

## DIVISION OF ENVIRONMENTAL CHEMISTRY

238th ACS National Meeting  
Washington, D.C.  
August 16-20, 2009

### WEDNESDAY EVENING

#### General Papers

D. D. Dionysiou, *Organizer, Presiding*  
6:00 - 8:00

#### Environmental Chemistry Division and Education

**99.** The Division of Environmental Chemistry. **R. A. Hathaway**

**100.** Certification for environmental chemists and technicians through NRCC. **R. A. Hathaway**

#### Advanced Oxidation, Catalytic, Electrocatalytic, and Photochemical Processes-Applications and Mechanistic Aspects.

**101.** Catalytic wet oxidation of phenol with metal ion-doped cryptomelane-type manganese oxides. **B. Hu**, C. Chen, L. Jin, S. Frueh, S. L. Suib

**102.** Experiment and model of diclofenac degradation in an advanced ozone membrane reactor. M. S. Islam, A. Blondy, K. L. Yeung, A. Julbe, A. Ayril, J. C. Schrotter, **X. Chen**

**103.** Mechanism and kinetics of parathion degradation by ultrasonic irradiation. **J. Yao**, N. Gao, C. Li, H. Guo

**104.** Photodegradation of 4-chlorophenol wastewater using dye sensitized C-TiO<sub>2</sub> photocatalysts under the visible light irradiation. **Y. Shen**, J. Shi, P. Zhu, Y. Zhang

**105.** Photoirradiation of polycyclic aromatic hydrocarbon diones by UVA light leading to lipid peroxidation. **Y. Zhao**, Q. Xia, J. J. Yin, H. Yu, P. P. Fu

**106.** Cavity ring-down spectroscopic study of gas-phase absorption cross sections of 2-nitrobenzaldehyde and benzaldehyde in the 285-400 nm region, and photolysis of 2-nitrobenzaldehyde vapor at 308 nm and 351 nm. **C. Zhu**, B. Xiang, L. Zhu

**107.** Chlorine-free disinfection of water contaminated with *Salmonella typhimurium* by treatment with an alternating current: Role of hydrogen peroxide formation. **N. N.**

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**108.** Inhibition of nZVI reactivity by magnetite on reductive degradation of 1,1,1-trichloroethane. **S. Bae**, W. Lee

**109.** Polymerization of Triclosan catalyzed by Fe(III)-saturated montmorillonite. C. Liyanapatirana, S. R. Gwaltney, **K. Xia**

**110.** Reductive dechlorination of vinyl chloride by cement/Fe(II) system. **H -M. Park**, S - J. Kang, J. Im, J -Y. Park

**111.** Removal of trichloroethylene by using FeO/Fe(II) system. **S -J. Kang**, H -M. Park, J. Im, J -Y. Park

**112.** Hydrodechlorination of DDT catalyzed by hydroxyapatite-supported Pd nanoparticles. **N. Hashimoto**, T. Yagi, T. Mitsudome, T. Mizugaki, K. Jitsukawa, K. Kaneda

**113.** Mechanism research on HCN removal through MgO at high temperature. H. Tan, **X. Wang**, C. Wang, T. Xu

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**114.** Biodegradation of volatile organic compounds using VOC-tolerant bacterial strains from activated sludge. V. Ibeanusi, M. LaFrance, S. Mohamed, E. Adeyemi, **Y. Jeilani**

**115.** Artificial neural network optimization tool for modeling environmental bioremediation processes. V. Ibeanusi, G. Menezes, J. Coffen, E. Jackson, I. Ajayi, **Y. Jeilani**

#### Solid Waste, Sewage, Physical Chemical Processes for Water Treatment.

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**117.** Pyrolysis and gasification of sawdust, sewage sludge and pre-treated RDF in thermobalance reactor. **S. Roh**, J. Yun, T. Min, W. Kim, S. Keel

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- 121.** Speciation of brominated disinfection by-products in drinking water: Influence of naturally occurring bromide and chlorine dose. **J. M. Wilson**, J. M. VanBriesen
- 122.** Characteristics and disinfection byproducts formation potential of *Microcystic aeruginosa* intracellular and extracellular organic components. **H. Ou**, N. Gao, L. Li, K. Zhang
- 123.** Reactivity and antimicrobial properties of nanostructured titanium dioxide. K. L. Yeung, W. K. Leung, N. Yao, S. Cao, **X. Chen**
- 124.** Effect of pH and orthophosphate levels of drinking water during the initial stages of copper corrosion investigated with atomic force microscopy. **S. L. Daniels**, B. R. Lewandowski, D. A. Lytle, J. C. Garno
- 125.** Free fatty acid profile of the maternal organs and fetal brain from pregnant rats treated with sodium arsenite. **I. A. Ross**, C. S. Kim, W. D. Johnson, R. L. Sprando, M. W. O'Donnell, D. Ruggles, T. Boyle
- Adsorption, Sorption, Interaction, Distribution, Fate, and Transport of Pollutants (Metal, Inorganic, Organic) and Nanoparticles in Natural Systems.
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- 128.** Sorption rate of phenanthrene into polyoxymethene-implication for application of equilibrium passive sampler. **Y. Ma**, W. Huang
- 129.** Vertical profile of polychlorinated biphenyls buried in sediments of the Coastal Plain Potomac River, Washington, D.C. **G. K. Bharat**, G. D. Foster
- 130.** Effect of dissolved organic matter composition on pyrethroids runoff. **L. I. Delgado-Moreno**, L. Wu, J. Gan
- 131.** Sources and input pathways of glyphosate into surface waters. **I. Hanke**, S. Bischofberger, I. Wittmer, H. P. Singer, C. Stamm
- 132.** Chemical properties of humic substances and sorption characteristics for pharmaceuticals. **H. Mori**, N. Fujitake

- 133.** Occurrence, phase distribution and biological effects of chemicals derived from wastewater discharge in tributaries of the Coastal Plain Potomac River, Virginia. **K. J. Dove II**, G. D. Foster
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- 138.** Removal of cadmium (II) in ppb level from aqueous medium. A. S. Lyons, P. A. Amoyaw, M. Williams, **X. R. Bu**
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- 140.** Sorption of mercury(II) onto iron sulfides (FeS and FeS<sub>2</sub>): Reaction mechanism and stability. **D. Han**, B. Batchelor
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- 142.** Mesoporous hydrous zirconium oxide for arsenic removal from drinking water. **A. Bortun**, M. Bortun, J. Pardini, S. Khainakov, J. R. García
- 143.** Removal of chloroform and MTBE from water by adsorption onto granular zeolites. **L. Abu-Lail**, J. A. Bergendahl, R. W. Thompson
- 144.** Mitigation of anthropogenic organic contaminants using vermiculture. **D. W. Bemis**, C. Kinney, B. J. Brownawell, C. Kelly, E. T. Furlong, D. W. Kolpin, S. D. Zaugg
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- 148.** Atmospheric particulate matter pollution during The 2008 Beijing Olympics. **W. Wang**, T. Primbs, S. Tao, T. Zhu, S. L. Simonich
- 149.** Comparison of acid aerosols between hot spring and urban areas in Taipei. **C -H. Lin**, I -F. Mao, P -H. Tsai, Y -J. Chen, M -L. Chen
- 150.** Decoupling secondary organic aerosol formation and aging processes. C. D. Hauser, **R. M. Jenkins, J. Godinho**
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- 154.** Evolution of H<sub>2</sub>S and SO<sub>2</sub> during the pyrolysis of three types of Chinese coal. Q. Zhao, **X. Wang**, Q. Qi, H. Tan
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- 157.** Fundamental study of environmental control in Oxy-PC combustion system. **J. Yun**, S. Keel, T. Min
- 158.** Role of silica-supported iron oxide nanoparticles in pollutant formation in combustion processes. **E. Mitran**, B. Dellinger, R. L. McCarley
- 159.** Self-retention of SO<sub>2</sub> by ash during fluidized bed combustion of biomass. **K. Zhao**, Q. G. Lu

**160.** Size and composition distribution of nanoparticulate emitted from four-stroke motorcycle. **C. Shu-Mei**, H. Yuh-Jeen, C. Kuan-Yi

#### Environmental Analytical Methods.

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**162.** Method development for nitric oxide radical determination in natural water. **E. F. Olasehinde**, K. Takeda, H. Sakugawa

**163.** Rapid lab-scale extraction and analysis of anthropogenic organic contaminants in sediments. T. J. Brown, **C. Kinney**

**164.** Speciation analysis of rare earth elements in soil of China. **X. Qi**

**165.** Steroid hormone determination in water using an polymer magnetic nanoparticle extraction technique. **Q. L. Li**

**166.** Trace determination of synthetic polycyclic musks in water by microwave-assisted headspace solid-phase microextraction and GC/MS. **W -H. Ding**

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**169.** New contamination derived from marine debris plastics. **K. Saido**, T. Itagaki, H. Sato, Y. Kodera, O. Abe, N. Ogawa, S -Y. Chung, K. Miyashita

**170.** Uptake of human pharmaceuticals in plants grown under hydroponic conditions. P. Gurung, P. Herklotz, B. Vanden Heuvel, **C. Kinney**

#### Properties of Chemicals and Materials of Environmental Concern.

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**173.** Effects of CO addition on the ignition temperature and burn off temperature of methane. **K. Zhao**, Q. G. Lu

**174.** Rate constants for the direct reaction of ozone with four selected pharmaceuticals. **F. J. Real**, F. J. Benitez, J. L. Acero, G. Roldan

Green Chemistry and Emerging Technologies.

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**176.** Imprinted polymers for the removal of hydrophilic metal complexes from water. **S. A. Ashraf**, A. Mueller

**177.** Latex-CNT composites with entrapped microbes as anodes in microbial fuel cells. B. Logan, **R. C. Wagner**

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**179.** Using an iron ball packed bipolar cell for groundwater contaminated by nitrate. J. H. Park, J. Im, **J -Y. Park**

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**180.** Toxicity and developmental defects of nickel nanoparticles in zebrafish. **C. R. Ispas**, D. Andreescu, K. N. Wallace, S. Andreescu

## ABSTRACTS

### ENVR 99

#### **The Division of Environmental Chemistry**

**Ruth A. Hathaway**, *ruthhathaway@msn.com*, Hathaway Consulting, 1810 Georgia St, Cape Girardeau, MO 63701-3816, Fax: 573-334-2551

Founded over 85 years ago, the Division of Environmental Chemistry is one of the largest Divisions in the American Chemical Society. The 5,000 members come from a broad spectrum of environmental professionals, including industry, consulting, government, and academia. The Division encompasses a broad spectrum of environmental issues covering air, water, and soil. Membership allows you to participate in programs and activities within the Division, interact with other environmental chemists, and foster professional development in environmental chemistry. The objectives of the Division are to promote research, disseminate information, and improve education and public awareness regarding the chemistry of the environment in all of its aspects. In addition, the Division provides assistance to other divisions and committees within the ACS regarding issues pertaining to the environment.

### ENVR 100

#### **Certification for environmental chemists and technicians through NRCC**

**Ruth A. Hathaway**, *ruthhathaway@msn.com*, Hathaway Consulting, 1810 Georgia St, Cape Girardeau, MO 63701-3816, Fax: 573-334-2551

There are education, experience, and examination standards for certification by NRCC. Applicants voluntarily present their education and experience credentials to the Registry's Board of Directors as part of an application to sit for examination. After applications are approved, candidates are eligible to sit for examination. A candidate who passes an examination is then certified by the Board for the current year and a certificate is issued in the candidate's name with a registration number. The National Registry in Clinical Chemistry was organized in 1967 to certify Clinical Chemists and Clinical Chemistry Technologists. NRCC started a certification program for Environmental Analytical Chemists and Environmental Analytical Technicians in 1998. In 1999 the Board of Directors of NRCC changed the organization's name to National Registry of Certified Chemists. Various states recognize NRCC certification as a method to qualify certain laboratory personnel for licensure. NRCC certificants may use their listing in the NRCC annual directory as one credential supporting their expert witness status. Basically, individuals seek certification to enhance their professionalism in their career fields and among their peers. The Registry is a 501(c)(3) nonprofit

organization incorporated in the District of Columbia. Its sponsors include major chemical and industrial hygiene organizations in the United States.

## ENVR 101

### Catalytic wet oxidation of phenol with metal ion-doped cryptomelane-type manganese oxides

**Boxun Hu**<sup>1</sup>, *huboxun@uconn.edu*, **Chunhu Chen**<sup>2</sup>, *chunhu.chen@uconn.edu*, **Lei Jin**<sup>2</sup>, *lei.jin@uconn.edu*, **Sam Frueh**<sup>2</sup>, *sam.frueh@uconn.edu*, and **Steven L Suib**<sup>3</sup>, *steven.suib@uconn.edu*. (1) Institute of Materials Science, University of Connecticut, 55 North Eagleville Rd, Storrs, CT 06268, (2) Department of Chemistry, University of Connecticut, 55 North Eagleville Rd, U3060, Storrs, CT 06268, (3) Department of Chemistry, University of Connecticut, 55 North Eagleville Rd, U3060, Storrs, CT 06269-3060

Phenolic compounds from polluted effluents are extremely harmful to the environment and human health. Doped cryptomelane-type octahedral manganese oxides (OMS) were prepared and their catalytic behavior has been investigated in the catalytic wet oxidation of phenol. The catalytic wet oxidation (CWO) of phenol was carried out at a moderate temperature range of 100-180°C and an O<sub>2</sub> pressure range of 75-150 psi. The reactivity, stability, leaching, fouling, and regeneration properties of these doped catalysts have been studied. The nature of metal ions, oxygen vacancies, and mixed oxidation states of manganese are related to the redox cycling in the oxidation of phenolic compounds. Compared with non-doped K-OMS-2, doped M-OMS-2 catalysts showed higher reactivity in CWO reactions. The pH value of the effluents significantly affects the oxidation rate and also the stability of these catalysts.

## ENVR 102

### Experiment and model of diclofenac degradation in an advanced ozone membrane reactor

**Mohammad Shahidul Islam**<sup>1</sup>, *shmo@ust.hk*, **A. Blondy**<sup>1</sup>, **King Lun Yeung**<sup>1</sup>, *kekyeung@ust.hk*, **A. Julbe**<sup>2</sup>, **A. Ayra**<sup>2</sup>, **J. C. Schrotter**<sup>3</sup>, and **Xinqing Chen**<sup>1</sup>, *kechenxq@ust.hk*. (1) Department of Chemical and Biomolecular Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China, (2) Universite Montpellier, Montpellier 34095, France, (3) Chemin de la Digue, Maisons Laffitte, France

Diclofenac is a popular non-steroidal, anti-inflammatory drug used in medical and veterinary medicines and considered as endocrine disrupting chemicals (EDCs) and hard to treat by the conventional wastewater treatment process. This work investigates the conversion and degradation of diclofenac in an advanced ozone membrane reactor. Above 40 percent TOC destruction has been achieved for diclofenac in case of blank

Ozonication in semi-batch ozonation reactor and additional 20% TOC conversion has been observed in case of ZSM-5 ozone membrane reactor with porous  $\alpha\text{-Al}_2\text{O}_3$  support in similar work done by previous companion researcher. Semi-batch experimentation turns out that diclofenac degradation follows pseudo first order kinetics during initial 60 minutes ozonation and afterwards it becomes independent of time (zero order) for 1-100ppm TOC solution within 30-60°C. Mathematical model as derived by forward modeling approach indicated that the advanced ozone membrane can effectively convert and degrade diclofenac into harmless products.

## **ENVR 103**

### **Mechanism and kinetics of parathion degradation by ultrasonic irradiation**

*Juanjuan Yao, yao\_juanjuan@yahoo.cn, Naiyun Gao, Cong Li, and Hongguang Guo, State Key Laboratory of Pollution Control and Resource Reuse, Tongji University, 1239 Siping Road, Yangpu District, Shanghai 200092, China*

Parathion degradation by ultrasonic irradiation in aqueous solution was investigated. The results indicate that at the operating condition in question (ultrasonic frequency of 200, 400, 600 and 800 KHz; applied power of 33, 66 and 100 W; initial concentration of 0.8, 3.0 and 5.2  $\mu\text{mol/L}$ ), the degradation rate of parathion was found to decrease with increasing initial concentration and decreasing power. Moreover, the optimal frequency for parathion degradation was found to be 600 KHz. The investigation using the radical scavengers tert-butyl alcohol (TBA) and sodium bicarbonate revealed that free radical reactions predominate in the parathion degradation by ultrasonic irradiation and the reaction zones are predominantly at the interfacial regions between the cavitation bubbles and the bulk solution and, to a much lesser extent, in bulk solution. Therefore, the gas-liquid interfacial regions are the real effective reaction sites for sonochemical degradation of parathion. The reaction can be well-described as a gas-liquid heterogeneous reaction which obeys a heterogeneous reaction kinetic model similar to the Langmuir–Hinshelwood model according to the data fitting results. The pathways of parathion degradation by ultrasonic irradiation were also proposed by qualitative and quantitative analysis of organic and inorganic intermediate products. It is indicated that the  $\text{N}_2$  in air takes part in the parathion reaction through the conversion to  $\bullet\text{NO}_2$  under ultrasonic irradiation. Parathion is oxidized to paraoxon and 4-nitrophenol at the first step, which is in agreement with the theoretical molecular orbital (MO) calculations.

## **ENVR 104**

### **Photodegradation of 4-chlorophenol wastewater using dye sensitized C-TiO<sub>2</sub> photocatalysts under the visible light irradiation**

**Yongjun Shen**, *shenyj@ntu.edu.cn*, **Jian Shi**, *shenyj@ntu.edu.cn*, **Peng Zhu**, and **Yan Zhang**, 86-513-85015494, School of Chemistry and Chemical Engineering, Nantong University, Young Man Road 99#, Nantong 226007, China, Fax: 86-513-85015501

TiO<sub>2</sub> is a promising photocatalyst as its high oxidative power, photostability and non-toxicity, however, it cannot efficiently utilize the solar energy due to the large band gap (3.2 eV). In this study, dye sensitization and carbon doping co-modified TiO<sub>2</sub> nanotubes, a new type of photocatalysts, were prepared to increase the visible light catalytic activity of TiO<sub>2</sub>. The C doping enhanced the visible light response of TiO<sub>2</sub>. Moreover, the C doping reduced the reduction potential of the conduction band electrons of TiO<sub>2</sub> decreasing the free energy of the electron transfer reaction between dye and TiO<sub>2</sub>. The catalytic activity of dye/C-TiO<sub>2</sub> was significantly higher than that of C-TiO<sub>2</sub> or dye/TiO<sub>2</sub>, which was attributed to the synergetic effect between sensitization and carbon doping. The synergetic fact of dye sensitization and C doping in dye/C-TiO<sub>2</sub> reached 1.61. The maximum removal of 4-chlorophenol was 92% within 2 h. It was found that the TOC removal of 4-chlorophenol wastewater attained 81%. The dye/C-TiO<sub>2</sub> photocatalyst was a good alternative for the wastewater treatment.

## ENVR 105

### Photoirradiation of polycyclic aromatic hydrocarbon diones by UVA light leading to lipid peroxidation

**Yuewei Zhao**<sup>1</sup>, *yuewei.zhao@fda.hhs.gov*, **Qingsu Xia**<sup>2</sup>, *qingsu.xia@fda.hhs.gov*, **Jun Jie Yin**<sup>3</sup>, *junjie.yin@fda.hhs.gov*, **Hongtao Yu**<sup>4</sup>, *hongtao.yu@jsums.edu*, and **Peter P. Fu**<sup>2</sup>, *peter.fu@fda.hhs.gov*. (1) Division of Biochemical Toxicology, National Center for Toxicological Research, Jefferson, AR 72079, (2) Division of Biochemical Toxicology, National Center for Toxicological Research, HFT-110 NCTR, 3900 NCTR Rd., Jefferson, AR 72079, (3) CFSAN, FDA, College Park, MD 20740, (4) Department of Chemistry, Jackson State University, 1400 J R Lynch Street, Jackson, MS 39217

Polycyclic aromatic hydrocarbons (PAHs) are widespread genotoxic environmental pollutants. In the environment, oxidation of PAHs to form PAH diones is considered a detoxification pathway. In this study we report the photoirradiation of a series of PAH diones (anthracene 9,10-dione, benz[a]anthracene 7,12-dione, pyrene 1,6- and 3,6-diones, and benzo[a]pyrene 1,6-, 3,6-, and 6,12-diones) by UVA at 7 and 21 J/cm<sup>2</sup>, respectively in the presence of a lipid, methyl linoleate. It was found that all these PAH diones induced lipid peroxidation and exhibited a relationship between the light dose and the level of lipid peroxidation formation. ESR spin trapping study showed that UVA irradiation of benzo[a]pyrene 3,6-dione generated singlet oxygen and superoxide. These results suggest that UVA photoirradiation of PAH diones generates reactive oxygen species (ROS) and induces lipid peroxidation. Our results also suggest that photo-oxidation of PAHs in the environment to form PAH diones may not necessarily be a detoxification pathway. Keywords: PAH dione, photoirradiation, UVA light, lipid peroxidation.

## ENVR 106

### **Cavity ring-down spectroscopic study of gas-phase absorption cross sections of 2-nitrobenzaldehyde and benzaldehyde in the 285-400 nm region, and photolysis of 2-nitrobenzaldehyde vapor at 308 nm and 351 nm**

**Chengzhu Zhu**<sup>1</sup>, *cxz01@health.state.ny.us*, **Bin Xiang**<sup>2</sup>, *bin\_xiang@hotmail.com*, and **Lei Zhu**<sup>1</sup>, *zhul@orkney.ph.albany.edu*. (1) *Wadsworth Center and SUNY-Albany, New York State Department of Health, Empire State Plaza, P.O. Box 509, Albany, NY 12201-0509, Fax: 518-473-2895*, (2) *SUNY-Albany Environmental Health Sciences, New York State Department of Health, 175 S. Swan St, Apt. 2A, Albany, NY 12201*

We have measured the gas-phase absorption cross-sections of 2-nitrobenzaldehyde and benzaldehyde in the 285-400 nm regions by using cavity ring-down spectroscopy (CRD). The HCO and the NO<sub>2</sub> product channels following 308 and 351 nm photolysis of 2-nitrobenzaldehyde vapor were examined using excimer laser photolysis combined with CRD. Both HCO and NO<sub>2</sub> were not detected. The end-products from the photolysis of 2-nitrobenzaldehyde at 308 and 351 nm have been investigated using FT-IR. The end-product yields from the 308 nm photolysis of 2-nitrobenzaldehyde and the end-products formation mechanism have been determined. Keywords: VOC, air pollutants, benzene, toluene, xylene.

## ENVR 107

### **Chlorine-free disinfection of water contaminated with *Salmonella typhimurium* by treatment with an alternating current: Role of hydrogen peroxide formation**

**Nikolay N. Barashkov**<sup>1</sup>, *nikolay@microtracers.com*, **David Eisenberg**<sup>1</sup>, *Sylvan Eisenberg*<sup>1</sup>, **Irina S. Irgibaeva**<sup>2</sup>, *irgsm@mail.ru*, **Gaukhar S. Shegebaeva**<sup>2</sup>, **Tamara V. Sakhno**<sup>3</sup>, and **Tamara S. Novikova**<sup>3</sup>, *tamara1206@hotmail.com*. (1) *Micro Tracers, Inc, 1370 Van Dyke Ave, San Francisco, CA 94124, Fax: 415-822-6615*, (2) *Department of Chemistry, Eurasian National University, 5 Munaitpasov Str, Astana, Kazakhstan*, (3) *Karpov Institute of Physical Chemistry, 10 Vorontsovo Pole, Moscow, Russia*

Deionized water, highly contaminated with *Salmonella typhimurium* and containing phosphate-buffered salt medium as an electrolyte, was treated in a circulating system with use of electrochemical cell with 10 stainless steel electrodes and low alternating current, AC (from 0.15 to 1.2 Å), relatively low current densities (from 45 to 360 ma/cm<sup>2</sup>) and the initial voltage demand 20-80 volts. It was found that the sanitizing effect is mostly related to the formation of hydrogen peroxide which has been experimentally confirmed by Ghormley's colorimetric method. The possibility of an additional formation of hydroxyl radicals which are able to contribute in killing bacteria due to well-known Fenton reaction between hydrogen peroxide and iron(II) cations (formed at low concentration from stainless steel electrodes under AC-electrolysis conditions) is discussed. The process of electrochemical treatment can be improved from the

technological and economical point of view. This will enhance its implementation in the disinfection of large amounts of water in continuous-flowing systems.

## **ENVR 108**

### **Inhibition of nZVI reactivity by magnetite on reductive degradation of 1,1,1-trichloroethane**

**Sungjun Bae**, *bsj1003@kaist.ac.kr* and **Woojin Lee**, *wojin\_lee@kaist.ac.kr*,  
Department of Civil and Environmental Engineering, Korea Advanced Institute of  
Science and Technology, 373-1 Guseong-Dong, Yuseong-Gu, Daejeon 305-701, South  
Korea, Fax: 82-42-350-3610

In this study, we have demonstrated that the reactivity of nZVI under its low content can be inhibited by iron oxide, magnetite, for the degradation of 1,1,1-trichloroethane (1,1,1-TCA). A significant dechlorination ( $0.289 \text{ hr}^{-1}$ ) was observed in nZVI (0.01 g) suspension during a reaction time, while the degradation of 1,1,1-TCA was not observed in nZVI (0.01 g) suspension with magnetite (0.5 g) in the reaction time. As the content of nZVI increased in the mixture, the kinetic rate constant for the reductive degradation of 1,1,1-TCA in nZVI suspension with magnetite increased. The inhibition of nZVI reactivity by magnetite was not significantly affected in the pH range from 6 to 9. Transmission electron microscopy showed the adsorption of nZVI particles on magnetite surface. X-ray photoelectron spectroscopic analysis revealed the significant increase of Fe(II) species on the magnetite surface, suggesting that the inhibition of nZVI for the reductive degradation was caused by its electron transfer to magnetite.

## **ENVR 109**

### **Polymerization of Triclosan catalyzed by Fe(III)-saturated montmorillonite**

**C. Liyanapatirana**, *cl321@msstate.edu*, Department of Chemistry, Mississippi State University, P.O. Box 9573, Mississippi State, MS 39762, **S. R. Gwaltney**, *drg51@ra.msstate.edu*, Department of Chemistry, Mississippi State University, P.O. Box 9573, Mississippi State, MS 39762, and **Kang Xia**, *kx6@msstate.edu*, Department of Chemistry, Mississippi State Chemical Laboratory, Mississippi State University, P.O. Box CR, Mississippi State, MS 39762

Triclosan (TCS) is a widely used antibacterial compound in consumer products and is frequently detected in wastewater treatment plants. If not degraded during wastewater treatment processes, there is a potential for this compound to get into the environment via wastewater effluent and biosolids, resulting in adverse effect on the environment. The objective of this study was to investigate TCS transformation in the presence of Fe(III)-saturated montmorillonite. In our study, TCS was incubated with Fe(III)-saturated

clay at different concentrations for up to 100 days. Transformation products of TCS were characterized using HPLC/MS and quantified using HPLC/UV. Our results showed that within 1 to 5 days, depending on initial TCS concentrations, 50% of the TCS was rapidly polymerized into dimers and trimers. The energies of the possible dimer isomers were calculated with density functional theory. The calculations predicted two dominant dimer and trimer products. The modeling results confirmed our experimental data obtained by HPLC/MS.

## **ENVR 110**

### **Reductive dechlorination of vinyl chloride by cement/Fe(II) system**

*Hye-Min Park, phm9061@hanmail.net, Su-Jung Kang, emily30@hanmail.net, Jeongran Im, jri@hanyang.ac.kr, and Joo-Yang Park, jooypark@hanyang.ac.kr, Department of Civil Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, South Korea, Fax: 82-2-2220-4322*

The system of cement/Fe(II) was assessed to investigate reductive dechlorination of vinyl chloride (VC). Experiments were performed under various conditions such as Fe(II) dose, Fe(III) addition and degradation by-products. The results showed that the optimum dosage of Fe(II) which improve the rate of dechlorination of VC was 100-200 mM. In case of the addition of Fe(III), the dechlorination rates did not accelerate, comparatively. The system of cement/Fe(II) was found to degrade VC more effectively than the system using zerovalent iron. The VC degradation followed a hydrogenolysis pathway (VC-ethylene-ethane). The major by-product was ethylene, which accounted for 80% of initial concentration of VC. Using ferrous iron as a reductant along with the binder of cement could be applied to reduce VC.

## **ENVR 111**

### **Removal of trichloroethylene by using FeO/Fe(II) system**

*Su-Jung Kang, emily30@hanmail.net, Hye-Min Park, phm9061@hanmail.net, Jeongran Im, jri@hanyang.ac.kr, and Joo-Yang Park, jooypark@hanyang.ac.kr, Department of Civil Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, South Korea, Fax: 82-2-2220-4322*

The ferrous iron reaction is known to be the adsorption of ferrous iron onto the oxide surfaces or reductive dechlorination of TCE by Fe(II). But the phenomena which is unexplained by conventional mechanism observed during the DS/S experiment using modified Fe(II)/slag. When the FeO/200 mM Fe(II) system was examined for treating 0.25 mM TCE, the TCE concentration was suddenly reduced less than 0.03 mM at 5 days, even though the TCE concentration did not change for 4 days. The result showed that some amount of injected Fe(II) from FeO/Fe(II) system adsorbed onto the solid

phase FeO at the point of TCE removal. This system needs to be continued to find out whether new species are generated or any unknown mineral oxides are produced in the system. From this study, it has been verified that there is a possibility of finding another reduction mechanism which is different from existing ones.

## ENVR 112

### Hydrodechlorination of DDT catalyzed by hydroxyapatite-supported Pd nanoparticles

**Norifumi Hashimoto**<sup>1</sup>, **Takeshi Yagi**<sup>1</sup>, **Takato Mitsudome**<sup>1</sup>, **Tomoo Mizugaki**<sup>1</sup>, **Koichiro Jitsukawa**<sup>1</sup>, and **Kiyotomi Kaneda**<sup>2</sup>, [kaneda@cheng.es.osaka-u.ac.jp](mailto:kaneda@cheng.es.osaka-u.ac.jp). (1) Department of Materials Engineering Science, Graduate School of Engineering Science, Osaka University, 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan, Fax: 81-6-6850-6261, (2) Research Center for Solar Energy Chemistry, Osaka University, 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan

DDT and its analogues are well-known toxic organic halides which pollute soil and water. Although there have been a lot of reports on dechlorination of DDT, most of the processes require harsh conditions and/or a large amount of reagents. For various environmentally benign processes, we have developed novel catalysts using hydroxyapatite (HAP),  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ , as macroligands of the active species. In particular, HAP-supported Pd nanoparticles (PdHAP) showed high catalytic activities for hydrodehalogenation of aryl halides. Here, we report that complete hydrodechlorination of DDT (1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane) and DDT analogues such as DDE (1,1-dichloro-2,2-bis(4-chlorophenyl)ethene) and DDD (1,1-dichloro-2,2-bis(4-chlorophenyl)ethane) to 1,1-diphenylethane catalyzed by PdHAP under mild conditions. Furthermore, PdHAP can be applied to complete hydrodechlorination of  $\text{sp}^3$  C-Cl bonds such as 1-chloro-2-phenylethane.

## ENVR 113

### Mechanism research on HCN removal through MgO at high temperature

**Houzhong Tan**, **Xuebin Wang**, [xuebinwang1984@yahoo.cn](mailto:xuebinwang1984@yahoo.cn), **Congling Wang**, and **Tongmo Xu**, State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xian Ning Xi Road 28#, Xi'an 710049, China, Fax: 86-029-82668703

Investigation on HCN removal using MgO was carried out in a fixed bed at 300-1273 K, and the original HCN was generated by the pyrolysis of pyridine. Results show that temperature is the main factor affecting HCN removal. With the formation of CO, HCN starts to decrease from 723 K, keeping unchanged from 873 K to 973 K. At 973 K there is a further decrease in HCN, and  $\text{CH}_4$  begins to decrease, with no CO detected. When

temperature is higher than 1098 K, HCN is removed completely. There is no N<sub>2</sub> detected at temperatures lower than 923 K, only detected at temperatures higher than 1123 K, and the nitrogen element in N<sub>2</sub> formed is equal to that in HCN removed. It is indicated that at lower temperature MgO is consumed to remove HCN by the route:  $\text{MgO} + 2\text{HCN} \rightarrow \text{MgCN}_2 + \text{CO} + \text{H}_2$ ; but at higher temperature, MgO acts by another catalysis route:  $2\text{C}_x\text{H}_y + 2\text{HCN} \rightarrow \text{N}_2 + (y+1-z)\text{H}_2 + 2\text{C}_{x+1}\text{H}_z$ .

## **ENVR 114**

### **Biodegradation of volatile organic compounds using VOC-tolerant bacterial strains from activated sludge**

*Victor Ibeanusi, Montoya LaFrance, Sarat Mohamed, Elizabeth Adeyemi, and Yassin Jeilani, yjeilani@spelman.edu, Environmental Science and Studies, Spelman College, 350 Spelman Lane, S.W., Box 235, Atlanta, GA 30314, Fax: 404-270-5869*

Volatile Organic Compound (VOC) plumes have been detected in groundwater at several sites owned by the U.S Department of Energy. Since much of the contaminant plumes cover a wide range of distribution, requiring treatment of very large volumes of soil and water, current methodologies present difficult problems in terms of both scientific technology and project costs. The development of new treatment methods are critically desired to a comprehensive environmental management plan. This project explores the use of an engineered microbial bioremediation system (EMBS) for VOCs degradation of contaminated groundwater. Among the targeted VOCs included: trichloroethylene, 1,1,1-trichloroethane, and 1,2,3-trichloropropane. TCE tolerant bacteria strains were isolated from an activated sludge obtained from a local sewage plant. The concentration of VOCs over a culture period was monitored during the biodegradation process by gas chromatography-tandem mass spectrometry (GC-MSMS). The sample was introduced in the GC by headspace sampling of 10 mL aliquot. The analytical method was optimized in terms of extraction temperature, extraction time, and injection value. In the biodegradation experiment, bacterial aliquot, target VOC concentration, and nutrients were significant for optimum biodegradation of the selected VOCs.

## **ENVR 115**

### **Artificial neural network optimization tool for modeling environmental bioremediation processes**

*Victor Ibeanusi, Gustavo Menezes, Juandalyne Coffen, Erin Jackson, Idia Ajayi, and Yassin Jeilani, yjeilani@spelman.edu, Environmental Science and Studies, Spelman College, 350 Spelman Lane, S.W., Box 235, Atlanta, GA 30314, Fax: 404-270-5869*

An artificial neural network (NN) is a computer-based model used to perform computational predictions based on a matrix of data inputs and outputs. The NN is based on the biological neural network of the brain and the weight of messages within

neurons. Neural networks are applied to not only computational research, but increasingly in the fields of medicine, biology, physics and the environmental sciences. The NN is designed to have the most accuracy with the increasing number of nodes, which are place holders for the weighted hidden layers and output values. The ideal model of a NN is to also prevent memorization as the network is being trained. The objective of our research is to create a neural network using the MatLab software and apply the model to bioremediation profiling. Using the written code in the MatLab, the GUIDE tool, and several other coding techniques, a more user-friendly NN that maximizes accuracy and decreases memorization was created. Results show, through a series of iterations it is possible to achieve an optimal NN design that maximizes accuracy and generalization. The model is tested using lab and field data to predict the efficiency of bioremediation processes of acid mine drainage.

## **ENVR 116**

### **Experimental study on the municipal solid wastes pre-treatment system**

*TaiJin Min<sup>1</sup>, tmin@kimm.re.kr, SeonAh Roh<sup>1</sup>, sos@kimm.re.kr, WooHyun Kim<sup>1</sup>, kwh0788@kimm.re.kr, **JinHan Yun<sup>1</sup>**, jhyun@kimm.re.kr, HaNa Jang<sup>2</sup>, janghana@hansol.com, and SeongBum Park<sup>3</sup>, sbpark@hansol.com. (1) Environmental Systems Research Division, Korea Institute of Machinery and Materials, 171 Jang-dong, Yuseong-gu, Daejeon 305-343, South Korea, Fax: 82-42-868-7284, (2) Environmental Research and Development Center, Hansol EME, 7th Fl., First Tower, 266-1, Seohyeon-dong, Bundang-gu, Seongnam, South Korea, (3) Environmental Research and Development Center, Hansol EME, 7th Fl., First Tower, 266-1, Seohyeon-dong, Bundang-gu, Seongnam*

Pilot studies were conducted to investigate the fuel potential of municipal solid waste (MSW) in saturated steam conversion processes. Municipal solid waste was converted into powder-like feedstock after reaction with 140°C saturated steam. In order to confirm the availability of biomass feedstock as an alternative fuel, grain size, heating value, and a chemical element analysis were investigated. Drying characteristics were also investigated for various conditions, such as reaction time and feedstock load to the vessel. By crushing process, feedstock size reduces from 75 mm to less than 5 mm. And only natural convection condition at 15°C, moisture content indicates 20-35% after 24 hours, and less than 5% after 48 hours. Also results show that in the 140°C saturated steam condition, plastic-like feedstock did not crush but shrunk. This result indicates that the separation with organic component and plastic-like materials could be easier. The experimental results show that the high moisture content of feedstock can reduce expenses of drying, crushing, and separation. And resultantly, using saturated steam for pretreatment of MSW could be a feasible method to produce alternative solid fuel.

## ENVR 117

### Pyrolysis and gasification of sawdust, sewage sludge and pre-treated RDF in thermobalance reactor

**SeonAh Roh**, *sos@kimm.re.kr*, **JinHan Yun**, *jhyun@kimm.re.kr*, **TaiJin Min**, *tmin@kimm.re.kr*, **WooHyun Kim**, *kwh0788@kimm.re.kr*, and **SangIn Keel**, *sikeel@kimm.re.kr*, *Environmental Systems Research Division, Korea Institute of Machinery and Materials, 171 Jang-dong, Yuseong-gu, Daejeon 305-343, South Korea, Fax: 82-42-868-7284*

Combustion and steam gasification kinetics of sawdust, sewage sludge and pretreated RDF chars has been determined in a thermobalance reactor (0.055 m x 1.0 m). RDF was used after pretreatment with superheated steam. The effects of combustion and gasification temperature (650°C-900°C) and partial pressure of O<sub>2</sub> and H<sub>2</sub>O (0.2- 0.8 atm) on combustion and gasification reaction rate have been determined in a thermobalance reactor. From the Arrhenius plot, the activation energy and the pre-exponential factor of chars are determined based on the various models.

## ENVR 118

### Flocculation behavior in hexagonal grid system dealing with high turbidity water

**Hui Wang**<sup>1</sup>, *wh13@163.com*, **Xing Li**<sup>1</sup>, and **Qin Wang**<sup>2</sup>, *86wangqin@sohu.com*. (1) *College of Architecture and Civil Engineering, Beijing University of Technology, Beijing, China*, (2) *College of Chemistry & Environmental Science, Hebei University, Baoding 071002, China*

The hexagonal grid flocculation system is very efficient to deal with high turbidity water of the 850 NTU and the color of 2300 PCU. The best conditions are determined through adjusting grid arrangements, concentration and dosage of flocculating agent. When the water velocity of flow is 100 L/h, the grid 2,1,3 module order is the best one. The water turbidity decreased to 19.5 NTU and color to 110 PCU, the removal rate of turbidity is 97.0% and that of color is 95.2%. The average effective mass density  $\rho_E$  of floc is 6066 Kg•m<sup>-3</sup>, the average equivalent size  $d_{ST}$  is 346.9  $\mu$ m, the average free-for-speed  $V$  is 13.24 mm•s<sup>-1</sup>, two-dimensional fractal dimension  $D_f$  is 2.70. The experimental results show that the water flow can create more stronger vortex in hexagonal grid flocculation system, thereby greatly increasing disorder of the flow, the rapid formation of dense, easy sedimentation alum flowers will have a positive effect, while increasing the effective flow of the water area, reducing the head loss and shortening flocculation time.

## ENVR 119

### Formation of haloacetamides during chlorination of dissolved organic nitrogen aspartic acid

Wenhai Chu, *feedwater@yahoo.cn*, State Key Laboratory of Pollution Control and Resources Reuse, Tongji University, 601-3, Doctor Building No. 4, 528 Siping Road, Yangpu District, Shanghai 200092, China, **Naiyun Gao**, *tjgaonaiyun@26.com*, State Key Laboratory of Pollution Control and Resources Reuse, Tongji University, No 1239 Siping Road, Shanghai 200092, China, and Yang Deng, *ydeng@miami.edu*, Department of Civil Engineering and Surveying, University of Puerto Rico, P.O. Box 9041, Mayaguez, PR 00681-9041

The stability of haloacetamides (HAcAms) such as dichloroacetamide (DCAcAm) and trichloroacetamide (TCAcAm) was studied in the absence and presence of free chlorine. DCAcAm and TCAcAm were the most stable at pH 5.0. Their concentrations decreased with the increasing chlorine dosage in the presence of free chlorine. The ascorbic acid was a good alternative dechlorinating agent for DCAcAm and TCAcAm. The yield of DCAcAm during Asp chlorination was measured at different molar ratio of chlorine atom to nitrogen atom (Cl/N), pH and dissolved organic carbon (DOC). Lower Cl/N favored the DCAcAm formation, implying that breakpoint chlorination might minimize its generation. Two possible pathways of DCAcAm formation during Asp chlorination were proposed. Based on the DCAN formation mechanisms, we concluded either direct hypochlorite catalyzed hydrolysis of the cyano group producing an amide to give DCAcAm, or an indirect route through chlorination by HOCl, forming Cl-N-DCAcAm that reacted with HOCl to give DCAcAm. Therefore, DCAcAm formation depended predominantly upon the DCAN level.

## ENVR 120

### Nitrite formation during ultraviolet photolysis of nitrate

Ning Lu<sup>1</sup>, *05498124@163.com*, **Nai-yun Gao**<sup>1</sup>, *gaonaiyun@sina.com*, and Yang Deng<sup>2</sup>, *ydeng@uprm.edu*. (1) State Key Laboratory of Pollution Control and Resource Reuse, Tongji University, 1239 Siping Road, Yangpu District, Shanghai 200092, China, (2) Department of Civil Engineering and Surveying, University of Puerto Rico at Mayagüez, Hwy. 108, Km. 1.1, Mayaguez 00681-9041

When nitrate ( $\text{NO}_3^-$ ) is present in raw water,  $\text{NO}_2^-$  formation is probably troublesome during ultraviolet (UV) disinfection. In this study, the formation of  $\text{NO}_2^-$  from  $\text{NO}_3^-$  was investigated under the irradiation of a low-pressure ultraviolet (LPUV) lamp at 253.9 nm. The investigated variables included initial  $\text{NO}_3^-$  concentration, pH (6.2-9.5), hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) dose (0-25  $\text{mg}\cdot\text{L}^{-1}$ ) and titanium dioxide ( $\text{TiO}_2$ ). Results showed that the formation of  $\text{NO}_2^-$  was enhanced by high initial  $\text{NO}_3^-$  concentration and high pH, and was inhibited, to some different degree, by introduction of  $\text{H}_2\text{O}_2$  or photocatalyst  $\text{TiO}_2$ .

The pH dependence of  $\text{NO}_2^-$  formation seemed to be due to the impact of hydrogen ions on the stability of several intermediates such as peroxyxynitrite ( $\text{ONOO}^-$ ),  $\text{N}_2\text{O}_3$ , and  $\text{N}_2\text{O}_4$ . And the inhibiting effects of  $\text{H}_2\text{O}_2$  and  $\text{TiO}_2$  were possibly ascribed to production of additional  $\cdot\text{OH}$  that scavenged  $\text{NO}_2^-$  generated in the system. At pH 9.5 and an initial  $\text{NO}_3^-$  concentration of  $10 \text{ mg}\cdot\text{L}^{-1}$  as  $\text{NO}_3^-$ -N, the concentration of  $\text{NO}_2^-$  produced was above  $0.1 \text{ mg}\cdot\text{L}^{-1}$  as  $\text{NO}_2^-$ -N, the Germany drinking water standard. When  $25 \text{ mg}\cdot\text{L}^{-1}$   $\text{H}_2\text{O}_2$  was added, the  $\text{NO}_2^-$  level was decreased below the standard.

## ENVR 121

### Speciation of brominated disinfection by-products in drinking water: Influence of naturally occurring bromide and chlorine dose

*Jessica M. Wilson, jwilson3@andrew.cmu.edu and Jeanne M. VanBriesen, jeanne@cmu.edu, Department of Civil and Environmental Engineering, Carnegie Mellon University, 5000 Forbes Avenue, Porter Hall 119, Pittsburgh, PA 15213*

The speciation of haloacetic acids (HAAs) in drinking water is affected by the concentration of bromide in surface waters. Naturally occurring bromide is readily incorporated into HAAs during water chlorination, leading to higher concentrations of brominated HAAs. The purpose of this work is to investigate the effects of chlorine dose on the speciation of haloacetic acids in drinking water for surface waters containing high bromide concentrations. Source water bromine was measured using ion specific electrodes, and capillary electrophoresis was used to successfully separate all HAA<sub>9</sub> species.

## ENVR 122

### Characteristics and disinfection byproducts formation potential of *Microcystic aeruginosa* intracellular and extracellular organic components

*Huase Ou, ouhuase@yahoo.com.cn, Naiyun Gao, gaonaiyun1@126.com, Lei Li, and Kejia Zhang, State Key Laboratory of Pollution Control and Resource Reuse, Tongji University, 1239#, Siping Road, Yangpu District, Shanghai 200092, China*

Characteristics of the intracellular organic components (IOCs) and extracellular organic components (EOCs), including dissolved organic carbon (DOC), dissolved organic nitrogenous (DON), algae toxin,  $\beta$ -cyclocitral, molecular weight distribution and hydrophilic-hydrophobic property, have been investigated. The results indicated the amount of IOCs was 3-10 times higher than that of EOCs. And the IOCs mainly consisted of 3 parts: less than 1kD (chlorophyll, renieratene, algae toxin, taste and odour compounds), 40kD-800kD (phycocyanin), more than 800kD (ribosome, starch and so on); the main molecular weight distribution of EOCs is 1kD-200kD (approximately 90%). In addition, the bases of both IOCs and EOCs were neutral hydrophilic substance, the percentage of which were respectively 83% and 57%; the

potential formation of chloroform and chloroacetate from IOCs were 0.01040 mg/mgTOC and 0.04535 mg/mgTOC; for EOCs are 0.0155 mg/mgTOC and 0.03978 mg/mgTOC, respectively. Moreover, the proportion of DON and TOC of intracellular solution was 3 times higher than normal water source (DON/TOC=1/7), which may increase the formation of chlorination byproduct nitrosamine. Furthermore, the intracellular extract also contained several kinds of organic compounds (such as  $\beta$ -Cyclocitral) which are not present in extracellular extract.

## ENVR 123

### Reactivity and antimicrobial properties of nanostructured titanium dioxide

King Lun Yeung<sup>1</sup>, kekyeung@ust.hk, Wai Kin Leung<sup>2</sup>, Nan Yao<sup>1</sup>, Shengli Cao<sup>1</sup>, and Xinqing Chen<sup>1</sup>, kechenxq@ust.hk. (1) Department of Chemical and Biomolecular Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China, (2) Department of Chemical Engineering and Environmental Engineering Program, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China

The photo-induced reactivity of three nanostructured titanium dioxides including TiO<sub>2</sub> nanoparticles (*i.e.*, nano-TiO<sub>2</sub>), titania-silica aerogel and nanotextured TiO<sub>2</sub> film, were investigated for gas-phase photocatalytic oxidation of trichloroethylene and inactivation of *B. subtilis* and *E. coli* microbial cells. A correlation was observed between photoreactivity for TCE conversion and bactericidal activity within TiO<sub>2</sub> of similar nanostructures and composition (*i.e.*, elemental and phase). This indicates that the photogenerated radical species from UV-irradiated TiO<sub>2</sub> responsible for TCE photo-oxidation, also play a major role in the inactivation of microbial cells. The superb bactericidal activities of titania-silica aerogels (*i.e.*, up to 6 log reductions in viable *B. subtilis*) and nanotextured TiO<sub>2</sub> film (3.4 log reduction) compared to commercial Degussa P25 TiO<sub>2</sub> (0.64 log reduction) and optimum nano-TiO<sub>2</sub> (1.3 log reduction) far exceeds the observed activity enhancement for TCE photo-oxidation. This implies that nanoscale chemical and structural environment also contribute towards the bactericidal activities.

## ENVR 124

### Effect of pH and orthophosphate levels of drinking water during the initial stages of copper corrosion investigated with atomic force microscopy

Stephanie L. Daniels<sup>1</sup>, sdanie9@lsu.edu, Brian R. Lewandowski<sup>1</sup>, blewan1@lsu.edu, Darren A. Lytle<sup>2</sup>, lytle.darren@epa.gov, and Jayne C. Garno<sup>1</sup>, jgarno@lsu.edu. (1) Department of Chemistry, Louisiana State University, 232 Choppin Hall, Baton Rouge, LA 70803, Fax: 225-578-3458, (2) National Risk Management Research Laboratory, Water Supply and Water Resources Division, U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, Cincinnati, OH 45268

Corrosion of copper piping used for plumbing to supply households with drinking water has an impact on consumer health and economy. Studies with copper surfaces were conducted using high resolution atomic force microscopy (AFM) to investigate the role of water chemistry during the initial stages of copper corrosion. The role of pH and phosphates for corrosion of copper surfaces was examined. After only 24 hours of exposure to water, differences in the structure and topography of copper surfaces were noticeably altered at the nanoscale, even at the earliest stages of the onset of corrosion. Nanoscale changes in the surface morphology were investigated using AFM after 6 and 24 hours of immersion. Addition of orthophosphate provided a passivating effect for copper surfaces; the pitting and corrosive deposits were diminished. Changes in pH and phosphate parameters for water chemistry were systematically investigated, and were found to significantly influence the extent of corrosion.

## ENVR 125

### **Free fatty acid profile of the maternal organs and fetal brain from pregnant rats treated with sodium arsenite**

*Ivan A. Ross<sup>1</sup>, Ivan.ross@fda.hhs.gov, Chung S. Kim<sup>1</sup>, Widmark D. Johnson<sup>1</sup>, Robert L. Sprando<sup>1</sup>, Michael W. O'Donnell<sup>2</sup>, Dennis Ruggles<sup>2</sup>, and Thomas Boyle<sup>1</sup>. (1) Division of Toxicology, U.S. Food and Drug Administration, 8301 Muirkirk Road, Laurel, MD 20708, (2) Biostatistics Branch, U.S. Food and Drug Administration*

Free fatty acids (FFAs) of the maternal organs and fetal brains from pregnant rats were assessed with an oral dose of sodium arsenite ( $\text{NaAsO}_2$ , 41 mg/kg) in  $\text{H}_2\text{O}$  ( $\text{AsH}_2\text{O}$ ) or in half-and-half ( $\text{AsHH}$ ) on gestation day (GD) 10 and sacrificed on GD 20. Controls were treated with either HH or  $\text{H}_2\text{O}$ . The FFAs were extracted and analyzed by GC. In the liver, there was a significant decrease of palmitic acid in  $\text{AsHH}$  group (32%) versus  $\text{AsH}_2\text{O}$ . Oleic acid increased in  $\text{AsHH}$  (115%) versus HH. In the maternal brain, myristoleic acid increased in  $\text{AsHH}$  (37%) versus HH, and docosahexaenoic acid increased in  $\text{AsH}_2\text{O}$  (20%) versus  $\text{H}_2\text{O}$ . There were no significant effects in kidney or plasma. In the fetal brain, myristic acid (411%, 688%) and stearic acid (265%, 775%) increased in  $\text{AsHH}$  versus HH and  $\text{AsH}_2\text{O}$ , respectively. This study shows that  $\text{NaAsO}_2$  produced differential effects on the FFAs profile in pregnant rats.

## ENVR 126

### **Distribution of PAHs in sediments along a rural-urban gradient in central Pennsylvania: Assessing input sources and transport pathways using compositional analysis, GIS, and multivariate methods**

*Amy Witter<sup>1</sup>, witter@dickinson.edu, Sunil Baidar<sup>1</sup>, and Peter Sak<sup>2</sup>. (1) Department of Chemistry, Dickinson College, P.O. Box 1773, Carlisle, PA 17013, (2) Department of Geology, Dickinson College, PO Box 1773, Carlisle, PA 17013*

The effects of increasing urbanization on the distribution of polycyclic aromatic hydrocarbons (PAHs) and aliphatic hydrocarbons (AHCs) were investigated in the Conodoguinet Creek Watershed, one of seven tributaries servicing the Susquehanna River in Pennsylvania. Alkane distribution patterns reveal strong terrigenous contributions of higher plant-derived alkanes (HPDA) to stream sediments. Compositional analysis and principal component analysis (PCA) suggest that PAHs are derived from multiple input sources *via* different transport pathways. Distribution patterns reveal PAH enrichment in sediments downstream along an increasingly urbanized land-use gradient. Isomer ratios in conjunction with PCA suggest the dominant source of PAHs to stream sediments is combustion-derived particulate matter, which enters the stream directly via atmospheric deposition, or indirectly *via* surface runoff. The combination of compositional analysis, PCA results and GIS information provides us with tools to begin to assess the effects of short- and long-range urbanization on this watershed.

## ENVR 127

### Investigating the tidal influence of PCB and PAH phase distribution in the estuarine turbidity maximum zone

*Kathleen J. Housman, KHousman@gmu.edu and Gregory D. Foster, GFoster@gmu.edu, Department of Chemistry and Biochemistry, George Mason University, 4400 University Drive, Fairfax, VA 22030*

Polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) are ubiquitous, persistent organic pollutants. It is known that these two classes of chemicals have a high affinity towards suspended particles in the water column based on their hydrophobic properties and relatively high octanol-water partition coefficients ( $K_{ow}$ ). The Estuarine Turbidity Maximum (ETM) zone in the Potomac River was sampled during high and low tide within both neap and spring tide events in the spring of 2008 to investigate the impact of this region on the transport of PCBs and PAHs downstream to Chesapeake Bay from highly contaminated sediments upstream near Washington, D.C. Potomac River water was sampled at ~2 m intervals through the halocline at the ETM to 10 m depths using a submersible pump. The water samples (20 L) were filtered and analyzed for PCBs and PAHs separately in the dissolved and particle phases to model phase distribution. The phase distribution of PCBs and PAHs directly correlated with total suspended matter at the ETM, which in turn directly correlated with the magnitude of river flow during the tidal event. Relatively greater enrichment in particles was observed vertically through the ETM for the higher  $K_{ow}$  PCBs and PAHs. The vertical TSM profile was dependent on the tidal strength, indicating that the deposition of PCBs and PAHs at the ETM may be influenced by tidal cycles.

## ENVR 128

### **Sorption rate of phenanthrene into polyoxymethene-implication for application of equilibrium passive sampler**

**Yingjun Ma**, *yma@envsci.rutgers.edu*, Department of Environmental Sciences, Rutgers, The State University of New Jersey, 14 College Farm Rd, New Brunswick, NJ 08901, Fax: 732-932-8644, and **Weilin Huang**, *whung@envsci.rutgers.edu*, Department Of Environmental Sciences, Rutgers, The State University of New Jersey, 14 College Farm Rd, New Brunswick, NJ 08901

Polyoxymethylene(POM) is increasingly used in passive sampling of HOCs such as PAHs and PCBs in soils/sediments. In the application, caution must be taken to make sure that POM-water-sediment system reaches equilibrium. In this study we determined sorption rates of phenanthrene by POM (0.794 mm and 0.076 mm thick) at POM/water ratios of 10, 2, and 0.4 g/L, and temperature (22°C, 37°C). The results indicated that with decrease of POM/water ratio or temperature, time to reach sorption equilibrium increased. At 0.4 g POM/L (22°C) it even needed more than 120 days to reach equilibrium. The linearity of sorption isotherm spanned a wide range of aqueous concentration (0.013-280 µg/L) with POM-water distribution coefficients  $\log K_{\text{pom}}=3.53$  at 22°C when equilibrium is reached. Therefore, when using POM as a passive sampler for highly hydrophobic PCBs and PAHs, it's necessary to use thinner POM and sample enough time to make sure real sorption equilibrium is reached.

## ENVR 129

### **Vertical profile of polychlorinated biphenyls buried in sediments of the Coastal Plain Potomac River, Washington, D.C**

**Girija K. Bharat** and **Gregory D. Foster**, Department of Chemistry and Biochemistry, George Mason University, 4400 University Drive, Fairfax, VA 22030

The Potomac River sediments represent a significant source of polychlorinated biphenyls (PCBs) to Chesapeake Bay. A fundamental question relevant to PCB contamination in sediments is: what is the rate of decline of PCB concentrations and inventories in surface sediments of the Potomac River? One way to answer this question is through the collection and analysis of PCBs in sediment cores. Sediments cores of 1-m depth were collected using a piston corer at a location in the Coastal Plain of the Potomac River. The cores were sectioned at 2.5 cm intervals and analyzed for PCBs along with sediment organic matter and texture. The core sections were also dated using  $^{210}\text{Pb}$ . The sediment core at the site showed a definite vertical profile of declining PCB concentrations at shallower depths to the surface. Sediment deposition rates and inventories appear to be declining in the Potomac River. Keywords: PCBs, sediments, vertical profiles, deposition rates.

## ENVR 130

### Effect of dissolved organic matter composition on pyrethroids runoff

*Laura I. Delgado-Moreno, lmoreno@ucr.edu, Laosheng Wu, Laowu@ucr.edu, and Jay Gan, jgan@ucr.edu, Department of Environmental Sciences, University of California-Riverside, 900 University Ave., Riverside, CA 92521*

Pyrethroids are highly hydrophobic compounds and tend to be adsorbed in soil but also to dissolved organic matter (DOM). Association of pyrethroids with DOM may increase their solubility and mobility. Residues of pyrethroids are increasingly found in aquatic sediments. However, little is known about the influence of DOM on adsorption-desorption of pyrethroids and the potential significance in facilitated transport such as runoff. Results showed that pyrethroids were strongly adsorbed in sediment and highly aromatic DOM had slight or no effect on sorption. More aliphatic DOM decreased the sorption of pyrethroids and enhances their solubility between 7 and 25 times. Independently of DOM composition, sorption of pyrethroids in sediment decreased between 2 and 3 times after previously interacted with DOM, indicating interactions between pyrethroids and DOM were very stable. Complexation of pyrethroids with DOM may therefore play an important role in pesticide mobility, leading to their ubiquitous occurrence in waterways.

## ENVR 131

### Sources and input pathways of glyphosate into surface waters

*Irene Hanke<sup>1</sup>, irene.hanke@eawag.ch, Simone Bischofberger<sup>1</sup>, Irene Wittmer<sup>1</sup>, Heinz P. Singer<sup>2</sup>, and Christian Stamm<sup>1</sup>. (1) Department of Environmental Chemistry, Eawag - Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstrasse 133, Duebendorf 8600, Switzerland, (2) Department of Environmental Chemistry, Eawag - Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstrasse 133, Duebendorf CH-8600, Switzerland*

Glyphosate is one of the most important herbicides worldwide. It is used in agricultural as well as in non-agricultural applications. There are thus many different possible sources for glyphosate in surface waters. To compare these inputs, a small catchment (25 km<sup>2</sup>) was investigated. Sampling sites at the outlet of four subcatchments represented the different agricultural and urban sources. Furthermore, a combined sewer overflow, a rain sewer, and the outflow of a sewage treatment plant were sampled to assess the urban sources. Seasonal and short-term dynamics were determined. The highest glyphosate concentrations were detected during peak flow (up to 4.2 µg/L). Glyphosate concentrations mostly exceeded the concentrations of other commonly used pesticides. The load was calculated based on the concentration and discharge. The comparison of the loads from the different subcatchments indicates that,

for glyphosate in surface waters, the input from urban sources may be more important than agriculture.

## **ENVR 132**

### **Chemical properties of humic substances and sorption characteristics for pharmaceuticals**

*Hisayo Mori, 053a554a@stu.kobe-u.ac.jp and Nobuhide Fujitake, fujitake@kobe-u.ac.jp, Graduate School of Agricultural Science, Kobe University, Rokkodai 1, Kobe 657-8501, Japan, Fax: 81-78-803-5847*

The interactions between several pharmaceuticals (NSAIDs, antihypertensive, antidepressant, and antibiotics) and humic substances were quantified using fluorescence quenching techniques. Humic materials included isolated humic acids and fulvic acids from soil, peat, sediment, and freshwater. All sources were characterized by elemental composition, molecular weight, and liquid-state  $^{13}\text{C}$  NMR. The result showed the different binding affinities of pharmaceuticals to humic substances, and the  $K_{oc}$  values correlated with the aromaticity of humic materials.

## **ENVR 133**

### **Occurrence, phase distribution and biological effects of chemicals derived from wastewater discharge in tributaries of the Coastal Plain Potomac River, Virginia**

*Kevin J. Dove II, kdove@gmu.edu and Greg D. Foster, gfoster@gmu.edu, Department of Chemistry and Biochemistry, George Mason University, 4400 University Drive, Fairfax, VA 22030*

It is suspected that wastewater treatment plants (WWTPs) discharge potentially toxic organic pollutants such as antibiotics, personal care products, hormones and materials associated with plastics and coatings. Recently, toxicology issues have arisen in the Potomac River due to a number of fish species with observed parasitic growths in the liver and other soft tissues. It is postulated that organic contaminants present in water are causing an immuno-suppression of these fish allowing the parasite infections. By examining the bioavailable concentrations of organic contaminants in the water column and in fish tissue, it is possible to correlate the possible cause of the high incidence of parasites. In this study, several organic contaminants present in wastewater were measured and analyzed in Potomac River water, sediments and fish tissues using microwave-assisted extraction and GC/MS. The chemical classes investigated included polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), antibiotics, endocrine disruptor chemicals (EDCs) and other domestic use chemicals. Positive correlations were observed between some of the contaminant concentrations in

tissues and sediments and the incidence of parasite infections. Wastewater derived contaminants show the potential for adverse health effects in aquatic organisms.

## **ENVR 134**

### **Stability and transport of commercial metal oxide nanoparticles in aquatic systems**

**Zhen Li**<sup>1</sup>, *liz2@email.uc.edu*, **George A. Sorial**<sup>1</sup>, *George.Sorial@uc.edu*, and **E. Sahle-Demessie**<sup>2</sup>, *sahle-demessie.endalkachew@epamail.epa.gov*. (1) Department of Civil and Environmental Engineering, University of Cincinnati, 765 Baldwin Hall, P.O. Box 210071, Cincinnati, OH 45221-0071, (2) Sustainable Technology Division, U.S. EPA, ORD, National Risk Management Research Lab, 26 W. Martin Luther King Dr, MS 443, Cincinnati, OH 45268

The use of nano-technology and the application of products containing nano-scale particles have been increasing. When nano-scale particles are released to the environment, their stability, transport properties and interaction with other pollutants and natural organic matter play a key role in the risk analysis. Although lab synthesized nanoparticles, for which the characteristics are easy to control, are the main source for most current studies on nanoparticle implications, the transport and fate of commercial available nanoparticles has greater practical importance. In this research, 15 types of nanoparticles were obtained from vendors and their potential risks were evaluated. The physical and chemical properties of the nanoparticles were characterized and the results differ from those reported by the vendor. Electrophoresis studies showed that isoelectric points of these nanoparticles vary over a wide range and impurities contained in these commercial nanoparticles. Inductively coupled plasma emission spectroscopy (ICP) was employed to trace the impurities in the commercial nanoparticles, which might impact the point of zero charge of the particles. Electrolyte concentration and the presence of natural organic matter have significant influence on zeta-potential of the particles. The results were correlated with the stability of nanoparticle in suspension the experimental data on their transport through sand-packed columns. Theoretical relationships are derived to link experimentally measured zeta-potential quantities of nanoparticles with classical DLVO theory.

## **ENVR 135**

### **Transport properties of lead phosphate aggregates formed on shooting ranges**

**Michael A. Butkus**, *Michael.Butkus@usma.edu*, **Marie Johnson**, **Phillip Dacunto**, and **Jason Lynch**, Department of Geography and Environmental Engineering, United States Military Academy, West Point, NY 10996

Efforts to prevent lead migration off shooting ranges include adding phosphate to form insoluble pyromorphite (HYP). Many studies suggest that formation of HYP retards the

movement of lead while other studies suggest the contrary. It was hypothesized that different phosphate-lead products will form based on the source of phosphate and lead (ionic or particulate) present in the system and that the products formed will have different transport properties. These hypotheses were tested by combining sodium phosphate ( $\text{PO}_4(\text{aq})$ ) or hydroxyapatite (HA) with lead nitrate ( $\text{Pb}(\text{aq})$ ) or lead oxide ( $\text{PbO}$ ) and comparing the relative transport behavior of each product in 12-inch sand columns. Column experiments were conducted with suspensions at unadjusted pH values and pH 7.2. XRD results indicated that HYP was formed when  $\text{Pb}(\text{aq})$  was combined with  $\text{PO}_4(\text{aq})$  (case 1) and transport of this solid through the sand columns was less than all other cases tested. Both HYP and  $\text{PbO}$  were observed in XRD patterns when  $\text{PO}_4(\text{aq})$  was combined with  $\text{PbO}$  (case 2). Transport of the particles produced in case 2 through the sand column was comparable to case 1, which implies that  $\text{PO}_4(\text{aq})$  did not appreciably enhance the mobility of particulate lead oxide under the conditions investigated. The XRD patterns for the system that contained  $\text{Pb}(\text{aq})$  combined with HA (case 3) indicated that the surface of HA was largely transformed into lead oxide and lead carbonate. Transport of the aggregates produced in case 3 through the sand column exceeded all other cases tested for the unadjusted pH experiments (pH 3.8). The XRD patterns for the system that contained  $\text{PbO}$  and HA (case 4) reveal the presence of HA and  $\text{Pb}_3(\text{CO}_3)_2(\text{OH})_2$ , but not  $\text{PbO}$ . Transport of the aggregates produced in case 4 through the sand column exceeded all other cases tested for the pH 7.2 experiments (including  $\text{PbO}$  by itself).

## ENVR 136

### Facilitated transport of toxic metals by liquid membranes containing different carriers

*Fatma Hassaine-sadi, sadifatma4444@yahoo.fr, M. Graiche, and H. Bouchabou, Faculty of Chemistry, University of Sciences and Technology, El-alia Box N° 32 Bab-ezzouar, Algiers 16000, Algeria*

The environmental impact of the emissions of heavy metals present in the industrial effluents has become more prevalent. These micro mineral pollutants are discharged into nature thus risking harm to living organisms. The discharge of toxic metals into the environment is a serious problem facing numerous industries. Therefore the search for extraction techniques to remove those heavy metals is of increasing interest. Liquid membranes have shown great potential in this way, especially in cases where metal concentrations are relatively low and other techniques cannot be applied efficiently. The fundamental parameters influencing the transport of zinc, nickel, and cadmium through the liquid membrane have been examined. Coupling the membrane (carriers) permits the different transfer phases to be defined and transportation mechanisms to be determined. The facilitated transport of zinc, nickel, and cadmium ions by liquid membranes containing TOPO, TOA, HDEHP as carriers was studied. The chemical variable permitted the determination of optimal parameters for extraction efficiency and re-extraction. The coupling required a optimization of the parameters. The symmetrical

behavior showed that the extraction–re-extraction association needed to achieve transportation is one of counter-transportation and of positive coupling. This allows an industrial application of the process, as well as, broad applications in the field of metalliferous processing liquid waste.

## **ENVR 137**

### **Interaction between lower generation poly(amidoamine) dendrimers and cadmium-contaminated soils**

*Han Uk Lee, seraphim4u@hanyang.ac.kr, Jun Won Jang, junun79@gmail.com, and Jae Woo Park, jaewoopark@hanyang.ac.kr, Department of Civil Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, South Korea*

Dendrimers are a new class of nanoscale three-dimensional material. These are highly branched polymers consisting of three structural components: the core, the branch repeating units, and the terminal groups. Dendrimers can control the repeating units and terminal groups. Owing to these properties dendrimers apply to numerous fields such as chemical, physical, and biological processes. Poly(amidoamine) (PAMAM) dendrimers have ethylenediamine(EDA) core and terminal NH<sub>2</sub> groups and synthesize repeatedly by the Michael addition and ester amidation reaction. First, EDA was dissolved in methanol, and excess of methylacrylate was added dropwise at EDA solution (Michael addition). Then mixture was purified by column chromatography. The purified mixture was gradually added to the excess of EDA solution at a rate keeping the temperature (amidation reaction). As a result, generation 0 PAMAM dendrimer was obtained. In order to increase the dendrimer generation repeats above process. Cadmium is a known toxic heavy metal and is fatal to humans. Cadmium is carcinogenic and genotoxic, and accumulates in the body such as liver, kidneys, lungs, bones and muscles. It affects the respiratory and gastrointestinal systems. Above all, renal injury, osteomalacia, osteoporosis, lumbago and skeletal deformation are major effects. In Japan, cadmium caused Itai-Itai disease. PAMAM dendrimers have the ability of binding the heavy metal. So this study investigated the ability of PAMAM for uptake of cadmium from contaminated soils by column test. Synthesized dendrimers were analyzed by <sup>1</sup>H and <sup>13</sup>C NMR spectroscopy and scanning electron microscope (SEM). Cadmium concentrations were analyzed by atomic absorption spectrophotometer (AAS).

## **ENVR 138**

### **Removal of cadmium (II) in ppb level from aqueous medium**

*Anastasia S. Lyons<sup>1</sup>, XBu@cau.edu, Prince A. Amoyaw<sup>2</sup>, Myron Williams<sup>2</sup>, and Xiu R. Bu<sup>2</sup>, XBu@cau.edu. (1) Forest Products Laboratory, USDA, Madison, WI 53726, (2) Department of Chemistry, Clark Atlanta University, Atlanta, GA 30314*

Cadmium, a toxin of environmental concern, can cause kidney, liver, and lung damage. It is also classified as a probable human carcinogen. The presence of such metal ion in the human is likely a result of various exposures including direct exposure to drinking water containing low concentrations of cadmium. The development of organic chelating materials has been initiated for metal removal materials. Bidentate chelating functional group such as salicylaldehyde-based polymer has been found to be capable of the removal of low concentrations of cadmium ion in ppb level from aqueous media. The adsorption fits best with the Langmuir model, indicating the monolayer coverage of the metal ion on the surface of chelating polymer. The RL values have been determined, indicating the favorable adsorption in the range of all the ppb concentrations studied. The kinetic study has revealed a very fast adsorption process with the rate following the pseudo-second-order. Support by DOE and NIH/RCMI, and NSF/CREST is acknowledged.

## ENVR 139

### Reduction of cadmium and lead uptake of carrots with calcium, zinc, and manganese

*Krista Fieselmann<sup>1</sup>, kfiesel1@ithaca.edu, Julian Halfmann<sup>2</sup>, julian.halfmann@gmail.com, and Akiko Fillinger<sup>1</sup>, afillinger@ithaca.edu. (1) Chemistry Department, Ithaca College, 243 Danby Rd., Ithaca, NY 14850, (2) Environmental Studies and Science Department, Ithaca College, Ithaca, NY 14850*

According to a recent experiment in Romania, foliar application of  $MnCl_2$  to carrots significantly reduced Cd and Pb uptake of carrots. Inspired by this report, we examined if Ca and Zn exhibit the same effect because all these elements form divalent ions. Carrots were hydroponically grown in Hoagland nutrient solutions spiked with  $Cd^{2+}$ ,  $Pb^{2+}$ ,  $Ca^{2+}$ ,  $Zn^{2+}$ , and  $Mn^{2+}$ . Spectrophotometric analysis with an atomic absorption spectrometer revealed that Ca lowered the uptake of Cd and Pb, and Zn increased the uptake of Cd. Interestingly, Mn increased the uptake of Cd, which may be due to the different application method (root application vs. foliar application).

## ENVR 140

### Sorption of mercury(II) onto iron sulfides (FeS and FeS<sub>2</sub>): Reaction mechanism and stability

*Dongsuk Han, ironhan@tamu.edu and Bill Batchelor, bill-batchelor@tamu.edu, Department of Civil Engineering, Texas A&M University, College Station, TX 77843-3136, Fax: 979-862-1542*

The main purpose of this study is to determine the stability of iron sulfides (FeS and FeS<sub>2</sub>) combined with inorganic mercuric ion (Hg(II)) and evaluate the solid phases to

better understand the chemical changes that occur to improve stability. In this system, “stability” is measured by the ability of Hg(II) compound to resist release back into the aqueous phase after removal to the surface of iron sulfides. Stability experiments were conducted by first contacting adsorbents with Hg(II) and allowing Hg(II) to be removed and to react with solid surface. Then the solution pH was changed in a series of steps and Hg(II) concentration in aqueous phase was measured. To understand what chemical changes occur when Hg(II) interacts with the surfaces of adsorbents and affect stability, the solid surfaces were characterized with different techniques, including SEM-EDS and XPS.

## **ENVR 141**

### **Comparative study of natural and synthetic iron oxides and their effectiveness for remediation of arsenic in groundwater**

*Michael D. Johnson<sup>1</sup>, johnson@nmsu.edu, Nancy J. McMillan<sup>2</sup>, nmcmilla@nmsu.edu, Michael Eberhart<sup>1</sup>, eberhart@nmsu.edu, and Jason D. Kegeles<sup>2</sup>, jkegel@nmsu.edu. (1) Department of Chemistry and Biochemistry, New Mexico State University, P.O. Box 30001, MSC 3C, Las Cruces, NM 88003, Fax: 505-646-2649, (2) Department of Geological Sciences, New Mexico State University, P.O. Box 30001, MSC 3AB, Las Cruces, NM 88003*

Arsenic is a toxin that occurs naturally in many water supplies due to aquifer geology. The EPA requires municipalities to meet a maximum of 10 ppb arsenic. Our study compares the effectiveness of natural and synthetic iron oxides for the remediation of ppb concentrations of arsenic. We studied natural and synthetic goethite, lepidocrocite, akaganéite, and hematite. These minerals were added to water samples containing 100 ppb arsenic. The treated sample was filtered and the remaining solution's arsenic concentration was determined using AAS-GF. XRD was used to confirm the mineralogy of the samples, and particle size analysis was used to normalize the results with respect to differing particle sizes. Differences in effectiveness were observed between natural and synthetic iron oxides with the latter most effective. These effects are likely due to differing particle sizes, mineral assemblages, or a combination of both factors. These plus a cost analysis will be presented.

## **ENVR 142**

### **Mesoporous hydrous zirconium oxide for arsenic removal from drinking water**

*Anatoly Bortun<sup>1</sup>, abortun@meichem.com, Mila Bortun<sup>1</sup>, James Pardini<sup>1</sup>, Sergei Khainakov<sup>2</sup>, and José R. García<sup>2</sup>. (1) MEL Chemicals Inc, 500 Point Breeze Rd, Flemington, NJ 08822, (2) Departamento de Química Orgánica e Inorgánica, Universidad de Oviedo, 33006 Oviedo, Spain*

Method of preparation of mesoporous hydrous zirconium oxide in powder form (20-50  $\mu\text{m}$ ) acceptable for thin bed type applications has been developed. Effect of some process parameters on product morphology, porous structure and adsorption performance has been studied. It was shown that mesoporous hydrous zirconium oxide differs significantly from other commercially available zirconium hydroxide products: it is more basic, exhibits higher affinity towards arsenic(V), shows higher kinetics of exchange and improved thermal stability that allows it to retain adsorption properties even after treatment at 550-600° C. Use of mesoporous zirconium oxide for selective arsenic removal from drinking water is discussed.

## **ENVR 143**

### **Removal of chloroform and MTBE from water by adsorption onto granular zeolites**

*Laila Abu-Lail<sup>1</sup>, laila@wpi.edu, John A. Bergendahl<sup>1</sup>, jberg@wpi.edu, and Robert W. Thompson<sup>2</sup>. (1) Department of Civil and Environmental Engineering, Worcester Polytechnic Institute, Kaven Hall, 100 Institute Road, Worcester, MA 01609, Fax: 508-831-5808, (2) Department of Chemical Engineering, Worcester Polytechnic Institute, Worcester, MA 01609*

Adsorption of chloroform and methyl tertiary butyl ether (MTBE) onto granular zeolites was investigated. While these contaminants are readily removed from water with powdered zeolites, the passage of water through fixed beds of powdered zeolite produces high friction losses that are not present in flow through granular zeolites. To evaluate the effectiveness of this process, equilibrium and adsorption kinetics studies were performed. Results of the batch equilibrium experiments showed that among the tested zeolites, ZSM-5 was the zeolite adsorbent with the greatest removal capacity for MTBE and chloroform from water. Column adsorption experiments with MTBE and chloroform were performed using granular ZSM-5. Breakthrough curves obtained from these column experiments were fitted to the bed depth service time model (BDST). Kinetic parameters obtained from the BDST model can aid in designing full-scale fixed-bed adsorbers. This work showed that MTBE and chloroform are effectively removed from water with granular ZSM-5.

## **ENVR 144**

### **Mitigation of anthropogenic organic contaminants using vermiculture**

*David W. Bemis<sup>1</sup>, dw.bemis@colostate-pueblo.edu, Chad Kinney<sup>1</sup>, chad.kinney@colostate-pueblo.edu, Bruce J. Brownawell<sup>2</sup>, bbrownawell@notes.cc.sunysb.edu, Carolyn Kelly<sup>3</sup>, gaiawellnesscenter@earthlink.net, Edward T. Furlong<sup>4</sup>, efurlong@usgs.gov, Dana W. Kolpin<sup>5</sup>, dwkolpin@usgs.gov, and Steven D. Zaugg<sup>4</sup>, sdzaugg@usgs.gov. (1) Department of Chemistry, Colorado State*

University - Pueblo, 2200 Bonforte Blvd, Pueblo, CO 81001-4901, (2) Marine Sciences Research Center, State University at Stony Brook, SUNY, Stony Brook, NY 11794-5000, (3) Gaia Institute Wellness Center, 622 E. 8th St., Pueblo, CO 81001, (4) National Water Quality Laboratory, U.S. Geological Survey, MS 407, Box 25046, Denver, CO 80225, (5) U.S. Geological Survey, P.O. Box 1230, 400 South Clinton Street, Iowa City, IA 52244

Sewage sludge from wastewater treatment facilities that meets state and federal regulatory requirements for pathogen and metal content can be classified as biosolids and land applied as an organic- and nutrient-rich soil amendment for plants, including some bound for human consumption. Biosolids are known to contain a complex mixture of a wide range of anthropogenic organic contaminants (e.g. pharmaceuticals, disinfectants, and detergent metabolites) some of which are known to be biologically active. In this study, the use of vermicomposting of biosolids was investigated as a potential viable process to mitigate the release of organic contaminants following land application. Red worms (*Eisenia foetida*) were added to a composted biosolid mixture (one part biosolid, three parts organic waste, and three parts street sweepings by mass) for 90 days. The results of this study suggest that vermicomposting may accelerate the removal of select organic contaminants (e.g., triclosan, phenanthrene, 4-tert-octylphenol, and indole) present in biosolids.

## ENVR 145

### Certification of three soil Standard Reference Materials® for inorganic environmental measurements

**Elizabeth A. Mackey**<sup>1</sup>, Steven J. Christopher<sup>1</sup>, [steven.christopher@nist.gov](mailto:steven.christopher@nist.gov), Russell D. Day<sup>1</sup>, [russell.day@nist.gov](mailto:russell.day@nist.gov), Stephen E. Long<sup>2</sup>, [stephen.long@nist.gov](mailto:stephen.long@nist.gov), Anthony Marlow<sup>1</sup>, [anthony.marlow@nist.gov](mailto:anthony.marlow@nist.gov), John L. Molloy<sup>3</sup>, [john.molloy@nist.gov](mailto:john.molloy@nist.gov), Karen Murphy<sup>4</sup>, Rick L. Paul<sup>5</sup>, Rachel S. Popelka-Filcoff<sup>1</sup>, [rachel.popelka-filcoff@nist.gov](mailto:rachel.popelka-filcoff@nist.gov), Savelas A. Rabb<sup>1</sup>, [savelas.rabb@nist.gov](mailto:savelas.rabb@nist.gov), John R. Sieber<sup>3</sup>, Rabia Oflaz Spatz<sup>6</sup>, [Rabia@nist.gov](mailto:Rabia@nist.gov), Bryan E. Tomlin<sup>1</sup>, [bryan.tomlin@nist.gov](mailto:bryan.tomlin@nist.gov), Laura Wood<sup>1</sup>, [laura.wood@nist.gov](mailto:laura.wood@nist.gov), Lee L. Yu<sup>2</sup>, [lee.yu@nist.gov](mailto:lee.yu@nist.gov), Rolf Zeisler<sup>1</sup>, Stephen A. Wilson<sup>7</sup>, [swilson@usgs.gov](mailto:swilson@usgs.gov), Clifton Jones<sup>8</sup>, and John Nebelsick<sup>9</sup>. (1) Analytical Chemistry Division, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8395, Gaithersburg, MD 20899, (2) Analytical Chemistry Division, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8391, Gaithersburg, MD 20899-8391, (3) Analytical Chemistry Division, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8391, Gaithersburg, MD 20899, (4) Analytical Chemistry Division, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8392, Gaithersburg, MD 20899, (5) Analytical Chemistry Division, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8395, Gaithersburg, MD 20899-8395, (6) Chemical Science and Technology Laboratory, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8395, Gaithersburg, MD 20899, (7) Mineral Resources Team, United States Geological

*Survey, MS-973, Denver Federal Center, Denver, CO 80225, (8) Shaw Environmental and Infrastructure Group, 2700 Chandler Ave, Bldg C, Las Vegas, NV 89120, (9) U.S. Environmental Protection Agency, 1200 Pennsylvania Ave NW, Ariel Rios Bldg (5102G), Washington, DC 20460*

For the past 18 years, three NIST soil Standard Reference Materials (SRM 2709, SRM 2710 and SRM 2711) have been used worldwide by laboratories for quality assurance in environmental, toxicology and soil sciences, and for environmental monitoring programs. Combined annual sales of these SRMs typically exceed 800 units. Supplies of the original three soil SRMs have been exhausted, so a certification campaign was undertaken to replace these materials. Collection, preparation, material homogeneity assessment and certification of renewal SRMs was accomplished through a collaboration of the NIST with U.S. Geological Survey. Analyses for element content have been completed, resulting in certified, reference or information mass fraction values for approximately 50 elements in each of the SRMs. These SRMs were also analyzed by participants in the U.S. Environmental Protection Agency's contract laboratory program for determination of acid-leachable content of selected elements. Results of those analyses are included as addenda to certificates of analysis.

## **ENVR 146**

### **Review of polychlorinated naphthalenes in polar environments**

***Terry F. Bidleman**, [terry.bidleman@ec.gc.ca](mailto:terry.bidleman@ec.gc.ca), Center for Atmospheric Research Experiments, Environment Canada, 6248 Eighth Line, Egbert, ON L0L 1N0, Canada, Fax: 705-458-3301, **Paul Helm**, [paul.helm@ontario.ca](mailto:paul.helm@ontario.ca), Ontario Ministry of the Environment, Toronto, ON M9P 3V6, Canada, **Birgit Braune**, [birgit.braune@ec.gc.ca](mailto:birgit.braune@ec.gc.ca), Wildlife Research Division, Environment Canada, Ottawa, ON K1A 0H3, Canada, and **Geir Wing Gabrielsen**, Norwegian Polar Institute, N-9296 Tromsø, Norway*

Polychlorinated naphthalenes (PCNs) were formerly used as industrial compounds for many of the same purposes as polychlorinated biphenyls (PCBs). They also occur at trace levels in commercial PCB mixtures and are produced during combustion. Manufacture of PCNs is thought to have ended, but their regulatory status is not clear in many countries. An assessment of PCNs concluded that they be considered persistent organic pollutants (POPs) within the UN-ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP), although they have not yet been formally added to the POPs list. This paper, prepared for the 2009 Arctic Monitoring and Assessment Program (AMAP) report, reviews the occurrence of PCNs in air and biota of arctic, subarctic and antarctic regions.

## ENVR 147

### **Atmospheric concentrations and gas/particle partitioning of polycyclic aromatic hydrocarbons (PAHs) at background, rural village and urban sites in the North China Plain**

**Wentao Wang**<sup>1</sup>, *elvin.wang@gmail.com*, **Staci L. Simonich**<sup>2</sup>, *staci.simonich@oregonstate.edu*, **Jingyu Zhao**<sup>1</sup>, **Miao Xue**<sup>1</sup>, **Wei Wang**<sup>1</sup>, and **Shu Tao**<sup>1</sup>. (1) *College of Urban and Environmental Sciences, Peking University, Laboratory for Earth Surface Processes, Beijing 100871, China*, (2) *Departments of Chemistry and Environmental and Molecular Toxicology, Oregon State University, 1007 ALS Hall, Corvallis, OR 97331*

Particle- and gas-phase PAHs were measured in air collected from a background site (Xiaolongmen), two rural village sites (Gubeikou and Donghe), and an urban site (Beijing) located in the North China Plain from September 2007 to August 2008 in order to evaluate their concentrations, relative abundance, and gas/particle partitioning. The annual average 15 PAH concentration in Donghe was  $730.7 \pm 608.0$  ng/m<sup>3</sup>, which was 18.2, 3.0, 1.8 times higher than Xiaolongmen, Gubeikou and Beijing, respectively. A good linear relationship between gas/particle partitioning coefficients,  $K_p$  and subcooled liquid vapor pressure,  $p_l$  was obtained. At the rural and urban sites, the regression slopes were much steeper than  $-1$ , indicating that adsorption of PAH to particulate matter dominated over absorption possibly because, at these sites, the freshly emitted particulate matter and PAHs had not yet reached equilibrium. However, gas/particle partitioning of PAHs approached equilibrium at the background site because of long-range transport of PAHs. In addition, the gas/particle partitioning was studied according to three different models: The Junge-Pankow adsorption model, the  $K_{oa}$  absorption model, and the dual organic matter absorption model combined with the soot carbon adsorption model. The Junge-Pankow model and  $K_{oa}$  model both under-predicted our experimental  $K_p$  values. However, the dual model fit our values well, suggesting that the main partitioning mechanism was PAH adsorption onto soot carbon in this region of China.

## ENVR 148

### **Atmospheric particulate matter pollution during The 2008 Beijing Olympics**

**Wentao Wang**<sup>1</sup>, *elvin.wang@gmail.com*, **Toby Primbs**<sup>1</sup>, **Shu Tao**<sup>2</sup>, **Tong Zhu**<sup>2</sup>, and **Staci L. Simonich**<sup>1</sup>, *staci.simonich@oregonstate.edu*. (1) *Departments of Chemistry and Environmental and Molecular Toxicology, Oregon State University, 1007 ALS Hall, Corvallis, OR 97331*, (2) *College of Urban and Environmental Sciences, Peking University, Laboratory for Earth Surface Processes, Beijing 100871, China*

To assess the particulate matter (PM) pollution during the 2008 Beijing Olympic games, size fractionated PM samples of  $>PM_{10}$ ,  $PM_{2.5-10}$ , and  $<PM_{2.5}$  were collected for a 2-

week time period prior to the Olympics, during the 2-week period of the Olympics, and for a 4-week time period following the Olympics, during both source control and non-source control time periods. The mean  $\text{PM}_{2.5}$  and  $\text{SumPM}_{10}$  concentrations were  $64.7 \pm 36.3 \text{ mg/m}^3$  and  $82.4 \pm 42.4 \text{ mg/m}^3$  during the Olympic time period and  $93.9 \pm 50.2 \text{ mg/m}^3$  and  $124.5 \pm 65.8 \text{ mg/m}^3$  outside of the Olympic time period, respectively, and were statistically different. In addition, air mass back trajectory analysis indicated that high PM concentration in Beijing was attributed to source regions located south of Beijing, including Tianjin municipality and Hebei, Shanxi provinces, while low PM concentration in Beijing was attributed to source regions located northwest of Beijing, including Russia and Mongolia. While meteorological parameters (air masses from the south and precipitation) accounted for 40% of the total variation in  $\text{SumPM}_{10}$  concentration, source control accounted for 16%, suggesting that meteorology accounted for more of the variation in PM concentration than source control measures. Based on our measurements during the 2008 Olympic time period, the  $\text{PM}_{10}$  concentrations in Beijing were 2.9, 3.5, and 1.9 times higher than  $\text{PM}_{10}$  concentrations during the Olympic time periods in Atlanta, Sydney and Athens. Finally, compared to October, November, and December 2007, the  $\text{PM}_{10}$  concentrations were reduced by 9 to 27% during the same months in 2008, suggesting that the source control efforts (and possibly a downturn in the economy) have resulted in lower  $\text{PM}_{10}$  concentrations in Beijing.

## ENVR 149

### Comparison of acid aerosols between hot spring and urban areas in Taipei

**Chih-hung Lin**<sup>1</sup>, *mimic2200@yahoo.com.tw*, **I-Fang Mao**<sup>2</sup>, *ifmao@csmu.edu.tw*, **Pei-Hsien Tsai**<sup>3</sup>, *eason31@yahoo.com.tw*, **Yi-Ju Chen**<sup>1</sup>, and **Mei-Lien Chen**<sup>1</sup>. (1) Institute of Environmental and Occupational Health Sciences, National Yang-Ming University, No.155, Sec.2, Linong Street, Taipei 112, Taiwan, Fax: 886-2-28278254, (2) Department of Occupational Safety and Health and Graduate Program, Chung-Shan Medical University, No.110, Sec.1, Jianguo N. Rd., Taichung 402, Taiwan, (3) Institute of Environmental and Occupational Health Sciences, National Yang-Ming University, No.155, Sec.2, Linong Street, Taipei 112

The characteristics of acid aerosol in Taipei hot spring and urban areas were compared. Acid aerosols were collected using a honeycomb denuder system (HDS).  $\text{NO}_2$  concentrations and  $\text{H}_2\text{S}$  in the hot spring area were also measured. Experimental results indicated the high concentrations of sulfur-containing compounds in hot spring area were attributed to natural emissions of sulfur-rich geothermal sources. Automobiles emit primary pollutants and contribute to secondary acid aerosols generated via photochemical reactions in the urban area. Seasonal variations in acid aerosol concentrations in urban and hot spring areas were found to be higher during spring and summer seasons. An increase in photochemical reaction and transportation of pollutants from Asian dust storms could contribute to this variance. This study also indicated the increment of exposure risk in acid aerosols for schoolchildren during those

two seasons, especially for those who live near high traffic density areas and the hot spring area.

## **ENVR 150**

### **Decoupling secondary organic aerosol formation and aging processes**

*Cindy D. Hauser, cihouser@davidson.edu, Randy M. Jenkins, rajenkins@davidson.edu, and Justin Godinho, jugodinho@davidson.edu, Department of Chemistry, Davidson College, 209 Ridge Road, P.O. Box 6183, Davidson, NC 28035, Fax: 704-894-2709*

Aerosols contribute to air pollution, have adverse effects on human health and affect climate cycles by scattering light and triggering cloud formation. Heterogeneous reactions of atmospheric aerosols affect their physical and chemical particle properties. Specifically, there is still much to learn about the aging of secondary organic aerosols (SOA). In the studies presented here, the formation and aging processes are decoupled. SOA are generated by the reaction of d-limonene with nitrate radical and then aged through heterogeneous chemical reactions with ozone in a separate chamber. We will present the products and kinetics of the heterogeneous chemical reaction as determined using aerosol flow tube/FTIR (AFT-FTIR).

## **ENVR 151**

### **Marine boundary layer O<sub>3</sub> and CO distribution during AEROSE III**

*Juanita Escalera, jennyescalera@yahoo.com, Department of Science and Technology, Universidad Metropolitana, Puerto Rico, San Juan, PR 00926, and Vernon Morris, Department of Atmospheric Science, Howard University, Washington, DC*

One of the goals of the Trans-Atlantic Saharan Dust Aerosol and Ocean Science Expedition (AEROSE) is to estimate the impact of Saharan dust on regional air quality and its ecosystem impacts in the Caribbean and US eastern seaboard. An AEROSE cruise aboard the NOAA ship Ronald H. Brown was again conducted in summer 2007. A report on trace gas measurements of surface level ozone (O<sub>3</sub>) and carbon monoxide (CO) were obtained throughout this cruise. O<sub>3</sub> is a reactive oxidant gas produced naturally in trace amount in the Earth's atmosphere. Major sources of CO in the tropical marine boundary layer (MBL) include technological processes (combustion and industrial processes), biomass burning, and the oxidation of hydrocarbons. CO and O<sub>3</sub> chemistry is strongly linked, but previous studies have indicated that this linkage is disrupted in the presence of significant atmospheric loading of Saharan dust aerosols. These measurements were taken from May 6 to May 24, 2007 along a cruise track that included encounters with both light and heavy Saharan dust episodes, a cross section of the intertropical convergence zone, and a cross section of the continental outflow from West Africa.

## ENVR 152

### **Studies on the city green patterns based on the atmosphere environment quality control**

*Huisheng Zhuang*, [hszhuang@sjtu.edu.cn](mailto:hszhuang@sjtu.edu.cn), School of Environmental Science and Engineering, Shanghai Jiaotong University, 800 Dongchuan Road, Shanghai 200240, China, and *Yuhua Jia*, College of Environmental Science and Engineering, Donghua University, 2999 Renmin Road, Shanghai 201620, China

The atmosphere pollutants removing rate of five types of green patterns of Changning district in Shanghai was determined in this paper, and a qualitative and quantitative analysis on the designed indexes and scenarios was carried out by AHP decision-making method. The five green pattern environmental contributions to the atmospheric environment harness target were determined. Consequently, the optimum city green patterns based on the atmospheric environment quality control have been achieved in the given district.

## ENVR 153

### **Characteristic of metallic elements on ultrafine/fine/coarse particles in the stack gas of a municipal waste incinerator**

*Ling-Yen Hsu*, [d948506@oz.nthu.edu.tw](mailto:d948506@oz.nthu.edu.tw), *Yuh-Jeen Huang*, [yjhuang@mx.nthu.edu.tw](mailto:yjhuang@mx.nthu.edu.tw), and *I-Fu Hung*, [ifhung@mx.nthu.edu.tw](mailto:ifhung@mx.nthu.edu.tw), Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, 101, Section 2, Kuang-Fu Road, Hsinchu 30013, Taiwan

Heavy metal is one of toxic pollutants released from the municipal waste incineration (MWIs). The intention of this study was to estimate the profile of metallic elements in aerosol samples, which were simultaneously collected at the stack of the municipal waste incineration by using electrical low-pressure cascade impactor (ELPI) coupled with a diluted system for particles with the size range from 7 nm to 10  $\mu\text{m}$ . Nineteen elements were analyzed by laser-induced plasma-mass spectrometry (LA-ICP-MS). Interesting, results show the main elements contained in the particles with various diameters are not similar. The K, Al and Zn were often found in these three size range of particles. Due to the fine (0.1-1  $\mu\text{m}$ ) and ultrafine (0.07-0.1  $\mu\text{m}$ ) particles formed through nucleation and further coagulation and condensation processes, these elements have low melting points and may vaporize and condense on the particle surface, so the elements are easily observed in small size range. In the meantime, the main elements contained in the fine and ultrafine particles were Mg, Ca and Cu as well as Pb, As and Fe. In addition, the coarse particles are formed through condensation of volatile elements Zn, K and Al on existing minerals. The coarse particles (1-10  $\mu\text{m}$ ) contained Fe, Cr, Mn, Ca and Si.

## ENVR 154

### Evolution of H<sub>2</sub>S and SO<sub>2</sub> during the pyrolysis of three types of Chinese coal

*Qinxin Zhao, Xuebin Wang, xuebinwang1984@yahoo.cn, Qiuna Qi, and Houzhang Tan, State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xian Ning Xi Road 28#, Xi'an 710049, China, Fax: 86-029-82668703*

Three types of Chinese coal (JZ-coal, S%=0.73; HJ-coal, S%=2.35; CZ-coal, S%=5.01) have been chosen to investigate the evolution rule of H<sub>2</sub>S and SO<sub>2</sub> during the progress of coal pyrolysis in a drop-tube furnace. Fourier transform infrared Spectroscopy and ultraviolet spectrophotometric are used to quantify the sulfur-containing species. Results show that the evolution rate of H<sub>2</sub>S is much higher than SO<sub>2</sub>, and the formation of H<sub>2</sub>S is more related to temperature. H<sub>2</sub>S increases sharply in the temperature range of 673-873 K, due to the decomposition of iron sulfides and organic sulfides. When temperature is higher than 1073 K, the evolution rate of total sulfur changes little. The order of evolution rate of total sulfur is HJ>CZ>JZ, which is not consistent with sulfur content in coal, but is consistent with volatile content. It suggested that in the process of coal pyrolysis or gasification the evolution of sulfur is more affected by coal rank.

## ENVR 155

### Experimental study on high temperature in-furnace deSO<sub>x</sub> in Oxy-PC power plants

*JinHan Yun, jhyun@kimm.re.kr, SangIn Keel, sikeel@kimm.re.kr, and SeonAh Roh, sos@kimm.re.kr, Environmental Systems Research Division, Korea Institute of Machinery and Materials, 171 Jang-dong, Yuseong-gu, Daejeon 305-343, South Korea, Fax: 82-42-868-7284*

In Korea, 100 million tons of CO<sub>2</sub> a year are discharging from 30 or more coal power plants. The contribution of coal power plant to total CO<sub>2</sub> generation is about 20%. It means coal power plants are good control targets for practical and economical CO<sub>2</sub> reduction. This research is focused on the understanding of sulfur oxides removal characteristics and on the determination of design parameters for in-furnace high temperature deSO<sub>x</sub> method in oxy-PC combustion field. Because of sorbent reactivity, in-furnace deSO<sub>x</sub> technology is only meaningful at highly concentrated CO<sub>2</sub> flow field. As a sorbent material, commercial limestone was used. O<sub>2</sub> concentration and an amount of sprayed limestone in the reaction field are most sensitive sulfur removal parameters. High sulfur removal efficiency can be achieved in high O<sub>2</sub> excess ratio and large amount of limestone spray. In-furnace deSO<sub>x</sub> method is effective in a wide range of sulfur dioxide species concentration. Sulfur dioxide can be removed well by proper amount of sorbent injection determined by SO<sub>2</sub> concentration. In a oxy-PC power generation system, N<sub>2</sub> can be come into the combustion chamber through air separation unit or coal-injection system. The inflow of N<sub>2</sub> brings the drop of sulfur removal

efficiency. But in case of small amounts of N<sub>2</sub>, severe removal efficiency drop was not observed.

## **ENVR 156**

### **Emissions from the combustion of fuels in a gas turbine engine**

**Mark Ortega**, *msobruin@ucla.edu*, **Maryam Ghadiri**, **Darrell Guillaume**, **Trinh Pham**, *tpham4@calstatela.edu*, **Sara Esparza**, and **Crist Khachikian**, *ckhachi@calstatela.edu*, Department of Civil Engineering, California State University, Los Angeles, 5151 State University Dr, Los Angeles, CA 90032

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants, usually found in soil and water. Incomplete combustion of carbon-based fuels is the largest anthropogenic source of PAHs to the environment. These compounds are of concern because of their potential carcinogenic, mutagenic, and teratogenic properties, especially when attached to particulates in air. Our preliminary research findings show that a gas turbine engine running on kerosene at a low swirl number (ratio of tangential to axial flow in engine) produced the PAHs acenaphthene, acenaphthylene, and fluorene. The PAHs were not detectable in high swirl number runs. We believe that higher swirl numbers, which result in increased combustion temperature and longer residence time (the time the products are exposed to the combustion process), reduce the abundance or eliminates the formation of PAHs. By refining our extraction method, which is vital to the detection and analysis of PAHs, it is possible to find other PAH compounds and their breakdown by-products in our experiments. Varying the type of carbon-based fuel (*e.g.*, biofuels) is another variable we would like to address in future studies.

## **ENVR 157**

### **Fundamental study of environmental control in Oxy-PC combustion system**

**JinHan Yun**, *jhyun@kimm.re.kr*, **SangIn Keel**, *sikeel@kimm.re.kr*, and **TaiJin Min**, *tmin@kimm.re.kr*, Environmental Systems Research Division, Korea Institute of Machinery and Materials, 171 Jang-dong, Yuseong-gu, Daejeon 305-343, South Korea, Fax: 82-42-868-7284

Carbon dioxide has become generally known as a greenhouse effect gas that contributes to more global warming and receives attention in international agreements, such as the Kyoto Protocol. Oxy-PC combustion is the real method to solve global warming problems and basic construction of greenhouse gases treatment because of great reduction of flue gas and CO<sub>2</sub> capture and storage (CCS) systems. Efficient control is necessary because SO<sub>2</sub> is concentrated in furnace, and minute particles can disturb a combustion and gas flow condition such as flue gas recirculation. This study

confirms the fundamental technology about environmental control with oxy-PC combustion for coal-fired plants, and it mentions experimental research about in-furnace deSO<sub>x</sub> and characteristics of electrical precipitator in CO<sub>2</sub>. Experimental equipment consists of a coal combustion furnace (max. 2 kg/hr pilot scale), pulverized coal and limestone hybrid injection system, and an electrical precipitator of 600 CMM scale. As the result of thermal balance analysis, we confirmed that desulfurization reaction tends to react with the CaO form at high temperature and CaCO<sub>3</sub> form at the low and medium temperature conditions with the limestone as a desulfurizing agent in CO<sub>2</sub>. In oxy combustion, sulfur removal efficiency using the limestone was higher than air combustion condition in in-furnace deSO<sub>x</sub> system. Specifically, it was confirmed that the sulfur removal effect by cinder was very large. Also, the result of collection experiment with electrical precipitator was confirmed that generated corona by electric current was decreased and collection efficiency was lower in CO<sub>2</sub> condition. Therefore, we need to change over the high efficiency discharge electrode and collecting electrode and high voltage apparatus for stable collection ability.

## ENVR 158

### **Role of silica-supported iron oxide nanoparticles in pollutant formation in combustion processes**

*Elisabeta Mitran, emitra1@tigers.lsu.edu, Barry Dellinger, and Robin L. McCarley, tunnel@lsu.edu, Department of Chemistry, Louisiana State University, 413 Choppin Hall, Baton Rouge, LA 70803*

Iron oxide is one of the highest concentration transition metals present during the combustion of naturally-occurring fuels and has the potential to be a significant source of polychlorinated dibenzo-*p*-dioxin and dibenzofuran (PCDD/F) emissions. In order to understand the role of iron oxide nanoparticles in combustion processes, especially in pollutant formation, we have performed a study of the formation of PCDD/F from chlorobenzene precursors over a surface of silica-supported Fe<sub>2</sub>O<sub>3</sub> nanoparticles in a temperature range of 300-550°C. The Fe<sub>2</sub>O<sub>3</sub> nanoparticles were obtained by air calcination at 450°C of silica-supported poly(propylene imine) dendrimers functionalized with peripheral ferrocenyl units. The mean diameter of the nanoparticles, as determined by HR-TEM, was 2.7 nm. The results obtained indicate that the Fe<sub>2</sub>O<sub>3</sub> nanoparticles promote PCDF formation and other chlorinated byproducts. We also observed that Fe<sub>2</sub>O<sub>3</sub> nanoparticles have different properties under pyrolytic and oxidative conditions.

## ENVR 159

### Self-retention of SO<sub>2</sub> by ash during fluidized bed combustion of biomass

**Ke Zhao**, *zhaokexjtu@gmail.com* and **Qing Gang Lu**, *Institute of Engineering Thermophysics, Chinese Academy of Sciences, Bei Si Huan Xi Road 11#, Beijing 100190, China*

Biomass contains higher Ca/S and Mg/S molar ratio than coal, which means self retention of SO<sub>2</sub> by ash is feasible during combustion process by adjusting the combustion parameters. In this paper, self retention characteristics of 4 biomass fuels, with ash content of 2.8-8.8% and sulphur content of 0.05-0.12%, were experimented in a lab-scale reactor between 670-920°C. The gas emission was analyzed by Gasmeter FTIR gas analyzer. The influence of combustion temperature on SO<sub>2</sub> emission was significant. With the use of corncob, the lowest of the maximum SO<sub>2</sub> emission was achieved at 720°C, about 23.7% of it at 820°C. Concerning the corn stalk, sawdust and wheat straw, the lowest SO<sub>2</sub> emission obtained at 670°C, about 63.2%, 20.3% and 20.9% of it at 820°C, respectively. Higher self retention of SO<sub>2</sub> was achieved 44.2-89.2% with the temperature of 670-720°C.

## ENVR 160

### Size and composition distribution of nanoparticulate emitted from four-stroke motorcycle

**Chien Shu-Mei**, *d9712809@oz.nthu.edu.tw*, **Huang Yuh-Jeen**, and **Chen Kuan-Yi**, *Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, 101, Section 2, Kuang-Fu Road, Hsinchu 30013, Taiwan*

Due to its high mobility and convenience, four-stroke motorcycles (4-stk/mc) are more popular and widespread than other vehicles. Simultaneously, more air pollutants (e.g., particulate matters (PMs) and polycyclic aromatic hydrocarbons (PAHs)) were emitted from this vehicle. However, the relationship of PMs and particulate PAHs emitted from 4-stk/mc are still not well known. In the study, the characteristics and the size distribution of PM and PAHs in diluted motor exhaust at idle, 15 km/h and 30 km/h were investigated. The test 95-unleaded gasoline from the Chinese Petroleum Company (CPC) is the most widely used unleaded gasoline in Taiwan. To enhance the PAH analytical sensitivity, each cycle for electrical low pressure impactor (ELPI) sampling was kept 60 minutes. The collected samples were extracted and then done the PAHs analysis by GC/MS. Experimental results indicate that the total number concentrations (TNC) of particles are 20663, 23527 and 26086 number per cm<sup>3</sup> for idle, 15 km/hr and 30 km/hr, respectively. Meantime number median diameters (NMDs) of particle are 0.67, 0.45 and 0.19 µm for idle, 15 km/hr and 30 km/hr, respectively. The smaller particles might dominate gradually in the exhaust with the speed increase. The results can provide motorcycle emission controls to alleviate health hazards.

## ENVR 161

### Electrochemical analysis of roxarsone, 3-nitro-4-hydroxyphenylarsonic, using palladium, gold and platinum electrodes

*Tsanangurayi Tongesayi*, *ttongesa@monmouth.edu*, *Eric J. Byam*, and *Andrea Grafton*, *s0585353@monmouth.edu*, Department of Chemistry, Medical Technology and Physics, Monmouth University, 400 Cedar Avenue, West Long Branch, NJ 07764, Fax: 732-263-5213

Roxarsone, an arsenic-containing poultry-feed additive, is stable in fresh poultry litter but degrades to inorganic arsenic among other products when the litter is composted. Inorganic arsenic is probably formed *via* the cleavage of the C-As bond but the mechanism still remains obscure. We used cyclic voltammetry to study the redox behavior of roxarsone on palladium, gold and platinum electrodes. On the gold and platinum electrodes, there were oxidation peaks which could not be attributed to redox activities at the nitro or the arsonic acid groups. These peaks could be due to oxidative aromatic fission which is expected to release inorganic arsenic.

## ENVR 162

### Method development for nitric oxide radical determination in natural water

*Emmanuel Folorunso Olasehinde*, *folasemb2004@yahoo.com*, *Kazuhiko Takeda*, *takedaq@hiroshima-u.ac.jp*, and *Hiroshi Sakugawa*, *hsakuga@hiroshima-u.ac.jp*, Graduate School of Biosphere Science, Hiroshima University, 1-7-1 Kagamiyama, Higashi-Hiroshima 739-8521, Japan, Fax: 81-82-424-6504

The measurement of photo-chemically generated nitric oxide radical (NO•) in natural water has long been an arduous task due to lack of simple analytical technique, even though the environmental significance of the radical is paramount. We have developed a simple analytical method for the determination of photo-chemically generated NO• in natural water using 4,5-diaminofluorescein (DAF-2) probe compound. This method is based on the reaction of photo-formed NO• with DAF-2 in the presence of oxygen to produce a highly fluorescent triazolofluorescein (DAF-2T). The product, DAF-2T, was determined by reversed-phase HPLC equipped with fluorescence detector for NO• quantification. Under optimum conditions, the calibration curve exhibited linearity in the range of 0.025-10 nM DAF-2T. The coefficient of variance for the determination of the NO• photo-formation rate (from the photolysis of 0.5 μM and 5 μM NO<sub>2</sub><sup>-</sup> with DAF-2) were less than 5 and 3% respectively. When the total irradiation time for one sample was 30 min, the detection limit of the photo-formation rate of NO• was 1.65 x 10<sup>-13</sup> Ms<sup>-1</sup>. The proposed method is relatively free from the potential interferents in seawater. The measured NO• photo-formation rate in seawater and river water samples collected from

Hiroshima prefecture, Japan, ranged from  $(5.3\text{--}32) \times 10^{-12} \text{ Ms}^{-1}$  and  $(0.094\text{--}30) \times 10^{-10} \text{ Ms}^{-1}$  respectively. Sources and sinks of  $\text{NO}^\bullet$  in natural water were also investigated.

## ENVR 163

### Rapid lab-scale extraction and analysis of anthropogenic organic contaminants in sediments

*Thomas J Brown, Department of Chemistry, Colorado State University-Pueblo, 2200 Bonforte Blvd, Pueblo, CO 81001-4901, and **Chad Kinney**, chad.kinney@colostate-pueblo.edu, Department of Chemistry, Colorado State University - Pueblo, 2200 Bonforte Blvd, Pueblo, CO 81001-4901, Fax: 719-549-2580*

An Ethos EZ microwave lab station was employed in the development of a robust and efficient microwave extraction method for organic contaminants of anthropogenic origin in sediments. The extraction method is designed for a small set of target compounds encompassing a range of physicochemical properties, 4-tert-octylphenol, benzo[a]pyrene, bisphenol A, carbamazepine, indole, *para*-cresol, phenanthrene, and triclosan. The sediments samples are left wet, which reduces preparation time, and allows the ambient moisture to aid in microwave energy absorption and the extraction process. Twelve samples can be simultaneously extracted in individual pressurized vessels using a mixture of three organic solvents allowing for rapid sample preparation with minimal solvent consumption. The extracts go through a solid phase extraction cleanup step using anhydrous sodium sulfate and florisil. The resulting extracts are then concentrated by evaporation to approximately one milliliter under nitrogen. The extracts are quantified by gas chromatography/mass spectrometry.

## ENVR 164

### Speciation analysis of rare earth elements in soil of China

***Xihong Qi**, xihongqi85@yahoo.com.cn, Department of Chemistry, Hebei Normal University, 100 NanXiang, GaoCheng, Hebei 052161, China, Fax: 86-311-88068263*

The content of the rare earth elements in soil are potentially influencing on the soil environment, which is directly related to the agricultural produce and food for humans. So, it is necessary to study the contents of the rare earth elements in soil. In this study, the soil samples were taken from Hebei province of China. We used both acid digestion and sequential extraction methods separately to concentrate the rare earth elements of samples. Then, the contents of the total rare earth and individual elements were determined by inductively coupled plasma mass spectroscopy. The measured results show that the soil samples contain the amount of rare earth in the range from 200 mg/kg to 1,418 mg/kg, in which the light elements are much more than the heavy elements. The recovery ratios are 88.2-110%, which implies the sequential extraction method is reliable to quantify the contents of rare earth elements of soil sample. In the soil sample, the residual fraction of rare earth elements are in 33-80%; ferromanganese

oxides are 10-31%; adsorbed in humic material and amorphous oxides are in 5-18%; carbonates are in 4-23%. The distribution of rare earths from the sampling sites were also discussed.

## **ENVR 165**

### **Steroid hormone determination in water using an polymer magnetic nanoparticle extraction technique**

**Qing Ling Li**, *lql\_sky@163.com*, Department of Biology and Chemistry, City University of Hong Kong, 83 Tat Chee Avenue, Hong Kong, China

A new approach was developed for determination of five steroid hormones in tap, ocean and sewage water from Hong Kong. Sample preparation and analysis were performed by polymer magnetic nanoparticle extraction (NPE) combined with liquid chromatography-mass/mass spectrometry. The time for sample preparation was only five minutes, much shorter than other techniques like SPE, SPME or liquid-liquid extraction. Several parameters were studied, including: adsorption isotherm, extraction time, sample pH and salt. A linear plot gave correlation coefficients better than 0.9996 and resulted in a method limit of detection of 0.001-0.002 ng ml<sup>-1</sup> for E1, 0.002-0.006 ng ml<sup>-1</sup> for E2, 0.006-0.024 ng ml<sup>-1</sup> for EE2, 0.003-0.010 ng ml<sup>-1</sup> for E3 and 0.019-0.036 ng ml<sup>-1</sup> for BPA in three real samples. The relative standards of five estrogens were in the range of 3.5-18.9% in tap, ocean and sewage water respectively. E1 and BPA were found in ShaTin sewage treatment at the concentration of 0.09 and 0.28 ng ml<sup>-1</sup>.

## **ENVR 166**

### **Trace determination of synthetic polycyclic musks in water by microwave-assisted headspace solid-phase microextraction and GC/MS**

**Wang-Hsien Ding**, *wanghsiending@gmail.com*, Department of Chemistry, National Central University, Chung-Li 320, Taiwan, Fax: 886-3-4227664

A rapid and solvent-free method, microwave-assisted headspace solid-phase microextraction (MA-HS-SPME), to extract six commonly used synthetic polycyclic musks (*i.e.*, galaxolide, tonalide, celestolide, traseolide, cashmeran and phantolide) in water samples was studied. The effects of various extraction parameters for the quantitative extraction of these analytes by MA-HS-SPME were systematically investigated and optimized. The parameters of SPME desorption conditions (*i.e.*, temperature, time and the fiber depth in the GC injection-port) were also optimized. The analytes in 20 mL water sample (in 40 mL sample vial with 4 g NaCl addition) can be efficiently extracted by PDMS-DVB fiber in headspace under 180 W microwave irradiation power for less than 4 min. The limits of quantification (LOQ) was less than 0.2 ng/L. Preliminary results show that HHCb and AHTN were two commonly detected

synthetic polycyclic musks in wastewater samples, ranging from 1.2 to 37.3 ng/L by standard addition method. The results from conventional oil-bath HS-SPME were also compared.

## **ENVR 167**

### **Control of genotoxic and carcinogenic impurities in an active pharmaceutical ingredient (API)**

*Yueer Shi<sup>1</sup>, yueer.shi@bms.com, Brian He<sup>1</sup>, brian.he@bms.com, Michelle L. Kubin<sup>1</sup>, michelle.kubin@bms.com, Helen Fyfe<sup>1</sup>, and Brent Kleintop<sup>2</sup>. (1) Analytical Research & Development, Bristol-Myers Squibb & Company, 1 Squibb Dr, New Brunswick, NJ 08903, (2) Analytical Research & Development, Bristol-Myers Squibb & Company, 1 Squibb Dr, New Brunswick, NJ 08901*

Because of their ability to induce genetic mutations and/or chromosomal rearrangements, control of genotoxic and carcinogenic impurities in pharmaceutical drug substances has garnered increased scrutiny in recent years. Guidelines from regulatory agencies have been recently published outlining limits for testing and control of potential genotoxic impurities (GTIs). For example, the European Medicines Agency (EMA) Committee for Medicinal Products for Human Use (CHMP) has defined a threshold of toxicological concern (TTC) of 1.5 mg/day intake of a genotoxic impurity is considered to be an acceptable risk. From this threshold value, a permitted level in the active pharmaceutical ingredient (API) can be calculated based on the expected daily dose. For a drug taken at a dose of 100 mg/day to 1 g/day, this equates to concentration limits of 1.5-15 ppm for each impurity. This represents levels significantly lower than the conventional ICH identification threshold for impurities, which provides a challenge for analytical scientists to develop sensitive analytical methodologies to monitor and quantify the GTIs. This presentation will provide a case study of the development of an array of high sensitivity methodologies developed to ensure multiple potential genotoxic impurities are controlled in a high dose drug substance (800 mg/day daily dose). This was a particularly challenging application due to different structural types of several GTIs which necessitated developing several different types of high sensitivity analytical methods.

## **ENVR 168**

### **Fate of steroid hormones in sewage sludge and poultry litter prior to land application**

*Christine Bevacqua, cbevacqu@umd.edu, Marine Estuarine Environmental Sciences Program, University of Maryland, College Park, MD 20742, Clifford P. Rice, Beltsville Agricultural Research Center, USDA-ARS, 10300 Baltimore Avenue, Beltsville, MD 20705, Alba Torrents, alba@eng.umd.edu, Department of Civil and Environmental*

*Engineering, University of Maryland, 1153 Glenn L. Martin Hall, College Park, MD 20742, and Mark Ramirez, mark\_ramirez@dcwasa.com, D.C. Water and Sewer Authority, 5001 Overlook Ave, Washington, DC*

Steroid hormones can act as potent endocrine disruptors when released into the environment. The main sources of these chemicals are thought to be wastewater treatment plant discharges and waste from animal feeding operations. While these compounds have frequently been found in wastewater effluents, few studies have investigated biosolids or manure, which are routinely land applied, as potential sources. This study is assessing the relative contribution of steroid hormones from biosolids and poultry litter by comparing their presence and concentrations prior to land application. The present focus is on levels in sludge and their prevalence after treatment. Limed biosolids samples collected over a three year period were analyzed for 17 $\beta$ -estradiol, 17 $\alpha$ -ethinylestradiol, estrone, estriol, progesterone, and testosterone, and for various conjugated forms of the estrogen hormones. Preliminary results indicate that estrone and progesterone are the most prevalent compounds. The fate of the hormones during composting will also be evaluated.

## **ENVR 169**

### **New contamination derived from marine debris plastics**

**Katsuhiko Saido**<sup>1</sup>, *saido.katsuhiko@nihon-u.ac.jp*, **Tadashi Itagaki**<sup>1</sup>, **Hideto Sato**<sup>2</sup>, **Yoichi Koderā**<sup>3</sup>, **Osamu Abe**<sup>4</sup>, **Naoto Ogawa**<sup>5</sup>, **Seon-Yong Chung**<sup>6</sup>, and **Kiyotaka Miyashita**<sup>7</sup>. (1) College of Pharmacy, Nihon University, Chiba, Japan, (2) College of Science & Technology, Nihon University, Japan, (3) National Institute of Advanced Industrial Science and Technology, Japan, (4) Seikai National Fisheries Research Institute, Fisheries Research Agency, Japan, (5) Faculty of Agriculture, Shizuoka University, Japan, (6) College of Engineering, Chonnam National University, (7) National Institute for Agro-Environmental Sciences, Japan

There is no report on polymer degradation in the environment. People know marine debris plastics become small particles physically. Styrofoam (foamed polystyrene) is crashed into pieces in the ocean. Low molecular weight compounds like styrene trimer and styrene dimer are not generated naturally. There are no researchers to study how and why those compounds were found in nature. A suspected source is polystyrene scattered in nature. This study would be a first link between the existence of plastics debris in the ocean and the chemical detection of low molecular weight fragments from plastic. We invented a new method to simulate plastic degradation at low temperature range and quantitatively evaluate the degradation. The quantities of plastics which have washed up onto the Japan coast were used as basis for simulating the generation rates of styrene trimer and the results for which were found quite consistent with those from field analysis.

## ENVR 170

### Uptake of human pharmaceuticals in plants grown under hydroponic conditions

*Prakash Gurung*<sup>1</sup>, *Patrick Herklotz*<sup>2</sup>, *Brian Vanden Heuvel*<sup>2</sup>, *brian.vandenheuvel@colostate-pueblo.edu*, and **Chad Kinney**<sup>3</sup>, *chad.kinney@colostate-pueblo.edu*. (1) Department of Chemistry, Colorado State University - Pueblo, 2200 Bonforte Blvd, Pueblo, CO 81001, (2) Department of Biology, Colorado State University - Pueblo, 2200 Bonforte Blvd, Pueblo, CO 81001, (3) Department of Chemistry, Colorado State University - Pueblo, 2200 Bonforte Blvd, Pueblo, CO 81001-4901, Fax: 719-549-2580

Two sets of plants were grown under ideal hydroponic conditions in order to determine the potential uptake of human pharmaceuticals. Wisconsin fast plants (*Brassica rapa*) and cabbage (*Brassica rapa var. pekinensis*) were grown in a sand substrate. One of these sets of plants was irrigated with a recirculating Hogland's nutrient solution and the other set was irrigated with a pharmaceutical fortified Hogland's nutrient solution. The human pharmaceuticals carbamazepine, salbutamol, sulfamethoxazole, and trimethoprim were measured in plant extracts using LC/MS. Carbamazepine and salbutamol were detected in the seedpods of the Wisconsin fast plants. All four of the pharmaceuticals were detected in the leaves of the cabbage indicating active uptake and transport of the pharmaceuticals within the plants. The maximum concentration of pharmaceuticals, 98.9 ppb carbamazepine, 120.9 ppb salbutamol, 138.3 ppb sulfamethoxazole, and 91.3 ppb trimethoprim, were detected in the root structure of the cabbage plants.

## ENVR 171

### Determining the vapor pressure of mineral oil lubricants as a function of temperature

*Shawn Abernathy*, *sabernathy@howard.edu*, Department of Chemistry, Howard University, Washington, DC 20059, Fax: 202-806-5442, and **Anwar Jackson**, *aj71@flash.net*, Chemistry, Howard University, Washington, DC 20059

There is a significant lack of empirical data on the temperature dependent vapor pressure (VP) of mineral based oils of petroleum origin. These types of oils are highly viscous and their normal boiling points typically exceed 200°C. Lubricating oil for motor vehicles is composed of a base mineral oil and additives that reduce deterioration and increases its useful lifetime. These additives make it more difficult to attain temperature-dependent vapor pressure information. Used lubricants contain potentially toxic substances that pose a substantial health risk. The aim of this investigation is to acquire temperature dependent vapor pressure data on mineral oil and its lubricants from 25°C (298 K) to over 200°C (473 K). This information provides another pathway for determining the heat of vaporization ( $\Delta H_{\text{Vap}}$ ) via VP data. Additional insight may

possibly be gained into the complex thermal degradation process and hazardous materials produced during use and operating conditions in which they are subject.

## ENVR 172

### Direct online solubility analysis of CO<sub>2</sub> under hydrate forming conditions for CO<sub>2</sub>

**Rheo B. Lamorena**, *rheolamorena@kaist.ac.kr* and **Woojin Lee**, *woojin\_lee@kaist.ac.kr*, Department of Civil and Environmental Engineering, Korea Advanced Institute of Science and Technology, 373-1 Guseong-Dong, Yuseong-Gu, Daejeon 305-701, South Korea, Fax: 82-42-869-3610

An analytical method has been developed using an online monitoring technique to measure CO<sub>2</sub> concentrations in a high-pressurized vessel under CO<sub>2</sub> hydrate forming conditions (30 bar, 0.3-2.0° C). We have developed a method to analyze aqueous CO<sub>2</sub> concentration by gas chromatography (GC) using a thermal conductivity detector (TCD) with direct aqueous injection (DAI). The solubility of CO<sub>2</sub> in aqueous electrolyte solutions (3.5% NaCl or CaCl<sub>2</sub>) under the hydrate forming conditions was determined. The optimized GC conditions were as follows: 200° C, 280° C, and 300° C for oven, injector and detector temperatures, respectively. The sampling line from the high pressure vessel is connected to a high-pressure metering pump, which is connected to a sampling loop of a 4-port injector valve of the GC. The minimum concentration we could detect was  $7.32 \times 10^{-4}$  mM. The results can be applied to an analysis on the distribution of CO<sub>2</sub> in each phase during the hydrate formation/dissociation and an approach for CO<sub>2</sub> solubility trapping as well.

## ENVR 173

### Effects of CO addition on the ignition temperature and burn off temperature of methane

**Ke Zhao**, *zhaokexjtu@gmail.com* and **Qing Gang Lu**, Institute of Engineering Thermophysics, Chinese Academy of Sciences, Bei Si Huan Xi Road 11#, Beijing 100190, China

The gas fuels of the co-generation of methanol and electricity from the coal system and the IGCC system are multi-component combustible gas mixtures. Interactions of combustion characteristic by different components were essential for combustion control. In this study, the effect of CO on methane combustion characteristic was investigated. The ignition temperature (T<sub>10</sub>) and burn off temperature (T<sub>90</sub>) were carried out in a quartz reactor at atmospheric pressure with the mixture flow rate of 800mL/min. The compositions of outlet gas were measured online by Gasmeter DX4000 FTIR gas analyzer. The results showed that CO enhanced the activity of methane, but the CO was less effective than the hydrogen. For 1 vol.% methane combustion, when the

CO/CH<sub>4</sub> was equal to 0.1, the T<sub>10</sub> and T<sub>90</sub> could decrease 35°C and 10°C, respectively. When the CO/CH<sub>4</sub> was 2.0, the T<sub>10</sub> could decrease 105°C.

## ENVR 174

### Rate constants for the direct reaction of ozone with four selected pharmaceuticals

**Francisco J. Real**<sup>1</sup>, *fjreal@unex.es*, **F. Javier Benitez**<sup>2</sup>, *javben@unex.es*, **Juan L. Acero**<sup>3</sup>, *jlacero@unex.es*, and **Gloria Roldan**<sup>3</sup>, *gloria@unex.es*. (1) Department Ingenieria Quimica y Quimica Fisica, Universidad de Extremadura, Facultad de Ciencias, Avda. de Elvas s/n, Badajoz 06071, Spain, Fax: 34-924-289385, (2) Department Ingenieria Quimica y Quimica Fisica, Universidad de Extremadura, Facultad de Ciencias, Avda de Elva s/n, Badajoz 06071, Spain, (3) Department Ingenieria Quimica y Quimica Fisica, Universidad de Extremadura, Facultad de Ciencias, Avda de Elvas s/n, Badajoz 06071, Spain

Four frequent pharmaceutical compounds, the beta-blocker metoprolol (pK<sub>a</sub>=9.6), the NSAID naproxen (pK<sub>a</sub>=4.2), the antibiotic amoxicillin (pK<sub>a</sub>=2.8 and 7.2) and the analgesic phenacetin (pK<sub>a</sub>=2.2) were selected in this study to be oxidized by using ozone. Apparent second order rate constants were determined at different pH which ranged between 2.5 and 9, by means of a competition kinetic model. The reactivity of every pharmaceutical was increased by increasing the pH, which confirms that dissociated forms are generally more reactive than un-dissociated ones. From the data obtained, the specific rate constants for the un-dissociated and dissociated forms of the pharmaceuticals are determined, resulting 2.6x10<sup>2</sup> and 1.3x10<sup>5</sup> L mol<sup>-1</sup> s<sup>-1</sup> for metoprolol; 2.5x10<sup>4</sup> and 2.8x10<sup>5</sup> L mol<sup>-1</sup> s<sup>-1</sup> for naproxen; and lower than 10 and 1.6x10<sup>3</sup> L mol<sup>-1</sup> s<sup>-1</sup> for phenacetin; while the results for amoxicillin were 2.2x10<sup>3</sup>, 2.2x10<sup>3</sup> and 1.0x10<sup>7</sup> L mol<sup>-1</sup> s<sup>-1</sup> for the protonated, un-dissociated and dissociated species, respectively. From the apparent rate constants at pH 7, the following order of reactivity and half-lives for an ozone concentration of 10 μM in the liquid phase were obtained: amoxicillin (0.05 s) > naproxen (0.26 s) > phenacetin (44 s) > metoprolol (49 s).

## ENVR 175

### Evaluating waste charcoal as potential rubber composite filler

**Steven C. Peterson**, *Steve.Peterson@ars.usda.gov*, Cereal Products and Food Science, United States Department of Agriculture, National Center for Agricultural Utilization Research, Agricultural Research Service, 1815 North University, Peoria, IL 61604, Fax: 309-681-6685, and **Akwasi Boateng**, *akwasi.boateng@ars.usda.gov*, Eastern Regional Research Center, USDA, Agricultural Research Service, 600 Mermaid Lane, Wyndmoor, PA 19038

Carbon black, a byproduct of the petroleum industry, is the world's most predominant filler for rubber composites. In this study, charcoal in the form of pyrolyzed agricultural products was evaluated as potential carbon-based filler for rubber composites made with carboxylated styrene-butadiene latex. This source of carbon is not dependent on the petroleum industry and (for two of the three samples) is a waste byproduct of a renewable biofuel process. Charcoal samples were ball milled, resulting in particle sizes of roughly 1 micron (based on number distribution; approximately 3-12 microns based on volume distribution). Composites were created using a method consisting of freeze-drying followed by compression molding to form bars that were tested rheologically. Charcoal-filled composites showed reinforcement factors of up to 50 times greater than the unfilled latex.

## **ENVR 176**

### **Imprinted polymers for the removal of hydrophilic metal complexes from water**

**Syed Ali Ashraf**, *ashra1sa@cmich.edu*, Science of Advanced Materials (SAM), Central Michigan University, Dow Science 374, Mount Pleasant, MI 48859, Fax: 989-774-3883, and **Anja Mueller**, *muell1a@cmich.edu*, Department of Chemistry, Central Michigan University, Mount Pleasant, MI 48859

In water treatment, the removal of heavy metals is difficult but important due to the health effects of these toxic compounds. The molecular imprinted polymers show high selectivity and affinity to the predetermined molecules (templates). In this research project, imprinting polymerization is used to develop a random copolymer of methacrylate and methacrylamide, which was found to be most effective for the removal of hydrophilic metal complexes, such as CsCl, CdCl<sub>2</sub> and NaH<sub>2</sub>AsO<sub>4</sub>, particularly when the porosity of these resins is increased. Copolymer is imprinted with heavy metal ions to increase the capacity of the flocculants for toxins. The structure and the thermal properties of all resins are carefully characterized with IR, TGA and DSC. Complete removal for up to 80 ppm of cadmium with only 50 mg of imprinted resin was obtained. As retention is highly dependent on surface area, porosity and swelling of these resins in water are also discussed.

## **ENVR 177**

### **Latex-CNT composites with entrapped microbes as anodes in microbial fuel cells**

**Bruce Logan**, *blogan@psu.edu*, Department of Civil and Environmental Engineering, The Pennsylvania State University, 231Q Sackett Building, University Park, PA 16802, Fax: 814-863-7304, and **Rachel C Wagner**, *rcw186@psu.edu*, Department of Civil and Environmental Engineering, The Pennsylvania State University, 217 Sackett Building, University Park, PA 16802

Microbial fuel cells (MFCs) harness electrons from microbial degradation of substrates to produce electricity. Using more conductive and biocompatible materials and developing a higher density biofilm on the anode are two strategies for increasing power produced by MFCs. Latex polymers were combined with conductive materials, including carbon black and carbon nanotubes, to create a composite that is flexible, sturdy, and electrically conductive. These enhanced polymers can retain conductivity even with very small quantities of carbon nanotubes, reducing cost compared to the pure carbon-based material. Microbes were also enmeshed in latex polymers with CNTs at very high cell densities. The latex preparation allows diffusions of substrate to the entrapped microbes. A combination of latex with exoelectrogenic microbes and conductive materials will help increase anode performance and therefore the overall power generation of MFCs.

## **ENVR 178**

### **Adsorption of metal ions using titanate nanotubes synthesized by hydrothermal methods**

*Chia-Wei Tsai, g9712514@oz.nthu.edu.tw and Ruey-an Doong, Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, 101, Section 2, Kuang-Fu Road, Hsinchu 30013, Taiwan*

Heavy metal contaminants such as copper, nickel, cadmium, lead and arsenic are known to be toxic and carcinogenic to the environment due to indiscriminate disposal. The purpose of this study was to investigate the effects of titanium nanotubes (TNTs) on the removal of metal ions in aqueous solutions. The TNTs were obtained from ST-01 at hydrothermal temperature of 120°C for 1 d and calcined at 200-400°C for 4 h. The SEM and TEM images showed that TNTs were tubular structures, and the interlayer were 3.3-5.0 nm. The BET analysis showed a high surface area of 400 m<sup>2</sup>/g. The fabricated TNTs exhibited a good adsorption capability toward heavy metal removal. The equilibrium time of metal ion was about 30 min, and adsorption capability of TNTs were 42-69 mg/g for Cu, 16-30 mg/g for nickel, 250-385 mg/g for lead, 101-147 mg/g for cadmium and 32-52 mg/g for arsenic (III), respectively.

## **ENVR 179**

### **Using an iron ball packed bipolar cell for groundwater contaminated by nitrate**

*Jung Ho Park, ltc12@naver.com, Jeongran Im, jri@hanyang.ac.kr, and Joo-Yang Park, jooyark@hanyang.ac.kr, Department of Civil Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, South Korea, Fax: 822-2220-4322*

An iron ball packed bipolar cell was studied to treat groundwater contaminated by nitrate (25 mg NO<sub>3</sub><sup>-</sup>-N/L). The factors of batch reactor were investigated in induced voltage and packing ratio of iron ball and glass bead. When the sample solution was

electrolyzed for 1:2 and 1:1 packing ratio under 60 min, the removal efficiency of nitrate ion was 78% and 88%, respectively. At induced voltage in parallel for low current, the removal of nitrate was 88% for 50 V and 94% and 95% for 100 V and 150 V, respectively. It is possible that dissolved iron on the anode side was precipitated as  $\text{Fe}(\text{OH})_2$  due to increased pH in the solution that nitrate was reduced into ammonium on the cathode side. These findings might be useful in order to treat the nitrate from groundwater.

## ENVR 180

### Toxicity and developmental defects of nickel nanoparticles in zebrafish

**Cristina R. Ispas**<sup>1</sup>, *eandrees@clarkson.edu*, **Daniel Andreescu**<sup>1</sup>, *dandrees@clarkson.edu*, **Kenneth N. Wallace**<sup>2</sup>, and **Silvana Andreescu**<sup>3</sup>, *eandrees@clarkson.edu*. (1) Department of Chemistry and Biomolecular Science, Clarkson University, 8 Clarkson Ave., P.O. Box 5810, Potsdam, NY 13699, Fax: 315-268-6610, (2) Department of Biology, Clarkson University, 8 Clarkson Ave., P.O. Box 5810, Potsdam 13699, (3) Department of Chemistry and Biomolecular Science, Clarkson University, 8 Clarkson Ave, P.O. Box 5810, Potsdam, NY 13699

While nickel nanoparticles are commonly used in catalytic, sensing and electronic applications, toxicity within biological systems is not well defined. We have investigated whether the toxic and developmental effects of nickel nanoparticles change due to different sizes and shapes using the zebrafish model system. We exposed embryos to a range of different diameter sphere and one flower shaped nickel nanoparticle. In order to restrict variation primarily to the dimension of the nanoparticle, each of these nanoparticles were synthesized in a similar manner and are of the same composition. Exposure to nickel nanoparticles over the course of the last four days of embryogenesis reveals intestinal defects that develop first around concentrations resulting in the  $\text{LD}_{10}$  with the appearance of additional skeletal muscle defects around the  $\text{LD}_{50}$ . While each of the nickel nanoparticles results in a common group of defects, we find that the flower nickel nanoparticles do this at a much lower concentration than the spheres. Exposure to 30, 60, and 100 nm spheres results in similar levels of toxicity lower than soluble nickel, while 60 nm flowers are more toxic than corresponding levels of soluble nickel. In addition, soluble nickel exposure does not produce intestinal defects, with skeletal muscle defects only beginning at much higher concentrations than the  $\text{LD}_{50}$ . This suggests that the effects of nickel nanoparticles occur by different biological mechanisms than soluble nickel.