

DIVISION OF ENVIRONMENTAL CHEMISTRY

238th ACS National Meeting
Washington, DC
August 16-20, 2009

THURSDAY AFTERNOON

Emerging Environmental Technologies towards a Cleaner and Sustainable Society

P. Bishop, *Organizer*
V. Shah, *Organizer, Presiding*

1:30 — Introductory Remarks.

1:35 —225. Influence of acetate on the removal of phenanthrene from contaminated soil by Fenton reaction. **W -H. Choi**, J. Seong, J. Im, J -Y. Park

1:55 —226. Vitamin B₁₂-catalyzed dechlorination of dichloromethane with bimetallic Cu/Al particles. C -C. Huang, **H -L. Lien**

2:15 —227. Electrochemical destruction of reverse osmosis brines: A sustainable technology to enhance water reuse. **B. P. Chaplin**, C. Duncan, G. Schrader, J. Farrell

2:35 — Intermission.

2:45 —228. Development of gasification and catalytic reforming technology for effective energy recovery. **K. Kawamoto**, J. Kobayashi

3:05 —229. New polymeric cathode binders for microbial fuel cells. **T. Saito**, V. Watson, M. D. Merrill, M. A. Hickner, B. E. Logan

3:25 —230. Perchlorate reduction catalysts derived by ligand-induced adsorption of perrhenate onto Pd/C. **Y. Zhang**, J. R. Shapley

3:45 —231. Impact of trona addition on ash leaching characteristics. **T. Su**

ABSTRACTS

ENVR 225

Influence of acetate on the removal of phenanthrene from contaminated soil by Fenton reaction

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Acetate was employed as a ligand of Fe^{2+} to enhance the removal efficiency of phenanthrene by securing the stability of hydrogen peroxide. The addition of acetate was 0.5-3 times (2mM-12mM) of the molar concentration of Fe^{2+} . The result showed that the hydrogen peroxide lifetime lasted up to 72 hours moreover, when more than 8 mM acetate was added, it was more than 50 times of normal lifetime. The removal efficiency of phenanthrene was improved up to 70% as the decomposition of hydrogen peroxide remaining active. When 8 mM or more of acetate was added, initial pH was increased rapidly and remained in the range of pH 4-5. This indicates that acetate may affect the stability of hydrogen peroxide. Acetate was also decomposed as a ligand of Fe^{2+} by Fenton oxidation, but it was slower than the rate of phenanthrene degradation. Therefore, phenanthrene took precedence over acetate as the competitive decomposition reaction.

ENVR 226

Vitamin B₁₂-catalyzed dechlorination of dichloromethane with bimetallic Cu/Al particles

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Vitamin B₁₂-catalyzed dechlorination was conducted to effectively degrade dichloromethane to methane with bimetallic Cu/Al in batch reactors. Dichloromethane has been known as a very recalcitrant chlorinated organic compound unable to be degraded by many reductive technologies including zero-valent metals and bimetallic iron nanoparticles. In this study, it was found that the dechlorination of dichloromethane by bimetallic Cu/Al alone was slow while an order of magnitude increase of reaction rates was observed when both bimetallic Cu/Al and vitamin B₁₂ were used in the reaction system. UV-visible spectra showed that in the presence of bimetallic Cu/Al,

vitamin B₁₂ Co(III) was reduced to vitamin B₁₂ Co(II) without further reduction to vitamin B₁₂ Co(I), an active species in reductive dechlorination. Nevertheless, a synergistic effect of copper that facilitates the C-Cl bond scission on the Cu surface enhanced the catalytic effect of vitamin B₁₂ on dechlorination.

ENVR 227

Electrochemical destruction of reverse osmosis brines: A sustainable technology to enhance water reuse

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The use of treated wastewater as a source for drinking water is becoming necessary due to limitation in water supplies. These water reuse applications often rely heavily on reverse osmosis (RO) membrane filtration to obtain the desired water quality. As a result, a large volume of concentrated waste brine is generated which contains high levels of salts, toxic oxyanions, dissolved organic matter, and trace organics (e.g., disinfection byproducts, pharmaceuticals, and personal care products). Due to the toxicity of many of these chemicals to humans and wildlife, disposal of these brines become problematic. In this talk we will discuss the use of boron-doped diamond film (BDD) electrodes as a means to treat RO brines. We use the disinfection byproduct N-nitrosodimethylamine (NDMA) as a model trace contaminant and study its mineralization under a variety of solution conditions and test for secondary byproduct formation. Initial results indicate that NDMA can be completely mineralized to products of CO₂, N₂, and NH₄⁺ with a half-life of 1.2 minutes. Several factors which make this process an attractive sustainable water treatment technology will also be discussed: 1) The low pH of the anode can prevent hydroxyl radical scavenging by carbonate species, 2) a low energy requirement that can be obtained from alternative energy sources, 3) ability to mineralize complex waste streams, and 4) oxidative and reductive reactions can proceed in a single reactor.

ENVR 228

Development of gasification and catalytic reforming technology for effective energy recovery

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Gasification and reforming technology that has the potential for resource recovery has been developed. The main product is hydrogen and the recovery is a promising approach that may be extended to use for fuel cells. Experiments were conducted by using a series of gasifier and reformer equipped with a catalyst bed in the temperature range from 923 to 1123 K. Biomass wastes such as waste wood were employed and nickel-based steam reforming catalysts were tested. The results showed that hydrogen could be obtained in a concentration of 50–60% vol in gas. Further, the combined use of calcium oxide with the catalyst improved the performance of hydrogen recovery and also reduced the generation of by-products such as tar. Dioxins were able to form during the pyrolysis process, even under oxygen-deficient conditions. However, their formation decreased with increasing temperature and gas residence time and with the use of catalyst.

ENVR 229

New polymeric cathode binders for microbial fuel cells

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A microbial fuel cell (MFC) utilizes a bacteria-laden anode to liberate electrons from organic compounds. Electricity-generating bacteria reside abundantly in domestic wastewater, ocean sediments, animal wastes, etc., making MFC technology a renewable energy technology. In addition to the bacterial anode, the cathode plays a crucial role in MFC performance because of poor kinetics of oxygen reduction and the expensive materials typically used in cathode construction. Polymeric cathode binders with a range of ion contents were examined here for their performance in single chamber air-cathode MFCs. The cathode binder polymers are based on sulfonated poly(phenylsulfone) and therefore much less expensive than Nafion, the standard material used in MFC cathodes. Sulfonated poly(phenylsulfone) binders showed better or equivalent performance to standard Nafion-based cathodes. It is hypothesized that tuning the ion-content of the cathode binder polymer to match the ionic concentration in the MFC buffer can help increase the performance of MFC cathodes.

ENVR 230

Perchlorate reduction catalysts derived by ligand-induced adsorption of perrhenate onto Pd/C

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Previous work in this laboratory showed that efficient reduction of aqueous perchlorate to chloride by hydrogen could be achieved with a heterogeneous catalyst prepared by adsorbing perrhenate (ReO_4^-) onto activated carbon containing palladium particles (5% wt. Pd/C). In this work, several pyridine ligands were examined (a) for their abilities to affect the adsorption of perrhenate onto Pd/C under hydrogen flow, and (b) for their effects on the catalytic capabilities of the materials formed. We observed that adsorption of perrhenate was significantly faster and more complete in the presence of the pyridine ligand. Catalysts formed *in situ* in this fashion showed dramatically increased activity toward perchlorate reduction (ambient temperature and 1 atm H_2). No products other than chloride were detected during the process. The most active catalyst was derived from 4-dimethylaminopyridine, with a normalized rate constant of $k(\text{Re})=24 \text{ L}/(\text{h}\cdot\text{g}\cdot\text{Re})$, compared to $k(\text{Re})=0.22 \text{ L}/(\text{h}\cdot\text{g}\cdot\text{Re})$ for perrhenate alone, under the same conditions. The dependence of activity on the nature of the pyridine ligands in this work points the way towards optimizing the properties of the catalytic system. Some comparable results with other ligands will be discussed.

ENVR 231

Impact of trona addition on ash leaching characteristics

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