SIP-HFS, SPK/A, ATJ-SPK, and co-processing. Registration work is currently in progress for the five transition processes, including CHJ/HFP-HEFA. Certified fuels must meet individual quality standards and can be mixed up to 50% with petroleum jet fuel. Bio jet fuel quality standards and analysis methods are specified in ASTM D7566(Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons), and are classified into 20 items including ASTM D3242(Standard Test Method for Acidity in Aviation).Bio jet oil is subject to strict quality standards compared to conventional aviation fuels such as hydrocarbon and non-hydrogen composition quality, lubricity, fatty acid methyl ester content, etc.

.

Keywords: ICAO, bio jet fuel, ASTM, HEFA-SPK

Removal of Ammonia, Zinc and Copper from Rainwater Runoff Using Sulfonated Biochar

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Due to the development of urbanization, the impervious surface area of cities has increased. Pollutants accumulating on the ground and roof are transferred into rainwater runoff during rainfall, which causes pollution of surface water. This study investigated the removal of ammonia, zinc and copper from rainwater runoff using sulfonated biochar (SBC) yielded from rice straw. The preparation procedure of the SBC was first optimized based on the adsorption of aquatic ammonia. The surface of SBC was loaded with acidic groups after sulfonation. The total acid amount of SBC obtained at optimized conditions reached 1.9744 mmol/g. The maximum adsorption capacities of total ammonia by the SBC reached 24.7 mg/g, which is much higher than that by the natural biochar (NBC). The kinetics and isotherm of the adsorption of total ammonia was further analysed via fitting to models. Ion exchange was the dominating mechanism for the adsorption of total ammonia on the SBC. Furthermore, the SBC was employed to remove zinc and copper coexisted with total ammonia in the rainwater runoff. The maximum adsorption capacities of zinc and copper were 88.4 mg/g and 69.0 mg/g, respectively, in a separate ionic solution. However, the adsorption was influenced by the coexisting of these three ions. The effects of initial pH, dosage and other impurity ions on the adsorption were also evaluated. Results indicate an promising approach for the removal of total ammonia, zinc and copper from rainwater runoff using the SBC.

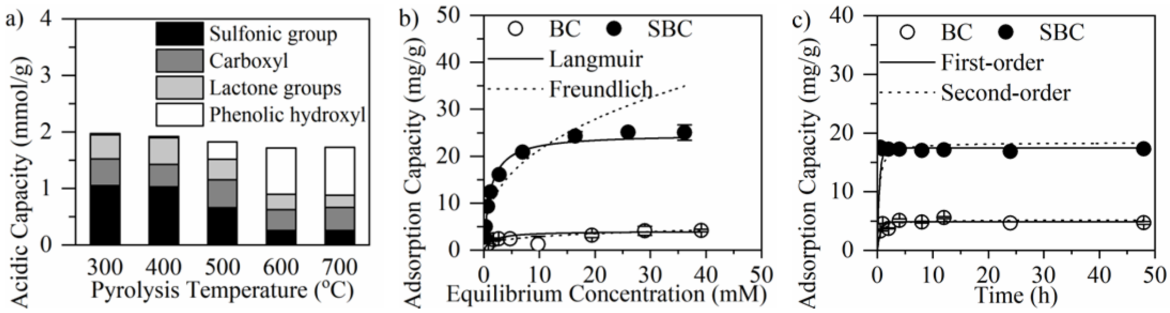

Figure 1 Boehm results, isotherm and kinetics of ammonia adsorption by NBC and SBC

Keywords: Sulfonated biochar, total ammonia, zinc, copper, rainwater runoff

Renewable Energy Capacity Selection Considering the Annual Load Properties of Office Building

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In this study, the capacity estimation of New & Renewable Energy facilities was made by using the annual load of an office building in which geothermal heat pump was installed. Also solar PV, solar thermal, geothermal heat pump and fuel cell system were considered as New & Renewable Energy facilities that can be available in office building. The integration and capacity of New & Renewable Energy facilities were calculated by its optimal and hourly operation that enables the sum of its installation cost and the cost of electricity and gas used in an office building to be minimized. In order to calculate the combination of the new & renewable energy facilities and the respective capacities, the annual resource, load, performance, and cost information related to the target office building are required. The combination of renewable energy facilities and the objective function for estimating each capacity can be expressed as the following equation (1) as the sum of the annual variable cost (Z_r) and the annual fixed cost (Z_f). The annual variable cost (Z_r)represents the sum of annual electricity and gas charge, and the annual fixed cost (Z_f) is given by the following equation (2).

$$Z = \min(Z_r + Z_f) \quad (1) \qquad Z_f = \sum_{k=1}^{n}(\mathrm{CRF}(i, n_k) + r_k)I_k \quad (2)$$

Here, k is new and renewable energy facility, CRF(i, nk) is the capital recovery coefficient, i is the discount rate, nk is the lifetime, rk is the annual maintenance rate for the initial investment cost, nk is the initial investment cost. It is confirmed that the combination of new and renewable energy facilities and capacity are different according to the constraint conditions even though the electricity, cooling and heating load patterns of the target office buildings are the same. In case of no constraint condition of solar installation (CASE1), it is confirmed that the capacity of solar and geothermal heat pump is increased when the initial investment cost is reduced. In the case of constrained solar installation (CASE2), even if the initial investment cost is reduced, the solar facility is constant at the maximum installed capacity.

Keywords: New&Renewable Energy Facilities, Capacity Estimation, Annual Load

Pavement Acceleration Test Results for Road Pavement Durability Evaluation of Piezoelectric Harvester for Road

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Nowadays, with the emergence of new technologies to convert the energy that is thrown away in the everyday life into electric energy, environmental destruction caused by the use of fossil energy and acceleration of global warming have necessitated an energy source that can replace the existing energy source. This energy harvesting technology can be converted simply, quickly and easily, unlike conventional transmission systems (power generation / transmission / distribution) that produce large-scale power at remote sites such as nuclear power, hydro power, tidal power and thermal power.

Therefore, In order to evaluate the durability of the piezoelectric harvester itself and the pavement filled with the piezoelectric harvester when the piezoelectric harvester, which converts the driving pressure of the vehicle into electric energy, was applied to the road, a pavement acceleration test was performed. In carrying out the pavement acceleration test, In order to investigate the physical properties of the pavement accelerated test materials, the following tests were carried out on the seven core materials (lean concrete, surface layer concrete, small-grain asphalt, interlayer asphalt, modified SMA, high elastic asphalt, polyurethane). The compressive strength in the case of concrete and indirect tensile strength test in case of asphalt were tested, before and after construction. In order to carry out the pavement acceleration test, the lean concrete base construction for the concrete pavement was made with the design thickness (15cm) and wet. The curing period of the base layer was based on 7 days.

The base, intermediate and surface materials of the asphalt pavement for asphalt pavement implementation are based on materials applied on the highway. The commonality evaluation test was carried out with a running speed of 20 km/h and a load of 7.5 tons on a straight track. As a result, at the first, the visual inspection results showed that no significant package failure occurred under the equivalent shortening load of 5.7 million. But cracking occurred in the super fast curing cement fill material and reflection cracking occurred in the displacement material of the 1 cm buried polyurethane at the equivalent shortening load of 5.2 million.

Keywords: Piezoelectric Harvester, Durability Evaluation, Pavement Acceleration Test

Test Road Installation and Demonstration Test Result of Piezoelectric

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Piezoelectric harvester for road power generation was installed on test roads owned by Korea Highway Corporation. 24 harvesters were installed on the concrete pavement and the remaining 12 harvesters were installed on the asphalt pavement. After installation, power generation performance and environmental tests were carried out with three types of vehicles: compact / passenger cars / trucks. The running speed of the vehicle was 30 km/h, 60km/h, 90 km/h. The test results show that the larger the weight of the vehicle, the higher the power generation, the concrete road than the asphalt road, and the exposed type rather than the buried type. The generation amount according to the depth of buried was at least 2.2 times at the depth of 1cm than 5cm depth. When the delegator lighting test was performed using 12 harvesters, it was possible to light up more than 20 seconds in one vehicle due to the improvement of the charging circuit. In addition, the wireless communication module driving test enabled temperature sensing and data transmission for 25 seconds. In addition, there was no breakage of the pavement when driving more than 180 times, and the generation amount was maintained more than 90%. However, Test for the durability of the pavement and the self-durability of the harvester is required more than 180 times of vehicle driving conditions and required more than minimum of 6-12 months of long-term monitoring.

Table 1. Summary of demonstrate test results

Test name	Test contents	Results
Test 0	Vehicle load and pass position measurement	Larger load increases
Test 1	Comparison of concrete / asphalt power generation	Concrete ≫ Asphalt
Test 2	Comparison of exposed / buried generation	Exposed ≫ buried
Test 3	Comparison of generation by depth of burial	1≫3≫5[cm], 2.2 times
Test 4	LED delineator lighting test	Light up more than 20 [sec]
Test 5	Wireless communication module driving test	Send data for 25 [sec]
Test 6	Comparison of generation by installation interval	no difference
Test 7	Durability measurement by load capacity	Driving more than 180 times

Keywords: Piezoelectric Harvester, Test road, Experimental Installation, Demonstration test

Rest Area Experimental Installation and Effect Analysis of Piezoelectric Harvester

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The piezoelectric generator is tested before piezoelectric harvester manufacture for roadway. Each piezoelectric generator produces 9.38[mW/cm^2] and piezoelectric harvester is manufactured by the number of 85 the piezoelectric generator. This harvester size has 50*20*9[cm^3] which is considered for wheel path of vehicle. When the chosen vehicle (about 2 ton) pass this harvester, the amount of electric energy is 255[W/m^2] under 2[mm] of deformation and 30[km/h] of velocity. In this situation, the gathered energy is multiplied the maximum of voltage and electric current then divide it for the area of harvester. The test result is the temperature difference between the inside and outside after the thermal insulation coating process. When the external surface temperature is increased to 180 degrees, the internal temperature is kept 80 degrees even after about 30 minutes, indicating that the internal materials are protected from heat. In spite of many advantages with piezoelectric harvesting system, it is very hard to fit between roadway and harvester because of pavement damage. Most of paving material has a strong thickness. In this study, instead of asphalt and concrete pavement, the paving material is compound of poly-urethane to protect rutting and damage. To analysis for behavior, test is conducted by 90,000 times of wheel load on the pavement. The red line on the graph is commonly used asphalt pavement and the green one is polyurethane pavement. As it seemed that polyurethane pavement shows that the depth from wheel load is over 5 times better performance compared with asphalt pavement. Construction design is first of all, cutting off asphalt which is established before, then set up the tenth of piezoelectric harvesters, twenty fourth of road markers is installed into the roadway. Before filling up to space with polyurethane materials, wire arrangement and connect to controller. Each harvester is connected with controller that makes a signal for voltage, temperature sensor, water leak sensor. In order to use electric energy by harvester, road markers are selected, which each harvester has three of road markers. A circuit for lighting the light emitting device using the output of the harvester installed in the rest area was designed and manufactured. Basically, a circuit is configured to light up the harvester output, and a commercial power supply can be used in case the output of the harvester is reduced due to the durability thereof, and a controller is manufactured for each harvester to connect the road markers.

Keywords: Piezoelectric Harvester, Durability Evaluation, Pavement Acceleration Test

Catalytic Pyrolysis of Pine Sawdust over a Ni/SiO_2 Catalyst using CO_2 as Reaction Medium

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This study aimed to explore the synergistic effects of CO_2 on catalytic pyrolysis of pine sawdust over a Ni-based catalyst (Ni/SiO_2). Thus, pyrolytic gas from pyrolysis of pine sawdust in N_2 and CO_2 were compared to elucidate the reaction mechanism of CO_2. To this end, one-stage and two-stage pyrolysis(non-catalytic/catalytic) pyrolysis of pine sawdust was carried out in this study. The enhanced CO evolution was observed from CO_2-cofeeding pyrolysis of pine sawdust. It was found that the gas phase reaction between CO_2 and pyrolysates led to the CO enhancement. The enhanced formation of H_2 and CO was observed from catalytic pyrolysis of pine sawdust. These observations implied that gas phase reaction between CO_2 and pyrolysates could be expedited during the CO_2-cofeeding pyrolysis of pine sawdust over Ni/SiO_2. In addition, using CO_2 as reaction medium during the catalytic pyrolysis could offer an innovative way for preventing coke formation in the catalytic bed.

Keywords: Catalytic pyrolysis, Biorefinery, Lignocellulosic biomass, Waste-to-energy

Catalytic Pyrolysis of Rice Husk with CH_4

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To address the environmental issues caused by fossil fuels utilization, and achieve energy sustainability, the production of BTEX (benzene, toluene, ethylbenzene xylenes) which are important feedstocks in petrochemical industry should be produced from biomass. Catalytic fast pyrolysis is an intensive technology by which solid biomass can be converted into bio-oil. However, bio-oil is not suitable to use as drop in fuel, hence it has to be upgraded on catalysts before the pyrolysis vapors condensed. Ex-situ catalytic upgrading is best method to produce the aromatics. The addition of methane, with highest $(H/C)_{eff}$ =2, could provide the methyl radical in the pyrolysis process and increase the bio-oil yield, the hydrogen radicals can maintain the Bronsted acidic sites on zeolite by exchanging the proton with zeolite and thus suppress the deactivation of zeolite. In this context, we employed the methane as the co-feeding gas to create hydrogen rich environment in the ex-situ upgrading of rice husk pyrolysis with aim to increase BTEX content in the upgrading bio-oil using HZSM-5. Ex-situ catalytic experiments performed in down flow fixed bed reactors connected in series. In the case CH_4 environment, methane was co-fed into the upgrading reactor, while to create hydrogen rich environment first methane was decomposed at 800 °C and the effluent gas was sent to the upgrading process. The yield of aromatics was in the order of N2 environment < methane environment < CH4 decomposition environment. The detailed presentation of high yield of aromatics under methane decomposition will be given.

Keywords: Rice husk, Catalytic fast pyrolysis, Methane, Aromatics

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Catalytic Co-pyrolysis of Biomass Waste and Oil Sludge Waste

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Biomass is considered to be a most practical renewable resources for replacing the petroleum based energy. Among the various methods of production of bio-energy, pyrolysis can produce bio-oil with high energy density from massive biomass resources. However, bio-oil has high oxygen and moisture contents, low hydrogen content, and low pH value so that it cannot be used as a high quality fuel oil. Therefore, the quality of bio-oil should be improved to overcome its drawbacks. Meanwhile, some waste residue materials such as plastics or biofuel residue contained high amount of carbon and hydrogen so that they can fill a deficiency of hydrogen in biomass itself and reduce relative oxygen content when they are copyrolyzed with waste raw biomass. Although catalytic copyrolysis is able to convert the components reducing the fuel quality into valuable high quality fuel components such as aromatics, there are few studies about catalytic co-pyrolysis of waste biomass and waste residue Therefore, in this study, catalytic co-pyrolysis of food waste biomass and oil sludge waste residue using microporous zeolite and mesoporous materials was performed for the first time. Synergistic aromatic production was found on the catalytic co-pyrolysis over HZSM-5 and Al-MCM-41. Especially, HZSM-5 had the quite higher synergy effect than Al-MCM-41 for aromatic formation due to its strong acidity and proper pore structure and size for aromatization.

Keywords: Oil sludge, Co-pyrolysis, Waste Biomass, Aromatics

Acknowledgements: This work was supported by the National Research Foundation of Korea (NRF) grants funded by the Korea government (MSIT) (NRF-2019R1A4A1027795).

CO_2 Effects for Syngas and Biochar Production in the Catalytic Pyrolysis of Peat Moss from the North Polar Region

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As per significantly proceeding global warming and climate change, the release of greenhouse gases (GHGs), especially CO_2, from the carbon stock (from peat moss and moss to permafrost) stored in the Earth's polar regions are considered as an increasing matter of concern. Herein, this study is focusing on the exploitation of CO_2 and surface substance (peat moss) to mitigate the potential global warming challenges. Particularly, CO_2 as an oxidant and reaction medium was utilized for energy recovery as syngas (CO and H_2) and for carbon sequestration as biochar from pyrolysis of peat moss. In detail, CO_2 expedited the thermal cracking of volatile organic compounds (VOCs) from peat moss pyrolysis through the gas-phase reaction (homogeneous reaction) between CO_2 and gaseous by-products. These mechanistic effect of CO_2 resulted by converting CO_2/peat moss to CO at ≥ 530 ˚C. Also, an industrial waste, steel slag, was employed as an *ex-situ* catalyst to expedite the reaction kinetics, resulting that the substantial CO and H_2 formation was achieved at ≤ 530 ˚C. The porosity of biochar, solid phase pyrolysates from peat moss, was evidently modified in the presence of CO_2, with a significant improvement in peat moss biochar surface area (70 %) and pore volume (60 %) as compared to the case of N_2 pyrolysis. This suggested that CO_2-assisted biochar production could facilitate improved carbon capture due to its higher porosity. To investigate a universal approach using CO_2 oxidant and a reactive gas medium for energy recovery from substances, CO_2-cofeeding pyrolysis of oxygen-free polystyrene was investigated as a case study, and our proposed reaction mechanisms and outcomes arising from CO_2 pyrolysis were well proven by the overall mass balance and compositional matrix of the liquid pyrolysates. Therefore, CO_2 has the potential to serve as an initial feedstock and reactive gas medium in sustainable biomass-to-energy applications and biochar production platforms, thereby reducing carbon

Keywords: Carbon dioxide, climate change, catalytic pyrolysis, peat moss, CO_2-to-fuels

Analysis on Environmental Effects of Electric Vehicles for Korea Electricity Mix Based on LCA

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In keeping with the global trend of suppressing the sales of internal combustion vehicles and promoting the use of eco-friendly cars, Korea has also been implementing policies for strengthening its electric car market through subsidies and building necessary infrastructure such as electric car charging stations. In this study, TOTAL 5.0, the life cycle assessment software specifically designed for the environmental product declaration system, was used to evaluate the life cycle of electric vehicles. The inventories of fuels used by the vehicles and the energy sources were taken from on the national LCI database. Also, for comparison, the life cycle of gasoline vehicles were assessed using the petroleum production inventory of the national LCI database, and the amount of pollutants emitted while driving was estimated using the emission coefficient of the environmental product declaration and the Regulation on the Method for Calculating the Total Pollutant Emissions of Vehicles. When the energy source is the 2017 electricity mix, the total PM produced by an electric vehicle is 0.117 g/km, which is only 3.7% of that by an internal combustion engine. The environmental impact caused by increasing of electronic cars and replacing gasoline cars with electric vehicles, using the changes in greenhouse gas (GHG) emissions as the indicator. Electric vehicles were found to emit 3.18 g/km of GHGs more than gasoline vehicles during the vehicle manufacturing and disposal stages. Also, assuming that the increase in electric vehicles will necessitate a 0.003% increase in electric power generation, this additional power generation will produce 0.0029 g/km of GHGs. When taken together, it became possible to predict a 61.7 g reduction in GHG emissions. This translates to a decrease of 7,024,452 tons of GHG emissions if one million electric vehicles are distributed and put into use by 2030, assuming 120,000 km of driving per each electric vehicle. The 8th Basic Plan for Electricity Supply and Demand aims to reduce the share of coal-fired power generation in the electricity mix by 2030 to 36.1%. This is a significant decrease compared to the current share of thermal power generation (45.3%), but the 2030 target still places the highest dependency on thermal power generation. Thus, greater efforts are required to make the shift to a more environmentally-friendly electricity mix. Also, since the PM from indirect emission accounts for 72% of the total amount of PM generated, additional measures should be implemented to reduce the environmental impact of acidification at the power generation stage.

Keywords: Electric Vehicle, Life Cycle Assessment, Electricity Mix, Greenhouse Gases

Degradation of Organic Pollutants using Fe-basedphotocatalysts

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Phenol is one of the primary pollutants classified as a teratogenic and carcinogenic agent by the United States Environmental Protection Agency. The effective removal of phenol from wastewater is challenging, and several treatment techniques, have been investigated. Most of these technologies have many limitations such as, low performance, long reaction time, high cost, and also releasing harmful byproducts to the environment.

In this study, three iron-containing catalysts, i.e., Fe-Zeo-A, Fe-ZSM-5, and Fe-silica have been investigated for the degradation of phenol in the aqueous solution. The activity of catalysts was assessed for phenol degradation via heterogeneous photolysis, Fenton, and photo-Fenton oxidation. All catalysts showed better performance in the photo-Fenton process.

It was found that Fe-silica and Fe-ZSM-5 achieved higher catalytic activity (~100% phenol removal) while only 64% removal was observed for Fe-Zeo-A. Moreover, among all catalysts, Fe-ZSM-5 was highly stable with low iron leaching, which was attributed to the uniform distribution of bonded Fe in the crystalline framework .On the contrary, amorphous Fe-silica showed higher iron leaching due to the presence of isolated iron species in the structure which resulted in the partial involvement of homogeneous reaction in the phenol degradation process. The overall analysis result showed that crystalline Fe-ZSM-5 is a promising catalyst for heterogeneous photo-Fenton processes.

The photolytic cleaving of hydroxyl groups, photo-active Fe species, and generation of radicals by the heterogeneous photo-Fenton process contributed towards the degradation of phenol.

Keywords: Heterogeneous catalysts; Phenol; Photo-Fenton

A Study on the Underground of Highway and Its Implications with Environmental Change

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The Paris Agreement, signed in 2015, has been halved in effect by the U.S. declaration of its withdrawal from the Paris Agreement, but focuses on drawing voluntary participation from the parties to the agreement. Therefore, Korea also has a new energy plan and is it eco-friendly?It is reorganizing its energy policy based on new and renewable sources. Since total greenhouse gas emissions in Korea have been on the rise since 2005 to the present, the government is making efforts to reduce greenhouse gas emissions by 2030, and is also exploring systems and ideas to reduce greenhouse gases in the road and transportation sectors.

Under the plan, the E-public corporation plans to make the highway underground where citizens can enjoy the effects of improving their leisure and reducing traffic jams and reducing the emission of environmental pollutants by providing parks and after-effects through the restoration of the environment in the city center. In Korea, the Gyeongin Expressway (Shinwol IC-Incheon IC) has been opened by 2027, focusing on improving the transportation-environment-road platform.

The undergroundization of highways is typical in Boston, Madrid, Spain, and Hamburg, Germany, and has had positive effects such as 62 percent reduction in vehicle traffic time and 12 percent reduction in carbon monoxide, and expansion of the area's commercial area on the ground of highways.

As such, the undergroundization of highways needs to be expanded from a public and social value perspective, as it plays an important role in terms of urban regeneration as well as the environment.

keywords: Undergrounding of highways, changing energy policies, changing environment changes

The Change of Highway from a Cultural, Economic, and Ecological Perspective through Healing Way Promotion

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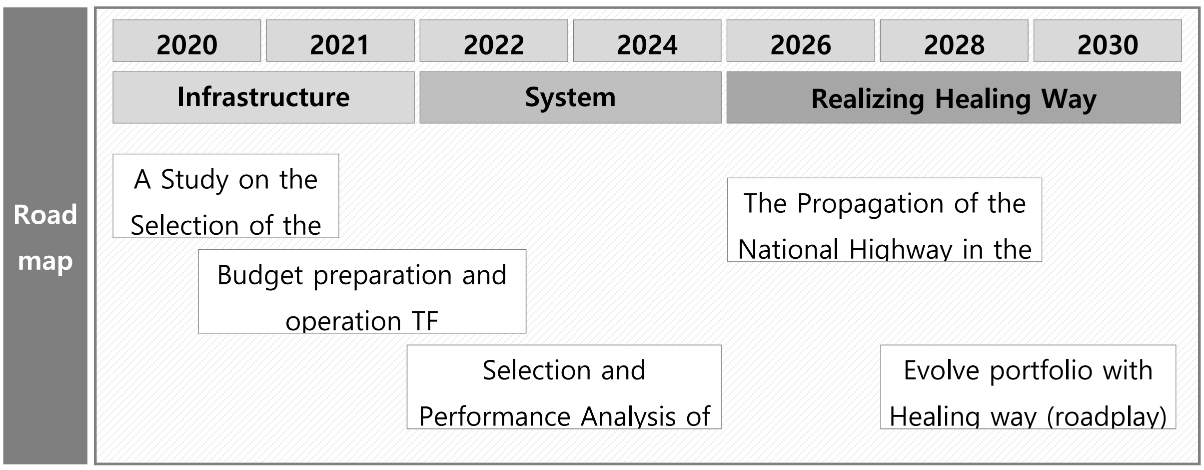
Urban regeneration projects, which are included in the current administration's national agenda, focus on preventing the hollowing out of the aging old capital city and revitalizing the local economy. In this regard, the healing way focuses on the revitalization of the local economy through the use of renewable energy facilities, the creation of eco-forests and the combined development of rest areas, using the old roads around the closed highway section and highway. In addition, over-the-air buildings through three-dimensional road construction can play a big role in securing local cultural space.

Most of the four-lane highways created in the early 1990s are 20 to 30 years old, and the quality level of the road transport environment needs to be secured by improving old infrastructure. In other words, it is necessary to increase healing way that introduces eco-friendly, scenic, green network and human-centered concepts from a conservation perspective of living environment. Is this a paradigm shift from the concept of lines to the concept of faces?In other words, it is necessary to approach the area with the concept of road capacity, driving safety, and pleasant view security.

To that end, related public organizations need to specify existing aged roads and select the destination. In addition, the government needs to establish an environmental analysis and DB for the surrounding areas and devise measures to form and legislate the implementation system to suit the characteristics of each region. As such, the healing way will enable the implementation of complex roads, including future cost savings and environmental values, on a policy level, and accelerate the spread of eco-friendly roads in a truly sustainable and diverse sense.



keywords: healing way, highway change

The Potential of Pt/TiO_2 as Thermal Catalyst for Gaseous Formaldehyde: Effects of Concentration Levels and Flow Rates of Formaldehyde at Room Temperature

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Indoor air pollution has become a significant process. Among as list of indoor pollutants, formaldehyde (FA) is one of the key targets for the abatement. In order to efficiently remove FA in indoor environment, the removal efficiency of thermal catalytic process has been investigated using Pt/TiO_2 as a function of the two key operational variables such as the concentration levels and flow rates of FA standard gas. 100% removal of FA was confirmed under the room temperature condition when the removal of FA was tested by varying the concentration of FA (50, 100, and 200 ppm) at 200 mL/min on 1% Pt/TiO_2. However, at higher concentration of FA (at 500 and 1000 ppm), the removal efficiency was 76.9% and 33.2%, respectively. In the case of 2% Pt/TiO_2, 100% of FA was removed to 50, 100, 200, and 500 ppm although the removal efficiency was 50% at 1000 ppm. The optimum ratio of catalyst and sand was determined. Sand was added to increase the contact area and efficient dispersion of the catalyst. The optimum ratio of sand and catalyst was 1:1 to show the optimum efficiency with the addition of 50 mg for each. Hence, all experiments were conducted at this optimum ratio. If the removal efficiency was tested with varying flow rates, the removal efficiency of 1% Pt/TiO_2 was 76.9, 63.1, and 18.1% at 0.5, 1, and 3L/min, respectively. In case of 2% Pt/TiO_2, the results were 100, 93.1, and 40.3%, respectively. Both 1 and 2% Pt/TiO_2 showed complete destruction of FA up to its concentration of 100 ppm, although distinction in their performance was seen at concentrations higher than 100 ppm. Comparison on the effect of flow rates indicated that there was no difference in removal efficiency between the two materials at a relatively low flow rate of 200 mL/min. However, 2% Pt/TiO_2 showed higher removal efficiency at flow rates above 200 mL/min. The performance of Pt TiO_2 was affected sensitively by both flow rate and concentration of FA in relation to the relative composition of Pt in such system.

Keywords: Formaldehyde, Oxidation, Pt, TiO2, Catalyst.

Effect of Palladium on the SBM Catalyst Prepared from Spent Zn/Mn Alkaline Battery for Catalytic Combustion of VOCs

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The black mass of spent Zn/Mn alkaline batteries was evaluated as a catalyst substance for the catalytic combustion of volatile organic compounds (VOCs: benzene, toluene, and o-xylene). The SBM catalyst was prepared by treating the black mass with 0.1N of sulfuric acid solution. Major elements of the SBM catalyst were manganese, zinc, iron, aluminum, potassium, and sodium except carbon. In addition, to find out the additive effect of palladium on the SBM catalyst, the Pd/SBM catalysts were prepared using a conventional impregnation method. The physicochemical properties of the SBM and Pd/SBM catalysts were investigated by instrumental analysis. Benzene, toluene, and o-xylene were oxidized completely over the SBM catalyst at reaction temperatures less than 410, 340, and 410 ℃, respectively. As expected, in the case of the Pd/SBM catalysts, increasing the palladium loading on the SBM from 0.1 wt.% to 1.0 wt.% led to an increase in the conversions of benzene, toluene, and o-xylene. In the 1.0 wt.% Pd/SBM catalyst, the reaction temperatures for complete oxidation of benzene, toluene, and o-xylene were greatly reduced to 310, 260, and 250 ℃, respectively. Instrumental analysis indicated that the increase in activity by adding palladium was due to the active ingredient (palladium oxide: PdO) and better redox properties.

Keywords: Volatile organic compounds, catalytic combustion, spent Zn/Mn alkaline battery, black mass, palladium

The Establishment of Environmental Governance in Public Institutions for Realizing Social Values

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As Korea underwent a global financial crisis in 2008, the interest in the roles and functions of the social economy has increased and the social and environmental economy has become more active. This is expected to solve social and economic problems facing the nation at the same time, and social consensus is being formed. In this trend, it is true that the expectation that the social economy will become more active has grown as the new government takes over in May, 2017. New government announced the government's task as a "public institution leading the realization of social value" and is actively ordering the realization of social value in the role of public institutions by including social value as a management evaluation item of public institutions. The 'Social Value Realization Act', as a value that contributes to the public interests and community development, is the core value needed to be pursued in order to reduce public anxiety and achieve social integration, in a situation where public concerns on safety is increasing and the quality of the people's life is deteriorating due to job insecurity and polarization. This is the core operating principle of the public sector. For example, in the case of the SOC sector, as there are various tasks to be pursued through social consensus, it is necessary to look at the relevant contents. The following is an environmental summary of the main contents.

K. Sustainability preservation of the environment

Therefore, public institutions should make every effort on each item to realize social value when carrying out all policy work. Finally, the SOC sector can take the lead in promoting social value through building the environmental governance. For example, in the process of consulting with local residents or environmental groups in constructing roads or conducting maintenance, another social problem may be conceived if the representative organization on-site does not establish good relations with local stakeholders, and this may offset the government's efforts to activate the social economy. Therefore, by establishing a governance system that takes this into account, public institutions in the public sector, especially the SOC sector, will be able to lead in enhancing social values and promoting the social economy.

Keywords: environmental governance, social value

Policy Implications of Creating Environmental, Social and Economic Shared Value in Roadside Public Institutions

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Creating Shared Value (CSV) is a concept first suggested by Harvard University professor, Michael Porter, in Harvard Business Review in 2011. It refers to the ‘policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic, social and environmental conditions in the communities in which it operates’. The concept of CSV does not refer to contributing activities after profit generation by a company, but rather the company activities pursuing economic profit while simultaneously generating social and environmental value. CSV is based on the recognition that corporate competitiveness and prosperity of surrounding communities are interdependent, and assumes that contribution to society can promote corporate development in the long run.

Therefore, the nation and public institution should take to lead to care for the relatively weak, and if a company needs to do business considering this aspect, it can be a good alternative to promote the social especially environmental value and business value at the same time. Accordingly, it is not an option but a necessity to create shared value in public institutions within road sectors, by taking this into consideration.

However, there are areas to consider in this case. First, public institutions are not in a position to plan new projects. Public institutions are established and run for legally defined tasks, and each sector has its own business purpose tailored to the organization. For example, public institutions related to road sectors need to conduct tasks to enlarge the economic pie by enhancing the social and environmental value in existing business areas, rather than develop new businesses based on tasks related to road construction, maintenance and safety. This naturally leads to a lower degree of freedom for public institutions in comparison to general companies.

In the case of the public institution in the road sector, it is important to promote of plans from the viewpoint of particular aspects or items of social and environmental value, but it is also important to identify and promote tasks or indicators that can create social and environmental value which could lead to inclusive growth in society as whole.

Keywords: creating shared value, public institution

A Comparative Study Report on the Annual Differences in Revegetation Methods for Expressway Slopes

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The results from the vegetation growth evaluation through follow up surveying according to the 2009 guidelines for designs construction work of slope revegetation on the West Chungju Interchange of the Pyeongtaek-Jecheon Expressway is as follows.

1. Among the test slope construction sites, in the first-year test, the upper layer consisted of hard soil while the lower layer consisted of ripping rock. The slope lied at 45 degrees and faced South West. The second-year slope was at 60 degrees, while the soil conditions were poor.
2. The first-year slope revegetation method test site showed neutral acidity at pH 6.5-7, while its hardness on the hardness scale was at 6-9 mm, providing fair conditions for vegetation growth.

The second-year slope revegetation method test site showed neutral acidity at pH 6.1-7.0, while its hardness on the hardness scale was at 6-9 mm, providing fair conditions for vegetation growth.
3. The average coverage rate of vegetation on the test sites showed high levels, 5 years after its initial construction. Most test sites showed an overall growth of *Humulus japonicas* Siebold et Zuccarini showing a poor level of vegetation health condition.
4. In the first year test construction, site C showed the best results with D in second place. The second year showed combination A with high results quantitatively and results from B and C following in succession. Parts of the subject sites showed *Pueraria thunbergiana*(Sieb. And Zucc.) Bentham and *Humulus japonicas* Siebold et Zuccarini species harmful to the ecosystem, showing a need for maintenance and management.

Keywords: Slope revegetation, Restoration method, Growth plant

Introduction to the Quality Evaluation Standards for Expressway Slope Revegetation Methods

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The conclusions derived from the analysis of the investigations focused around the study of formulating an evaluation standard for slope revegetation work is as follows.

1. 1-2kg samples were an effective sample size when taking vegetation base material for analysis.
2. Total vegetation coverage rates, vegetation coverage rate of cold-temperate grasses, vegetation growth and development quantity, damages by blight and harmful insects were analyzed and evaluated to analyze vegetation growth. The number of trees growing, number of appearing species of grasses and trees, and the infiltration of harmful species and the disturbance of the test sites were analyzed and evaluated to find the number of appearing species, and to complete quantitative evaluations, the physical characteristics of the vegetation base material and the drop-out and collapsing points were analyzed and evaluated.
3. For the qualitative evaluation of the test construction of the slope revegetation work, the durability of revegetation and possibility of vegetation infiltration and the construction’s similarity to its surrounding environments were analyzed and evaluated.
4. The slope revegetation inspection management report is evaluated for the regular evaluation of the vegetation quality on expressway construction sites.
5. In the long-term, by regularly checking and maintaining the vegetation in and around expressway construction sites, the loss of surface layers and the conditions of the surrounding environment must be improved.

Keywords: Quality evaluation standards, Revegetation method, Number of tree

Temporal and Spatial Differences of Atmospheric Ammonia Concentration in Agricultural Area

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High concentrations of particulate matter threaten the health of citizens and cause disruption in life. Particulate matter is emitted from various sources and is formed from many chemicals in the atmosphere. Ammonia (NH_3) is mainly emitted in the course of livestock raising, manure processing, and fertilizer spraying. Ammonia reacts with sulfur oxides (SOx) and nitrogen oxides (NOx) in the atmosphere to produce ultra-particulate matter containing ammonium sulfate and ammonium nitrate. Ammonia is generated from chemical fertilizers and composts that are applied for growing crops in paddy fields and dry fields. Gaseous ammonia, which is mainly produced in farmland and barns, directly affects the concentration of local atmospheric ammonia and combines with nitrogen oxides and sulfur oxides in surrounding metropolitan areas to produce ultra-particulate matter; therefore, it is very important to know the temporal and spatial distribution of agricultural ammonia concentrations. Various assays are used to measure atmospheric ammonia concentration. The analytical method can be selected by a comprehensive consideration of economic, temporal, and labor input feasibilities. This study has been carried out since 2019 by introducing various experimental methods to determine the temporal and spatial distribution of the atmospheric gaseous ammonia concentration in agricultural areas. Atmospheric ammonia concentration was analyzed by the indophenol blue method after collecting ammonia by a passive sampler. Atmospheric ammonia concentrations tended to be higher at night than during the day, ranging from as low as 13 ppb to as high as 18 ppb. From the livestock complex, the west area was higher in the atmospheric ammonia concentration than in the southwest area. Atmospheric ammonia concentrations measured at the test sites of Wanju-gun and Geumsan-gun were 33 ppb and 15 ppb, respectively, showing differences by region; however, there was no difference between atmospheric ammonia concentrations measured at

1 m above ground and 50 m above ground. Starting in 2020, it is planned to measure ammonia levels in paddy fields, dry fields, protected cultivation, and orchards in agricultural areas. Wet and dry deposits will be collected in important areas of the agricultural zone to analyze the contents of ammonium, ammonia, nitrogen oxides, sulfur oxides, particulate matter, and ultra-particulate matter, and the impact of local air pollutants in agricultural areas as well as urban areas will be evaluated.

Keywords: Agriculture, Atmospheric Ammonia, Temporal, Spatial, Particulate Matter

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Up-Regulated Temperature Inducing Change of Nutrient Output in Upland Runoff

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Temperature rises due to climate change are affecting various sectors of agriculture. Temperature is one of the most important environmental factors controlling plant growth and yield, and all biological processes vary depending on temperature. Elevated temperatures increase nitrogen mineralization and net nitrification rates. Various nutrient input materials applied in crop cultivation may experience changes in degradation, absorption by plants, and outflows because of temperature rises. This study was conducted to investigate the change of total nitrogen and total phosphorus among nutrients in runoffs by rainfall after creating a climate with an up-regulated temperature in a climate simulation and fertilizer and livestock compost application. A medium open top type chamber having a width of 6 m and a height of 3 m was constructed by modifying an open top chamber and vinyl house frame to create an up-regulated temperature environment. The medium open top chamber has the advantage of elevating only temperature while other environmental elements such as rain, wind, and solar intensity are maintained similarly to those of an open field. The maximum and average temperatures of the improved open top chamber were higher by 2.7℃ and 0.4℃, respectively, than the open field, and maintained so that the up-regulated temperature could be applied during all the growing stages of maize. The amount of runoff generated in the field by rainfall and the nutrient concentration in the runoff were analyzed to calculate the runoff of nutrients. The total nitrogen (T-N) emission in the control was 4.09 $kg \cdot ha^{-1}$, while it was 4.48 $kg \cdot ha^{-1}$ in the up-regulated temperature treatment, an increase of 9.7% over the control. The total outflow of T-P was 0.87 $kg \cdot ha^{-1}$ in the control and 1.0 $kg \cdot ha^{-1}$ in the up-regulated temperature

treatment, an increase of 15%. The weight of maize fruits in the up-regulated temperature treatment tended to increase. These results are similar to the results of an experiment using a Wagner's pot conducted in 2018 that showed an increase in total nitrogen content from 26% to 31% because of an up-regulated temperature treatment with application of chemical fertilizers and pig manure composting water. The results of the present study may be because of promotion of mineralization and nitrification of paddy soil by the up-regulated temperature. Therefore, it was concluded that the nitrogen change in the field soil is caused by the elevated temperature environment and that the discharge of a nonpoint pollution source to the water system around the farmland could be changed by rainfall.

Keywords: Maize, Nutrient, Open Top Chamber, Runoff, Up-regulated Temperature,

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Ammonium Concentration of Precipitation in Agricultural Area

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The recent frequent occurrence of high concentrations of particulate matter symbolizes the importance of air pollutant management. While enjoying the conveniences of modern life, everyone would like to inhale fresh air freely and look at blue skies, but it is time to pay the cost. Ultra-particulate matter ($PM_{2.5}$), which is smaller than PM_{10} and harmful to health, is composed mainly of ammonia, nitrogen oxides, and sulfur oxides. Ultra-particulate matter is mainly composed of ammonium nitrate and ammonium sulfate produced by combining ammonia from agricultural areas, nitrogen oxides mainly generated from automobiles, and sulfur oxides generated from factory areas. Ammonia (NH_3) mainly arises from livestock and fertilizer sprayed on agricultural land. To investigate local air pollution conditions, wet deposition and dry deposition can be investigated. In particular, rainfall can be used as an important indicator of air pollutant conditions in a region. Nitrogen and phosphorus content in the rainfall at the test field of the National Institute of Agricultural Sciences in Wanju-gun, Jeollabuk-do in 2019 were recorded as follows. From April to December 2019, the total rainfall frequency was 43 and the precipitation was about 800 mm. The total nitrogen (T-N) concentration in the rainfall was 3.04 $mg \cdot L^{-1}$, NH_4-N was 2.02 $mg \cdot L^{-1}$, and NO_3-N was 1.02 $mg \cdot L^{-1}$. Total phosphorus (T-P) in the rainfall was 0.20 $mg \cdot L^{-1}$. The nitrogen concentrations in the rainfall may represent a process of nitrogen circulation in agricultural areas. Rainfall can also affect crop growth and outflow of nutrients by runoff. In particular, a high concentration of particulate matter caused a sharp increase in NH_4-N concentration in rainfall during December. High concentrations of NH_4-N and NO_3-N in the precipitation can represent a large supply of nitrogen from the local nitrogen source to the atmosphere. Total phosphorus (T-P) is also believed to be supplied by human activity. In conclusion, the supply

of high concentrations of nitrogen and phosphorus by rainfall can give a complex effect on the agricultural ecosystem. Therefore, there is a need of long-term studies in areas such as the natural supply of nutrients by rainfall and consequent material balance, nitrogen circulation, and the impact of the agricultural ecosystem.

Keywords: Particulate Matter, Ammonium, Phosphorus, Agricultural Area, Precipitation

Acknowledgements. This study was carried out with the support of the "Research Program for Agricultural Science & Technology Development (Project No. PJ014910)" of the National Institute of Agricultural Sciences, Rural Development Administration, Republic of Korea.

Up-Regulated Temperature Inducing Change of Nutrient Output in Rice Paddy Runoff

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The average temperature in Korea has risen recently because of global warming at a rate twice as fast as the rise in the global average temperature. Temperature is one of the most important environmental factors that control the growth and yield of plants. All biological processes are changed as the reaction rate depends on temperature. Also, temperature rise directly and indirectly affects the physicochemical characteristics of the soil and material circulation through degradation of organic matter and nitrogen mineralization. In addition, various nutrient input materials applied for crop cultivation may experience changes in decomposition, absorption by crops, and nutrient outflows because of temperature rise. Therefore, this study was conducted to evaluate the effect of temperature rise on outflows of nutrients such as total nitrogen and total phosphorus in paddy runoff. A medium top open type chamber having a width of 6 m and a height of 3 m was constructed using a vinyl house frame by modifying an open top chamber to create an up-regulated temperature environment in a paddy experimental field. The medium open top chamber has the advantage of elevating only temperature while other environmental elements such as rain, wind, and solar intensity are maintained similarly to those of an open field. In the improved open top chamber, the average temperature and average soil temperature were increased by 0.4℃ and 2.1℃, respectively. The amount of runoff from the field by rainfall and the nutrient concentration in the runoff were analyzed to calculate the runoff of nutrients. Total nitrogen (T-N) emissions were 1.82 $kg \cdot ha^{-1}$ in the control and 2.38 $kg \cdot ha^{-1}$ in the up-regulated temperature treatment,

an increase of 30.7%. The total runoff of T-P was 0.49 $kg \cdot ha^{-1}$ in the control and 0.57 $kg \cdot ha^{-1}$ in the up-regulated temperature treatment, an increase of 16.8% over the control. These results may be because of the promotion of mineralization and nitrification of paddy soil by the up-regulated temperature and are similar to the results of an experiment using a Wagner's pot conducted in 2018 that showed an increase of total nitrogen content of chemical fertilizer, manure compost, and pig manure compost treatment water from 7% to 19%. Therefore, it is judged that nutrient runoff by rainfall may be increased because of fluctuations in paddy soil nitrogen in an elevated temperature environment.

Keywords: Nutrient, Up-regulated Temperature, Open Top Chamber, Rice, Runoff

Acknowledgements. This study was carried out with the support of the "Research Program for Agricultural Science & Technology Development (Project No. PJ012546)" of the National Institute of Agricultural Sciences, Rural Development Administration, Republic of Korea.

Degradation of Naproxen by Plasma in Liquid Process with Hydrogen Peroxide and TiO_2 Photocatslysts

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The waste pharmaceutical could contaminate water, groundwater, soil, and sediments. They and their by-products can cause hazardous effect to human health and ecosystem. Several process have been applied for treatment the environmental pollution generated from waste pharmaceuticals. Plasma in liquid process, which have been highlighted recently, can generate reactive oxygen species, ultraviolet light, and shockwave. The reactive oxygen species such as hydroxyl radical and superoxide have strong oxidation power and effectively degrade the environmental pollutants in aqueous solution. In this work, we adapted the plasma in liquid process (PiLP) to effectively degrade naproxen, which known as representative non-steroidal anti-Inflammatory drug. The effect of electrical operation parameter and reaction condition were assessed with comparing the degradation kinetic of naproxen. Also, the hydrogen peroxide and TiO_2 photocatalysts were added into PiLP reactant for enhancing degradation efficiency. Our experimental results indicate that the degradation rate of naproxen and production of its by-products were highly dependent on the electrical operation parameter of power supply. The degradation rate of naproxen was proportional to an increasing electrical operation parameter. The concentration of by-products generated during naproxen degradation was increased and then decreased with reaction time. The degradation rate of naproxen was improved with the addition of hydrogen peroxide or TiO_2 photocatalsyst, but decreased with their excess addition. When hydrogen peroxide and TiO_2 photocatalysts were added into aqueous naproxen solution simultaneously, the highest degradation rate of naproxen was showed. The representative by-products during naproxen degradation were 2-ethyl-6-methoxynaphthalene, 6-methoxy-2-vinylnaphthalene, and 2-acetyl-6-methoxynaphthalene.

Keywords: Plasma in Liquid Process, Naproxen, Hydrogen peroxide, TiO_2 photocatalysts.

Estimating Reduced Nonpoint Pollution Load of Highways by Road Sweeping

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The stormwater runoff from road is known as one of important nonpoint source (NPS) pollution. Especially highway surfaces accumulate significant quantities of road deposited sediment (RDS) including pollutants since high vehicle speed and traffic load. To reduce the pollutant, many best management practices (BMPs) have been applied and planned. Among the BMPs, road sweeping is commonly regarded as effective way to prevent pollutant wash off to environment. However, there is little quantitative evidence that it directly reduces NPS in Korea. Therefore, it is necessary to investigate countrywide the characteristics of collected RDS from road sweeping as fundamental data for estimating removal efficiency of highway NPS.

This study is performed to generalize unit concentration after quantitatively evaluate the nutrient and heavy metal contents in collected RDS. Korea Expressway Corporation operates 4,113km of 30 highway routes and it is managed by 56 branches nationwide. Among them, 27 branches were selected considering traffic load and locality, and collected RDS were sampled three times at 21 branches nationwide and five times at 6 branches in metropolitan area. The samples were analyzed for Moisture content, BOD, TN, TP, TOC and heavy metal concentration. Moisture content was analyzed to 11.6 ± 4.4%, BOD to 211.9 ± 93.3mg/kg, TN to 837.8 ± 461.1mg/kg, TP to 603.6 ± 182.4mg/kg and TOC to 14,996.6 ± 2,749.8mg/kg. In heavy metals, Cu was analyzed to 103.5 ± 45.6 mg/kg, Pb to 31.3 ± 15.4 mg/kg, Zn to 327.1 ± 104.5 mg/kg, Ni to 19.2 ± 6.7 mg/kg, and Cr was not detected. And reduced nonpoint pollutant load by road sweeping was estimated using the result of monitoring. That is calculated by multiplying the amount and concentration of collected RDS by the road sweeping vehicle. The consignment of collected RDS on highways was 18,381 ton/year, which was assumed to be annual collection, and reflected in the calculation of the reduced pollutant load. By road sweeping, nonpoint source pollutant annual reduced load were resulted that BOD was 3,894.9 kg/year, TOC was 275,652.5 kg/year, T-N was 11,095.6 kg/year, T-P was 11,095.6 kg/year, respectively. And heavy metal annual reduced load were resulted that Cu was 1,902.6 kg/year, Pb was 575.0 kg/year, Zn was 6,011.8 kg/year, Ni was 352.9 kg/year, respectively.

Keywords: Nonpoint Source Pollution, Road deposited sediment, highway, road sweeping

Estimating Particle Matter and Nonpoint Source Pollution Removal Effect of Road Sweeping by Water Quality Modeling

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The particle matter(PM) from road accounts for 62% of the total PM, and there is a concern that the concentration of particle in the atmosphere will increase due to re-scatter PM of road deposited sediment. In addition, one of the main sources of PM has been reported to be caused by cars. When PM is scattered, it includes pollutant sources in road deposited sediment(RDS) that may adversely affect the human body.

In this study, the effect of road sweeping was to be verified by analyzing the change of RDS amount on highway surface area using the build-up and wash-off modules of the Surface Layer in SWMM model. Based on the four-lane road, the width of the road was set at 10 m and the road length was 1,000 m, with a total area of 1 ha. Surface condition was an impervious asphalt, which is used to compensate for asphalt as proposed in the SWMM manual. It was applied rainfall data during five years (2014~18) in Giheung-gu, Yongin, Gyeonggi Province..

Using SWMM model, the collection RDS amount of road sweeping was calculated for one day, three days, seven days, 10 days, 20 days, 30 days term of road sweeping period. When road sweeping is carried out every month, the annual collection of RDS was 6,638.0 kg/ha/year, with 37.2% deposits of the annual amount was 17,860.2 kg/ha/year. According to the analysis of the annual reduced PM load per unit area, the reduced load by every month of TSP is 64.2 kg/ha/year, PM10 is 15.5 kg/ha/year, and PM2.5 is 4.4 kg/ha/year, accounting for 28.5%, 32.5%, 37.2%, respectively.

Using the results by SWMM model, as a result of estimating the reduced nonpoint pollutants load through the difference between the loads without road sweeping and the loads for each cleaning cycle was calculated as the total solids (TSS) reduced load. The annual load of TSS is 10,598.7 kg/ha/year, BOD is 0.5 kg/ha/year, TOC is 32.8 kg/ha/year, TN is 1.8 kg/ha/year, TP is 1.3 kg/ha/year, Cu is 0.227 kg/ha/year, Pb is 0.068 kg/ha/year, Zn is 0.716 kg/ha/year, and Ni is 0.042 kg/ha/year when road sweeping was performed at every month. The removal rates of nonpoint pollutants load was 17% for sweeping every month and 57% for every week.

Keywords: road sweeping, particle matter(PM), road deposited sediment(RDS), SWMM

Survey on Maintenance of Nonpoint Pollution Treatment Facilities

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As the importance of managing nonpoint pollution has been recognized, Ministry of Environment has been pursuing a project to reduce nonpoint pollutant since 2004. In order to reduce the spillage of nonpoint pollutant on highways, Korea Expressway Corporation has continuously installed and operated apparatus type facilities and natural type, such as detention basin, sand filter, infiltration ditch, and vegetation waterway, with the focus of IC and highway offices.

Periodic maintenance and management are necessary for nonpoint pollution treatment facilities to operate normally. In this study, the maintenance status of nonpoint pollution treatment facilities was investigated and problems and improvement were derived for each type of nonpoint pollution treatment facilities.

A total of 1,308 nonpoint pollution treatment facilities in nationwide are divided into detention basins, vegetation waterways, infiltration ditches, sand filters, and apparatus types. On-site inspections were conducted for a total of 133 nonpoint pollution treatment facilities, approximately 10% of the total.

The survey found that 47.4% of the total number did not have a flow distribution structures. 4.5% of flow distribution structures were wall types and 42.9% were orifice types. In addition, most of the cases where rainfall runoff was not flowing smoothly due to blocked entrances were found in orifice types. 79.7% of whole facilities have detention basin and 9.4% of them is required dredging. Overall, 35.3% of nonpoint pollution treatment facilities require cleaning, 28.6% dredging, 28.6% needing repair, and 56.4% need harvest.

Keywords: highway, nonpoint pollution treatment facilities, flow distribution structures, orifice

Evaluation of Particle Size Distribution of Road Deposited Sediments Collected by Expressway Sweeping

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In this study, we investigated the particle size distribution of RDS(Road Deposited Sediments) collected by expressway sweeping and conducted a quantitative evaluation of the amount of removal for each particle size. Particle size analysis proceeded with collected RDS sample from storage yard using an electric oven keeping 105±5 ℃ in 24 hours to dry.

A seive analysis was executed regarding particle larger than 75 ㎛, particle size analysis was executed regarding particle smaller than 75 ㎛ using particle size analyzer. Annual reduced load of PM(Particle Matter) by expressway sweeping is calculated as the ratio of dust collected using the results of the grain size analysis of sediment collected by the road sweeping vehicle. In here, particles sizes less than 50um, 10um, 2.5um were defined as TSP, PM10, PM2.5, respectively. Annually collected RDS were estimated using data by branch office from 2013 to 2017. The consignment of collected RDS on expressways was 18,381 ton/year, which was assumed to be annual collection, and reflected in the calculation of the reduced pollutant load. Since TSP, which is assumed to be less than 50 ㎛, includes 10 ㎛ of fine particle (PM10) and 2.5 ㎛ of ultra-fine particle (PM2.5), by accumulating the results of the grain size analysis, TSP was calculated by applying the annual collected RDS to 18,381 ton/year.

The size of the collected RDS collected from storage yards in 4 metropolitan areas was analyzed. The results including and excluding over 2,000 ㎛ of collected RDS were analyzed together. Looking at the results including larger than 2,000 ㎛ of the collected RDS, the actual collected RDS of larger than 2,000 ㎛ was 24.6%, and the particle ratio of 2,000 ~ 50 ㎛ was found to be 73.7% of actual collected RDS. The particle size ratio below 50 ㎛ was 1.6% for actual collected RDS. And looking at the results excluding larger than 2,000 ㎛ of the collected RDS, the particle ratio of 2,000 ~ 50 ㎛ was found to be 73.7% of actual collected RDS. The particle size ratio below 50 ㎛ was 1.6% for actual collected RDS. Annual reduced load of TSP, PM10 and PM2.5 by expressway sweeping were 312,477 kg/year, 55,143 kg/year and 18,381 kg/year respectively.

Keywords: Expressway Sweeping, Particle Size Distribution, RDS(Road Deposited Sediments)

Development of GIS-based Highway Climate Change Impact Analysis Tool

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In order to predict future climate change vulnerable areas and expected damage period, climate change RCP scenario and yearly analysis results of major climate factors (heat wave, cold wave, heavy rain, heavy snow, fog) are derived, and based on GIS A climate change impact analysis tool was developed. For the performance of the project, ① collect RCP climate scenario and meteorological data from the Korea Meteorological Administration's Climate Information Portal and Meteorological Data Open Portal, ② perform GIS based analysis, future (2020-2100) climate change (heat wave, cold wave, heavy rain, heavy snow, In the fog, the weak areas centered on the highway route and the expected period of damage were derived. In the case of heat waves, there is a strong tendency in the metropolitan area, Daegu, parts of Gyeongbuk, the south coast, Jeolla-do, and Chungcheongnam-do. Many highway routes except Seoul Yangyang Expressway, Yeongdong Expressway, Donghae Expressway, and Tongyeong Daejeon Expressway in Gangwon Province were analyzed as the risk area. In the case of cold waves, there is a strong tendency in northern Gyeonggi, Gangwon, Jirisan and Deogyusan areas such as Hamyang and Muju. Some routes of Seoul Yangyang Expressway, Yeongdong Expressway, Donghae Expressway, Jungang Expressway, and Tongyeong Daejeon Expressway in Gyeongnam and Gyeongbuk were analyzed as potential risk areas. In case of heavy rain, the Seoul Yangyang Expressway, Yeongdong Expressway, Donghae Expressway, and some routes of Tongyeong Daejeon Expressway in Jeonnam-Gyeongbuk region, Namhae Expressway, Honam Expressway, and Gwangju Daegu Expressway were analyzed as possible risk areas. In case of heavy snowfall, some routes of Seoul Yangyang Expressway, Yeongdong Expressway, Donghae Expressway, and Namhae Expressway in the south coast were analyzed as potential risk areas due to the factors used in the prediction, the minimum temperature and precipitation.

Keywords: RCP climate scenario, GIS based analysis

Introduction to Evaluation Indicators for Climate Change Projects

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At present, there is no evaluation index for climate change adaptation projects for highway facilities, and it is difficult to evaluate adaptation projects. Consultation and surveys were conducted to determine the validity and priority of evaluation indicators. Evaluation indexes for existing and new climate change adaptation projects were developed.
As a result of prioritizing the final evaluation indicators of the existing climate change adaptation project, the specific details are as follows: 'Reduction of greenhouse gases, climate change impact reduction' ranked first and 'Resolving climate problems in target facilities and regions' Above, 'achievement of planned results' ranked third, 'socio-economic effects such as cost reduction' ranked fourth, and 'improving user service through business results' ranked fifth.
As a result of prioritizing the final evaluation indicators for new mid- and long-term climate change adaptation projects, the details are as follows. As a result, 'Reduction of climate change of technology, climate change impact reduction' ranked 3rd, 'Possibility to solve climate problems in indicators and regions' ranked fourth, and 'Ease of application' ranked fifth.

Keywords: evaluation indicator, target facilities

Derivation of Highway Facility Design Standards considering Climate Change

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As a result of dividing the policy matters related to climate change into sectors and major climate change factors, the design policy for heavy rains accounted for more than half of the factors. We analyzed the design elements related to climate change among the design elements by highway design type. The factors of climate change were classified based on the analysis of design factors related to climate change, and the qualitative considerations related to climate and the design elements that can be reflected quantitatively were classified. The quantitative design elements that are directly related to climate change-related design criteria are design rainfall intensity, design flood rate, and freezing index.

Design rainfall intensity, which is directly related to climate change, can be applied by using precipitation intensity data provided by the Korea Meteorological Administration. In this study, the premium rate was applied to the design rainfall intensity.

The Korea Meteorological Administration reviewed the Korean Peninsula Climate Change Forecast Report and the Ministry of Land, Infrastructure and Transport's revised Probability Rainfall Report. In the case of the Meteorological Administration's scenario, the point using the Korean peninsula forecast value and the Ministry of Land, Infrastructure and Transport's average value were also applied as complementary points. In this study, we propose that climate change scenarios apply regional forecasts in future design applications. When comparing the existing design method with the design method reflecting climate change scenarios by region, the premium rate difference was more than 10%. Therefore, this study suggests that climate change scenarios will be applied to regional forecasts for future design applications.

In order to apply design considering climate change in the future, the following process is required. First, the target year for climate change scenario is set in consideration of road opening year and public year. Second, the Meteorological Agency scenarios for each year of the climate change scenario target year are identified (precipitation, temperature, freezing days, etc.). Finally, premium rates based on climate change scenarios for the target areas are applied to the design.

Keywords: design rainfall intensity, design flood rate

A Study on Optimal Pore Range for High Adsorption Behaviors by Activated Carbon Fiber Prepared from a Various Precursor

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In this study, we prepared ACF with a high specific surface area from various precursors (cellulose and pitch based fibers) by a steam activation technique and investigated the effects of the micropore and mesopore fraction on DMMP adsorption behaviors. The N_2 adsorption isotherm characteristics at 77K were confirmed by Brunauer-Emmett-Teller, Barrett-Joyner-Halenda and non-local density functional theory equations. The DMMP adsorption capacities of the ACF were measured by breakthrough experiments in the gas phase (120 μg/mL of DMMP in N_2 flow). The removal efficiency of the ACF was evaluated and compared with that of AC. From the results, specific surface areas and total pore volume of the ACF were determined to be 840-1670 m^2/g and 0.33-0.82 cm^3/g, respectively. It was also observed that various pore characteristics of ACF were found to be dependent on crystallite structure of each precursor. The breakthrough time (C/C_0 = 0.10) was in the order of Pitch-H-9-2 < Cellulose-H-9-4 < Saratoga AC < Cellulose-H-9-5 < Pitch-H-9-4. This indicates that DMMP adsorption capacity could be a function not only of specific surface area or total pore volume, but also of sub-mesopore volume fraction in the range of 2.0–3.0 nm of adsorbents.

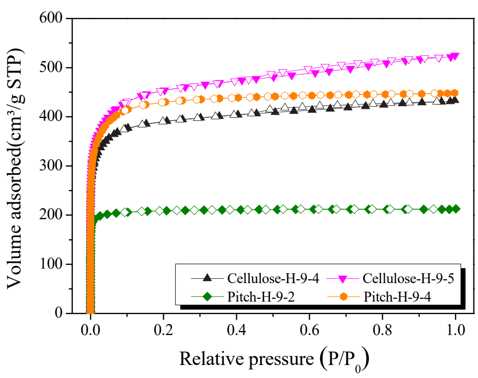

Figure 1. N_2/77K isotherm adsorption-desorption curves of activated carbon fiber as a function of various precursor.

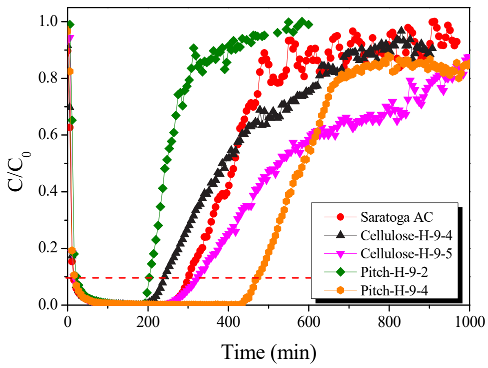

Figure 2. Breakthrough curves of activated carbon fiber as a function of various precursor.

Keywords: chemical protective overgarment, DMMP, activated carbon fiber, steam activation

Effects of Electron Beam Irradiation on DMMP Adsorption Behaviors of Activated Carbon Fibers

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Activated carbons fibers (ACF) were modified via e-beam irradiation at various doses for use as an adsorption material in chemical protective overgarment. The N_2 adsorption isotherm characteristics at 77K were confirmed by Brunauer-Emmett-Teller, Barrett-Joyner-Halenda and non-local density functional theory equations. The surface properties of e-beam irradiated ACF were characterized using an X-ray photoelectron spectroscopy. The DMMP adsorption capacities of the ACF were measured by breakthrough experiments in the gas phase (120 μg/mL of DMMP in N_2 flow). The textural properties of the ACF was largely unchanged by the e-beam irradiation. The DMMP adsorption capacity of the ACF treated with the e-beam at radiation doses of 200 kGy increased by 14 times compared with the untreated ACF. The enhancement of the DMMP adsorption capacity of the e-beam irradiated ACF can be attributed to a change in their surface functional group.

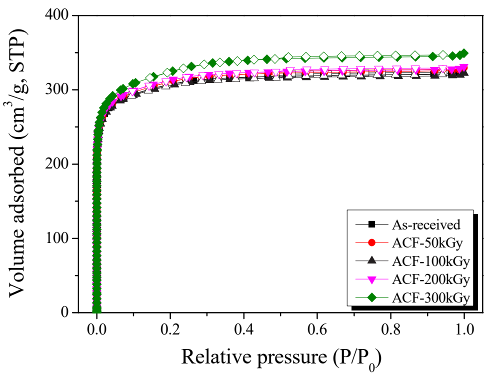

Figure 1. Nitrogen adsorption curves of electron beam-irradiated activated carbon fiber.

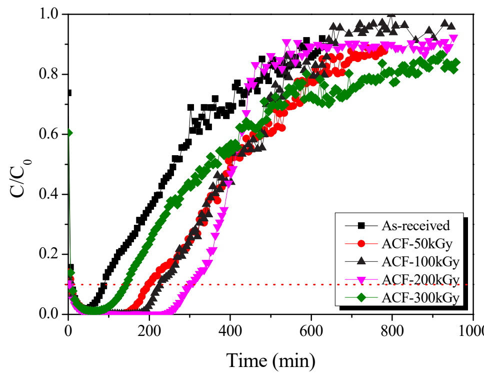

Figure 2. Breakthrough curves of electron beam-irradiated activated carbon fiber.

Keywords: chemical protective overgarment, DMMP, activated carbon fiber, e-beam

Correlation Analysis of Fine Dust Concentration between a Highway Tunnel and Government Measuring Post nearby

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Fine dust or particulate matters have already emerged as a national concern, which has led not only the central governments but also local governments to establish and implement management measures for the public health. Much effort has been made to measure fine dust in highway management, and among them tunnels is one of the road facilities where workers inside the tunnels are putting a lot of effort into fine dust management for the health of workers inside the tunnels, not only for the health of workers inside the tunnels. However, it takes a lot of budget and effort to continuously monitor fine dust inside the tunnel to manage the schedule of work inside the tunnel, which requires additional budget assurance for monitoring at all times. Therefore, this study compared the concentration of fine dust in the tunnel and in the area around the entrance and exit, and the concentration of fine dust in the automatic measuring network operated by the neighbouring countries or local governments, and analysed the correlation. The concentration of traffic and vehicle type (large, small) and fine dust (PM10 and PM2.5) were measured at three or seven measuring points equally spaced within the tunnel for five highway tunnels that differ in traffic volume and length. In addition, the correlation was analysed by comparing the concentration of fine dust in the environment's air measuring network closest to the tunnel at the same time period as the fine dust measurement time for each tunnel. According to the analysis, there was a site where some degree of correlation (R^2-value 0.6 or higher) was confirmed depending on the tunnel, and there were sites where none of the correlation was confirmed. In the future, it is deemed necessary to analyse the causes of sites where further studies confirm the correlation and those that do not

Keywords: particulate matter, fine dust, ultrafine dust, concentration, correlation

Case Considerations of Highway Noise Abatement with Low-noise Pavements

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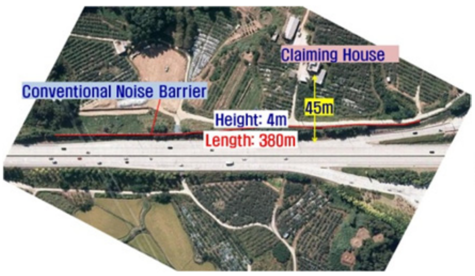
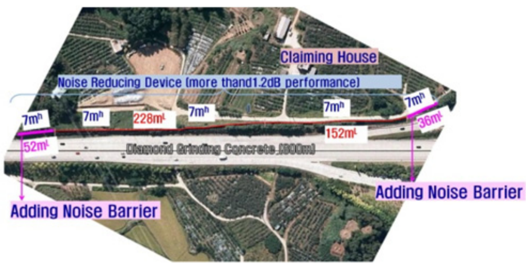
Recently, as the acoustic performance of low-noise pavement has been verified, cases of applied to road noise reduction measures have been increased. And, also increased the number of cases where low-noise pavement like "drainage asphalt pavements" and "diamond grinding concrete pavements" adopted on the Korea highways. In this study, a comparative review has been discussed where 'noise barrier' and 'noise barrier + low-noise pavement' have been adopted as highway noise abatements. Noise analysis for the study, a ‘Korea Highway Transportation Noise (KHTN)’ was used, which is a 3-Demensional road traffic noise analysis model developed by the Korea Highway Corporation. Based on the conventional concrete pavement, the scale of noise barrier which satisfying the road traffic noise management limit has been calculated.



[Conventional]Concrete Pav.+Noise Brrier**[Case1]**Concrete Pav. +Noise Barrier



[Case2]Drainage Asphalt Pav.+Noise Barrier**[Case3]**Diamond Grinding Concrete Pavement + Noise Barrier+ Noise Reducing Device

Keywords: low-noise pavement, noise abatement, case considerations, noise barrier

Noise Reduction Performance Estimation of Surface Modified Concrete Pavements

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Concrete pavements have the disadvantage of being noisy compared to asphalt packaging, but due to its durability and ease of maintenance, nearly half of the nation's highways are paved with concrete. The surface treatment of concrete pavements was designed to improve friction for driving safety of aging concrete pavement, but it is also known to be effective in reducing noise, which has led to the recent construction of some highways in Korea. In this study, two concrete pavement improvement techniques applied to highway sites have been measured and compared to the conventional concrete pavement. In this study, 24 hours L_{Aeq},24h pass-by noise and CPX noise (ISO 11819-2) have been measured for conventional concrete pavement (transverse and longitudinal tinning) constructed on highways and adjacent diamond grinding and NGCS (Next Generation Concrete Surface) surfaces. Pass-by noise was analysed by installing microphones at height of 3m, 5m and 7m of highway shoulder roads by means of an arithmetic average of the measured noise levels. As results of the study, It was analysed that the concrete pavement with the diamond grinding (DG) method has a noise reduction effect of 2 to 4.9 dB compared to the conventional concrete pavement of the lateral tinning. However, in some cases the noise reduction was up to 4.9 dB with the same type pavement. The noise reduction effect of diamond grinding considered in this study can be estimated to be between 2 and 2.7 dB, since the noise level of the existing pavement being compared (transverse tinning) was measured on average 2.2 dB higher than that of other sites on the same pavement. However, there is not enough data to conclude the noise reduction by surface grinding, and needed to add more sites to secure the data in the future studies.

Keywords: road traffic noise, low-noise pavement, noise abatement, road/tire noise

Measurement Position Consideration at Highway Roadside for Noise Measurements

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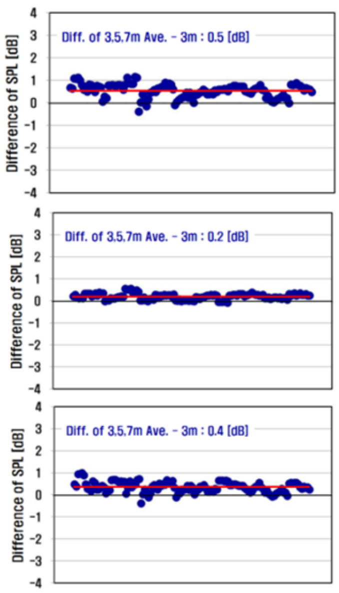
In measuring the highway noise at the roadside, it is important to decide the measuring height. In particular, knowing the acoustic performance of the pavement, such as low-noise pavement, positions of measuring points become very important. In the evaluating of pavement noise, CPX(Close-proximity) noise measurement is very popular and convenient but, this method lacks the measurement of the noise except from the tire-road noise, so the results of measurements could not be used for environmental noise abatements. In this study, measured road noises by measuring at the roadside were reviewed and summarized. Using 128 data which measured at the height of 1m, 3m, 5m and 7m were analyzed. The difference between the average of the remaining height noise levels and the noise level for each height except for a height of 1 m with a large degree of dispersion was not considered. As the result, the noise level measured at a height of 5 m was most representative.



Keywords: road traffic noise, noise management, noise abatement, measuring position

The Effects of 3 Different Kinds of De-icing Salt on Physiological Response of Tree Species by using Infra-red Camera

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In the winter, tree species on the expressway have been suffered from de-icing salt. It causes severe physiological damage to tree species such as leaf browning, growth reduction, early defoliation and death. Ultimately, these problems from de-icing salt cause enormous economic and environmental damages. Therefore, we investigated to find out which tree species have remarkable ability to resist on de-icing salt by planting seedlings in Seoul National University Forest in Suwon, Gyeonggi province. We selected 22 tree species (*Acer buergerianum, Acer palmatum, Acer triflorum, Chionanthus retusus, Cornus officinalis, Euonymus alatus, Forsythia koreana, Lagerstroemia indica, Ligustrum obtusifolium, Metasequoia glyptostroboides, Pinus strobus, Pinus densiflora, Pinus thunbergii, Prunus yedoensis, Quercus acutissima, Rhododendron indicum, Sophora japonica, Sorbus alnifolia, Spiraea prunifolia, Weigela subsessilis, Zelkova serrata*) that are mainly planted on the expressway by Korean Expressway Corporation. 6 trees were planted per plot (experimental plot area : 2.94m^2) at 0.7m intervals with 3 repetitions. Three major kinds of de-icing salt sprays (calcium chloride, sodium chloride, PC-10) were selected and treated once in January and February with three different concentrations (25mM, 50mM, 100mM). Also, wood walls (40cm height) were installed underground to prevent different kinds and concentrations of solution to be mixed among plots. To determine the effect of de-icing salt sprays on the soil in which the plants are growing, soil samples per experimental plot were collected monthly to measure SAR (Sodium Absorption Ratio), electrical conductivity (EC) and quantity of sodium and chlorine. In addition, we will measure the temperature of the leaves using infra-red camera to measure degree of damage to ultimately perform quantitative analyse about salinity stress on the plants. In this study, it is expected to find out species which have high resistance ability to de-icing salt sprays.

Keywords: De-icing Salt, Salt Stress, Physiological Response, Leaf Temperature, Growth

An Analysis of the Visual Preferences of the Driver for Bird Deterrent Patterns in Transparent Noise Barriers using Driving Simulator

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As the number of transparent noise barriers increases, the accident of birds crashing into transparent windows has become a social issue in Korea. In order to prevent bird-glass collisions, the Korean Ministry of Environment published the guideline to provide a denser pattern of visual markers on transparent windows at a spacing of 5 cm in height and 10 cm in width. Since transparent noise barriers are installed in terms of view rights or landscape, appropriate patterns need to be selected to prevent visual confusion and excessive design.

To investigate the visual effects of bird deterrent patterns from the drivers, the simulated driving experiment was conducted using the driving simulator in Korea Expressway Corporation Research Institute (Fig. 1 and 2). Twenty men and women with driving experience participated in the experiment on virtual roads with transparent noise barrier (Fig. 3). A total of five typical bird deterrent patterns were used in the experiment. The participants drove and conducted a survey at each speed (30, 70, 100 km/h).

70% of the participants did not recognize the pattern itself when driving at 100 km/h without prior information on applying the bird deterrent pattern to transparent noise barrier. A survey of the preferences for patterns in the aspect of the road's landscape showed a higher preference for dots or lines pattern than for the squares or net pattern.

It is desirable to apply bird deterrent patterns that satisfy the so-called “5×10 cm rule” to transparent panels in noise barriers, but adopt dots or lines patterns instead of complex ones.

Fig. 1 Driving Simulator

Fig. 2 Test vehicle

Fig. 3 Virtual Road and Barrier

Keywords: bird deterrent pattern, transparent noise barrier, road drive simulator

Acoustic Performance Estimation of Noise Reducing Devices Considering with Source Characteristics

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A noise reducing device(NRD), generally called ‘noise reducer’ is an acoustic device which installed on the noise barrier for the purpose of reducing the diffraction noise by a noise barrier. It was suggested by Dr. Fujiwara(Japan) in the early 1990’s and introduced in Korea at the end of 1990’s and then many kinds of products have been developed and installed on railway noise barriers as well as road barriers in Korea. The acoustic performance of NRD is depending on the frequency characteristics of noise source. But because of installing without any considerations about source frequency characteristics, the performance could not be showed as designer’s intention. In this study, a estimation method which reflected the source spectra has been considered and suggested for appropriate installation of NRD’s.

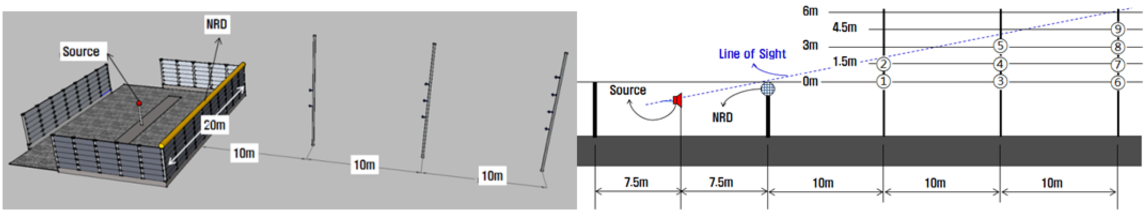
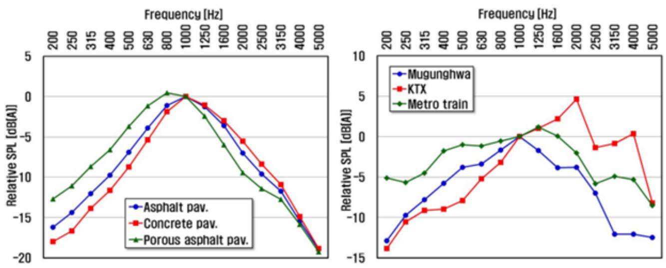


Fig. 1 Scheme of test facility for noise reducing device acoustic test



(a)Road traffic noise sources (b)Railway noise sources

Fig. 2 Noise source spectra for acoustic performance estimation of NRDs

Keywords: noise reducing device, noise reducer, road traffic noise, railway traffic noise

Analysis of Air Pollutants Concentration Variation in the Operation of Ventilation System in Tunnel

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Increased The number of road tunnels is increasing as part of environmentally friendly construction technology is recommended for road construction in mountainous areas, and the number of road tunnels has been extended to a long time due to the development of construction technology.
About 23 percent of the tunnels currently operating on highways are long-range tunnels with more than 1 kilometer, and more than 30 percent of the new tunnels are being constructed as long-range tunnels.
In the case of a tunnel, the characteristics of a road but enclosed space make it difficult for various air pollutants generated by the vehicle to be discharged from the outside and accumulated in the tunnel space to cause discomfort to the driver. In particular, the air quality in the tunnel due to vehicle emissions is worse when the vehicle is stationary, and in the case of long-range tunnels, that is even worse.
In tunnels, ventilation is provided to improve the internal air environment. In case of a single tunnel (1 km or less), natural ventilation is dependent on the wind-driven natural ventilation generated when the vehicle is passing, and in the case of a long tunnel, natural ventilation is used and ventilation is installed to improve the air quality in the tunnel and the driving environment for users. However, the tunnel ventilation system is operated at the maintenance level of CO (100 ppm or below) and NOx (25 ppm) and falls short of the user's requirement, and the ventilation effect was not known when operating the ventilation system according to the actual status of air pollutants in the tunnel.
Therefore, this study was intended to develop efficient measures to reduce air pollutants in tunnels by identifying the ventilation effects of the operation of tunnel ventilation facilities.
This study measured changes in the concentration of contaminants (PM10, PM2.5, NO-NO2-NOx) with changes in the operation methods of ventilation facilities at five points in the tunnel.
Although the concentration of contaminants was less changed during partial operation compared to the entire operation, it was found that the effect of the operation of the ventilation system was effective.
After examining the effects of improving the concentration of contaminants in the operation of ventilation facilities, it was found that although the effect size varies depending on the operation method of ventilation facilities, the degree of contamination was improved. It is believed that efficient management and improvement of the air environment in the tunnel will be necessary through changes in the operation of ventilation facilities depending on the traffic conditions, distribution of pollution and concentration of tunnels.

Keywords: Ventilation, Ventilation effect, Long-range tunnels

Scope and Methodology for Calculating Air Pollutant Emissions on Expressway

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To calculate air pollutant emissions on domestic expressways, the methodology of calculating the emissions for domestic on-road mobile source was analyzed, and the main applicable activity data were surveyed. As the activity data to calculate the emissions for on-road mobile source, there are driving distance, traffic volume, and average travel speed for the application and calculation emission factors. The improvement possibility of main activity data was surveyed and analyzed. Main activity data that are applied to the calculation of expressway air pollutant emissions were improved. The improved main activity data are 1) average travel speed as the basic element for emission factors, 2) emission factors of each pollutant based on the improved average travel speed, 3) a trip ratio of each type of vehicles driving on expressways, 4) the improved traffic volume for applying emission factors, and 5) the driving distance that reflected the extended length of each section in expressway routes. Based on them, expressway air pollutant emissions were calculated. Pollutants for on-road mobile source are mostly emitted from fuel combustion. Particulate pollutants like fine dust are additionally emitted from physical factors including tire and brake wear and environmental factors like re-scattering dust on roads. A hot-start emission among fuel combustion induced emissions are calculated in consideration of drive characteristics on expressways. And we analyzed additional emissions of fine dust due to tire wear discharged by physical factors and discharge amount of re-scattering dust on the road due to environmental factors. For the method applied within the calculation range of emissions, the methodology applied in the existing overseas and domestic Ministry of the Environment was applied. Basically, the amount of emissions was calculated by multiplying the emission factor classified by the classification system of the calculation range and the activity data of the emission factor, and it was readjusted based on the classification system of the calculation range. Through the basic data and detailed data analyses, activity data for emission calculation were analyzed, and improved activity data were drawn for calculating an emission of each pollutant. For the method applied within the calculation range of emissions, the methodology applied in the existing overseas and domestic Ministry of the Environment was applied. Basically, the amount of emissions was calculated by multiplying the emission factor classified by the classification system of the calculation range and the activity data of the emission factor, and it was readjusted based on the classification system of the calculation range.

Keywords: calculating air pollutants emission, emission factor, activity data

Sensitivity Analysis of CALINE4 through Actual Measurement to Determine the Impact of Air Pollution on Highways

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Increased domestic car and traffic is deepening the environmental impact of roadside by road caused by other environmental factors such as exhaust gas and tire abrasion of driving vehicles. The emission of fine dust and nitrogen oxides from road transport pollutants such as automobiles was 9,583 ton/yr based on CAPSS in 2015, while PM2.5 was 8,817 ton/yr and NOx 369,585 ton/yr. This accounts for 4.1 percent, 8.9 percent and 31.9 percent of all emissions, including bio-burning and scattering dust, respectively.
To identify the effects of air pollutants on the side of highways and to analyse the sensitivity of the air quality prediction model CALINE4, three types of air pollutants, PM2.5 and NOx, were selected to conduct a field measurement and measurement of the air pollution by the CALINE4 model developed by the California Highway Traffic Administration.
The measurement site selected parts of the Pyeongtaek-Siheung Expressway, which had less impact on the surrounding area, and installed measuring equipment at a total of 14 points (0, 50m, 100m, 150m, 200m, 250m, and 300m) for each of the seven points on the wind/bottom side in the direction perpendicular to the highway. To implement the model, the Land, Infrastructure and Transport Ministry applied the ratio of vehicle registration to each vehicle type at the measurement date, and the emission coefficient was calculated by applying the differential and the formula for calculating the emission coefficient. In addition, by installing a meteorological system, the concentration of weather data, highway resources, and accommodation facilities was entered to the same location as the actual measurement equipment. The sensitivity of CALINE4 was analysed by comparing the actual value of each air pollutant with the predicted value of CALINE4.

Keywords: roadside, exhaust gas, sensitivity, CALINE4

Development of Eco-friendly Soil Restoration Assessment System for Surface Soil Failure

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The topsoil erosion in Korea is considered to be a serious level due to changes in land use and climate variation. According to a survey of topsoil erosion as of 2012, the annual soil erosion in Korea has been reached to more than 33 t/ha. This is classified into a level of “very severe” which is the highest level of the OECD's soil erosion class. Topsoil is recognized as an important and finite resource because of its environmental value, including ecological function, carbon storage, and the purification of pollutants. Relevant policies should be specified to preserve this. Recently, the methods for preventing and restoring topsoil loss have been proposed, but more practical and systematic policy support is needed. For the restoration of topsoil damaged areas, it is urgent to establish a comprehensive management system for this areas. Consideration should be given to systematic topsoil conservation plans and topsoil investigations based on the development of evaluation indicators and follow-up measures. Therefore, this study aims to 1) develop a decision-making and evaluation system based on the monitoring of topsoil damaged areas, 2) propose a policy for topsoil restoration and post management monitoring, and 3) suggest possible practical uses of an evaluation system for topsoil damaged area management. This work was carried out with the support of ‘Cooperative Research Program for Agriculture Science & Technology Development (Project No. PJ014821032020)’ Rural Development Administration, Republic of Korea.

Keywords: post management, restoration, soil conservation, soil erosion, topsoil damage

Evaluation the Risk of Soil Erosion against Climate Change

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Sustainable soil environment with sufficient water resources is critical for food security and healthy agricultural environment in the future. Especially, the orchards of Korea are territory consisted of 39% of valley and alluvial fan hill and 36% of mountainous topography and the variability of rainfall is also rapidly increasing due to climate change, thereby increasing a risk of soil erosion. Soil erosion by water has been estimated using empirical equations with accumulated data in the U.S. since 1930s, such as Universal Soil Loss Equation (USLE) published by the U.S. Department of Agriculture (USDA); however, these equations were not always well fitted to all estimations of soil erosion in other countries because of different regional characteristics. Moreover, the conventional equations of soil erosion such as USLE cannot be enough to estimate soil erosion against climate change. Therefore, this study used data of rainfall erosivity for past 110 years (1901~2010) and recent 9 years (2011~2019) observed from ~58 observations in Korea and compared them to evaluate the effect of climate change on soil erosion in Korea. Based on each 10-year interval, the average precipitations in July and August showed large changes by 30.8% and 26.6%, respectively, and the degrees of these changes were gradually increasing recently. It might be due to the impacts of climate change and land-use. The relationship between rainfall erosivity and daily maximum precipitation was positive (R^2=0.66), but indicated different central tendencies between data for past 110 years and recent 9 years. Especially, the values of rainfall erosivity in the southeast part of the country, Daegu, Ulsan, and Busan cities, have increased over the past 9 years compared to the past 30 years. The more effective and practical estimation technique of soil erosion should be developed to ensure the climate change effects. This work was carried out with the support of 'Cooperative Research Program for Agriculture Science & Technology Development (Project No. PJ014821032020)' Rural Development Administration, Republic of Korea.

Keywords: highland, orchard, soil erosion, soil moisture, upland

Capping Efficiency of Ca-Rich Mineral Under Nonwoven Fabric Mats and Sand Armour for Interrupting Nutrient Release from Liver Sediments

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In-situ capping is an economic and effective technology for the remediation of contaminated sediments by minimizing resuspension and transport of sediment particles, stabilizing sediments, and reducing the diffusion of dissolved contaminants into the overlying waters. We investigate the applicability of the use of calcium rich minerals including attapulgite, dolomite and epiolite to interrupt the nutrients from contaminated lake sediments. Firstly, the sorption capacities of attapulgite, dolomite and sepiolite for ammonium, nitrate, phosphate, and humic acid were evaluated under batch condition. The capping efficiency was evaluated in a cylindrical reactor with an internal diameter of 15 cm and a height of 25 cm, and 6 cm of contaminated sediments were filled in the reactor. The laboratory sediment incubation experiments were conducted by setting up ten columns to assess the efficiency of capping materials under nonwoven fabric mats (NWFM) and sand armour depth (1 cm and 2 cm) to reduce the release of organic matter, nitrogen, and phosphorus. Each 1 cm of attapulgite, dolomite, or sepiolite was placed on the contaminated sediments, respectively, and the NWFM) and sand armour depth (1 cm and 2 cm) were placed on top of capping materials. Laboratory incubation experiments were performed to monitor environmental parameters, including dissolved oxygen (DO), pH, oxidation reduction potential (ORP), and electric conductivity (EC), as well as on fluxes of contaminants from sediments to overlying water during 70 days. After the laboratory incubation experiments, the fractionation of phosphorus in the sediments were analysed by sequential extraction. Batch adsorption experiments showed that attapulgite was effective for adsorbing ammonium than other adsorbents and phosphate was effectively removed by dolomite. The dissolved oxygen (DO) in uncapped condition was exhausted in 30 days but DO under capping conditions was prolonged until the end of this experiment. The capping efficiency for ammonium when capped attapulgite with 1 cm-sand armour, 2 cm-sand armour, and NWFM were 93.7%, 96.4% and 61.6%, respectively. The capping efficiency of dolomite with 1 cm-sand armour, 2 cm-sand armour and NWFM for phosphate were 86.6%, 96.9% and 93.7%, respectively.

Keywords: In-situ capping, Sediment, Ca-mineral, Phosphate, Nitrogen

Field Test of Stormwater Treatment Devices for Improving Heavy Metals Removal in Expressway

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The concentration of heavy metals, TSS, and oil & grease is generally higher in the stormwater runoff from highways than from residential area and commercial area. It is attributed to the vehicles, roads, and road facilities. Therefore, heavy metals removal should be considered seriously for the treatment of the runoff from highways. In Europe, seven (7) heavy metals were proposed as the selected stormwater priority pollutants (SSPP).

A pilot plant was installed at the site of the monitoring of the main line of the highway, to evaluate the field performance of the mortar/NaCl-zeolite filter. Mortar was prepared in laboratory by mixing cement, sand and water, dried, crushed and sieved to 3-5 mm. NaCl-zeolite was prepared in laboratory using domestic natural zeolite of 3-5 mm by impregnating in NaCl solution. A couple of Φ840 x H 925 mm FRP TANKs were filled with sand (600 mm) or mortar, gravel and NaCl-zeolite (350, 50 and 250 mm), I.e., sand filter and mortar/NaCl-zeolite filter. The influents and effluents of the tow filters were monitored for the events 2-5. The flowrate of the sand filter and the NaCl-zeolite filter was 0.5-8.8 and 0.4-7.5 L/min, respectively.

For the average EMC removal of sand filter and mortar/NaCl-zeolite filter; BOD was 43.4 (34.4-54.9)%, and 52.4 (39.7-64.2)%, T-N was 42.8 (29.1-61.8)%, and 45.5 (24.1-64.5)%, T-P was 32.2 (0.1-73.5)%, and 63.5 (37.6-74.8)%, SS was 82.0 (65.3-93.2)%, and 82.5 (66.9-95.4)%, Cu was 59.5 (41.2-80.3)%, and 73.3 (59.1-90.1)%, Zn was 60.8 (18.7-95.8)%, and 92.2 (84.9-99.7)%, Cr was 81.3 (54.4-100.0)%, and 100.0%, Ni was 94.3 (83.9-100.0)%, and 100.0%, Fe was 24.5 (0.1-39.9)%, and 85.3 (78.7-94.4)%, the total metal, which is the sum of Cu, Zn, Cr, Ni and Fe was 31.4 (12.2-44.6)%, and 85.8 (78.8-95.1)% and electric conductivity was 63.1 (52.4-79.1)%, and 86.3 (80.9-90.3)%, respectively.

The removal of EMCs by mortar/NaCl-zeolite filter was slightly higher than the sand filter, that of T-N and SS was comparable to the sand filter and that of heavy metals was greatly higher than the sand filter. Meanwhile, the sand filter also showed good removal of Cu, Cr and Ni, of which the influent concentration was very low.

Keywords: Stormwater Treatment, Heavy Metal, Expressway, Event Mean Concentration, Mortar/NaCl-Zeolite Filter, Field Test

Potential Impacts of Large-scale Climate Variabilities on Transpacific Transport of Springtime Asian Aerosols

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Anthropogenic and natural aerosols emitted from East Asia have received a great attention partly due to its potential impact on environment and climate over the past decades. Transpacific transport of Asian aerosols is of particular interest because the increased aerosols inflow may offset tSeoul , Republic of Korea he benefits from regional emission control strategies over downwind continents. A number of studies attempted to identify dynamical mechanisms leading to long-range transport. These studies revealed three stages of transport: the outflow from Asian boundary layer into free troposphere over the northwest (NW) Pacific, flow over the North Pacific, and inflow into the northeast (NE) Pacific. Most of those studies have primarily dealt with physical mechanism of outflow and inflow stages, based on the comprehensive assessment that Asian aerosols can be rapidly transported in strong westerly winds over the North Pacific. However, meridional fluctuations in these westerly winds (i.e., Asian-Pacific jet and Pacific jet) associated with large-scale climate variabilities over the North Pacific can significantly affect transport efficiency. In this study, the potential impacts of large-scale circulation associated with North Pacific (NP), Western Pacific (WP), and Pacific-North American (PNA) patterns on transpacific transport of springtime Asian aerosols are examined using aerosol optical depth (AOD) from the Moderate-resolution Imaging Spectroradiometer (MODIS) and meteorology from reanalysis data. Composite analyses reveal that the increased westerly winds are evidently observed to the north and south of the North Pacific, respectively, during NP positive (NP+), WP positive (WP+), and PNA positive (PNA+) phases. Along the favorable pathways during WP+, the large amount of aerosols can be more efficiently transported over the north of 40°N, resulted in ~36 % increased transport probability compared to the case in the opposite phase (WP–). Similarly, the distinct route over the south of 40°N during PNA+ associated with more frequent high aerosol loading days as compare to PNA–. Concurrent with these reinforcements due to large-scale climate variabilities, we find that the long-range transports of aerosols emitted from northeastern and southeastern Asia can be effectively controlled by respective patterns.

Keywords: Asian aerosols, transpacific transport, North Pacific pattern, Western Pacific pattern, Pacific-North American pattern

Spatiotemporal Characteristics of PMs and Satellite-based AOD in the Korean Peninsula

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Particulate matters (PMs) is known as one of the air pollutants causing serious human health problems. Like many countries in the world, the South Korean government has made efforts to monitor the PM concentration and reduce the concentration. The ground observation network for monitoring PMs has been continuously expanded due to concerns on high concentration PMs cases in South Korea. However, the spatial resolutions of the stations are still not enough to resolve local concentration of PMs. To resolve limitations of the in-situ measurements, satellite-based aerosol optical depth (AOD) has been widely employed to estimate surface PMs concentrations. Numerous statistical approaches have been used AOD data to estimate ground PM based on the link between AOD and PMs. The fundamental assumption in the previous studies is fixed AOD-PMs relationship. The relationship, however, changes over time and space due to the space-time varying meteorological variables.

In this study, the spatiotemporal characteristics of the AOD-PMs relationship were investigated through various meteorological factors and optical characteristics data of satellites. And to estimate PM2.5 and PM10 (PMs with aerodynamic diameters less than 2.5 and 10 μm, respectively), we constructed a multiple linear regression (MLR) model and the estimation performance of the model was examined.

Keywords: Particulate matter, Aerosol optical depth, Satellite, meteorological variables

Effective Applying of Noise Reducing Devices for Traffic Noise Abatements

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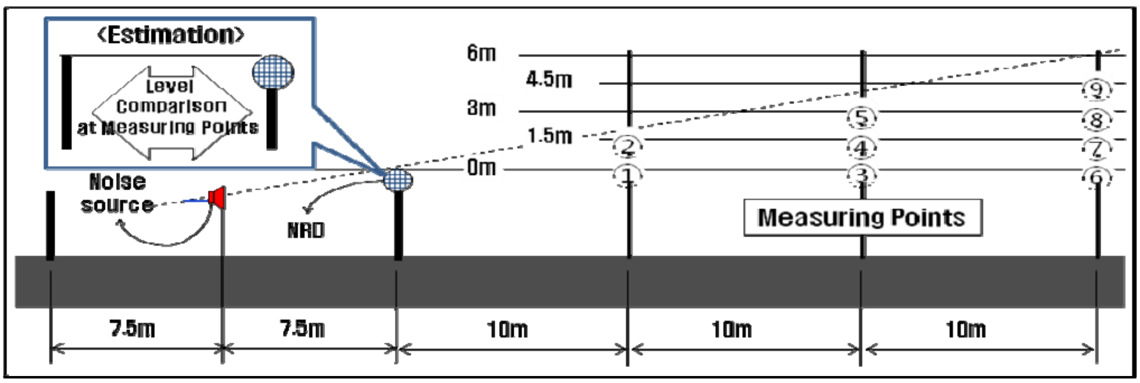
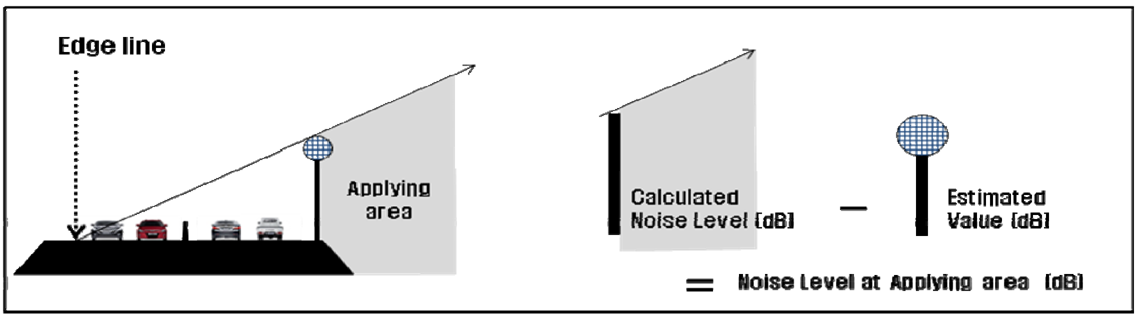
Various types of noise reducing devices(NRDs) called "Noise reducer" have been applied for getting more shielding efficiency on the top of noise barriers in Korea. For effective applying the NRDs to the noise barrier a few important principles have to be considered. The NRD has been developed for reducing edge potential of the noise barrier. From view point behind a noise barrier, the top edge of the barrier acts like a virtual sound source. So, reducing the edge potential of a barrier can make the diffraction area silent. Figures belowshow test and applying method of a NRD for practical use respectively. The performance of NRD is measured at 9 points and then averaged as one value for treating as the performance of a NRD. The second figure shows schematic procedure of counting the estimated performance.





Keywords: noise reducing device, noise reducer, road traffic noise, railway traffic noise

Contribution to Thermal Comfort and CO_2 Mitigation of Urban Park with Complex and Heterogeneous Landscape in Seoul

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Recently cities are beginning to recognize that trees can be part of the solution to various environmental problems such as greenhouse gas emissions and excess heat. For the purpose of thermal comfort and CO_2 reduction, park areas in cities are increasing but studies providing quantitative information about the effect of the urban park on microclimate are still insufficient. By analysing 2-year eddy-covariance data at the Seoul Forest Park in Seoul, Korea, the present study: 1) reports the temporal and spatial water, energy and CO_2 exchanges and 2) identifies abiotic and biotic factors controlling them, and 3) quantifies the effect of the temperature reduction and CO_2 mitigation at an artificial urban park.

Keywords: urban park, eddy covariance, CO_2 mitigation and temperature reduction

Estimation of Surface CO_2 Flux over Asia using Inverse Modeling with CO_2 Observations in the Korean Peninsula

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In this study, surface carbon dioxide (CO_2) flux was estimated over East Asia using the inverse modeling approach. Two CO_2 mole fraction datasets observed from South Korea (Anmyeon-do (AMY) and Gosan (GSN)), along with ObsPack observation data package, were additionally assimilated in the CarbonTracker system, and the characteristics of the estimated surface CO_2 flux was analyzed over ten years. To investigate the impact of the inclusion of the two observation datasets in the Korean Peninsula, the other experiment which only assimilated the ObsPack data was conducted and used for comparison. The result showed that by including two more datasets in the data assimilation process, the surface CO_2 flux absorption was slightly enhanced in summer and the surface CO_2 flux emission was weakened in late autumn and spring. This characteristic was shown particularly in Eurasian boreal and Eurasian temperate regions. Validation was done using independent observations from surface and aircraft (Comprehensive Observation Network for Trace gases by Airliner; CONTRAIL), and it showed smaller root mean square error (RMSE) values and greater uncertainty reduction effect with the experiment which additionally assimilated two Korean observation datasets.

Keywords: surface CO_2 flux, inverse modeling, CO_2 observations

Acknowledgements

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Oxidative Degradation of 1,2-dichloroethane in Groundwater

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1,2-dichloroethane (1,2-DCA) is persistent, highly toxic, and potential carcinogenic compound. The chlorinated chemical is a by-products in the PVC manufacturing industries, and is one of dense non-aqueous phase liquid. Even though several destruction techniques have been applied including biodegradation, chemical reduction and oxidation, the removal or degradation of 1,2-DCA is limited [1]. The compound is slightly biodegradable, but it requires too long time [2]. It has been reported that the reductive dichlorination by zero valent iron is ineffective [3]. The Cl-C bond in the saturated compound is stable and very difficult to destroy using radicals compared to C-H and C-C bond in unsaturated compounds.

Therefore, in this study, several reduction and oxidation techniques were evaluated to degrade 1,2-DCA including hydroxyl radical ($OH^{\cdot}$), sulfate radical ($SO_4^{-\cdot}$), dithionite (S_2O_4), and sulphite (SO_3^{2-}). In addition, the intermediates such as chloroethane were monitored using GC-ECD. To evaluate the applicability of chemical treatment, the 1,2-DCA-contaminated groundwater was sampled in the field, and chemical oxidation by hydroxyl radicals was proposed for the most suitable technique to treat 1,2-DCA.

Keywords: 1,2-DCA, Groundwater, Oxidation, Reduction.

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A Development of Reconstruction and Temporal Extension Model for Fine Dust in Korea

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Air pollution has become a key social issue due to the increase of concentration of fine dust particles which is one of the main causes of respiratory and cardiovascular illnesses. The capital of Korea, Seoul, has already introduced emergency measures, such as limiting vehicle use, curbing the use of coal-fired power stations and cutting the amount of dust generated by building sites and power plants. These emergency measures are dependent upon air pollution monitoring and warning system. The quality of these systems requires a robust forecast method based on reliable data of the air pollution monitoring network. However, the air pollution monitoring network started to record from 2001 and 2015 for fine and ultra-fine dust particles, where the number of monitoring stations expanded from 170 in 2001 to 460 in 2019. This study aims to develop a model for reconstruction and temporal extension of ultra-fine dust particles (i.e., PM2.5) with the use of relationships with fine dust particles (i.e., PM10) and other climate variables as inputs in a stochastic modeling framework. More specifically, the fine dust particle and climate variables are considered as a set of exogenous variables for the spatial and temporal reconstruction of ultra-fine dust particle sequences. The proposed model was validated within a cross-validation framework. The results confirmed that the proposed model could provide a reliable reconstruction of ultra-fine dust sequences. The reconstructed ultra-fine dust information was further used to explore a long-term trend and changes in risk over time.

Keywords: *Air pollution, Fine dust, Reconstruction, Stochastic model*

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Fe(III)-based Washing Process for Remediation of Multi Metals-Contaminated Soil

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Soil washing, consisting of physical/chemical separation extraction, has been a widely used technique to remediate contaminated soil. Inorganic acid including HCl, HNO_3, H_2SO_4, and $FeCl_3$ are mainly used in the washing agents [1]. However, the metals extracted can be re-adsorbed onto the soil, which increases the bioavailability or phytoavailability of metals in soil. Thus, it is necessary to remove the re-adsorbed heavy metal to lower the labile fraction of metals, a major portion of bioavailable metals.

In this study, ferric chloride-based soil washing was improved by the combination of HCl and ferric chloride. The re-adsorbed metals were extracted by calcium salts, where the metals were ion-exchanged with calcium ions and formed chloride-metal complexes.[2] In addition to the overall removal of metals, the sequential extraction (BCR), leaching test (TCLP), phytoavailability, and bioaccessibility were evaluated.

Keywords: Soil washing, Ferric chloride, Calcium chloride, Re-adsorption

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A Bivariate Frequency Analysis of Fine Dust using Copula Function

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The Copula model has been applied in various research areas in economics, finance, environment, climate, and hydrology due to its flexibility in representing dependency between variables. The Copula function approach allows us to describe dependencies with different marginal distributions on variables of interest. In this context, this study employed the Copula model to describe the dependencies in the find-dust duration and severity and to explore bivariate risk. This study develops a Bayesian approach for parameter estimation in a copula-based bivariate find-dust frequency analysis. The proposed Copula model was applied to estimate joint return periods on a network of air quality stations in South Korea. Moreover, this study explored a spatial distribution of the estimated joint return period of the recent fine-dust events. The obtained results were generally favorable as compared with the existing univariate risk analysis that has limited capability for the reliable estimation of fine-dust risk in South Korea. A discussion of the potential use of the proposed bivariate frequency model is offered.

Keywords: Bivariate Copula model, Bayesian, Uncertainty, Fine dust, Risk analysis

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Water Quality Estimation Using Hydrometeorological factors within the Hierarchical Bayesian Framework

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In Korea, the water quality of the rivers is known to be highly dependent on hydrometeorological factors owing to the apparent seasonality of the region. In addition, climate change also increases uncertainty in water quality prediction in consequence of spatio-temporal variability. In this regard, we analyzed the interdependencies and correlations between hydrometeorological factors and the water quality variables to construct a water quality prediction model. More specifically, we investigated the use of hydrometeorological variables (i.e., rainfall and temperature) as well as the autocorrelation characteristics of water quality variables (i.e., TN and TP) for the Nakdong River basin within a hierarchical Bayesian regression model. The obtained results were generally good agreement and favorable as compared with those of previous studies that have limited predictability over South Korea. A discussion of the potential predictability is offered.

Keywords: Hierarchical Bayesian Regression, Water Quality estimation, Hydrometeorological factor

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Latent Markov Processes for Identifying Spatio-temporal Pattern of Water Quality

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A multivariate stochastic approach based on a latent Markov process is introduced in this study to identify spatio-temporal patterns for multiple locations in South Korea. To be more specific, this study proposes a five-state Markov process model representing a latent state associated with water quality. The main question of this study is that water quality can be effectively clustered with a small set of states that could link to intra-seasonal, seasonal and interannual variability in climate. Moreover, we explore potential predictability in spatio-temporal patterns of water quality and their dynamics in the nonstationary context. Eventually, we accurately identified the transition processes of spatio-temporal patterns in water quality that can be potentially used to predict the water quality for multiple locations for the upcoming season. A detailed discussion on the use of the latent Markov model is offered.

Keywords: Classification, Hidden Markov chain model, Water quality

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The Relationship of the Price Movements of Raw Materials and Recyclable Materials in South Korea

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This study analysed the long-run equilibrium and causality relationship between raw material prices and recyclable material prices in South Korea. The selected materials were classified into two categories-plastic group, and paper group. The materials of the plastic group consisted of Dubai crude oil and recycled plastic material (polyethylene, polystyrene, and polypropylene). The materials of the paper group consisted of imported pulp and recovered paper (newspaper and cardboard). As long-run equilibrium results, all groups were not in the long-run equilibrium between raw material prices and recyclable material prices. And as a result of the causality relationship, short-term causality was found in the paper group. In the plastic group, the Dubai crude oil price caused recyclable plastic material in short term.

Keywords: recyclable material, raw material, price equilibrium, causality analysis

Analysis of the Harmful Algal Blooms in the Upstream of the New Dam

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The Yeongju Dam was completed in October 2016 and has been suffering from persistent water quality problems since its completion. In 2016, the Yeongju Dam was impounded, but the water storage rate was kept at 16% due to the algae blooms problem. However, although it was recently re-impounded by the request of the residents, the issue is still repeated. In South Korea, four species of *Microcystis* sp, *Anabana* sp., *Osillatoria* sp. and *Aphanizomenon* sp. are managed as harmful algae. Accordingly, in this study, the characteristics of harmful algae blooms in the upper stream of Yeongju Dam was analyzed. The study stations were 4 points in total and were targeted at points where algae blooms frequently occur. There have been continuous algae blooms except when the water temperature starts to rise from low to high. The water temperature was 25.8±2.9°C, which is suitable for algae blooms. T-P was high at the start of the stagnant zone, and T-N and TOC were high at the start of the river's bend. But the chl-a appeared to be the highest at the station of the dam. Dominant algae also showed different patterns by stations. In the shallow points, the *Phormidium* sp. and *Microcystis* sp. were dominant. Where the stream bends, *Microcystis* sp. and *Pandorina* sp. were dominant. Finally, at the main dam point, when the water temperature is 25.5°C, the *Aphanothece* sp. was dominant, and when the water temperature increases to more than 30 degrees, *Microcystis* sp. and *Anabana* sp. were dominant. In particular, *Microcystis* sp. was dominant at all stations, which is considered to be a favorable condition for *Microcystis* sp. However, despite the high water temperature, *Pandorina* sp. was dominant in the area where the River bends. As a result, the dominance of algae species vary depending on factors such as the shape of the water body, water temperature and nutrients.

Keywords: algal bloom, upstream, dam, stagnant zone

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Analysis of Quality Characteristics of Soil Ameliorant using Microalgal Sludge

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Recently, microalgae have attracted much attention as a capable biorefinery of producing various green compounds. Microalgae are not only available useful bio-based fertilizers with high nutrients, but also known for their high N, P recovery and good economic value. In this study, microalgae-based soil ameliorant was prepared through the composting process using recycling discarded microalgal sludge after the water treatment process in freshwater system. The main ingredient of the material was microalgal sludge, and we used additive materials (oilcake, perlite, etc.) for co-composting during 127 days. During the composting period, there was a clear increase of temperature and it was estimated that cleavage and utilization of polymers (cellulose, hemicelluloses, etc.) were possible after the thermophilic phase. Also, these behaviors were indirectly confirmed in the result of reduction of organic matter and C/N ratio, whereas macronutrients and secondary nutrients showed an increasing pattern. The fertility index (*FI*) surged in stage 2, corresponding to the thermophilic and cooling down phase in the whole composting stage. The clean index (*CI*) was showed relatively good value in the 4.7-5.0 range. Overall, quality variations of soil ameliorant were thought to be closely related to transition in microbial communities. Indeed, depending on the composting process, stage 1 (bacteria, filamentous fungi) → stage 2 (actinomycetes, bacteria) → stage 3 (*Bacillus* sp.) showed a strong relationship with temperature changes and nutrient behaviors. Therefore, it was judged that the quality of soil ameliorant using microalgal sludge could be influenced by microbial activity. Through this study, the possibility of soil ameliorant using microalgal sludge was confirmed, and the identification of useful substances including detailed mechanisms for soil environment or plant growth will be needed in future studies.

Keywords: Microalgal sludge, composting, soil ameliorant, microbial activity, nutrients

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Analysis of Operational Status of Hog Barns using Closed Composting Equipment

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The massive generation of livestock manure has been considered as problematic due to its environmental impact on soil and air pollutions. In these contexts, the closed composting systems has been widely used as promising way to treat the solids part from swine manure while unwanted gas emissions were effectively decreased during the composting process. In this study, operating conditions of closed composting system from domestic hog bars were investigated. In addition, the change of physio-chemical properties of swine manure during composting properties were also monitored. In order to optimize the operating condition of closed composing system, 10 domestic hog farms were employed. Specifically, the number of breading heads, daily input (Ton/day), hydraulic retention time (days), and species of bulking agents were investigated, and all samples were collected from 3 locations (Separated manure, Compost, Maturation). It was founded that pH, Germination Index(GI) and Total solid(TS) were increased during the composing period, while Water content(WC) and Volatile solid(VS) decreased.

Keywords: closed composting system; swine manure; composting;

Comparison of Two Odor Evaluating Parameters, Sensory and Instrumental, to Estimate Odor Strength in Livestock Facilities

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In Korea, livestock industry has been growing continuously as a demand from domestic meat market expand. However, despite the success in quantitative growth, the pig farming industry's survival is still under threat, as complaints from neighbors due to malodor has been persisting. Understandably, livestock odor has been an ultimate target to be solved for folks in animal research and industrial sectors for many decades. According to numerous research papers, livestock odor is a sense caused by a mixture of numerous volatile chemical compounds, such as volatile fatty acids, amines, sulfurs, indoles, and aromatics. Since odor is a recognition of volatile chemicals, we hypothesized that the strength of odor is proportional to the concentrations of odorous compounds floating around inside hog barn. To test the hypothesis, we visited several pig farms regularly to measure two odor strength parameters; complex odor and OAV-15. Complex odor is an odor strength parameter measured using sensory recognition. OAV-15 is also an estimation of odor strength measured using instrumental analysis. OAV-15 represent sum of OAV (Odor Activity Values) of 15 odorous compounds which have been suggested to be major contributor of livestock odor. OAV can be calculated by dividing measured concentration with threshold concentration which is unique to each compounds. Since threshold concentration is inversely proportional to the odor strength, OAV is a value, weighted with odor strength.

After visiting pig farms for over 40 times, both complex odor and OAV-15 were measured inside hog barns and relation between two parameters were statistically analyzed using Pearson correlation. In addition, correlation between concentration of other odor compounds were analyzed. Statistical results suggest that correlation coefficient (r) between complex odor and OAV-15 was unexpectedly small (less than 0.5). Correlation between complex odor and ammonia concentration was even smaller (less than 0.3). In contrast, correlation between complex odor and hydrogen sulfate was quite high (higher than 0.7). Conclusively, our results suggest that OAV-15, an instrumental quantification of odor, may not sufficient to represent sensory complex odor. *This research was funded by the Rural Development Administration (Project No. PJ0135772020) Republic of Korea*.

Keywords: Livestock Odour, Complex odour, Hydrogen sulfate, Odor activity value

Applying Negative Pressurizing Technique May Contribute to The Homogenous Air Supply in Statically Composted Manure Piles

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This experiment was designed to transform pig manure of high moisture content (over 80%) into a high quality fertilizer using a static plie composting technique. To achieve the objective, we performed a composting experiment using four chambers, each contains 700ℓ of pig manure. Since the moisture content should be less than 70% for the successful composting, we mixed the manure with saw dust, of which, the moisture content was less than 30%. Subsequently, composting was initiated by injecting piles with air (150ℓ/m^3/min) in four different manners; (1) negative pressurizing, (2) positive pressurizing, (3) negative along with positive pressurizing, and (4) no pressurizing. During the composting process, we accessed temperature of the compost surface using temperature probes inserted into the compost. At the end of experiment, compost samples were collected from the piles at three different depths (top, middle, bottom) and analyzed for their physical and chemical properties such as Moisture Content (MC), Organic Matter (OM), pH, Electric Conductivity (EC), Total Nitrogen (TN), Total Phosphorus (TP), and C/N ratio.

Results of experiments indicated that compost temperature was maintained at highest level (above 70°C) throughout the experimental period (639 days) in negatively pressurized pile, while temperature was maintained at high level only for 90 days and dropped to below 40°C in other piles. Physical and chemical properties of compost at different depth were very interesting. Moisture content of pile's bottom were low in positively pressurized pile (16%), compared with negatively pressurized piles (68%). At the same time, TN and TP concentrations were also low (9,117 & 4,014 mg/Kg DM) in the bottom of positively pressurized pile, compared with negatively pressurized pile's (22,553 & 13,652 mg/Kg DM).

Conclusively, some results of this experiment suggest that negatively pressurizing has some advantage over positively pressurizing when microbial activity and the compost temperature is to be maintained throughout the composting period. This superiority observed in negatively pressurized compost might be caused by vertical homogeneity of physicochemical properties. In negatively pressurized compost, MC, TN, TP, and C/N are vertically homogenous, while, those were not homogenous as moisture and other soluble components were ousted from bottom in positively pressurized pile. *This research was funded by the Rural Development Administration (Project No. PJ0135772020) Republic of Korea.*

Keywords: Composting, Livestock manure, Static pile, Moisture content

Enhanced Redox Chemical Reactions in Ice and the Role of Freeze Concentration Effect

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Most chemical reactions take place slowly as temperature goes down based on the Arrhenius Equation (*k = Aexp(-E/RT))*. However, it has been reported that several chemical processes can be accelerated by freezing. For example, it was found that the nitrite(NO_2^-) oxidation to nitrate(NO_3^-), which is very slow reaction in aqueous phase, was significantly enhanced in ice phase (about 10^5 times). Understanding of the redox conversion of chemical compounds is very important since that may control the bioavailability, mobility, toxicity, and environmental fate of chemicals. Although the redox reactions in aqueous and gaseous phase have been extensively investigated, those in frozen state have hardly been studied. In this presentation, we will introduce accelerated redox transformation of organic and inorganic compounds in ice. According to our results we believe that the accelerated chemical reactions by freezing is due to the *freeze concentration effect*. The detailed experimental conditions and mechanistic processes will be discussed in the presentation. We also discuss about the environmental implication and application of these intrinsic redox transformation in ice.

Keywords: *ice chemistry, redox reaction. freeze concentration effect, pollutants*

Development of Eco-efficient and Cost-effective Critical Metal Extraction Process from Waste LCD through Mechano-chemical Treatment

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For the industrial recycling of waste LCD glass and extraction of critical metal values like indium, eco-efficient and cost-effective critical metal extraction process need to be developed. ITO oxide is the main critical metal bearing component in the waste LCD essentially important for the circular economy of indium. Though several reports have been reported for extraction of critical metal value recovery processes for the industrial-scale indium recovery from waste LCD rarely has been developed. For efficient recovery size reduction is essential which adds cost, energy and process time, hence, for cost-efficiency determining proper size is essential, hence, a mechanical process for size reduction and classification has been developed. To optimize extraction efficiency and reduce process cost, the correlation between Indium tin oxide (ITO) leaching behaviour from waste LCD glass and cullet size has been investigated. Hence, metal leaching efficiency as a function of the cullet size of waste LCD glass has been investigated. Indium leaching parameters like; lixiviant concentration, solid-liquid ratio, the temperature of leaching reaction, agitation speed and leaching time were optimized for cost efficiency.

Keywords: Indium extraction, circular economy, waste LCD, Recycling

Decreased Odorous Compounds in Response to Evolution of a New Microbial Community in a Full-scale Swine Manure Pit Recharge System with Recirculation of Aerobic Treated Liquid Fertilizer

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One of the main emerging issues for animal manure management today includes complaints about nuisance due to odor generation. Odor complaints from residents have increased as growth in the number of large livestock facilities. In addition, since urbanization has been accelerated, urban areas are often extended to be close to existing livestock facilities, affecting the quality of human life. To date, over 100 swine farms in South Korea have been employed by PRS with recirculation of aerobic treated liquid animal manure. However, it is only believed that volatilization of these problematic substances of the pit was prevented with dilution by recirculating aerobic treated liquid animal manure while it is still very little known about the biological mechanism of odorous compounds reduction with the scientific point of view. In this study, microbial community in the pit recharge system (PRS) by recirculating liquid fertilizer (LF) was successfully established for enhancing the biodegradation of chemical components while reducing generation of odorous compounds. Accumulation of organic acid in low level in the PRS was possibly due to the dominance of *Lewinella* and *Membranicola,* which are known to convert organic compounds to CO_2 and H_2O in aerobic condition. In addition, Methannogens, responsible for converting organic acid to CH_4 in anaerobic condition, could be also involved in organic acid consumption. However, the generation of high level of H_2S in the PRS was found, which was supported by increased share of SRB. Further study may focus on analysis of microbial community with different periodical pit recharge in PRS. The mass balance analysis for verifying the efficiency of odorous compounds reduction in the PRS should be also performed.

Keywords: Microbial community, Odorous compounds, Swine manure pit recharge system, Sulfate reducing bacteria

Relationship between Increased Solubilization and Biogas Productivity of Pretreated Microalgae Waste

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It is widely known that the pretreatment of organic solid wastes increase biogas productivity in anaerobic digestion (AD) by enhancing rate of hydrolysis, which is commonly called as rate-limiting step. In this study, the relationship between increased solubilization and CH4 productivity in response to the individual pretreatment (acid and ultrasonic) and combined pretreatment conditions of microalgae waste was investigated. The ultrasonic (10-60 min), acid (HCl; pH = 1-5), and combined pretreatments (9 combinations) were applied to assess the solubilization of microalgae waste. The biological methane potential (BMP) test was then performed to assess the solubilization impact on methane (CH_4) production in the response to pretreatment. Combined pretreatment (ultrasonication: 60 min at pH = 1) was found to be a most efficient method for LEMW, the feedstock after this pretreatment had a 50% of solubilization (control 4%). In consequence, at these conditions the highest CH_4 production was achieved (1,245 mL *vs* 176 mL in control). Additionally, it has been observed that the prolonged ultrasonication and low pH increases the share of soluble non-biodegradable fraction (up to 19%). These results indicated the importance of LEMW pretreatment, but increased solubilization of LEWM did not result in enhanced CH_4 yield which contradicts the general understanding that most of the solublized fraction can be metabolized to produce CH_4 by AD.

Keywords: Anaerobic digestion, Microalgae waste, Pretreatment, Solubilization

Evaluation of Maximum of Hopping Distance of Adjacent Humic Acid Molecules as Electron Shuttle

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The redox activity of humic acids (HA) plays a crucial role in the migration and transformation of pollutants in soil. In soil micropores (under 2.5 nm) which microorganisms and large HS molecules are poorly accessible to, insoluble heavy metals and large size organic pollutants are hard to be removed. Fortunately, low molecular weight fractions (LMWF, less than 1.25 or 2.5 nm diameter) of HA have shown a quite stronger reducing capacity than bulk HA. In this study 3500-LMWF Leonardite humic acids (LHA) and 14000-LMWF LHA obtained from dialysis are able to accelerate the process of microbial reduction of ferrihydrite as electron shuttle. We found that the 3500-LMWF and 14000-LMWF LHA as electron shuttle were able to accelerate the rate of microbial ferrihydrite (Fe(III) oxyhydroxide) reduction. In contrast, no stimulation of Fe(III) reduction was observed after amendment with molecules with a size between 3,500 Da and 14,000 Da as electron shuttle. This suggests that the 3500-LMWF is the main contributing size fraction to accelerate microbial ferrihydrite reduction. Finally, a maximum distance between adjacent humus acid molecules that allowed electron hopping was calculated to be certain distance, based on an electron transfer spatial modelling. The results improve our understanding of electron hopping via LMWF humic acid molecules as electron shuttle.

Keyword: humic acid, low molecular weight fractions, redox, electron shuttle, electron hopping maximum distance

Assessing of Impact Of Redox Properties of Natural Organic Matter on Transformation of Pollutants in Groundwater

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Redox processes in groundwater play an important role in bioavailability, toxicity, and mobility of many major elements and redox-active contaminants including Fe, Mn, P and As. Redox-active organic matter, dependent on its redox potentials (Eh) and redox active functional groups (RAFGs), can catalyze the redox transformation and degradation of contaminants. Although a recent study has demonstrated that low molecular weight (LMWF) of humic substances owning great number of functional groups exhibit great reducing capacity, whether LMWF of natural organic matter (NOM) exhibit high redox capacity and the relationship between RAFGs and their Eh in these LMWF NOM remain still unclear. To this end, this study first collected LMWF from NOMs extracted from Pahokee peat soil and Leonardite soil by dialysis method. Electron exchange capacity (EEC) and RAFGs of LMWF NOMs at different Eh were analyzed using a novel electrochemical method and three-dimensional excitation emission fluorescence (3DEEM) spectroscopy. We found that approximately 5-6 times higher reducing capacity in LMWF PPNOM than bulk NOMs, while only 4.1-7.8% LMWF PPNOM was accounted for bulk NOM. An increasing in EEC (EAC + EDC) of LMWF PPNOM and LNOM with Eh reduced from -0.49 V to -0.69 V. Additionally, detected high numbers of quinone-like fluorophores in LMWF LNOM at reduced state compared to its at native state by 3DEEM is responsible for a high EAC of LMWF LNOM. An understanding of LMWF in NOM and its relationship of RAFGs and their Eh is crucial for predicting and protecting groundwater environmental health and fate of transformation and transport for redox-active contaminants in groundwater.

Keyword: Groundwater; Natural organic matter, electron exchange capacity, redox-active functional groups.

The Hybrid of Soil Exposure and Land Use Model to Access Lead Exposure Among Children in North Taiwan

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Lead (Pb) exposure increases risk of neurodevelopmental disorders in children. Children specific activities lead to elevate opportunities for intake hazards from soil. Land use scenarios may influence Pb exposure frequency to soil. Further study reported that children living in capital city was associated with higher hair Pb levels. We investigated hair Pb concentrations among children in north Taiwan, in relation to soil pollution and land use characteristics. A total of 235 healthy children less than six years old from a medical centre and regional teaching hospital were recruited from October 2010 to April 2012 and January 2018 to July 2019. Hair samples were collected and determined Pb levels using an inductively coupled plasma/mass spectrometer. Lead concentrations in soils and land use types around the children's residences were accessed by geographic information system to identify the association with hair Pb levels. We used multivariable regressions to examine the relationships of interest. The geometric mean concentration of Pb in hair of children in soil were 3.8±4.3 μg/g and 21.9±7.8 mg/kg, respectively. Hair Pb level was positive correlation with soil Pb (r=0.19, p=0.009). There are negatively related to green land use around residences and hair Pb levels. Further investigation among children in north Taiwan are warranted to identify other lead exposure sources.

Keywords: lead exposure, land use model, geographic information system, children

Effects of Particle Diameter on the Accumulation and Phytotoxicity of Platinum Nanoparticles in Hydroponic Rice Plant

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The widespread use of metallic nanomaterial have been caused people's concern for its release in soil and water with unconsciousness, and it may influence people's health through accumulation, migration and transformation by plants, especially food crops. Many researchers have focused on metal nanoparticles accumulation in crops such as Ag, TiO_2 and ZnO, however, platinum have received little concern. Metallic nanoparticles of platinum are of great scientific interest as they have many industrial and biomedical applications such as automotive catalysts. To better understand the speciation transformation of platinum nanoparticles in rice and its phytotoxicity in rice seedling in this study, uptake, translocation and speciation of Pt nanoparticles was studied with hydroponic cultivations of rice seeding under the stress from three diameter size of PtNPs (40 nm, 70 nm and 100 nm) and platinum ion with 1 mg/L, 2 mg/L and 5 mg/L. The single particle inductively coupled plasma mass spectrometry (SP-ICP-MS) was used to evaluate the nanoparticle concentration and size distribution. The extraction method of macerozyme R-10 was adopted to release the intact PtNPs from the different plant tissues, and the SP-ICP-MS technique was used to provide the information of size distribution and number concentration of PtNPs in rice tissues. To further understand the effect of physiological and biochemical indexes, the chlorophyll and carotenoid content, autioxidant enzyme activities and malondialdehyde (MDA) content of rice seeding was also evaluated. After four weeks hydroponic root exposure, our experiments results have been done to reflect the damage of deferent part of rice.

Keywords: Platinum nanoparticles, Phytotoxicity, Rice seeding, Root exposure, Single particle ICP-MS

Ammonia Emission Characteristics in Mechanically Ventilated Fattening Pig Farm in Spring

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To quantitatively analyze ammonia emissions from pig farming in South Korea, a mechanically ventilated fattening pig farm was selected and experiments were repeatedly conducted for 48 days in three rooms (Room A~C) with similar fattening conditions (Mar 1-Jun 2). All pigs were bred under the all-in/all-out production system (average 102 pigs). The floor of the pens comprised a concrete floor and a plastic slatted floor in a 1:1 ratio. The ammonia concentration was measured at 1-hour intervals at the center of the ceiling and exhaust fan using photoacoustic spectroscopy (INNOVA). Ventilation rates were collected once every minute and determined as an hourly average to compare to ammonia concentration data. The mean daily ammonia concentration of three rooms is 10.1±3.4 ppm (Room A 11.6±3.3 ppm, Room B 11.4±2.4 ppm and Room C 7.1±2.1 ppm), and the ventilation rates per pig were Room A 24.0±5.7 m^3/h·pig, Room B 24.1±5.9 m^3/h·pig and Room C 26.4±6.8 m^3/h·pig. The mean daily ammonia emissions were calculated as 4.6, 4.5, and 3.1 g/d·pig for Room A, Room B, and Room C, respectively (average 4.1 g/d·pig).

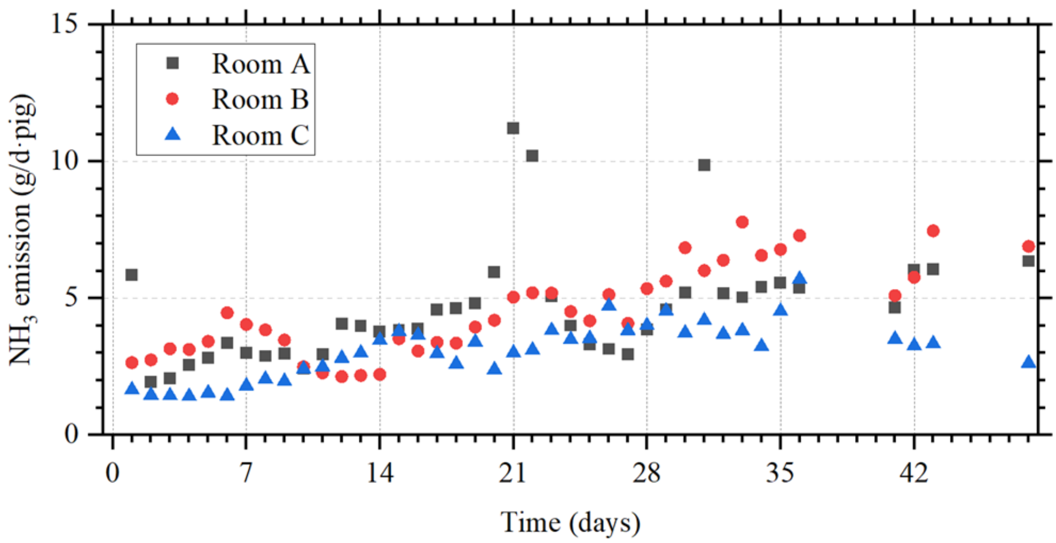

Fig. 1. Time series graphs of daily ammonia emission in Rooms A, B, and C.

Keywords: All-in/all-out, Ammonia, Emission factor, Fattening pigs, Mechanical ventilation

Effects of Loading Change and Promoters on V/MPTiO$_2$ for Selective Catalytic Reduction of NO with NH$_3$

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NO_x emission regulations have been strengthened and demands for efficient NO_x removal systems have been grown. NH_3-SCR is considered as an effectual NO_x removal technique and in particular, vanadium based catalysts are often used in SCR. Vanadium based catalysts have broad operating temperature range and are strongly resistant to sulfur and its affordable price is also advantageous. Recently, microporous titania[1] has been used as a promising support because of its noticeable benefits over the commercial titania (DT51). It obtains a larger surface area, 158.6 m^2/g, than the commercial titania, 82.47 m^2/g, restrains undesired product, N_2O and has broad performance temperature range. Due to these advantages, the catalysts supported on $MPTiO_2$ were expected to have higher NO_x conversion in low temperature than on DT51[2]. In the present study, different amounts of vanadium (3-10 wt%) and various promoters were loaded. Characterizations including NH_3-TPD and H_2-TPR were performed to investigate how the catalytic activity was effected by loading change and promoter effects.

Catalytic Co-pyrolysis of Lignocellulosic Biomass and Food Waste for Reducing the Formation of Benzene Derivatives

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In this study, metal catalyst was used to reduce the amount of benzene derivatives contained in tar obtained from the co-pyrolysis of lignocellulosic biomass (e.g., woody biomass remained after manufacturing furniture) and food waste. The pyrolysis experiments of bio-waste were performed in tube furnace at a range of temperatures from 400 to 800 °C in CO_2 and N_2 environments respectively. A gas chromatography/mass spectrometry (GC/MS) were used to identify benzene derivatives contained in product. Gas chromatography equipped with thermal conductivity detector (GC/TCD) were also utilized to identify and quantify syngas such as H_2, CO, and CH_4. The results show that catalytic pyrolysis decreased concentrations of benzene derivatives in tar compared to non-catalytic process. This is because the catalyst promotes tar cracking, it follows that increase the yield of syngas. This work offers evidence that metal catalyst helps reduce the formation of benzene derivatives and develop energy recovery from waste.

Keywords: waste treatment, co-pyrolysis, air pollution control, energy recovery

Pilot-scale Cu Recovery and Metal Removal in Plating Wastewater by a Combined System of Electrowinning and Chemical Precipitation

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Wastewater from plating industry normally contains various of toxic substances such as heavy metals, cyanides, and organic compounds. Most of the heavy metals such as copper, nickel, chromium, iron, and zinc can cause serious environmental problems when they are discharged without proper treatment. Recently, recovery of valuable metals in industrial wastewater has attracted an attention owing to limited metallic resources in the earth. In this study, pilot-scale electrowinning system combined with chemical precipitation was designed to selectively recover Cu and remove heavy metals from plating wastewater. Highly concentrated wastewater obtained from electrodialysis of plating wastewater was used for the electrowinning process. Approximately, 90% of Cu (about 1,000 mg/L) was selectively recovered from plating wastewater at a low current density of 1 mA/cm^2 after 10-h reaction. XRD analysis of the Cu deposits showed that Cu was recovered in the form of Cu metal and Cu_2O with high purity, indicating valuable for reusage in plating industry. The remaining heavy metals in plating wastewater, i.e. Fe-Cr and Ni-Zn were separately removed by chemical precipitation via formation of metal hydroxides at different pH levels. The findings in this study can provide a pilot-scale feasibility of the electrowinning system combined with chemical precipitation to achieve sustainable and economic treatment of plating wastewater.

Keywords: pilot-scale, plating wastewater, Cu recovery, metal removal, electrowinning, chemical precipitation

Vertical Pattern of Hydrocarbons in the UTLS region during the 2019 – 2020 Australian Bushfires Season

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Australian bushfire, occurred in September 2019, induces unprecedented damages. It causes huge concerns about the variation of atmospheric composition in the surrounding fire area. In this study, therefore, we investigate the vertical distribution of Hydrocarbons emitted from these bushfires, in Upper Troposphere and Lower Stratosphere (UTLS) including C_2H_2, C_2H_6, CH_3OH, HCOOH, HCHO, HCN and CO using Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS). For the research area, we determine the state of New South Wales, Queensland and Victoria which have the largest burned area so far in Australia. To figure out the status of bushfires in the research area, we first analyze the number, locations and Fire Radiative Power (FRP) of monthly active-fire pixels for the research during bushfire season (September – December, 2019) using the Moderate-Resolution Imaging Spectroradiometer (MODIS) fire products (Thermal Anomalies). Since FRP is related to the increase in the burned area rather than the number of fire pixels, we will further analyze the patterns of the burned area later. Then, we run the Hybrid Single-particle Lagrangian Integrated Trajectory (HYSPLIT) model to find the horizontally affected range of smoke plume emitted from these bushfires. In this range, we finally examine the monthly vertical pattern of hydrocarbons comparing with the climatological patterns for the pre-fire season. This comparison enables us to assess the extent to which hydrocarbons emissions from the Australian bushfires can affect the UTLS region, which is the useful information to understand the upper atmosphere chemistry of ozone and hydrocarbons in the Southern Hemisphere.

Keywords: ACE-FTS, Biomass-Burning, Australian Bushfire, Hydrocarbons (HCs)

Total Ozone Column Comparison at the King-Sejong and Jang Bogo Station, Antarctica using Ground-based and Satellites Observations

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Korea has two Antarctic stations, the King-Sejong (58.47°W, 62.13°S) and Jang Bogo station(164.23°E, 74.62°S). For the long-term monitoring of total ozone column (TOC), the ground-based Brewer Spectrophotometer (Brewer) was installed at these sites, in 1996 and 2014, respectively. Since there are also many satellites to observe the TOC over the Antarctica, we can evaluate these measurements using station's Brewer spectrophotometer. In this study, therefore, we compare the Brewer-measured TOC to the multiple satellite TOC measurements over the King-Sejong and Jang Bogo station, and examine their differences. For this purpose, we mainly conduct the correlation analysis. For example, the correlation coefficients(R) of Ozone Monitoring Instrument (OMI) TOCs with TOCs of Brewer direct sun measurements at the King-Sejong and Jang Bogo station were 0.86 and 0.96, and its slopes were 0.85 and 0.96. Using Brewer zenith sky measurements, R values were 0.88 and 0.93, and slopes were 1.00 and 0.92. Additionally, we perform the correlation analysis with TOCS from other satellite sensors, such as TROPOspheric Monitoring Instrument(TROPOMI) of Sentinel-5 Precursor satellite, Global Ozone Monitoring Experiment(GOME-2) of MetOp satellite, Ozone Mapping and Profiler Suite(OMPS) of Suomi-NPP satellite, and Atmospheric Infrared Sounder(AIRS) of Aqua satellite were used in this study, and discuss about their differences.

Keywords : Antarctic, Jang Bogo station, Ozone, Satellite

Acknowledgement

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Long Term Trend of Surface Air Pollutants in Metropolitan Cities, Korea

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South Korea got a high degree of economic expansion through rapid industrialization and urbanization, but socio-economic development caused severe environmental issues and increased health risk, especially in densely populated cities. Thus, air quality in the Korean peninsula has been a serious issue for the public and researchers. To figure out the situation of air pollution in Korea, we need to examine the long-term trend of air pollutants which have high spatiotemporal variability. Here, we investigate trends of air pollutants (PM_{10}, O_3, NO_2, SO_2 and CO) in seven metropolitan areas, Korea from 2002 to 2018 using the surface measured data provided from the AIRKOREA data archive. Trends of PM_{10}, NO_2, SO_2 and CO vary within cities (PM_{10}: -1.5~-0.1 μgm^{-3}/yr, SO_2: -0.2~0.0 ppb/yr, NO_2: -0.6~0.1 ppb/yr, CO: -21.8~-1.2 ppb/yr). Seoul metropolitan area shows the largest decrease of four pollutants. But Daejeon where is located near Seoul doesn't have clear negative trends in concentrations of pollutants. O_3 pollution gets worse (0.5~0.9 ppb/yr), especially in inland cities (Seoul, Daejeon and Gwangju). The results suggest importance of local scale emission in the long-term perspective. Comprehensively, we identified significant differences of trends according to pollutants and cities. Our study has its significance as a basic data for understanding and diagnosing air pollution. We expect our analysis to be used as a reference in establishing a policy for air quality. Establishing a long-term air quality improvement plan which is considering local characteristics will effectively reduce the damage caused by air pollution.

Keywords: air quality, aerosol, trace gas, trend, AirKorea

A novel Strategy to Control HABs by Adsorption based Technology using Cotton based Sorbent

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Harmful algal bloom (HAB) caused by cyanobacterial species like *Microcystis aeruginosa* in water resource has become a serious environmental issue due to its negative effects including secretion of cyanotoxins to water environments. To control HABs, various efforts based on physical, chemical and biological methods were investigated such as sedimentation, filtration, oxidizing agent/algicide treatment, coagulation, and UV irradiation. However, during the process of HAB control measures, cyanotoxins like microcystins (MCs) could be released into water bodies by the chemical/biological cell lysis or physical cell destruction. Therefore, a new way able to safely control HABs in water body was urgently required. In this regard, the adsorption-based method was investigated for HABs control in aqueous environment. To this end, we prepared the fabricated sorbents, polyethylenimine-modified cotton sorbent (PEI-Cotton), through the series of hydrolysis of fabricated cotton and PEI-modification process. To evaluate the removal efficiency of sorbent generated against harmful algal species and phosphorous responsible for HAB, *M. aeruginosa* was cultivated along with PEI-Cotton. With the application of PEI-cotton, cell densities of *M. aeruginosa* was significantly decreased compared to those of *M. aeruginosa* cells cultivated without sorbent. In addition, SEM analysis demonstrated that *M. aeruginosa* cells were adhered to the surface of the sorbent without cell lysis or destruction, thereby avoiding secondary contamination.

Keywords: Harmful algal bloom (HAB), Adsorption, Adsorbent, Microcystis aeruginosa, PEI modified

Development and Application of PEI(polyethylenimine) modifed sorbents to Control Harmful Alga, *Microcystis aeruginosa*

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Harmful algal bloom (HAB) has become a serious water pollution, since some microalgae secrete toxic compounds such as microcystin-LR from *Microcystis* species, anatoxin-a from *Anabaena* species and so on. So, it is urgently necessary to find a way suppressing HAB. There have been many different methods to suppress HAB including sedimentation, filtration, oxidizing agent/algicide treatment and UV sterilization and so on. However, these methods have only temporary effects causing additional secondary problems in water ecosystem. So, in this study, we attempted to develop 'adsorption' technique, directly suppressing HAB in freshwater.

Our adsorption technique has unique advantages over traditional adsorption technique. First, we designed a novel 'sorbents' made from synthetic polymer, PVC(Polyvinyl Chloride). In addition, further PEI(polyethyleneimine) modifications of functional groups on the surface of sorbent were performed to enhance the capability of 'PEI-PVC fiber'. On the process of controlling HABs, we measured cell density, T-P(Total-Phosphorous) and Microcystins concentration to confirm the sorbent's adsorption capacity. After controlling HABs on lab-scale, we did desorption and re-control test by used sorbent, PEI-PVC.

Consequently, newly designed and generated 'sorbents' were applied to control *Microcystis aeruginosa* bloom, demonstrating the possibility of our strategy against HAB

Keywords: Harmful algal bloom (HAB), Adsorption, PEI modified adsorbent, Desorption & Re-use test, PEI-PVC

Assessment of Microplastic Removal in Drinking Water Treatment Process

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The plastic particles smaller than 5 mm, called microplastics (MPs), have aroused increasing concerns in recent years as they can pose various threats to living organisms. The massive use of plastic products and inadequate management of plastic wastes lead to MPs being ubiquitously found in water bodies, including not only oceans but rivers and lakes that are the main drinking water supply sources in Korea. Despite the fact that drinking water is directly relevant to human health, little attention has been paid to the occurrence and fate of MPs in drinking water treatment plants from surface water sources. Under this frame, the present work aims to identify the removal performance of MPs at different stages (coagulation and sand filtration) of the lab-scale drinking water treatment system that derived from the purification of surface waters. We applied polystyrene (PS) particles in the size range of 10−90 μm and analyzed their mass with Raman imaging technique to estimate the removal efficiency of MPs. The results showed that the larger the particle size of PS, the higher the removal efficiency was during coagulation and sand filtration. Although PS is widely found in natural environment, other plastic materials should be considered in future research to understand their removal behaviors in water treatment system.

Keywords: Microplastics, polystyrene, drinking water treatment, coagulation, sand filtration

The Lifecycle Assessment of Livestock Manure Treatment in Korea

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As the livestock industry grows, the amount of livestock manure also increases, causing a problem of excessive nutrients in the soil. It is necessary to recovery livestock manure as resources according to environmental changes, such as prohibiting marine discharge of livestock manure and enlarging livestock industry. This study reviews Korea's current livestock manure management policies and performs environmental and energy analyses according to livestock manure treatment methods to sustain sustainable measures for livestock manure management. The facilities subjected to evaluation were purification treatment facilities and biogasification facilities which can collect and provide data for the material flow analysis. Also, purification treatment facilities that treat the wastewater produced by livestock manure treatment facilities were divided into those that specifically treat this type of wastewater and those that treat combined wastewater. The life cycle assessment of the facilities showed that biogasification facilities had a higher avoidance effect than the purification treatment facilities, showing positive avoidance effects for resource depletion, acidification, global warming, and photochemical oxide effects by using the biogas they generate as energy. In particular, concerning global warming, purification treatment facilities were found to generate about 9 times more CO_2 than biogasification facilities. The analysis on the energy substitution effect of biogasification facilities revealed that when electricity is produced from biogas (100%), about 18-24% was utilized based on energy heating value, and when steam is produced from biogas, up to 82% could be utilized. Furthermore, the greenhouse gas (GHG) reduction effect of biogasification facilities calculated based on the amount of GHGs produced during energy generation against energy input showed that GHG production can be avoided by 27-59% through utilization as biogas and by 71-202% through utilization as electricity. Therefore, to improve the energy substitution effect of biogasification facilities, it is important reflect the energy demand in the design and management of the facilities to minimize the loss of energy during conversion and combustion.

Keywords: Livestock Manure, Biogas, Environmental Analysis, Energy Analysis

Three Years of Biochar and Straw Applications to Mitigate Greenhouse Gas and to Improve Rice Productivity in a Paddy Field

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1

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A three-year field experiment (2015–2017) was carried out on rice cultivation in South Korea. The objective of this study was to evaluate and compare the effects of biochar and straw applications on rice yield, soil properties, global warming potential (GWP), and greenhouse gas intensity (GHGI) in a paddy field over a three-year period. Study treatments consisted of control (CN), barley straw biochar (BC, 2,000 kg ha^{-1}), barley straw (BS, 2,000 kg ha^{-1}), and BC+BS (each 1,000 kg ha^{-1}). The BC was applied once in 2015, while BS was applied every year. During the rice-growing season, significant interactive BC and BS treatment effects were shown compared to those from CN treatment. Relative to the CN treatment, the average rice yields in BC, BS, and BC+BS treatments were higher by 4.6%, 4.7%, and 18.7%, respectively. After final rice harvesting, BC, BS, and BC+BS treatments had lower soil bulk density values compared to that of CN treatment. Soil chemical properties (pH, Soil organic carbon (SOC), Total nitrogen (TN), and cation exchange capacity (CEC)) and microbial activity were compared among BC, BS, BC+BS, and CN treatments. Our results support the theory that biochar and straw applications to soil can improve rice yield from and soil quality in a paddy field. However, the total produced GWP from the paddy field over the three-year study increased among treatments in the order of BS, CN, BC+BS, and BC. These results clearly show the advantages and disadvantages of biochar and straw applications in a paddy environment. Based on our results, we suggest that a combination of biochar and straw applications can be the most effective approach to improving rice productivity and soil fertility while mitigating GWP and GHGI.

Keywords: Rice cultivation, Barley straw, Biochar, Global warming potential, Greenhouse gas intensity

Analysis of Changes in Pollutant Reduction Efficiency of a Rain Garden through Long-term Monitoring

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Stormwater runoff and non-point pollution source were managed through the application of LID facilities in urban areas. However, over time, facility efficiency was reduced due to the accumulation of pollutants and sediments in the LID facility, resulting to media pore clogging and decreased permeability. Therefore, Therefore, this study evaluated the long-term performance of rain garden through analyzing the characteristics and behavior of pollutants inside the facility. As a result, monitored events were characterized by rainfall depths ranging from 0.5 mm to 40.3 mm with mean antecedent dry days and average rainfall intensity of 5.46 ± 4.7 days, 5.33 ± 6.7 mm/hr, respectively. The concentration of TSS, COD, TN, and TP were 98.0 ± 32.7 mg/L, 133.6 ± 6.3 mg/L, 5.77 ± 4.05 mg/L, and TP 0.54 ± 0.03 mg/L, respectively. The five-year mean TSS removal efficiency of the system was 86%; however, it was observed that the TSS removal efficiency in 2018 only amounted to 69%, which was about 15% lower as compared with the 5-year mean removal efficiency. The decrease in TSS removal can be attributed to the high frequency of overflows in the facility during periods of high rainfall intensity which cause pore blockage or filter media clogging. The mean removal efficiency of COD, TN and TP were 90%, 76%, and 88%, respectively. Unlike TSS, the removal of nutrients and organics by the facility increased over time due to the continuous stabilization of the vegetative components and microbiological activities in the rain garden. The removal efficiency of Total Cu, Total, Cd, and Total Pb exhibited similar trend with COD and TP since heavy metals can also be removed through physical filtration and adsorption, biological mechanisms, and plant uptake. As compared with other water quality parameters, the removal efficiency of heavy metals was relatively low due to inferior uptake mechanisms of the facility's vegetative components.

Keywords: Raingarden, Removal efficiency, Sediment, Long-term monitoring

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Cu/Cu_2O-Immobilized Cellulosic Filter for Iodide Removal of Radioactive Waste

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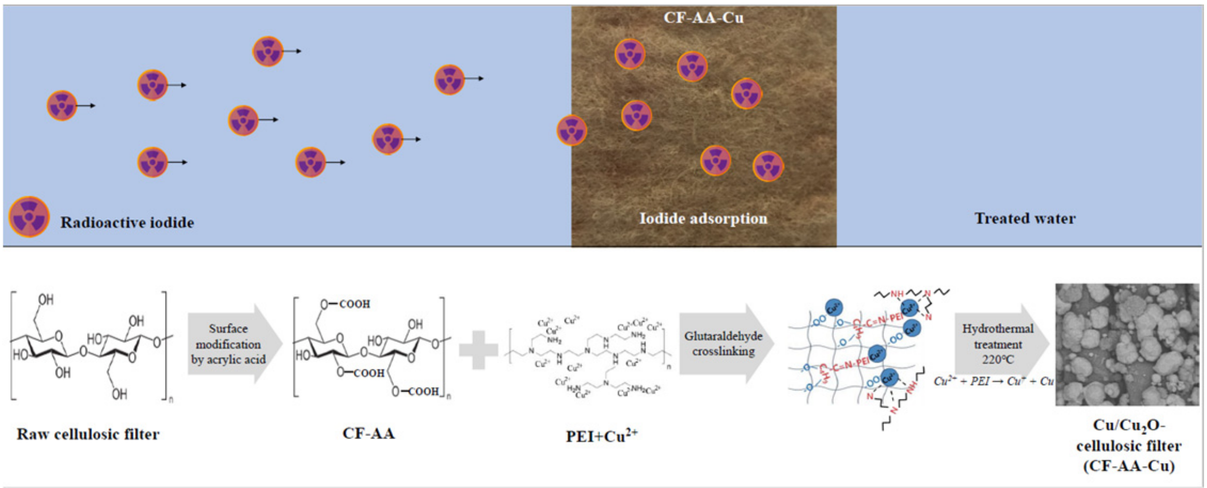
We developed a Cu/Cu_2O-immobilized filter-type adsorbent for efficient iodide anion removal. A cellulose filter (CF) was used as a support, and its surface was modified using acrylic acid to enhance copper immobilization. The modified filter (CF-AA) exhibited 10x higher copper adsorption than the unmodified filter. Cu/Cu_2O was prepared on CF-AA by using a simple hydrothermal method to obtain CF-AA-Cu, and the prepared Cu/Cu_2O was characterized with scanning electron microscopy/energy-dispersive spectroscopy, x-ray photoelectron spectroscopy, and thermogravimetric analysis. While CF and Cu_2O themselves exhibited limited iodide adsorption performance, CF-AA-Cu exhibited fast adsorption kinetics with a half-life of 60 min as well as a high adsorption capacity of 10.32 mg/g, as obtained using the Langmuir adsorption isotherm model. Moreover, it exhibited high selectivity for iodide when high concentrations of other anions were present. The adsorption mechanism was proved by means of material characterization before and after adsorption. The coexistence of Cu^0, Cu^+, and Cu^{2+} in CF-AA-Cu make it effective in broader pH conditions via the redox reaction between Cu^0 and Cu^{2+}. Overall, iodide adsorbents in the form of filters with high adsorption capacity, selectivity, ability over a wide pH range are potentially useful for the removal of iodide from water.



Keywords: Radioactive iodide, Adsorption, Cu/Cu_2O, cellulose filter, hydrothermal synthesis

This study was supported by the Creative Convergence Research Project (CAP-15-07-KICT) of the National Research Council of Science and Technology (NST).

Research on Improvement of Activity Data through Monitoring on Ammonia Emission in Agriculture Sector

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Fine particulater matter is produced by chemical reactions between various precursors. Fine particulate matter(PM-2.5) has greater human risk than Particulate matter(PM-10). Ammonia (NH_3), nitrogen oxides (NOx) are the sources of secondary generation Fine particulate matter. These substances generate Fine particulate matter through reaction in the atmosphere.

In Korea, the amount of Fine particulate matter emissions is 20.3 thousand tons in the agricultural sector. Particulate matter emission is generated during heating, Biomass burning, and agricultural machine in agricultural areas. Ammonia is emission from fertilizer and livestock manure.

The ammonia concentration, emission characteristics and emissions in the agricultural sector are not clear. In addition, the conversion rate of Fine particulate matter(from ammonia produced in the fields of livestock manure, chemical fertilizer, and compost is not clear. In order to reduce Fine particulate matter generated in agricultural areas, it is necessary to examine the emission characteristics and concentration of ammonia.

In this study, an ammonia monitoring system in agricultural areas (Farm) was established and measured To analyze the ammonia emission characteristics.

Keywords: Fine particulater matter, Ammonia, secondary generation Fine particulate matter, monitoring, Emission

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Evaluation of Heavy Metal Uptake of Different Plants in LID Systems

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Non-point pollutants, such as heavy metals, organic matter, and non-biodegradable organics transported during rainfall events can adversely affect soil and water quality. Low impact development (LID) technique is a type nature-based solution (NBS) utilized to promote effective urban water circulation. LID facilities utilize physico-chemical and biological treatment to reduce pollutant concentrations form different runoff sources. In particular, plants provide significant contribution in pollutant reduction through phytoremediation mechanism. This study was conducted to determine the heavy metal uptake capabilities of plants in LID systems and to determine the adverse effects of heavy metals in different types of LID vegetation. Bridal wreath (*Spiraea fritschiana*) and Dianthus (*Dianthus chinensis*) were collected from an LID facility installed at Kongju National University, Cheonan Campus. The plant organs were separated and oven dried at 40°C for one week. The dried samples were analyzed using inductive coupled plasma atomic emission spectroscopy to quantify different heavy metal species in the plant organs (Kalra et al., 1997). The heavy metals examined include, chromium (Cr), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), and lead (Pb). According to the analysis, the concentration of heavy metals, excluding Fe, is high in both Dianthus and Bridal wreath in LID facilities. In particular, the concentration of Zn in the Dianthus collected in the LID facility was 160.5 mg/kg in the roots and 125.6 mg/kg in the leaves. On the other hand, lower concentrations were found in the control group, with concentrations amounting 48.9 mg/kg in the roots and 33.6 mg/kg in the leaves. Similar observation was found for the Bridal Wreath. The Zn concentration in the stem and branches of the Bridal Wreath harvested in LID facilities were 195.1 mg/kg and 243.2 mg/kg, respectively, whereas the concentration of Zn in the stem and branches of Bridal Wreath control group only amounted to 50.7 mg/kg and 46.1 mg/kg, respectively. In terms of different plant organs, the Fe concentration in the roots of Dianthus (3804.5 mg/kg to 3612.1mg/kg) was found to be greater than that of the leaves (1176.9mg/kg to 1443.7mg/kg). Overall, this study was essential in evaluating the heavy metal accumulation potential of different plant species in LID facilities.

Keywords: Heavy Metal, Low Impact Development, Vegetation

Acknowledgement: This work was supported by Korea Environment Industry & Technology Institute(KEITI) through Public Technology Program based on Environmental Policy Project, funded by Korea Ministry of Environment(MOE)(2016000200002)

Assessment of the Microbiological Components in HSSF constructed wetland through Long-Term Monitoring

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The constructed wetlands' pollutant treatment mechanisms including uptake of plants, microbial fixation, adsorption to soil and filter media, and biological activities of plants and microorganisms affect the mass circulation in water bodies. This study provided an ecological LID design by understanding the mechanisms for restoring ecosystem services through the results of long-term monitoring of constructed wetlands. A constructed wetland receiving storm water runoff from roads and parking lots has been monitored from 2010 up to present. In addition to water and soil samples collection, monthly monitoring of plant growth and chlorophyll data were also conducted. Soil samples were also analyzed for microbial content. The number of microorganisms collected from influent and effluent were 39,600 and 26,800, respectively. On the other hand, the vegetated part of the constructed wetland showed the highest amount of microorganisms amounting to 48,900. Symbiosis between bacterial and vegetation roots inside the constructed wetland affected the microorganism count inside the facility. *Proteobacteria*, a microorganism that influences plants, accounted for 36% of the total microorganism count. The high specific gravity of *Proteobacteria* contributed a large effect on nitrogen reduction and vegetation growth in the facility. The percentage of *Actinobacteria* in the total microbial count was found to be 16% and 12% in the influent and effluent, respectively. On the other hand, *Acidobacteria* accounted for 12% and 10% of the microorganism weight in the influent and effluent, respectively. *Proteobacteria, Actinobacteria* and *Acidobacteria* was accounted for about 60% of total microorganisms in the constructed wetlands. These findings implied that the dominant microorganism species found in the wetlands were *Proteobacteria, Actinobacteria* and *Acidobacteria.*

Keywords: BEEM 2020, abstract template

Behaviour and Removal Mechanism of Ultra-fine Microplastics in Filtration Process

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Plastic has been used in many fields because of its lightweight, durability, and low cost. Recently, plastics have attracted attention all over the world due to the wide range of waste distribution and potential toxicity. Microplastics refer to plastics less than 5 mm in length or diameter, and most microplastics are currently removed from water treatment facilities. However, microplastics with a size of less than 100 μm are not effectively removed in the current water treatment process, and in the case of ultrafine microplastics with a size of less than 10 μm, the current research is also insufficient. Therefore, this study investigated the behavior and removal mechanism of ultra-fine microplastics with a size of less than 10 μm in the filtration process. The experiment was conducted using PE(Polyethylene) particles having a size of less than 10 μm. The surfactant (Tween 20) was used for dispersing PE in deionized water. Sand and activated carbon were used as filter media in the filtration process. The effect of each media and surfactant was investigated. The removal efficiency was evaluated through particle size analysis and turbidity analysis. The high removal efficiency was obtained in the case of activated carbon. It was due to the adsorption of the surfactant, subsequently reducing the stability of the microplastic. In contrast, the stability was maintained in the sand filter because the surfactant was not effectively removed. Therefore, it is necessary to fully understand the interaction between the surfactant attached to the MP surface and the removal process in order to remove MP in the water treatment process effectively.

Keywords: Filtration, Microplastic, Polyethylene, Surfactants

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Preparation of Biochar from Industrial Waste Bacterial Biomass and Application as an Adsorbent for Heavy Metal Removal in Aqueous Solution

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Biochar is a carbon-based material converted from various biomaterials (wood, manure, and leaves, etc.) under high temperature and oxygen-limited condition. It has been showed the potential as an efficient and ecological adsorbent for heavy metal removal because of their pore and functional groups properties. In the present study, bacterial biomasses (*Escherichia coli* and *Corynebacterium glutamicum*) that generated as a waste from industrial fermentation process for amino acids production were used for biochar adsorbents for removal/recover heavy metal resource, copper (Cu) from aqueous solutions. The conversion temperature and time for biochar production were significantly affected to yield and adsorption capacity of biochars. To evaluate Cu sorption performances of converted biochars, experimental investigations such as pH effect, isotherms, kinetics and reusability were carried out. In addition, to enhanced sorption capacity of biochars, various surface activation methods (oxidation and ionic polymer-coating, etc.) were applied, and the Cu sorption capacities of surface activated biochars were compared.

Keywords: Biochar, Bacterial biomass, Heavy metals, Adsorption, Industrial wastes

Application of Biochar based on of Feedstock to Reduce the Risk Posed by Organic Contaminants

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Food wastes with their increasing amount have been both social and environmental concerns. In South Korea, the major treatment process of food wastes is conversion into feedstock and compost as incineration and landfill of food wastes have been legally prohibited. However, feedstock and compost produced from food wastes have not been fully utilized due to high chlorine contents. In this study, we produced biochar based on those feedstock by using pyrolysis and relevant treatment procedures with aim of reducing any risks posed by organic contaminants. With pyrolysis under varying conditions (e.g., temperature, pH, and chemical treatments), physico-chemical properties of produced biochar was characterized. Sorption behaviour of target contaminants to biochar was investigated and their partition coefficients were determined. Sorption performance of biochar will contribute to environmental remediation by efficiently remove organic contaminants from environmental matrix.

Keywords: Food waste, risk assessment, biochar, feedstock, pyrolysis

Acknowledgements: This study is financially supported by Korea Institute of Civil Engineering and Building Technology (KICT) (project number: 2020166-001)

Freezing-enhanced Reduction of Hexavalent Chromium by Coffee and Tea Waste

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Chromium, one of the major heavy metals, is released to the environment by various industries (e.g., electroplating, leather tanning, and steelmaking). It mainly exists in the environment as trivalent chromium (Cr(III)) and hexavalent chromium (Cr(VI)). Although Cr(III) is consider as an essential element in human, plant, and animal metabolism, Cr(VI) is recognized as a hazardous substance due to its carcinogenicity. Therefore, Cr(VI) should be treated to reduce environmental risk before releasing to the environment. Coffee and tea, most worldwide-consumed beverages, have been sold with the average of many billion cups daily. As a consequence, large amounts of coffee and tea wastes are produced, and these wastes have attracted interest as a potential material for remediating Cr(VI)-contaminated water as a reductant because they still contain large amounts of organic compounds such as polyphenols (antioxidant). Although coffee and tea waste have been demonstrated to be removal of Cr(VI), its actual performance is still lower than that of conventional materials. Recently, it was reported that the redox conversion and ion dissolution from solid particles are dramatically enhanced during freezing process due to the freeze concentration effect in the ice grain boundary. In this work, we studied the freezing-enhanced reduction of Cr(VI) in the presence of coffee and tea waste. According to this research, the Cr(VI) reduction was significantly enhanced in ice (-20 ^{o}C), whereas the efficiency was low in water (25 ^{o}C) The detailed experimental conditions and mechanism will be discussed in the presentation. We also discuss the environmental implication and application.

Keywords: Ice, Freezing concentration effect, Coffee ground, Tea waste, Hexavalent chromium

Carbon Nanotubes Reinforced Electrospun Sorbent for Spilled Oil in Ocean

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Industrial oily wastewater discharge and oil spill in the ocean often cause the severe contamination of marine environment. There are several methods to clean-up oil spill at sea; using oil booms, skimmers, detergents, manual labor and sorbents, burning in-situ, and bioremedation etc. However, existing sorbent is not reusable and its adsorption capacity is not high. In this study, carbon nanotubes (CNTs)-based oil sorbents that can effectively adsorb the oil were fabricated and tested for oil sorption as well as desorption. CNTs/polymer composite nanofiber film type oil adsorbent was produced using a simple electrospinning. Oil sorption efficiency was evaluated with different CNTs sources and concentrations to find optimal CNTs and its concentration. Sorption test was conducted at different NaCl concentrations to study the effect of salt on the oil sorption. In addition, resistance heating was applied for oil desorption and then reusability test was conducted. The marine environment will be protected by using the conductive CNTs based oil adsorbent when the oil spill is occurred.

Keywords: oil spill, carbon nanotubes, sorbent, reusability, electrospinning

Advanced Wastewater Reclamation Method with Ferrate for Water Reuse in Direct Contact with Human

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Membrane-bioreactor (MBR) process is an increasingly used to wastewater treatment because it produces high quality effluent, which can be used for water reuse. However, compared to organic removal, biological nutrient removal is more difficult to acheive with the MBR, and phosporus (P) is the most difficult one to remove. To remove residual P, additional processes including coagulation, mixing, activated carbon processes, filtration, etc. are required. In this study, ferrate was used to remove mainly organic and P residual after the MBR process by advanced coaguation and oxidation. In addition, ferrate can be acted as a disinfectant to quench the microbes released to water environment. The experiment was conducted to find the optimal conditions for the *in situ* formation of ferrate by injecting different concentrations of NaOCl and Fe^{3+} using a jar tester at neutral pH level. In addition, performances of two different separation modes; sedimentation and dissolved air floatation processes were compared in terms of organic and P removal efficiency. The results showed that the quality of effluent treated by ferrate met the water reuse standards. Therefore, the ferrate treated MBR effluent can be used for water reuse in direct contact to human by eliminating microbial growth potential (organic, P and microorganisms).

Keywords: membrane bioreactor, ferrate, floccuation, oxidation, water reuse

Indoor Fine Dust Control using Membrane Distillation with Liquid Desiccant Cycle

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Recently, the indoor air purification and dehumidification market is growing with an increased interest in a pleasant environment and public health. In this study, liquid dessiccant (LD) was applied to dehumidify from indoor air and to capture the fine dust during the dehumidification. After the dehumidification, LD diluted by water in the air was re-concentrated and regenerated using membrane distillation (MD) process. Two different LDs (LiCl and $CaCl_2$) were tested in terms of dehumidification rate at different concentrations. LD's regeneration performance was evaluated using a simple direct contact MD depending on fine dust size and concentration. This system can be used as a device to improve the air quality of a building by removing fine dust and controlling humidity. Ultimatively, a pleasant and healthy living environment can be created with additional heating and cooling effects.

Keywords: liquid desiccant, fine dust, air purification, membrane distillation, reactive membrane.

Fabrication of Novel Phase Inversed Feed Spacer in Reverse Osmosis to Mitigate Fouling

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Reverse osmosis (RO) membrane has been widely used to produce pure water for desalination process. Among various of the configurations for a RO module, spiral-wound module configuration is mainly employed. Feed spacer which placed between the membranes is considered a crucial component of the RO module for creating feed channel. The spacer affects cross flow velocity and pressure drop and finally produces highly purified water. However, the fouling can be exacerbated at an interfacial effective area formed between spacer and membrane. Furthermore, spacer occupies part of RO membrane surface that may undo the advantages on water productivity by spacer. Numerous studies have been carried out on coating the spacer surface with the anti-bacterial compounds and modifying the geometry of spacer to reduce fouling on the spacer. Some convincing results from both surface and geometry modifications, however, study on long term effect and practicality on large scale of the modified spacers has been limited. In this study, novel phase inversed spacer is proposed to minimize the spacer surface area occupying the membrane surface and increases the hydrophilicity of the spacer surface. To enhance the applicability in large scale, phase inversion technology which can be add to the RO membrane operation was used. The geometry of the spacer was further analysed with CFD to optimize the flow to mitigate fouling and reduce pressure loss.

Keywords: Phase inversion, feed spacer, reverse osmosis, biofouling

Development of Metal Organic Frameworks (MOFs)-based Adsorbents for Clofibric Acid Removal: Modification of Porosity and Acidity and Its Impact on Removal Efficiency

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Pharmaceutical and personal care products (PPCPs), generated from personal health and cosmetic usages, are of emerging concerns, as they pose adverse impacts towards the ecosystem and are frequently detected in the environment. Among various PPCPs, clofibric acid is known to be a highly toxic substance that interferes with the synthesis of cholesterol, thus is considered as a potential endocrine disruptor. The removal of PPCPs via adsorption process has gained attention for its simplicity and cost-effectiveness. However, studies related to clofibric acid adsorption are limited. In this study, an effective adsorbent for clofibric acid based on the metal organic frameworks (MOFs) is to be suggested. MOFs-based materials can be simply modified by linking various organic ligands to the center metal ion, therefore, their properties such as porosities and acidities could be easily adjusted. Four different organic linkers, terephthalate (Benzene-1,4-dicarboxylic acid; BDC), BDC-(COOH)2, BDC-NH2, and 1,3,5-tris(4-carboxyphenyl)benzene (BTB), were incorporated with iron (Fe) as the center metal ion, to obtain four MOFs that have various porosities and acidities. Scanning electron microscopy (SEM), X-ray diffraction (XRD), and Fourier-transform infrared spectroscopy (FTIR) proved the successful fabrication of four MOFs-based adsorbents. Adsorption kinetics and isotherms of clofibric acid are to be studied using the four synthesized adsorbents. By comparing the adsorption kinetics and capacities of the four adsorbents, the effect of porosity and acidity on the adsorption of clofibric acid will be evaluated. Furthermore, the effect of pH and competing ions on the adsorption efficiencies by four adsorbents will be examined. Based on the adsorption experiments, the most effective adsorbent for clofibric acid removal will be selected.

Keywords: Adsorptive removal, Metal Organic Framework (MOF), Pharmaceutical and Personal Care Products (PPCPs), Emerging contaminants

Hydrogeochemical Investigation for the Development of an Integrated Subsurface Model

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Integrated subsurface models are required to assess the fate and transport of contaminants in the subsurface environment. We are obtaining the physical, chemical and biological property data from soils, groundwater and rocks to construct an integrated subsurface model for a testbed site, which had been used for agriculture and livestock farming. Hydrochemical investigation is also conducted in the testbed site. So far, six sampling campaigns had been performed quarterly, which indicate the following hydrogeochemical characteristics: (1) High NO_3 concentrations (43.9 ± 15.0 mg/L; 6.1–77.3 mg/L; n=45) were observed; (2) high NO_3 was observed in the bedrock groundwater (esp. BH-2 and BH-4) as well, although the shallow groundwater (49.2 ± 13.4 mg/L; 24.3–72.4 mg/L; n=20) had higher levels than the bedrock groundwater (38.6 ± 16.9 mg/L; 6.1–77.3 mg/L; n=19); (3) $\delta^{15}N$ and $\delta^{18}O$ of nitrate indicated the nitrate derived from manure and/or sewage and denitrification occurring in the bedrock aquifer; (4) despite the denitrification, the high NO_3 levels were steady in the bedrock aquifer for one and half year, which implies that the nitrate inflow was undergoing and exceeded the denitrification in the bedrock aquifer; (5) the nitrate at this depth (> 80 m) was probably recharged along the regional groundwater flow path from sources out of the testbed site; (6) whereas the nitrogen inflow through fractures from contamination sources (e.g., livestock and agriculture) within the testbed site cannot be excluded because manure-borne E. coli, NH_3 and NO_2 were detected in the bedrock groundwater (esp. BH-1); (7) δD and $\delta^{18}O$ of water were not different between the shallow and bedrock groundwater and indicated the groundwater mixing in the subsurface environment, consistent with the water type of Ca-HCO_3 and Ca-NO_3+Cl regardless of depth; (8) factor analysis indicated four major hydrogeochemical processes: water-rock interaction controlling pH, Cl, As, U, Li and Rb; water-rock interaction enhanced by nitrate contamination controlling major ions; nitrate influx into the reducing condition affecting Fe^{2+}, NH_3-N, Fe_{total}, Mn_{total} and Mo; water-rock interaction controlling K, Al and Ti. These hydrogeochemical characteristics will be used to verify the integrated subsurface model for the testbed site. <Acknowledgement> This research was supported by Korea Environmental Industry and Technology Institute (KEITI) through Subsurface Environmental Management (SEM) Project funded by Korea Ministry of Environment (MOE) (2018002440002).

Extreme Spatial Variability of Geogenic Soil CO_2 Flux in Non-Volcanic and Seismically Inactive Area

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Spatial variability of geogenic soil CO_2 flux was intensively investigated at intervals of tens of centimeters, and the causes of spatial variability were discussed based on the geophysical properties in a natural CO_2 emission site. In the study area which has no volcanic activities and is seismically inactive, CO_2-rich water discontinuously occurs and high CO_2 fluxes were reported in a point close a CO_2-rich well (w-2). The intensive CO_2 flux measurement confirmed that extremely high CO_2 fluxes occur in a narrow area close to w-2, whereas high fluxes were not observed close to other CO_2-rich wells or springs. The topographic analysis indicated that the study area is a catchment into which surface water converges, and CO_2-rich water occurs where northwest-southeast and northeast-southwest trending lineaments are developed. The 2D electrical resistivity distributions showed a vertical zone with low electrical resistivity (< 500 Ω-m) below the high CO_2 flux area, implying a vertical fracture zone. The weathered soil layer was thick up to 30 m below w-2. Besides, layers with high electrical resistivity were observed in the deep part below w-2, which seemed to play a role of cap rocks, trapping the deep-seated CO_2. Then the trapped CO_2 gas seemed to be either dissolved in shallow groundwater or moved upward to the surface through highly weathered fractures. Ground-penetrating radar (GPR) images showed monocline or anticline structures in the weathered rock layer below the CO_2-rich wells, probably due to the buoyant force in relation to gaseous CO_2. Based on the study result, the extremely high CO_2 fluxes in a narrow area can be explained with the following emission scenario: the deep-seated CO_2 moves upward along permeable layers formed with foliations and joints in gneiss and granite, and is trapped below the dome-shaped weathered rock layer with high electrical resistivity. Then some of the trapped CO_2 moves upward through highly weathered fractures, while the other may dissolve in shallow groundwater and discharge as CO_2-rich springs [Acknowledgement] This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MEST) (No. 2019R1A2C1084297).

Keywords: soil CO_2 flux; hot spot; electrical resistivity; ground-penetrating radar; emission scenario

Evaluation of the Applicability of Ecological LID technology in an Urban Regeneration Project

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Industrialized cities with high population densities experience difficulties in adapting to environmental conditions subjected to climate change. At present, urban regeneration projects, low impact development (LID) schemes, and urban resilience policies have been developed in order to solve this current scenario; however, the linkage between the urban regeneration, LID, and urban resilience to promote a multifunctional services are yet to be realized. This study mainly focused on the urban indentity of various LID techniques to enhance the urban water environment, restore ecological functions, and preserve the cultural identity of various urban regeneration project areas. The traditional market and park were considered as the highly utilized amenities in the study area. In coordination with the community center, the government plans to introduce ecological engineering strategies and urban regeneration projects to reduce high pollutant concentrations in the study area. The site covered by the urban regeneration project has a total land area of 3,500m^2, average water depth of 0.75m, and a processing capacity of 1500m^3. Generally, the urban regeneration project was able to reduce pollutant concentrations in the 5-hectare basin area and improve the overall quality of life among the residents. The SWMM-LID model was utilized in order to evaluate the effectiveness of LID facilities in reducing pollutant concentrations in the study area. Based on the result, the facilities were able to reduce the surface runoff volume, BOD, total nitrogen, and total phosphorus concentrations by 37.8%, 58%, 40.5% and 64.9%, respectively.

Keywords: urban identity, LID, urban regeneration, urban resilience, urban basin.

Effects of Plastic Mulch on Soil Properties and Crop Productivity in Agroecosystems

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Over the last few decades, plastic mulch has been widely implemented to attain high crop productivity against threatened food security. Due to improper disposal, the plastic mulches are often left in agroecosystems and broken down into small plastic particles. Despite the emerging accumulation of these particles in agricultural soils, their environmental impacts have been rarely explored, particularly on soil and crop. The objective of this research was to evaluate the changes of soil properties and crop growth in response to the plastic particles originating from the plastic mulches. First, based on environmentally relevant concentrations, soil microcosm experiments were designed in the presence of micro-sized plastic mulches by different doses (i.e., 1%, 3%, 5%, and 7%), and subsequently, the long-lasting fate of plastic mulch in soils was estimated under field conditions through measurement of soil physicochemical and biological properties. In addition, the soybean (*Glycine max*) were grown on the plastic mulch accumulated soils to assess crop productivity using growth parameters and photosynthetic characteristics. This work was carried out with the support of "Cooperative Research Program for Agriculture Science and Technology Development (Effect of plastic mulch wastes on crop productivity and agro-environment, project no. PJ01475801)" Rural Development Administration, Republic of Korea.

Keywords: plastic mulches, food security, soil properties, crop productivity, agroecosystems

Immobilization of Pb in Contaminated Soils with Standard Biochars

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This study evaluated the lead (Pb) immobilization efficiency of standard biochar in Pb contaminated soil along with different capacities that it demonstrated. Biochar has been identified as an efficient material for heavy metal immobilization in soils. The Standard biochar which produced from UKBRC (UK Biochar Research Centre) was selected in this study. It is a set of biochar pyrolyzed under perfectly controlled conditions and provided to biochar research groups worldwide, providing the standardized reference of biochar to researchers. Ten kinds of Standard biochar that derived from five kinds of feedstocks and each pyrolyzed at 550℃ and 700℃ (Softwood 550/700, Miscanthus straw 550/700, Rice husk 550/700, Oilseed Rape straw 550/700, Wheat straw 550/700) were applied to the microcosm experiment. The microcosm was comprised of 100 g of Pb contaminated soil and 2.5% (w w^{-1}) biochar treatments in 70% of water holding capacity. The incubation lasted for 21 days at room temperature. The soil samples were analysed for pH, EC (electric conductivity), total nitrogen, organic matter contents, exchangeable cations and available Pb. As a result, except few biochar treated soils, soil pH increased from 6.0 to 7.0 and EC also increased from 0.0805 dS/m to 0.2707 dS/m. The largest increase of pH and EC was found with OSR 700 treatment. Correspondingly, OSR 700 treated soil showed the greatest content of both exchangeable cations and available Pb. It suggests that OSR 700 is the most efficient biochar on Pb immobilization in soil, while most of the Standard biochar treatments performed Pb immobilization with different range. The result improves and supports the research using Standard biochar as a heavy metal immobilization. This work was carried out with the support of "Cooperative Research Program for Agriculture Science and Technology Development (Effects of plastic mulch wastes on crop productivity and agro-environment, Project No. PJ01475801)" Rural Development Administration, Republic of Korea.

Keywords: Lead contamination, Heavy metal immobilization, Biochar amendment, Standard Biochar, Soil remediation

Estimation of the Available Energy Potential from Woody Biomass and Policy Suggestion

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This study estimates the amount of domestically available energy potential from woody biomass in the future. In the power sector, the RPS (Renewable Portfolio Standards) have been implemented from 2012 and in the transport sector, the RFS (Renewable Fuel Standard) has been enforced from 2015. However, renewable energy policy in the heat sector has not provided a standard yet. Therefore, the RHO (Renewable Heat Obligation) that obligates the use of fixed amount of renewable energy such as biomass, solar heat and geothermal energy as heating fuel is going to be implemented soon.

In particular, bioenergy has the potential to promote the efficient use of a variety of organic wastes and biomass resources. However, little research has been carried out regarding the domestic energy potential and contribution level of woody waste and biomass for RHO.

The target sources of the RHO can include solar, biomass and geothermal heat. And solar energy accounts for about 5% and geothermal energy accounts for about 16% of total renewable heat energy supply. Meanwhile, woody biomass such as wood chips and pellets represents about 80% of the total. In this study, woody biomass was classified into wood wastes, by-product and unpolluted wood and the amount of woody biomass available for heat energy was estimated.

For the preparation of the RHO, it is necessary to develop additionally available energy resources in anticipation of growth in future demand. In particular, forest residues are generated in a much higher volume than other woody biomass and contain fewer impurities. At present, it is difficult to use them effectively due to high collection cost and institutional problems. Once these issues are addressed, domestic self-sufficiency of fuel could be greatly improved by better utilizing forest residues. In addition, the information on the supply chain of waste wood fuel produced through processing needs to be managed.

Keywords: Renewable Heat Obligation (RHO), Woody Biomass, Bioenergy Potential

Impact of Endospore Forming Bacteria on Treatment Performance in Food-waste Recycling Wastewater Treatment Process

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Food-waste recycling wastewater (FRW) treatment process was developed using endospore forming bacteria under decreasing aeration condition. Four kinds of Bacillus species (*B. subtilis, B. licheniformis, B. mycoides, B. thuringiensis*) were applied for the treatment of FRW in lab-scale system. The FRW treatment process was operated for 200 days which influent concentration was maintained as 30,000 mg BOD/L and a 2 L/d of FRW flowed into the system. Dominance of endospore forming bacteria was achieved (< 65%) by an addition of *Bacillus* broth continuously. Carbohydrates, lipids, proteins, nitrogen and phosphorus in FRW were removed 99.4, 94.0, 86.9, 80.9 and 96.5%, respectively. Produced sludge has been contained endospore forming bacteria that can be recycled as a soil conditioner. Our result shows that FRW treatment system using endospore forming bacteria could be an echo-friendly alternative for promising FRW treatment.

Keywords: endospore forming bacteria, food-waste recycling wastewater

Factors Affecting Microplastic Retention in Terrestrial Environment

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Fate of microplastics (MPs) in terrestrial environment is barely studied and explicit description of the transport behaviour in variably saturated porous media is largely unknown due to their random dispersion, and difficulties of detection. To understand the fate of MPs in porous media, combined reactive transport modelling and 1-D column experiments were conducted with the aid of non-destructive X-ray technique.

A transport model for MPs is constructed based on the advection-dispersion-reaction equation modified with colloid filtration theory (CFT). By combining MP-specific reaction coefficients (i.e., attachment, detachment, and straining, etc…) from bench-scale experiment, a depth-profiles with respect to various conditions (different particle size, rainfall rate, and co-existing substances) could be effectively simulated, which will be validated with the following column experiments; a series of column experiments are designed with different operational conditions and retained MPs in the each column are monitored to compare their depth profiles.

Based on the preliminary simulations, a depth profiles of MPs were mostly hyperexponential, whereas nonmonotonic distribution was also observed in the presence of co-existing substance. Straining coefficient is known to be the most important parameter of conventional colloids transport in subsurface, however, retention profile of MPs in this study showed that additional mechanisms such as (homo/hetero) aggregation needs to be also prudently considered.

Dos and Don'Ts in the Design of Indoor Air Quality Studies on Smoke-free Products

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Indoor air quality (IAQ) studies on smoke-free products (SFP), such as heated tobacco products and e-cigarettes, have demonstrated substantial reduction of environmental emissions compared with cigarette smoking. IAQ studies on these products involve measurement of common airborne markers (volatile organic compounds and particulate matter) together with specific tracers such as nicotine. Although indoor environments are typically free of such specific tracers, they naturally contain certain levels of the general markers depending on human occupancy and activities. Accordingly, assessment of environmental aerosols of SFPs requires evaluation of confounding sources of pollution (e.g., study participants). Likewise, for studies in real-life environments, the impact of different daily life and recreational activities must be investigated.

To assess the influence of these parameters on the concentrations of selected airborne constituents, we performed a study under simulated residential conditions in an environmentally controlled exposure room. The human subjects either remained for a certain time in the exposure room or participated in predefined activities such as drinking wine or using toiletries. Each activity was assessed separately by using our analytical platform and exposure room under controlled environmental conditions.

The results showed that prolonged human presence and activities indoors led to an increase in the levels of several airborne constituents. This enforces the importance for specific experimental requirements for IAQ assessment of SFPs. Accordingly, simply using "empty room air" as the background is insufficient; it is essential to use "room air" obtained in the presence of the same number of panelists doing the same activities as those during the sessions with SFPs. When experiments with SFPs are performed in real-life conditions (restaurant, bars, etc.), it is crucial to carefully monitor the activities (drinking, dancing, cooking, and serving hot food) during measurement as well as the levels of constituents in outdoor air for proper interpretation of the results.

Keywords: smoke-free products, volatile organic compounds, particulate matter, human presence, human activities e

Human Chemical Signature — Investigating the Influence of Human Presence and Selected Activities on Concentrations of Airborne Constituents

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There is increasing evidence that the very presence of human beings in an enclosed environment can impact the quality of the air via emissions from exhaled breath and other biological excretes released into air. This influence increases considerably when humans perform different recreational and daily life activities. To understand the influence of these parameters on the concentrations of selected airborne constituents, we performed a study under simulated residential conditions in an environmentally controlled exposure room. The subjects either remained for a certain time in the exposure room or participated in predefined activities (drinking wine, doing sport, using toiletries, cooking, and serving hot food). Each activity was assessed separately by using our analytical platform and exposure room under controlled environmental conditions.

The results showed that prolonged human presence leads to increased levels of isoprene, total volatile organic compounds (TVOC), formaldehyde, and acetaldehyde. These outcomes were further supported by the results of meta-analysis of data acquired during 2-year period.

The indoor concentrations of several of the selected constituents rose when certain activities were performed. An increase in the indoor levels of acetaldehyde was observed in all tested conditions, and this increase was especially notable during the wine drinking and cooking sessions. Serving hot fried food led to an increase in the indoor concentrations of acetaldehyde, formaldehyde, and ultra-fine particles. TVOC concentrations increased in all experiments. Few constituents identified in the TVOC trace were specific to a given type of experiment (e.g., fusel alcohols for the wine drinking session). In contrast, most compounds in the TVOC trace simply had different patterns of increase; for example, methylcyclosiloxane had the highest concentration in the session where toiletries were used.

In conclusion, prolonged human residence indoors and some recreational and daily living activities cause substantial emission of several airborne pollutants under ventilation typical for residential environments.

Keywords: indoor air quality, volatile organic compounds, carbonyls, particulate matter

Magnetically Separable bismuth Oxyiodide/Magnetite Photocatalyst for Bisphenol A Removal under Solar Light

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Magnetic bismuth oxyiodide/magnetite ($BiOI/Fe_3O_4$) composites were synthesized by interaction between BiOI and Fe_3O_4 in hydrothermal reaction. The prepared $BiOI/Fe_3O_4$ composites were characterized by various technologies including X-ray diffractometer, Fourier-transform infrared spectrophotometer, energy dispersive X-ray spectrometer, diffuse reflectance UV-vis spectrophotometer, Brunauer–Emmett–Teller method, and vibrating sample magnetometer. The photocatalyst was applied to bisphenol A (BPA) removal from aqueous solution under simulated solar light. The mass ratio of Fe_3O_4 in $BiOI/Fe_3O_4$ substantially affected BPA degradation; with the obtained $BiOI/Fe_3O_4$ (4:2) ratio in the composite, a complete removal of BPA was achieved within 30 min. The optimum operating conditions were 1.0 g/L catalyst dosage, 10 mg/L initial BPA concentration, and pH 7. The main reactive oxygen species were verified to superoxide radicals and holes in oxidative species experiments and the reusability of magnetic $BiOI/Fe_3O_4$ was tested through recycling experiments. The derivatives in $BiOI/Fe_3O_4$ photocatalytic system were investigated and a possible BPA degradation pathway was proposed. These results showed that the $BiOI/Fe_3O_4$ composite has great potential for BPA removal from practical wastewater.

Keywords: Bismuth oxyiodide, Photocatalysis, Solar light, Magnetic separation, Bisphenol A

Stabilization of Mercury and Arsenic Contaminated Soil Using a Combination of Hydrated Lime, Steel Slag and Calcium Sulfide (CaS) Fertilizer

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Mercury (Hg) and arsenic (As) contamination in orchards near abandoned mine sites may cause crop and food chain contamination. Significant levels of Hg and As are often observed in orchard soils which requires remedial action. The stabilization process has widely been used to immobilize heavy metals/metalloids in contaminated soil. In the past, various stabilization agents such as hydrated lime, fly ash, quicklime, acid mine drainage sludge, oyster shells, etc have been studied. In this study, a combination of hydrated lime (HL), steel slag (SS) and calcium sulfide fertilizer (CSF) were used to immobilize Hg and As in contaminated soil. The dosages of each stabilizing agent ranged between 1wt% and 5wt%. The stabilized samples were cured for 4 weeks. Following the curing period, stabilization effectiveness was evaluated with 1N HCl extraction for Hg and 0.1N HCl extraction for As. The stabilization results showed that the leachability of Hg and As decreased with increasing dosages of HL, SS and CSF. A reduction of more than 79% in Hg and As leachability was obtained with the 1wt% HL, 5wt% SS, and 4 wt% CSF treatment. The results indicated that the combination of HL, SS and CSF can be beneficially used for simultaneous immobilization of Hg and As in contaminated soil.

Keywords: mercury, arsenic, stabilization, hydrated lime, calcium sulfide fertilizer

Catalytic Oxidation of VOCs with Ozone over Waste Alkaline Battery

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Catalytic oxidation of volatile organic compounds such as toluene with ozone was investigated using waste alkaline battery at room temperature. Various characterization of waste alkaline based catalysts were performed using XRD, SEM/EDX, TGA, and H_2-TPR. The waste alkaline battery showed high catalytic activity for the degradation of toluene and ozone at room temperature. The high activity of waste alkaline battery may be ascribed to the Mn content of waste alkaline battery. Also, the increase of calcination temperature of waste alkaline battery enhanced catalytic activity of VOCs removal. The detailed data will be suggested.

Keywords: VOCs, Catalytic oxidation, Ozone, Waste alkaline battery

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Effect of Surfactants in Waters on Plants

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Pesticide formulations contain surfactants, which aid the application of active ingredients. Previous studies on agrochemicals have focused on the fate and effects of the active ingredients such as pesticides and herbicides in the environment and only a little attention was given on the fate and effect of surfactants. Therefore, this study aims to investigate the effects of surfactants on plants using Triton X-100 as a target compound. The effects of Triton X-100 on the growth of duckweed, lettuce, and wheat were studied using lab-scale batch tests and an aquaponics system. As the initial Triton X-100 concentration increased from 0 to 1,000 mg/L, the germination of lettuce decreased by about 64%, while the germination of wheats was not significantly affected. The increasing Triton X-100 concentrations also tend to negatively affect the growth of lettuce, possibly due to the absorption of Triton X-100 by lettuce. The results suggest that surfactants contained in pesticide formulations may have adverse effects on crops, but such effects are not given enough consideration. Therefore, more studies on such effects need to be carried out.

Keywords: Surfactant, Triton X-100, Lettuce, Wheat, Duckweed

Recovery and Utilization of Aluminum from Water Sludge as Adsorbent and Precipitant for Phosphate Removal

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Abundant aluminum source in alum sludge, a ubiquitous residue from Water Treatment Plant, could be utilized for phosphate adsorption owing to the strong affinity between aluminum and phosphorus. However, this kind of sludge is also composed of mainly of organic matters, which are potentially competing elements with phosphate for negative sites, and eventually deter phosphate adsorption significantly. Thermal treatment approach was adopted to enhance phosphate adsorption capacity of alum sludge by: (1) eliminating organic matters, and (2) enriching aluminum content. The results were in agreement with the prediction while maximum adsorption capacities of ignited alum sludge doubled that of oven-dried alum sludge. Interestingly, air-dried alum sludge performed a fairly high phosphate adsorption capacity even though containing large amount of organic matters. The oven-dried alum sludge owned not only the lowest phosphate adsorption capacity but also the highest risk of intrinsic pollutants release.

Keywords: Aluminum recovery, aluminum sludge, phosphorus removal, sludge drying, thermal treatment

Mass-transfer Characteristics and Process Optimization of a Hollow Fiber Membrane Contactor for Ammonia Removal

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The negative effects of ammonia and related compounds commonly found in industrial wastewater streams have promoted the development of more efficient methods for their removal. In this study, a commercially available hollow-fiber membrane contactor was used to achieve this purpose. The effects of several factors such as the pH and temperature of the feed solution, the velocity of the feed stream, initial concentrations of the ammonia, and types of absorbent on the overall mass transfer of the ammonia were investigated. The membrane contactor system was found to be very effective in removing ammonia, in optimal conditions, the ammonia mass flow rate of over 10 g/m^2hr was achieved in a single-stage operation. Results show that increasing the pH value of feed solution up to 10.5 enhanced the removal of ammonia efficiently while further increasing the pH to the higher values resulted in insignificant improvements. Increasing the ammonia feed velocity decreased the ammonia removal in the range studied. However, the initial ammonia concentration in feed solution had negligible effects on the ammonia removal in the range from 250 mg/L to 3,000 mg/L. The results revealed that the membrane contactor is a promising technology for removal (recovery) of ammonia from industrial wastewater.

Keywords: Membrane contactor, ammonia removal, optimization, mass transfer

Adsorption of Fluoride from Water- Sri Lanka by Fe Impregnated Tea Waste Biochar

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Due to geological and hydrogeological conditions, mankind activities contamination of natural resources such as soil, water bodies have occurred. Among the contaminants, fluoride contamination is a highly discussed topic due to its adverse effect to living beings, especially relatively high concentration of fluoride has been reported in ground water of lots of countries including Sri Lanka. Fluoride is one of the essential elements for human health, but it is toxic at the concentration of > 1.0 mg/L. The World Health Organization have set maximum permissible limit to 1.5 mg/L in drinking water [1]. Fluorine in soil can easily be transported and reach the underlying soil through soil solution or ground water migration. Water defluorination techniques include adsorption, ion exchange, precipitation and reverse osmosis. Among them adsorption is now evolving as a front line of defense because of its simplicity, effectiveness as well as the availability of a wide range of sorbents.

Objective of the research is to remove fluoride from water in Sri Lanka using waste materials. Sri Lanka is a tropical and agriculturally based country. Agricultural wastes such as rice husk, rice straw, cone stove, and tea waste are abundant in the country. When it comes to tea, annual production is around 338, 000 tons and estimated that 10 % of the yield ending up as waste [2]. Biochar produced from biomass pyrolysis is used as a promising sorbent for various contaminant removals. Alum is a common coagulant ant used for drinking water treatment and accumulated alum sludge is abundant waste in water treatment plants. In textile industries and steel mining industries, effluent wastewater contains high concentrations of iron. Aluminum extracted from alum sludge and iron in industrial wastewater have been used for impregnation of tea waste biochar, and the modified biochar was effective in fluoride removal with maximum adsorption capacity of 7.3 mg/g. This study shows that the tea waste and other waste can be used to prepare effective adsorbent to remove fluoride from aqueous stream.

Key words: Fluoride, Sri Lanka, Tea waste, Biochar, Impregnation

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Recycling of Bottom Ash to Control Turbid Water from Agricultural Fields

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Climate change resulted from global warming frequently causes natural disasters. As soil loss and turbid water occur, they induce the non-point source pollution and aggravate the surrounding ecosystem. The objects of this study were to propose a practical way to reduce soil erosion and turbid water from agricultural fields by using a waste material like bottom ash. The modified gabion filled with a bottom ash (MG; 200×1,000×500-mm) was installed in the upland located in Haean-myeon, Yanggu-gun, Gangwon province, Korea (38°15’54” N lat., 128°07’02” E long.). The upland soil was sandy loam with 57% sand and 18% clay. The samples of turbid water were collected from two spots (S1 as MG and S2 as the control) during heavy rainfalls more than 12.5 mm, in order to evaluate the effect of MG on soil loss and turbidity. Under a rainfall intensity of 50 mm/h, the turbidity and suspended solid (SS) were reduced by 329-fold (34 and 11,180 NTU, respectively) and 2.5-fold (13,624 and 33,763 mg/L, respectively) for S1 and S2, respectively. Over the summer season including four times rainfalls more than 12.5 mm, the installation of MG reduced turbidity and SS by 106- and 35-fold on average, respectively. This might be resulted from the impacts of physical screening and filtration of MG. The adsorption of porous bottom ash which has large specific surface area can also contribute to the reduction of SS. Various applications of MG in consideration with different topography would further be necessary for practical use. Moreover, the use of MG cannot only reduce soil loss and turbid water effectively, but also be an eco-friendly way as waste recycling against climate change. This work was carried out with the support of ‘Cooperative Research Program for Agriculture Science & Technology Development (Project No. PJ014821032020)’ Rural Development Administration, Republic of Korea.

Keywords: climate change, coal bottom ash, gabion, turbid water

Effect of Static Magnetic Field on H_2O_2 Production in Bioelectrochemical Systems

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Hydrogen peroxide (H_2O_2) has been known to be a versatile chemical because H_2O_2 can be used in numerous industrial area such as chemical synthesis, pulp paper and textile bleaching, treatment of wastewater and destruction of hazardous organic wastes. In a BES (bioelectrochemical system), the potential energy which can be extracted from wastewater by electrochemically active bacteria at the anode can be used to power the production of H_2O_2 at the cathode which is potentially useful chemical at various industries. Recently, it was reported that static Magnetic fields (SMFs) provide a cost-effective approach in changing microbial activity and enhanced treatment efficiency of wastewater. For example, the removal of organic matters in wastewater increases when SMFs are applied on microbial fuel cells (MFCs) and SMFs influenced microbial community structure in MFCs that affect extracellular electron transfer (EET). In this study, we used this SMFs to produce enhanced current density by facilitating EET when treating wastewater at the anode in microbial electrolysis cells (MECs) which leads to increased H_2O_2 yields. Different SMFs were applied to the MEC and the optimum condition of SMFs was obtained for the enhanced performance. Furthermore, we tested different cathode materials and potentials to further reduce energy input for H_2O_2 generation.

Keywords: Bioelectrochemical system, Hydrogen peroxide, Magnetic field

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Changes in Ammonia Generation according to Pig Manure Composting Period in Machine-Stirred Composting Facility

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In Korea, the feed for pigs contains 14 to 22% of crude protein. Crude protein that cannot be absorbed into the pig's body during digestion is contained in the manure in nitrogen form and is excreted to the outside of the pig's body. This nitrogen is converted into ammonia during the composting of the manure. Ammonia released into the atmosphere is known to be a source of odor. In addition, it has been argued that ammonia generated during the composting process of livestock manure becomes a precursor of fine dust. In this study, the concentrations of ammonia generated at each location of the compost pile are measured in the pig manure composting facility. The concentration of ammonia measured on the surface of the compost pile at the initial stage of composting was 5 mg/L. The ammonia concentration at the point of compost pile corresponding to one-third of the composting period was 55 mg/L, and at the stirring point, it rose to 76 mg/L. At two-thirds of the composting period, the ammonia concentration decreased to about 20 mg/L, and at the completion of the composting period, the ammonia concentration decreased to less than 10 mg/L. The temperature of the compost pile at a point corresponding to a third of the composting period was 62℃ to 64℃, but after agitation, it decreased to 52℃ to 54℃. The pH at the one-third, two-thirds and end points of the composting period were 8.4, 9.0 and 8.8, respectively.

Keywords: Ammonia, Composting, Pig manure

Sustainable Energy Recovery via Catalytic Pyrolysis of Swine Manure using CO_2 and Steel slag

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The massive generation of livestock manure has resulted in adverse environment impacts such as soil and stream contamination with greenhouse gas emissions. In this study, pyrolysis of swine manure (SM) was performed to establish energy recovery and biochar production instead of conventional process (composting, anaerobic digestion). Also, carbon-dioxide (CO_2) was employed as a reaction medium to construct environment-friendly platform. As such, CO_2-cofeed pyrolysis of SM was conducted to produce syngas and hydrocarbons. It was founded that CO_2 contribute to substantial CO generation at ≥ 520 ˚C through the homogeneous reactions (HRs) of CO_2 and Volatile organic compounds (VOCs), while H_2 and CO gaseous were mainly formed at ≤ 520 ˚C through dehydrogenation and deoxygenation under both environments (N_2 and CO_2), showing effectiveness of CO_2 on SM pyrolysis was restricted to high temperature region (≥ 520 ˚C) due to slow reaction kinetics. As such, steel slag (SS) were employed to expedite the HRs of CO_2 and VOCs, and SS substantially enhance (up to 80%) the syngas production at the low temperature region (≤ 520 ˚C). Therefore, all experimental findings suggest the feasibility of CO_2 can be used as a feedstock in thermo-chemical process for syngas production

Keywords: valorization of manure; swine manure; waste-to energy; pyrolysis; CO_2 utilization

Animal Manure Valorization for Bioethanol Production: A Case Study of Horse Manure

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In this study, bioethanol production (BE) from horse manure (HM) was evaluated to build sustainable and environmentally benign waste-to-fuel platform. To this end, both pretreatment methods, namely acid-/alkaline-pretreatments using H_2SO_4/NaOH were performed for HM. Also, to optimize the pretreatment process, the surface methodology response with Box-Behnken design was employed. It is pertinent to claim that alkaline-pretreatment is more suitable way for BE synthesis for HM since its sugar recovery yield was higher (80%) than that of acid-pretreatment (71%). The fermetability of acid/enzyme- and alkaline/enzyme- hydrolysates without additional nitrogen source were tested using GRAS strain of yeast, showing that the ethanol productivities of alkaline/enzyme-hydrolysates were higher (0.075 g L^{-1} h^{-1}) than that of the acid/enzyme-hydrolysates (0.050 g L^{-1} h^{-1}). Experimental results from fermentability test also suggest that carbon and nitrogen contents from HM were sufficient for BE synthesis. For an in-depth investigation, removal capacity of total N-source after ethanol fermentation were analysed, and about 83% of total N were utilized under both conditions (acid/enzyme- and alkaline/enzyme-hydrolysates) during the fermentation process. Therefore, all experimental findings demonstrate that HM can be used as a feedstock for BE production.

Keywords: valorization of manure; horse manure; waste-to energy; fermentation; bioethanol

Effect of Reducing Pollutants in Pig Manure by Deodorizing Agents

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As the distance between local resident and livestock farms is getting closer due to innovation city and agro migration, complaints about the smell of livestock are on increase. Therefore, various deodorizing agents are being developed to manage the environment of the farm. Among them, farmers are a growing interest in easily accessible microorganisms agents. In this study, when an oligosaccharide(deodorizing agent) mixed with *Bacilus Subtillis* was applied to pit in pig farm, it was attempted to confirm the effect of reducing odor in manure and physico-chemistry properties. The manure from the experimental site was removed while maintaining 40-50 cm at intervals of 2 weeks during the test period, and about 30 cm of the fermented liquid manure was added there to and replaced. At this time, a deodorizing agent having a concentration of 10^7 CFU was put twice a week to the treatment site, and the putting amount was 0.3% of the total manure. In the control site, the experiment was performed in the equal to the treatment site and without a deodorizing agents, and there was performed for 8 weeks. Analytical substances were odor substances such as short chain fatty acid (SCFA), branch chain fatty acid (BCFA), phenols, and indoles. and the physicochemical components were biochemical oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen (T-N), and ammonium nitrogen (A-N). The odor substances in manure were measured as SCFA (996.4±963.3 mg/L), BCFA (996.4±963.3 mg/L), phenols (31.0±36.2 mg/L), and indoles (20.1±5.6 mg/L) in the control site. treatment site was SCFA (1068.4±1072.4 mg/L), BCFA (294.9±157.9 mg/L), phenols (33.6±36.0 mg/L), and indoles (13.3±11.6 mg/L). The physicochemical properties in manure were measured as BOD (28,604±4,403 mg/L), COD (14,680±2,340), T-N (0.69±00.04%), A-N 0.33±0.08%) in the control group. treatment site was BOD (23,545±4,231 mg /L), COD (19,945±2,099 mg/L), T-N (0.60±0.01%), A-N (0.33±0.07%). There was no statistically significant difference in the concentration of all contaminants in the treatment and control ($p<0.05$). . This research was funded by the Rural Development Administration (Project No. PJ**0135772020**) Republic of Korea.

Keywords: Deodorizing Agents, Pig manure, Pollutants, Reduction

Effective Medium for Black Solider Fly Applied in Food Waste Treatment

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Black soldier fly larvae (BSFL) have been regarded as an effective decomposer of food waste. Food waste can thus be an appropriate medium for breeding BSFL but there are some limitations when breeding BSFL on processed food waste due to factors such as diverse composition and high salt concentration of food waste. Therefore, in order to use food waste as a medium for breeding BSFL, it is necessary to adjust the composition of the medium. In this study, the growth and substrate reduction of BFSL reared on medium based on food waste was analyzed. BSFL were grown using four types of media based on food waste that has been dried at 80 ^{o}C under vacuum. The four types of media included processed food waste only, processed food waste to which bean sprouts or wheat bran have been added to, and chicken feed. Chicken feed was used as the control because it is commonly used for rearing BSFL in large scale. Bean sprouts and wheat bran was each added to the processed food waste to allow the ratio of protein to fat to be 2:1, which is the ratio reported to be optimal for growing BSFL. Media suitable for breeding BSFL were screened for among the four types of media used. The growth rate of BSFL reared on food waste + wheat bran was similar to BSFL reared on chicken feed, and this suggests that food waste + wheat bran has the potential to be used as media for rearing BSFL at a large scale. The rate of development was also the fastest in BSFL reared on food waste + wheat bran and chicken feed. On the other hand, the survival rate of BSFL was 89% or more in all media. Productivity was higher in BSFL grown in media to which bean sprouts and wheat bran have been added to. Our research shows that processed food waste, in combination with agricultural by-products such as bean sprouts and wheat bran can be utilized for rearing BSFL, and further study is required to identify optimal media requirements for growing BSFL at a large scale.

Keywords: Black soldier fly larvae, food waste, organic waste, waste treatment, vermicomposting.

Experiment on the Evaluation of Particulate Matter Reduction Capacity of Tree Species

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Exhaust gas is one of the major sources of particulate matter (PM) that causes harmful effects on trees planted on the expressway. However, there are still less information of trees' reduction ability of PM. In this study, we investigated to figure out which tree species have the excellent ability to declining PM. For this research, we selected 21 tree species mainly planted on the express way by Korea Expressway Corporation. These are *Spiraea prunifolia, Rhododendron indicum, Forsythia koreana, Euonymus alatus, Ligustrum obtusifolium, Pinus densiflora, Chionanthus retusus, Metasequoia glyptostrodoides, Pinus strobus, Prunus yedoensis, Sorbus alnifolia, Lagerstroemia indica, Ginkgo biloba, Zelkoba serrata , Quercus acutissima, Acer palmatum, Acer buergerianum, Cornus officinalis, Acer triflorum, Sophora japonica* and *Weigela subsessilis*. We made two circular acrylic chambers (600 * 1000mm, 2R * H) for calculating PM reduction rate of tree species. we are going to use environmental tobacco smoke (ETS) to generate fine dust by using cigarette smoke generator chamber. It will be injected into control and treatment chambers by transparent tygon tubing and compressor. Also, we are planning to install diffusion dryer to absorb the initial humidity in the air because it can interfere to exactly calculate the PM reduction rates of tree species. The PM concentration changes were measured every 1 minute by installing particle counter equipment (DC1700, Dylos) in the chambers. This equipment can count PM 2.5 and PM 10 particles every seconds. There is only one tree species planted into the pot in the treatment chamber, however the control chamber will be empty during the experiment. As a result of this study, it can be expected to confirm the differences of the reduction capacity among the tree species. Furthermore, we can figure out which species is the most promising to be planted on the highway for reducing PM occurred from Exhaust gas.

Keywords: air pollution, PM reduction, adsorption function, leaf area

Thermal Catalyst Performance Evaluation Synthesized using Metal Oxide (MeOx)

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Due to the development of industry, various technologies are being developed to acquire comfortable conditions for indoor environment. For such purpose, the removal of volatile organic compounds (VOCs) is important. As an effective means for such treatment, the potential of reactive adsorption process is explored using activated carbon (AC) or metal-organic frameworks (MOFs) combined with metal oxide (MeOx), especially manganese oxide (MnOx). The hollow/porous structure of the reactive adsorbent not only promoted the diffusion of reactants by lowering the diffusion resistance but also captured high molecular weight compounds efficiently for a long time to promote the efficient removal of VOCs. The potential of seven adsorbents prepared by combining AC or MOFs with MnOx (such as MnOx-AC, $CoMnO_2$-AC, δ-MnO_2-AC, Ag-MnO_2-AC, MnOx-UiO-66, 20% MnOx-UiO-66-NH_2, and 6% MnOx-UiO-66-NH_2). The thermal catalysis was carried out using formaldehyde (100 ppm) and toluene (100 ppm) as target compounds at a flow rate of 200 mL/min. Initially, adsorption was induced by loading up to 40 L of target standard gas at room temperature and then temperature was raised at 25°C intervals at every 30 min up to 300°C (total loading volume of up to 100 L). The results of our experiment were helpful to confirm the synergistic effect of adsorption and catalysis effect. Among all tested materials, MnOx-AC showed the best performance for formaldehyde (100 ppm) and toluene (100 ppm) to achieve their full decomposition at 125 and 300°C, respectively.

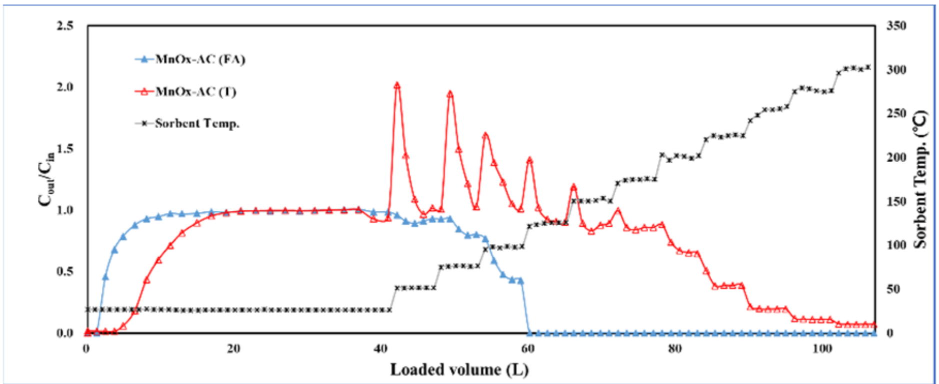

Figure 1. The results of reactive adsorption of 100 ppm FA and 100 ppm toluene by MnOx-AC

Keywords: Activated carbon, Thermal catalytic, Metal oxide, Volatile organic compounds

Analysis of Volatile Organic Compounds in Mainstream Smoke of Tobacco Cigarette and Heat-not-burn Cigarette

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Mainstream cigarette smoke is a complex aerosol known to contain more than 4400 chemicals. To evaluate VOCs released from the mainstream cigarette smoke, we monitored their concentration levels from a total of 8 different types of cigarette samples: (1) flavoured cigarette with popped capsule (n=2), (2) flavoured cigarette with non-popped capsule (n=2), (3) non-flavoured cigarette, (4) standard cigarette (i.e., 3R4F), and (5) heat-not-burn cigarette (n=2). This study aimed to assess the contents of tobacco and heat-not-burn cigarette with reference to standard cigarette based on quantitative analysis of 7 major VOCs (i.e., isoprene (IP), acrylonitrile (AN), methyl ethyl ketone (MEK), benzene (B), toluene (T), o-xylene (o-X), and styrene (S)). The flavoured, non-flavoured cigarette with reference to 3R4F had higher emissions of most VOCs compared to heat-not-burn cigarette. Also, the flavoured cigarette emissions of IP, MEK, B, T, and other VOCs were somewhat higher than non-flavoured and 3R4F. The results of our study offer the comparative evaluation on the actual impact of composition between flavoured, non-flavoured and heat-not-burn cigarette in reference to 3R4F.

Keywords: Volatile organic compounds; Flavoured cigarette; Heat-not-burn cigarette

Analysis of Carbonyl Compounds Released from Diverse Commercial Cigarette Products: Flavored Cigarettes vs. Heat-not-burn Cigarettes

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Public awareness of the health effects on smoking and second-hand smoke has increased. In an effort to reduce the discomfort of smoking, the production of cigarettes with reduced cigarette smoke smell has gained a great attention. Cigarette companies have made and sold a variety of tobacco products that include patented design features and additives to minimize or disguise tobacco smoke by reducing odor or visibility. Cigarette manufacturers have used the term "Less Smoke Smell (LSS)" to promote designed cigarettes. However, the effect of such products (e.g., with respect to the reduction of the cigarette smoke or masking of the smell of cigarettes with the aid of fragrance (or flavor) additives) is yet questionable. In addition, controversy about harmful ingredients in capsules used for the addition of flavor into cigarette has recently emerged. Consequently, it is desirable to assess the occurrence of chemical components due to the use of capsules. In this study, 10 kinds of carbonyl components were measured for comparison with or without capsules. Further, the concentrations of carbonyls in heat-not-burn (HNB) cigarettes were compared using 1) flavored cigarettes made by LSS technology, 2) regular flavored cigarettes, 3) non-flavored cigarettes, and 4) HNB cigarettes.

Keywords: Carbonyl compounds, Cigarette, LSS, HNB

The Effects of Particle Size of Carbon Materials on the Adsorption Performance against Gaseous Benzene

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As one of the key solutions for controlling gaseous pollutants (i.e., volatile organic compounds (VOCs)) in indoor environment, the utility of adsorbents has been recognized. In this context, the proper evaluation of their performance is critical to use them with the maximum efficiency. In order to properly measure the overall performances of adsorbents, it is important to understand the interactive roles between various factors (e.g., particle size, flow rate, and sorbent mass) in the adsorption system. To evaluate the effect of such variables, adsorption experiments were conducted using commercial activated carbon (AC) products prepared in four different particle size ranges ((1) below 0.6 mm, (2) from 0.6 mm to 1,7 mm, (3) from 1.7 mm to 2.36 mm, and (4) from 2.36 mm to 5 mm). The effects of size effects were assessed in relation to the two sets of sorbent mass and corresponding flow rate ((1) 30 mg and 300 $mL.min^{-1}$ and (2) 300 mg and 3000 $mL.min^{-1}$). Adsorption performance metrics (e.g., breakthrough volume (BTV: $L.g^{-1}$), adsorption capacity (Q: $mg.g^{-1}$), and partition coefficient (PC: $mol.kg^{-1}.Pa^{-1}$)) were used to assess the combined roles of such variables. The overall results indicated that increase in particle size is inversely proportional to adsorption performance, especially in the initial stage. The kinetic and mathematical models were also useful to address the role of particle size in controlling the adsorption of VOCs.

Keywords: Particle size; air pollution; activated carbon; breakthrough; benzene; flow rate.

Changes in Net Ecosystem Productivity in Temperate Forests in Northern China Depend on the Form and Level of Simulate Nitrogen Addition

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Abstract

Forest ecosystems are vital to the terrestrial ecosystem carbon (C) cycle and storage, while nitrogen (N) deposition is an important factor in the processes. We conducted a six-year field experiment to examine N addition effects on net ecosystem productivity (NEP) in a Quercus liaotungensis forest in northern China. Three N fertilizers $NaNO_3$, NH_4NO_3, and $(NH_4)_2SO_4$ were used in this study. $NaNO_3$ and $(NH_4)_2SO_4$ were added at a level of 50 kg N ha−1 yr−1, and NH_4NO_3 was added at three levels (50, 100, 150 kg N ha−1 yr−1).

N addition resulted in a significant increase in biomass C storage (17.5%–48.6%) and changed the allocation pattern of above- and belowground biomass C storage, resulting in a 9.6% to 23.2% reduction in the proportion of belowground biomass C compared to the control. The annual average heterotrophic respiration was significantly increased by additional N (by 0.06–0.9 Mg C ha-1 yr-1). In comparison with the control, C sequestration driven by N addition ranged from 7.1 to 33.5 kg C/ kg N. NEP was significantly increased in the N addition plot. The difference in effect on NEP between medium- and high-level N was not significant, and both were significantly higher than low-level N addition. NH4+-N, rather than NO3--N, dominated the increase of NEP.

We found that the *Q. liaotungensis* forest acted as a C sink. The increase in NEP in the study forest in northern China was mainly due to an increase in net primary productivity (NPP) caused by N addition. Atmospheric N deposition increased C sequestration efficiency depending on the level and form of N deposition.

Keywords: Nitrogen addition; Nitrogen form and level; Net ecosystem productivity; Northern temperate forest; Carbon sequestration

Climate Change Undermines the Reliability of Hydropower Plants: Evidence from China

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Hydropower generation largely depends on water availability, which is highly sensitive to climate change. Exploring how hydropower plants respond to increasingly frequent extreme climatic events helps enhance the reliability and resilience of power supply infrastructures. To analyse the impacts of climate change on China's hydropower generation, this study mainly focuses on the revenue variation of 5,082 hydropower plants subject to droughts, floods, annual total precipitation, and average daily maximum temperature with a fixed-effect model ranging from 1998 to 2013. Substantial regional heterogeneity exists. Heavy rain days' impacts dominate the high-intensity precipitation region with one more heavy rain day leading to 0.2% revenue increase, while no rain days and high temperature reduce the revenue in moderate and low-intensity precipitation regions by 0.1% and 5.6% respectively. Based on regressions in different climate zones, this study also predicts the damage function driven by 21 GCMs under two climate change scenarios (RCP 4.5 and RCP 8.5) in the 21st century. More importantly, pumped storage, as an adaptive behaviour, shows statistical significance in avoiding hydropower plants' revenue loss threatened by droughts. The results advocate climate change adaptation and highlight that a failure to incorporate climate change into hydropower planning could overestimate the power supply reliability.

Keywords: hydropower plants revenue, climate change, damage function, pumped storage

Transformation Kinetics and Products Identification of Aqueous Chlorination of Progesterone and Norgestrel

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Natural and synthetic steroid hormones such as progesterone and norgestrel in the aquatic environment may cause adverse effects on aquatic organisms. This study investigated the transformation kinetics and products of progesterone and norgestrel in an aqueous chlorinated solution by using UPLC-ESI-MS/MS. Under the condition of sufficient available chlorine, the reactions followed the pseudo first order reaction kinetics, and the degradation rate of norgestrel was faster than progesterone. Three products were identified for norgestrel, and two for progesterone for the first time. Chlorine-substitution reactions followed by dehydration is proposed to be the main transformation pathways.

Synthesis and Characterization of CeO_2-ZrO_2@MoS_2 Nanohybrid for Sonophotocatalytic Degradation of Recalcitrant Organic Pollutants in Water

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The combination of the unique properties of MoS_2 with unique characteristics of metal oxide nanomaterials has become a widely accepted pathway for achieving desirable properties useful for various applications. In this study, MoS_2 nanosheet has been decorated with CeO_2-ZrO_2 nanoparticles by a two-step method at three different MoS_2 percentages (25%, 50%, and 75%). MoS_2 nanosheets were pre-synthesized using a hydrothermal method and then added to CeO_2- ZrO_2 nanoparticles under ultrasonication. Sonophotocatalytic degradation studies of synthesized nanohybrids toward bisphenol A and naproxen in wastewater were performed and discussed. Structural, morphological, and photo-physical properties of the prepared sonophotocatalysts were systematically investigated using various spectroscopic and microscopic techniques such as X-ray diffraction, Fourier transform infrared spectra, Field emission scanning electron microscopy (FE-SEM) equipped with an energy dispersed spectrometry, high-resolution transmission electron microscopy (HR-TEM), thermal gravimetric and differential thermal analysis, and X-ray photoelectron spectroscopy. The CeO_2-ZrO_2 nanoparticles can be attached to the surface of the layered MoS_2, which was confirmed by FE-SEM and HR-TEM. The operating parameters for the sonophotocatalytic degradation of the selected recalcitrant organic pollutants were investigated by optimizing the amount of the sonophotocatalyst, duration of sonophoto irradiation, and the solution pH.

Keywords: Molybdenum disulphide, nanohybrid, sonophotocatalytic activity, organic pollutants

Titanium Carbide MXene-Intercalated Nanosheets for Antibiotic Ciprofloxacin Adsorption and Electrochemical Regeneration

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Two-dimensional titanium carbide ($Ti_3C_2T_x$) MXene-intercalated nanosheets (MIN) were synthesized and their performance was evaluated for ciprofloxacin (CPX) adsorption and electrochemical regeneration. The physical and chemical properties of $Ti_3C_2T_x$ MXene and MIN before and after CPX removal, and electrochemical regeneration were investigated using SEM−EDS, TEM, XRD and XPS analysis. As ciprofloxacin showed zwitter-ionic effect in water, the pH of the system was set to 5.5. The MIN exhibited ultrafast kinetic behaviour as 80% CPX was removed in just 30 sec and adsorption equilibrium was achieved in 20 min. The Elovich model and the Redlich-Peterson isotherm model well described the kinetics and adsorption behaviours of MIN adsorbent, respectively. An electrochemical regeneration technique was applied for examining the reusability of MIN. Due to the high electrical conductivity of MXene the electrochemical regeneration process was rapid with low electrical energy consumption, compared to conventional adsorbents such as activated carbon and graphite. Even after six adsorption-regeneration cycles, MIN showed ~99% CPX removal and ~160% regeneration efficiency (Figure 1). The experimental results suggests that the MXene-intercalated nanosheets could be a potential candidate for ciprofloxacin and other pharmaceutical drug removal from water/wastewater.

Keywords: MXene nanosheets, ciprofloxacin, adsorption, electrochemical regeneration

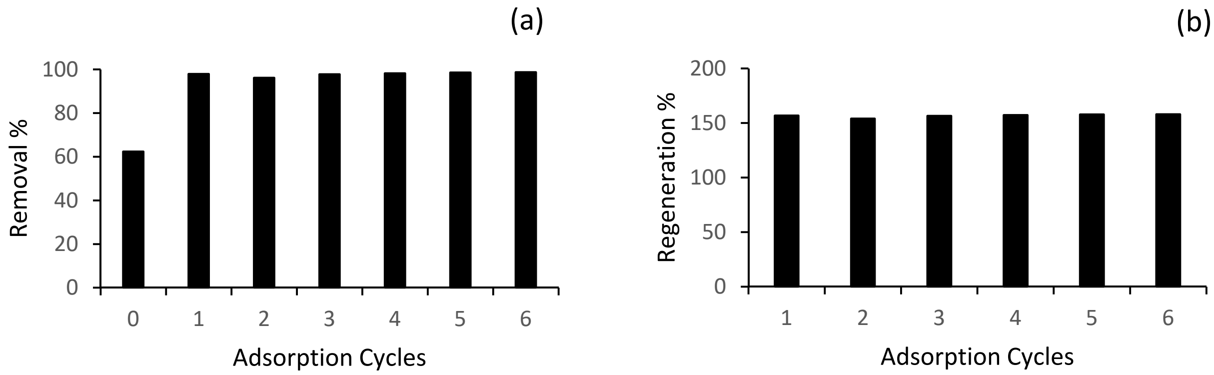

Figure 1. Reusability of MIN adsorbent using an electrochemical regeneration process: (a) Removal efficiency and (b) Regeneration efficiency.

A Study on the Quality Criteria of Sound-absorbing Materials for Soundproof Panels in Road Noise Barriers

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The sound-absorbing material used in soundproof panels is largely divided into polymer type (polyester fiber) and mineral wool type (glass wool, rock wool). Polyester fiber is easy to handle because it is light and has no skin irritation, but its sound-absorbing performance and fire safety are lower than the minimal wool. Glass wool used in soundproof panels is wrapped in protective film. If glass fiber is exposed to the outside due to film damage, the fiber may be dispersed or glass wool does not hold its shape. Also, disposal is not easy. However, glass wool has excellent sound absorption performance and does not produce toxic gases in combustion, so it is relatively advantageous where safety in fire is important, such as soundproof tunnels.

According to the Korean Industrial Standards for soundproof panels (KS F 4770-1~4), the sound-absorbing materials used in soundproof panels should not contain substances harmful to the human body, such as carcinogens. And, protective film for mineral wool is simply referred to as waterproof and durable. In addition, the explanatory section provides examples of test results for PVF (polyvinyl fluoride) films and recommends using a product with a quality level equal to or higher than that. However, there is no verification of the reproducibility of the suggested values, which is ambiguous for the actual quality criteria. According to NEXCO in Japan, sound-absorbing materials used for metal soundproof panels should use glass wool (GW-B32K, 50 mm thick) or polyester that has been specially engineered on the surface. In the case of glass fiber, PVF or ETFE (ethylene tetrafluoroethylene) shall be used as a protective film.

Soundproofing materials are located inside the soundproof panel, so it is so difficult to check the quality at the site. Therefore, it is desirable to suggest the simple specifications for materials that have been verified in actual field.

Keywords: sound-absorbing materials, soundproof panel

An Experimental Study on the Fire Safety of Steel Columns in Road Noise Barriers

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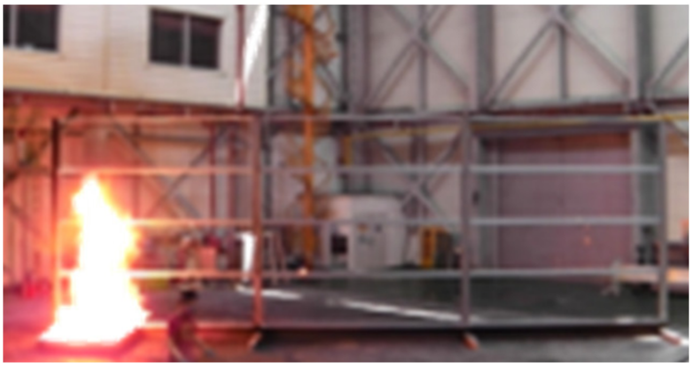
A test noise barrier with a height of 4.0 m and a full length of 12 m was constructed to estimate the effect on the columns of the noise barrier in the event of fire with flammable soundproof panels. The columns of test noise barrier consisted of steel H-beams (H-125×125×6.5×9). The soundproof panels used in the experiment consisted of polycarbonate (PC) with a thickness of 8 mm and a steel fan containing 20 litres of gasoline as a fire source is placed at one end of the test sound barrier.

After igniting the fire source, combustion was conducted rapidly for about four minutes, but the soundproof panels gradually stopped burning when the gasoline was exhausted (Fig. 1). At a point of 1m and 3m in height of two columns adjacent to the fire source, the mechanical properties of the columns before and after combustion were measured by the instrumented indentation technique (Fig. 2). IIT is a method for evaluation mechanical properties as an elastic modulus, tension technique and stress.

The test results showed no apparent degradation of yield strength and tensile strength at all points examined, with only the surface of columns charred by flames.

In the event of an ordinary fire, not an explosion, it is not likely that the fire will have a significant impact on the structural stability of the columns in the road noise barrier.



Fig, 1 Fire test of road noise barrier

Fig. 2 IIT method

Keywords: noise barrier, steel column, fire safety

Light Transmittance Properties of Transparent Materials for Soundproof Panels in Road Noise Barriers

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The light transmission is one of the most basic properties for transparent sheets used in road noise panels. Visible light transmittance (VLT), which is commonly used for glass materials, can be measured by using spectrophotometer. It is measured by sequentially changing the wavelength of light irradiated on the specimen, obtaining the transmission ratio at each wavelength, then multiplying by the weighting factor corresponding to each wavelength. On the other hand, total luminous transmittance (TLT) is the measure of the total incident light compared to the light that is actually transmitted. It can be measured by the haze mater and also deals with visible light. In Korea, visible light transmission is applied for evaluation of transparent materials used in soundproof panels, while for foreign countries, total luminous transmittance is usually applied.

In this study, VLT according to ISO 9050 and TLT according to ISO 13468-2 were measured and compared. The types of transparent materials used for test are polycarbonate (PC), polymethylmethacrylate (PMMA), and laminated glass. The thickness of the samples used for the test is 8 to 12.76 mm.

As a result of VLT measurement to PC specimen, the absorption peaks between 650 and 700 nm appear only in the specimen of 8 mm in thickness, not in the specimen of 10 mm in thickness. This is due to differences in resins used to manufacture PC sheets, and it is desirable to use sheets that do not show these absorption peaks for soundproof panels. PC specimens with improved weather resistance were similar to regular PC samples, except that the absorption peak appeared relatively small between 650 and 700 nm. For PMMA, the thickness of the specimen shows a sharp drop in the transmittance below about 400 nm, while for the specimen of 10 mm thickness there was no such drop between 380 and 400 nm. For three types of laminated glass samples, VLT values gradually decreased above 600 nm as the thickness of the glass increased. The difference between VLT and TLT was very small -0.06 to 0.11% in PC and PMMA samples and 0.18 to 0.56% in laminated samples.

Keywords: light transmittance, transparent noise panel

Low Temperature Synthesis of Urea-assisted NiOx Thin Films as a Hole Transport Layer for Inverted $CH_3NH_3PbI_3$ Perovskite Solar Cells

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The incorporation of urea in NiOx precursor solution can promote the growth of NiOx film grains and passivate the defects at the grain boundaries and, thereby, enhance the photovoltaic performance. Inverted $CH_3HN_3PbI_3$ perovskite solar cell was developed using a urea-assisted NiO thin films as a hole-transporting layer (HTL). Nickel acetate tetrahydrate dissolved in 2-Methoxyethanol solution with various urea concentrations (1 to 10 wt% vs Ni precursor) was spin-coated on the indium tin oxide (ITO) substrate in an atmosphere. The effects of annealing conditions and urea concentration on the photovoltaic performance were systematically investigated. The post-annealing process was progressed in atmosphere, and then the annealing time fixed for 30 min. The 3 wt% urea assisted NiOx thin film demonstrated the best performance at same annealing temperature. This NiO thin film with an amorphous phase and thickness of about 20 nm was found to be optimal for hysteresis-free high photovoltaic performance. The 3 wt% urea-assisted NiOx based devices displayed a PCE of 16.1% with Jsc of 24.4 mA cm^2, Voc of 1.01 V, and FF of 65.4%.

Keywords: NiOx, Perovskite solar cell, Urea, Hole transport layer

A Study on the Service Life and Remodeling of Soundproof Panels in Road Noise Barriers

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The aluminium sound absorbing panels, which are commonly used in road noise barriers in Korea, were introduced from Japan, which was standardized by NEXCO in the mid-1970s. In Japan, the Metropolitan Expressway Company considers the service life to be 25 years for aluminium sound absorbing panels. This takes into account the deterioration, such as significant rust generation, that needs to be replaced at about 25 years since the panels were installed. In Central Nippon Expressway Company, there is a case where the service life of panel is regarded as 18 years in consideration of the functional life.

According to a survey of the appearance of the metal soundproof panel on the expressway in Korea, soundproof panels, which have been 20 years since their installation, have often been corroded. The service life for the aluminium sound absorbing panel may vary depending on the detailed structure, the painting quality, the location of installation and the de-icing chloride in winter, but it is generally considered to be about 20 years. On the other hand, soundproof panels with plastics can also vary significantly depending on the raw material, shape, thickness, surface treatment, etc. and require careful consideration such as referring to the results of performance tests.

The remodeling method for deteriorated noise barriers is mainly used to attach additional metal sheets to existing noise barriers. Cost of remodeling by attaching metal sheets and replacement of new panel was analyzed. An analysis of the cost showed that the higher the sound barrier, the greater the economic effect, if only the lower part of the noise barrier is remodeled. From an economic point of view, it is desirable to apply the reform sheets to a range not exceeding 50% of the existing noise barrier height. Economic effects can vary depending on conditions at sites where noise barriers are installed, the type of soundproof panel for replacement, and types of reform sheets. It is expected that economic effects can be further improved if application of re-form panels is increased in the future and material cost for re-forms is reduced.

Keywords: the service life, soundproof panel, remodelling, deteriorated noise barrier

Construction of $BiVO_4$ co-deposited with Plasmonic Ag and N-doped Graphene Quantum Dots for Enhancing Photocatalytic Activity

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Antibiotic have become the serious hazardous pollutants in the water, the efficient removal of antibiotics could be an important part of protecting water environment. In this study, a novel N-GQDs/Ag/$BiVO_4$ composite photocatalyst with Ag as the electron acceptor was prepared to improve photocatalytic activity for degrading and mineralizing tetracycline hydrochloride in water. The physicochemical properties, morphology and structure as well as photoelectrochemical behaviour of the N-GQDs/Ag/$BiVO_4$ were investigated. In comparision with pure $BiVO_4$, the enhanced photocatalytic activity of the N-GQDs/Ag/$BiVO_4$ is explained in terms of upconversion effect of N-GQDs and local surface plasmon effect of Ag. The synergetic effects enlarge light absorption range and promote significantly the separation of photoinduced carriers. Moreover, possible photocatalytic reaction processes including carrier migration process, active species in the reaction, intermediate products during degradation are deeply analyzed.

Keywords: N-GQDs/Ag/$BiVO_4$, Upconversion effect, Local surface plasmon effect, Photocatalytic degradation, Tetracycline hydrochloride

Flexible and Elastic E-GaIn Liquid Metal Fuel Cell with High Performance

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The fuel cell has been considered as a promising energy conversion and generation technology. Meanwhile, as wearable energy devices, flexibility and stretchability are required. Unfortunately, up to now, few reports focus on development of wearable fuel cells. The membrane electrode assembly (MEA), consisting of catalyst layer and diffusion layer, in fuel cells, and the metal anode in metal-air batteries, are the limiting factors to create wearable devices since current gas diffusion layers and metals are not stretchable. Based on the Eutectic GaIn (EGaIn) liquid metal anode, a completely flexible and elastic liquid metal fuel cell (LMFC) with high and stable electrochemical performance has been systematically investigated. Depending on the understanding of influence mechanism of various Ga/In ratios in anode and working parameters on corrosion of anode and discharge performance of fuel cells, the power density of LMFC has reached as high as 62 mW cm^{-2}, with 84.4 wt% Ga in anode. The overpotential of the 84.4 wt%Ga-based LMFC is the lowest owing to balancing the activity and corrosion of anode. Appropriate additive of In ratio could protect Ga corroding. However, too much additive of In element decreases activity of EGaIn anode. Furthermore, the LMFC presents excellently soft, stretchable, shape-recoverable properties, and stable discharge performance under various stretching-situations, due to the fluent, ductility and high conductivity of EGaIn anode with the liquid phase, and excellent electrochemical stability and activity of EGaIn.

Keywords: liquid fuel cell, wearable energy device, liquid metal, high performance.

Oxidation Controlled Black phosphorus/WS_2 Nanocomposit Photocatalyst for Water Treatment

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The discovery of graphene, a hot issue in the field of materials science, has clearly attracted great interest worldwide and has had tremendous impact in many areas. Over the past few years, research on 2D materials has actually been very advanced. Research on layered 2D materials is at the forefront of material science. In addition to graphene, there are many other two-dimensional materials, but the transition metal chalcogenide is a typical two-dimensional material. It is characterized by a variety of series and easy to control, but with a slightly slower charge mobility. Black phosphorus is an intermediate between graphene and Ttransition metal dichalcogenide (TMDC) and is studied as a next-generation two-dimensional material due to the anisotropy caused by the curved honeycomb structure. Since the 2D material basically has many plate shapes, there is a great deal of research on the layer-by-layer type junction structure. This composite catalyst is designed to have a lower dimension than two dimensions and to be combined with each other, so that the band structure can be designed to suit the application and complement each other's disadvantages. Among the TMDCs, WS2 can be a promising catalytic material due to its unique electrical properties, and black phosphorus with properly controlled oxidation can act as a redox functional group.[2] We synthesized black phosphorus that was oxidized properly and easily at a low cost and made a catalyst for water quality improvement through composite with WS2 (figure 1). Through these composites, we studied nanocatalysts that satisfy bandgap changes and disadvantages of each other. This material was measured by TEM, SEM, XRD, XPS, UV-VIS spectrophotometer, FT-IR and RAMAN spectroscopy. Such catalyst materials are used in various fields such as hydrogen generation, atmospheric purifi-cation, and water purification.

Keywords: Two dimensional material, nanocomposit, Transition metal chalcogenide, black phosphorus, water treatment, nano catalyst

A Highly Sensitive Quartz Crystal Microbalance Sensor Assisted with ZnO Nanosheets for Nerve Agent Detection

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ZnO is known as a promising material for surface acoustic wave sensor devices because of its piezoelectric property. Recently, quartz crystal microbalance has been promising as sensor platform due to their high sensitivity and ease of measurement. In particular, the alignment of ZnO nanosheet into ordered nanoarrays is expected to improve the device sensitivity and stability due to the large specific surface area which can be captured significant quantities of gas molecules. In this study, we fabricated a quartz crystal microbalance sensor with ZnO nanosheet structures using polyvinylidene fluoride as a receptor for nerve agent detection. We synthesized two dimensional nanosheets by chemical bath deposition, potassium hydroxide etching method. The chemical bath deposition is an excellent method which can easily form a uniform structure as well as low cost. We fabricated ZnO nanosheet modified with polyvinylidene fluoride and used it for detection of dimethyl methylphosphonate vapor. The structures of nanosheet showed that when a similar functional group material is coated, the specific surface area increased compared to the nanorod structure. As a result, the sensitivity of the quartz crystal microbalance sensor improved about dimethyl methylphosphonate gas.

Keywords: ZnO, nano structure, SAW sensor, gas sensor, DMMP

Preparation of Surface Fluorinated TiO_2 Hollow Structures with Enhanced Photocatalytic Performance by Facile Solution Route

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TiO_2 is one of the most widely researched semiconducting metal oxides and it often used in various industrial fields such as photocatalyst, Li ion battery, solar cell(DSSCs/QDSSCs), sensor, pigments, cosmetics because of its unique structure, nontoxicity, low cost, chemical properties. Up to now, numerous studies have revealed that the performance of TiO_2 photocatalytic activity is generally determined by the physical properties such as crystal structure, surface, morphologies and phase. In terms of photocatalytic performance improvement, surface properties of TiO_2 act a very critical role in determining photocatalytic reaction efficiencies. One of them, surface fluorinated TiO_2 has been introduced a more effective method than pure TiO_2 to promote the photocatalytic activity by a simple ligand exchange reaction between hydroxyl groups and F ion.

Herein, surface fluorinated TiO_2 hollow structures are synthesized by one-pot facile solution route from dissolved ammonium hexafluoro titanate ($(NH_4)_2TiF_6$) and boric acid (H_3BO_3) without any surfactants or templates. The structure, morphology, elemental composition, and binding energy were determined through various characterization techniques, including field emission scanning electron microscopy (FESEM), high-resolution transmission electron microscopy (HRTEM), energy dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). Also, we evaluated the effect of various experimental conditions and proposed possible growth mechanisms for hollow structures. The UV-light photocatalytic performance as photocatalyst for degradation of Rhodamine B aqueous solution is evaluated by using UV-vis absorption spectroscopy at room temperature. Significant improvement in photocatalytic efficiency of synthesized TiO_2 hollow structure was observed and discussion of relationship between enhanced photocatalytic activity and structural and surface were addressed.

Keywords: TiO_2, hollow structure, facile solution route, photocatalytic activity

Post-modification of Mesoporous MIL-101 with Brønsted Acid for Removing Radioactive Gas

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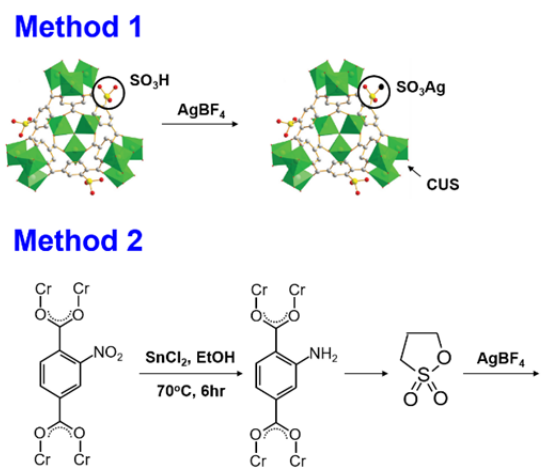
Up to date, several porous materials, such as activated carbon, zeolite, silica-gel and the metal-organic frameworks (MOFs) have been received the spotlight in the fields of catalysis, gas storage, capturing for specific gas, gas or liquid separation, sensing, drug delivery, air purification and toxic gas removal. Among them, MOFs have been extensively studied due to their highly designable framework diversity, which provides a great variety of pore structure and properties. Especially, mesoporous MIL-101 can be recognized as a good candidate for the decoration of pore surface because it has not only large mesopores (28 and 32 Å), but also chemical and mechanical stabilities. Meanwhile, functionalization of Brønsted acid group in MIL-101 has been generally obtained by either one-pot synthesis or post-synthetic modification. Here, we have succeeded in the post-synthetic covalent modification of MIL-101 to retain sulfonic acid group even after humidity treatment. Physico-chemical properties of samples were characterized by XRD, N_2 isotherm, XPS, FT-IR, ICP, EDS and EA analysis. Surface functionalized MIL-101 by Brønsted acid group can be used for removing radioactive gas.



Keywords: Metal-Organic Frameworks, Post-synthetic modification, MIL-101, Radioactive gas removal, Ag ion exchange

Solar-to-hydrogen Peroxide Conversion of TiO_2@Graphite-derived Carbon Dot Nanocomposites

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Carbon dots (CDs), as one branch of fluorescent nanomaterials, have attracted great interest as photoactive materials due to their superior optical response and electron donating/accepting activity. Also, CDs can be synthesized from abundant carbon sources such as graphite, biomass, charcoal, etc. Lately, visible light photocatalysts are being pursued because the photocatalysts based on metal oxides lack visible light activity. Titanium dioxide (TiO_2), the irreplaceable photocatalyst, has been attracted particular attention on modifying the wide band gap (3.2 eV), making it become the practical material that could be induced by visible light. Herein, we reported graphite-derived CDs (GCDs) in combination with TiO_2 as an effective material. This TiO_2@GCDs performed the excellent photocatalytic ability under visible light for both hydrogen peroxide generation and organic pollutant decomposition. Simultaneously owing the outstanding properties of graphene oxide (tunable band gap) and carbon dot (scalable synthetic routes, low toxicity), TiO_2@GCDs can be utilized as a promising photomaterial for solar chemical conversion.

Keywords: titanium dioxide, photocatalyst, carbon dot, hydrogen peroxide photogeneration

Synthesis, Characterization, and Electrochemical Studies of Iron Sulfide Modified TiO_2 NPs Decorated Carbon Nanofibers

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TiO_2 can be considered as one of the potential electrode material in supercapacitor; however, poor electric conductivity and stability are the major issues to be addressed for practical application. Herein, iron sulfide modified TiO_2 NPs embedded into the carbon nanofibers have been prepared by the electrospinning technique followed by carbonization under the argon atmosphere. The prepared composite nanofiber was characterized by state-of-art techniques. The electrochemical studies revealed that the introduction of iron sulfide and TiO_2 into the conductive carbon nanofibers is greatly beneficial to the structural stability and overall performance of the composite electrode. Therefore, we observed enhanced electrochemical performance as compared to pristine TiO_2 nanofibers.

Keywords: Electrospinning; Composite Fibers; $Fe_{1-x}S$-TiO_2; Supercapacitor

Ag NPs Embedded Spider-web-like Polyurethane Nanofiber Membrane as An Efficient Antibacterial Medium

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A new and straightforward route was proposed to prepare Ag NPs assembled spider-net like polyurethane nanofibers mats as a potential antibacterial medium. The addition of $AgNO_3$ and tannic acid in a PU solution prior to the electrospinning resulted into the formation of Ag NPs embedded spider-net like morphology of PU nanofibers. The tannic acid acts as a reducing agent and also helps in the formation of sub-nano scale fibers. The antibacterial performance of the as obtained composite nanofiber membrane was tested against *Staphylococcus aureus (S. aureus)* and *Escherichia coli (E. coli)* bacteria. The composite fibers showed good antibacterial behavior against both *S. aureus* and *E. coli* bacteria. Overall, following this synthetic route, Ag NP loaded spider-web nanofiber PU mat with excellent antibacterial properties can be achieved and it can be considered as an appropriate candidate for various applications such as water filtration, wound dressing, and breathable mask etc.

Keywords: Electrospinning; Polyurethane nanofibers; Ag NPs; Antibacterial

Three-dimensionally Assembled MnO_2 Nanowires as Efficient Supercapacitor Electrode

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A new synthesis route was proposed for the synthesis of three-dimensional MnO_2 ultrathin nanowires in order to exploit their electrochemical properties in supercapacitors. The formation of ultrathin nanowires and their 3D assembly was achieved via a slow-reduction of potassium permanganate by oleylamine under constant stirring at 80 °C for 50 h. The resultant material was characterized using FE-SEM, TEM, XRD, FTIR, BET, XPS and Raman techniques. The electrochemical studies of the material revealed an excellent electrochemical performance with a high specific capacitance of 544.7 Fg^{-1} at 1 Ag^{-1} and excellent life span of 86.3% after 5000 cycles. We believe that this study provides an easy and cost-effective method for the synthesis of a three-dimensional network of MnO_2 ultrathin nanowires with excellent electrochemical properties, leading them to industrial utilization.

Keywords: MnO_2 nanowires; 3D assembly; Supercapacitor; Electrode

TiO_2 / Carbon Nanofiber Composite for Supercapacitor Applications

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Titanium dioxide nanoparticles (TiO_2 NPs) embedded into carbon nanofiber (CNFs) were synthesized by a simple electrospinning method followed by subsequent thermal treatment under inert atmosphere. The resulting composite was characterized by state-of-the-art techniques and exploited as the electrode material for supercapacitor applications. Upon heating at 900 °C, the anatase to rutile phase transformation was achieved. The electrochemical studies revealed that the loading of TiO_2 into the amorphous carbon lead to extraordinary enhancement in terms of electrochemical properties. The cyclic voltammetry, galvanostatic charge–discharge, and EIS test results exhibited a combined synergistic effect of TiO_2 and carbon fibers. The as-obtained TiO_2-CNF composite exhibited a specific capacitance of 106.57 F/g at a current density of 1 A/g and capacitance retention of about 84% after 2000 cycles. The results obtained from this study demonstrate that the prepared nanocomposite could be used as electrode material in a supercapacitor. Also, the results obtained from the electrochemical study and the easy synthesis protocol show potential application in several applications, including supercapacitors.

Keywords: TiO_2; Carbon nanofibers; Electrospinning; Composite; Supercapacitor

A Strategic Approach to Forming Advanced Porous Carbon for Electric Double Layer Capacitors: Sophisticated Nanospace Management from Transgenic Hybrid Poplars

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The electrode materials for electric double layer capacitors shall have a high surface area and well developed pore structure in the range from sub-nanometers to tens of nanometers. Woody biomass is very attractive material because it is the most abundant natural materials. The application of lignocellulosic biomass in the field of electrochemical energy storage would reduce the material cost and make system more sustainable. In line with these advantages, lots of researches for developing new supercapacitor electrode materials derived from wood materials are ongoing. However, natural precursor derived activated carbons are known to be non-ideal for high performance supercapacitors because the constituents of biomass are things we cannot control and these are very different depending on the species, location, and the season. With plant biotechnological approach, now we can design composition of cellulose, hemicellulose, and lignin in the same type of woody biomass for high performance supercapacitor electrodes. The control over the biomass composition in the same species will provide fairest correlations between compositional changes and electrochemical performances and further enlighten multiple fundamental knowledge to make generalized theorem. In this study, we prepared activated carbon derived from the wood powder of transgenic poplar tree. The activated carbon was obtained by KOH activation at 600°C and 800°C. We confirmed considerable change in capacitance of supercapacitors made from poplar tree with different chemical compositions. Transgenic poplar tree with lower lignin concentration demonstrates 39% higher capacitance compared with wild type poplar at 0.2A/g. We also compared with commercial activated carbon (YP-50F) and transgenic poplar tree demonstrates 82% higher capacitance at 0.2A/g. In this talk, we will discuss key factors affecting capacitance of biomass derived carbons and provide design principles to get high performance of supercapacitors.

Keywords: electric double layer capacitor, hybrid poplar, biomass constituents, activated carbon, pore structure

Effect of Sulfate Doping on the Antibacterial Activity of Ag_3PO_4 Nanoparticles Loaded on Polymer Electrospun Nanofiber

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Composite nanofibers of PAN and sulfate doped Ag_3PO_4 nanoparticles (SO_4^{2-}-Ag_3PO_4/PAN) were successfully fabricated using simple and versatile electrospinning technique followed by ion exchange reaction. Thus obtained composite nanofibers were characterized using FESEM, XRD, FTIR, XPS and DRS. Presence of SO_4^{2-}-Ag_3PO_4 nanoparticles on PAN nanofiber surface was evidenced from FESEM characterization. The antibacterial activity of as fabricated composite nanofibers was investigated using Gram negative (*E. coli*) and Gram positive (*S. aureus*) bacteria under day light condition. Experimental results demonstrated the higher antibacterial performance of SO_4^{2-}-Ag_3PO_4/PAN than that of sulfate undoped composite nanofibers (Ag_3PO_4/PAN), which may be due to the doping effect of sulfate into Ag_3PO_4 crystal lattice that can provide sufficient electron-hole separation capability to SO_4^{2-}-Ag_3PO_4 to produce reactive oxygen species (ROS). Thus obtain ROS are responsible for bactericidal activity of the proposed composite nanofibers.

Keywords: Electrospinning; SO42−-Ag3PO4/PAN heterojunction; antibacterial; visible light; reactive oxygen species

Anion Doping: A New Strategy for Enhancing Antibacterial Activity of Ag_3PO_4 Nanoparticles Anchored on Polymer Electrospun Nanofibers

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Doping of suitable ions into crystal lattice of semiconductor material is considered as excellent way to enhance its photocatalytic/antibacterial activities. It is believed that the dopant ion can modify the surface structure of host material and causes changes in band gap energy along with light absorption properties. Also, dopant ion acts as capture center of photogenerated electrons to inhibit the recombination of photogenerated electron-hole pairs thereby increasing the performance of semiconductor material. Therefore, in this work, we present a facile method to fabricate antibacterial composite of SO_4^{2-} ion doped Ag_3PO_4 nanoparticles anchored on polyacrylonitrile nanofibers (Sulfate- Ag_3PO_4/PAN composite) via electrospinning followed by ion exchange method in aqueous solution. Doping of SO_4^{2-} ion into Ag_3PO_4 crystal lattice by replacing PO_4^{3-} ion was feasible due to difference in ionic radius (0.218 nm of SO_4^{2-} ion and 0.230 nm for PO_4^{3-} ion). Thus obtained composite was characterized using various techniques, such as FESEM, XRD, FTIR, XPS, DRS. Experimental results showed the higher antibacterial activity of Sulfate-Ag_3PO_4/PAN composite than that of sulfate undoped (Ag_3PO_4/PAN) composite under visible light irradiation, which might be attributed to the role of SO_4^{2-} ion for trapping and transferring of electrons to prevent the recombination of photogenerated electron-hole pairs. Moreover, Ag_3PO_4/PAN composite can receive additional electrons from S atom due presence of more valence electrons in S atom as compared to P atom.

Keywords: Electrospinning; Anion doping; Composite nanofibers; Antibacterial; Reactive oxygen species

Ag_3VO_4 NPs Decorated Polyacrylonitrile Nanofibers: Synthesis, Characterization, and Photocatalytic Activities

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An ion-exchange method was employed to fabricate Ag_3VO_4 nanoparticles loaded polyacrylonitrile (PAN) nanofibers for photocatalytic and antibacterial applications. The structural, optical, and photocatalytic properties were studied by the state-of-art techniques. The photocatalytic degradation of methylene blue (MB) was investigated under UV irradiation and it showed about 99% degradation of the dye within 75 min. The antibacterial performance of the as-synthesized Ag_3VO_4/PAN composite nanofibers was experimentally verified by the destruction of Escherichia coli *(E. coli)*. These results suggest that the developed inexpensive and functional nanomaterials can serve as a non-precious catalyst for environmental applications.

Keywords: Ag_3VO_4/PAN fiber; Composite; Photocatalyst; Antibacterial

Carbon Quantum Dots Incorporated Keratin/PVA Nanofiber Membrane for Multifaceted Applications

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The carbon quantum dots (C-dots) assisted photoluminescent keratin/poly(vinyl alcohol) (PVA) nanofibers (NFs) with optical transparency and biocompatibility were prepared by an electrospinning technique for multiple applications. The synthesized composite nanofibers were characterized by scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), ultraviolet-visible spectroscopy, and spectrofluorometer. The morphological analyses showed that the C-dots were distributed inside the polymer matrix throughout the fiber body. The resultant nanocomposite fibers preserved both the nanofiber morphology of polymer fiber and optical properties of C-dots. The as-synthesized nanofiber membrane also demonstrated biocompatibility in the living cell environment. These results may lead to the development of a new family of advanced composite NFs consisting of C-dots and polymer for different applications such as optoelectronic devices, metal ion detection, and biomedical application such as cell culture and imaging.

Keywords: Carbon dots; PVA nanofibers; Keratin; Biomedical; Photoluminescent

Thermally Stable Polymer Binders for Hybrid Separators in Lithium Ion Battery

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Rechargeable batteries have attracted keen interest due to the wide spreading of portable electronic devices such as smart phones and tablet PCs. Recently, the rechargeable batteries with high safety are of great importance for new paradigms such as electric vehicles as well as artificial intelligence (AI) systems. Of various rechargeable batteries, lithium ion batteries are mainly employed for such portable and vehicle applications because of their high voltages and energy densities. However, there are several reports on the explosions of lithium ion batteries, which can be attributable to the components including electrolytes. In more detail, the flammable electrolytes can be ignited by the shortage between cathodes and anodes when the separators in between them cannot play properly. The separator films should satisfy various requirements such as high ion permeability and low electrical resistance at operating temperatures, electrical insulating roles between anodes and cathodes, chemical stability for electrolyte solutions, and thin membranes capable of high-density filling for high capacity. The conventional separator films do still have a demerit of weak mechanical strength and severe thermal deformation, leading to the often explosion of lithium ion batteries at elevated temperatures. Our group has recently focused on the development of thermally stable polymers for hybrid separators. This presentation will discuss the improved thermal stability of hybrid separators together with the resulting battery performances.

Keywords: lithium ion battery, hybrid separator, thermally stable polymer.

Organic Transistor Sensors with Quercetin-Embedded Polymer Nanolayers for Detecting Reactive Oxygen Species

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Reactive oxygen species (ROS), derived by the side reactions in biosystems including human bodies, has been recognized as a hazardous source, leading to inflammations, cancers, ageing, etc., at the excess production level. The effective sensing of ROS has been one of the important milestones in biomedical applications, while it does recently become one of the key challenging technologies in clinical tests. In particular, the easy and portable ROS sensors are keenly required for skin monitoring in cosmetic applications. Recently, our group has devoted to develop flexible organic transistor sensors by employing polyphenol-embedded polymers because of the outstanding detection of ROS by polyphenols. We demonstrated that the sensitivity of ROS detection could be remarkably increased by adjusting the gate voltage in the geometry of organic field-effect transistors. Very recently, we have focused on quercetin, which is one of the naturally abundant polyphenols, for the fabrication of ROS-sensing organic field-effect transistors. In this presentation, we demonstrate organic transistors with the quercetin-embedded semiconducting polymers which act as a ROS-sensing nanolayer.

Keywords: ROS, quercetin, sensors, organic field-effect transistors, semiconducting polymers.

Kinetics of Oxytetracycline Degradation by Oxygen-doped Graphitic Carbon and Peroxymonosulfate

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In this study, the kinetics of oxytetracycline (OTC) degradation by oxygen-doped g-CN (O-g-CN) and peroxymonosulfate (PMS) was investigated using various models. The pseudo first order reaction kinetic model has been generally applied to analyse catalytic degradation. However, it dose not fit to the experimental results of most of the conditions due to the catalyst deactivation and the heterogeneous nature of a solid catalysts. Therefore, kinetic models incorporating deactivation, i.e., pseudo first order deactivation and reactant dependent deactivation, were proposed and tested to properly describe the reactions. Results showed that the experimental results were poor fit to the pseudo first order model (dC/dt=$-kC$) and that incorporating reactant dependent deactivation ($dC/dt=-kC\cdot\exp(-k_D\cdot(C_0 - C)/C_0)$). However, the pseudo first order model incorporating the pseudo first order deactivation ($dC/dt=-kC\cdot\exp(-k_D\cdot t)$) was a good fit to most of the conditions in this study. The pseudo first order reaction rate constant (k) and the deactivation constant (k_D) were well correlated with experimental conditions such as O-g-CN dose and the pH in the system of O-g-CN, PMS, and OTC. It suggests that the deactivation in the system was attributed to the change in O-g-CN property during the reaction than to the accumulation of OTC and/or its reaction products on O-g-CN. It was supported by the continuous decrease in OTC removal rate as the O-g-CN was repeatedly used for five times. The values of k and k_D were decreased and correlated to the number of uses. It was also supported by the decrease in crystallinity, graphitic carbons, and the degree of structural disorder identified by Raman spectroscopy, X-ray diffraction patterns, and X-ray photoelectron spectroscopy. Based on the results in this study, it is suggested that the protection of O-g-CN from the structural changes, probably by reactive particles immobilization and/or thermal treatment, would significantly increase the catalytic activity and durability.

Keywords: catalyst, deactivation, graphitic carbon nitride, kinetics, peroxymonosulfate, oxytetracycline

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Bimetallic V_2O_5-TiO_2 Catalyst Coupled with Ceramic Membranes for the Facile Oxidation of di(2-ethylhexyl) Phthalate

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A residue of micropollutants in drinking water cause health problems. However, conventional water treatment couldn't mineralize it. To enhance the removal efficiency, ozone with ceramic membrane system is proposed. Moreover, the heterogeneous catalysts are introduced in the ozonation processes due to the increased production of hydroxyl radicals. In this study, we conducted the hybrid ozone-ceramic membrane process with V_2O_5-TiO_2 for the enhancement of removal of micropollutants. After V_2O_5 was successfully coated on the membrane through filtration-coating method, the catalytic oxidation effect was evaluated in the presence of ozone. The hybrid system was conducted in the dead-end cell, 2 mg/L of dissolved ozone concentration, and 1 mg/L of 4 selected compounds. As a result, the hybrid system with V_2O_5-TiO_2 catalyst depicted higher removal rate than without catalyst due to the catalytic reaction between ozone and V_2O_5 nanoparticles incorporated in the ceramic membrane.

Keywords: Plasticizer, Phthalate esters, di(2-ethylhexyl) phthalate (DEHP), V_2O_5-TiO_2 catalyst

Waste Resource Flow Analysis of End-of-Life Vehicles in Korea

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The increase in the number of end-of-life vehicles (ELVs) has led to environmental problems from the ELV dismantling and recycling process such as improperly discarded wastes and wastewater discharge into nearby rivers. In this study, a waste resource flow analysis was conducted to identify the recoverable valuable resources and environmentally-detrimental residues in the ELV recycling process. The waste resource flow analysis looks at the lifespan of a product after it is discarded. In this study, the lifespan of ELVs was divided into five stages: discarding - collection/disposal – pretreatment - resource recovery - sale/export. Understanding the flow of the product after disposal, as opposed to the flow of each material, can be vital to the improvement of resource circulation, and thus, this study analyzed the flow of recoverable resources and the treatment of residues after each stage of resource recovery. The analysis showed that the recycling rate of ELVs was 88.7%. The residues remaining at the final stage of ELV recycling was the loss of the heat energy produced from formal sectors and final sludge, while losses in liquid waste, airbags, waste refrigerants due to destruction or releasement into the atmosphere during the recycling process were also found to occur. Valuable metal scraps, reusable parts, and ferrous and nonferrous metals were relatively well-recycled in the resource recovery stage, thus, what was revealed to be necessary is a measure to promote the recycling of less valuable materials such as plastic, glass, rubber, and sheet foam. Ferrous and nonferrous metals recovered through shredding or recycled automotive shredder residue (ASR) were being sold to steel refining and production companies, and the heat energy recovered through ASR recycling was being supplied to nearby industrial facilities. Further studies employing waste resource flow analysis on ELV vehicles will help to identify the obstacles hindering the improvement of the ELV recycling rate and to develop appropriate policy measures.

Keywords: End-of-life Vehicle; Material Flow Analysis; Waste Resource Flow Analysis; Lifecycle Flow; Automotive Shredder Residue

The Relationship of the Materials Consumption and Economic Growth in OECD Countries

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This study examined the long-run relationship between material consumption, economic growth, and the share of service industry for OECD countries. The analysis was based on the panel unit root tests, panel cointegration test, and fully modified ordinary least squares (FMOLS) estimator and dynamic ordinary least squares (DOLS) estimator. As long-run equilibrium results, all analysed countries were in the long-run equilibrium between the material consumption, the economic growth, and the share of service industry. Furthermore, the panel FMOLS and DOLS estimators reveal that the relationship between material consumption and economic growth was positive, and between material consumption and the share of service industry was negative.

Keywords: material consumption, economic growth, service industry, panel cointegration analysis, OECD countries

Evaluation of Correlation between Air Resistance Coefficient and Optical Porosity of Windbreak Tree, *American Arborvitae*

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Vegetative Environmental Buffers (VEBs) have shown been to be effective in diluting, and dispersing odor and dust laden air streams associated with animal production sites. The effect of reducing the spread of the odor and dust can be estimated through techniques such as Computational Fluid Dynamics(CFD) using the air resistance coefficient of the VEBs. In this study, we tried to develop a method that can efficiently and conveniently estimate the air resistance coefficient of the VEBs, such as a windbreak tree in the field. The air resistance coefficient of windbreak tree, American arborvitae was derived by conducting a wind tunnel experiment. Optical porosity was applied as a method for estimating the aerodynamic coefficient in the field, and optical porosity was derived by image analysis using pictures of the experimental trees. Additionally, in order to evaluate the changes in the air resistance coefficient and optical porosity according to the leaf density, the experiment was conducted by pruning step by step. The air resistance coefficient (C0) and optical porosity had a high negative correlation, and the coefficient of determination (R2) and the slope were 0.9460 and -0.5603, respectively. Through the derived regression equation, the air resistance coefficient of American arborvitae trees can be easily estimated. In addition, it can be used to analyze effect of mitigating and dispersing odor and dust by designing a numerical analysis model for aerodynamics of windbreak trees in the future.

Keywords: air resistance, Optical porosity, regression, windbreak tree, CFD

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Aqueous Mercury Removal by Sulfurized Magnetic Activated Carbon Derived from Simultaneous Activation, Magnetization, and Sulfurization of Bamboo

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Mercury (Hg) is a toxic metal released to the hydrosphere as a result of anthropogenic activities and natural sources. Hg has received worldwide attention due to its bioaccumulation and biomagnification through food nets in the water environment. Sulfurized magnetic activated carbon (SMAC) is a feasible material for aqueous Hg(II) removal, mainly due to the high affinity towards Hg(II) and the simple magnetic separation. In this study, SMAC was synthesized by a one-step pyrolysis of $FeCl_3$/S-laden bamboo powder to remove Hg(II) from aqueous solution. Results of physical and chemical characterization showed that the specific surface areas (S_{BET}) of SMAC was 227 m^2/g with the presence of 4.25 wt% S and 7.28 wt% Fe. The surface of SMAC possessed a significant magnetite structure, thus providing a saturated magnetization value (M_s) of 3.36 emu/g. The adsorption results showed that the Hg(II) removal efficiency reached 100% by the addition of SMAC (i.e., 10 mg/100 mL) at the initial Hg(II) concentration of 2435 μg/L and 30 °C. In conclusion, Hg(II) can be successfully removed from aqueous solution via selective adsorption onto SMAC; furthermore, the release of Hg(II)-adsorbed SMAC into the water environment could be prevented by using magnetic recovery.

Keywords: mercury, activated carbon, adsorption, magnetic adsorbent

Insights into Adsorption of Diclofenac on Metal-organic Frameworks

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In the last few decades, great concern has been raised on the increasing number of pharmaceuticals which were detected at different levels in diverse water environments, such as wastewater, surface water, groundwater, and even drinking. Diclofenac (DCF) is one of the most frequently detected non-steroidal anti-inflammatory drugs in the water environmental. Therefore, it has become urgent to find new useful methods for the removal of DCF from aqueous solutions. Herein, we investigated adsorption capacity of porous metal-benzenetricarboxylates (MOFs), such as MIL-100(Al, Fe and Cr), MIL-110(Al) and MIL-96(Al) towards DCF. Adsorption of 20-750 mg/L of diclofenac on MOFs from aqueous solutions was investigated without any additions at 25 ^{o}C. Combination of physicochemical methods and mathematical modeling (Langmuir, Freundlich and Temkin models) was used for the analysis of the adsorption mechanism. Adsorption capacity was demonstrated to rise with increasing amount of Lewis acid sites determined by EPR spectroscopy using 2,2',6,6'-tetramethyl-1-piperidinyoxyl radical as the probe molecule in the order:

MIL-96(Al) > MIL-110(Al) > MMIL-100(Al) > MIL-100(Cr) > MIL-100(Fe)

It was found that structural and textural properties affect adsorption of DCF. Thus, the increasing microporosity of MOFs led to the decreasing adsorption capacity, while increasing specific surface area favoured to rising adsorption value. Experimental data point that adsorption of DCF involves electrostatic interaction between functional groups of MOFs and DCF and p-p interaction/stacking. The comparison adsorption capacity of Carbon materials were lower in compared with that of studied MOFs.

Keywords: Metal-Organic framework, Adsorption, Diclofenac, Textural properties, Lewis acidity