

# Learning Laboratory Session Abstracts

National Environmental Health Association (NEHA)  
72<sup>nd</sup> Annual Educational Conference & Exhibition

## Student Research Presentations

Monday, June 23

### NSF International Scholar Award Presentation

8:30 – 9:00am

#### **Use of Third Party Review to Reduce Health and Environmental Hazards from Surfactant and Cleaning Products in the Janitorial Industry**

*Kazuhiro Okumura, Student, University of Washington, WA*

The demand for environmentally preferable products is increasing in the area of Institutional and Industrial (I&I) cleaners. The GreenBlue Institute (GreenBlue) and US Environmental Protection Agency's (EPA) Design for Environment (DfE), launched a program to review surfactant ingredients and final cleaning products. The National Sanitation Foundation (NSF) is serving as a third party reviewer in these efforts.

The Local Hazardous Waste Management Program in King County (LHWMP) with Public Health Seattle and King County (the local public health department for King County, Washington), as a part of its strategic goals, is seeking to reduce the risk of exposure of hazardous chemicals to vulnerable populations such as janitorial workers. Due to information barriers, workers in the janitorial industry are at-risk daily to these hazardous chemicals. Products that have gone through the NSF review process, would have reduced health and environmental impacts, and therefore would require less label comprehension for the users.

This presentation summarizes the NSF partnership with GreenBlue, CleanGredients, and EPA's DfE to perform third party reviews of cleaning product ingredients and its relevance to LHWMP's interest in reducing risks to workers in the janitorial industry.

### Student Research Presentations

#### **Undergraduate Presentations**

9:00 – 9:20am

#### **Rain Harvesting for Industrial Use**

*Valerie Scola, Junior, Illinois State University, IL*

*Lucy Loftus, Senior, Illinois State University, IL*

*Faculty Mentors: Guang Jin, PhD, PE and Tom Bierma, PhD, MBA*

Demineralized water can improve the efficiency of many industrial operations. Improvements include the reduction of energy and water consumption, the reduction of greenhouse gas emissions and waste generation, and the enhancement of process quality. For example, the use of demineralized water in a typical steam boiler could reduce costs by more than \$75,000 per

year, most through improved energy efficiency. However, current methods of demineralizing water are, in most cases, cost prohibitive. Rainwater, which is naturally low in dissolved minerals, is free and abundant in many manufacturing areas of the U.S. Most literature regarding rainwater harvesting focuses on domestic and agricultural use, leaving significant gaps in information that must be filled to determine whether rainwater harvesting can be used for industrial applications. The objective of this project was to provide preliminary data on the quality of rainwater from industrial/commercial roofs and the feasibility of using this rainwater in selected industrial operations, particularly the steam boiler system at Illinois State University.

A collection system was designed and installed to collect rainwater from a classroom building on the Illinois State University campus. The design allowed the collection and separation of the first 105 gallons of run-off during a rainfall event. A weir system was devised to gather a representative sample of remaining water run-off into a separate tank. Samples from each tank were tested for dissolved minerals, hardness, pH, total, settleable and suspended solids, and microorganisms content.

Results indicate that, in most respects, harvested rainwater is consistent with industrial applications. In fact, dissolved solids were almost 10-fold lower than local tap water. Settleable solids and microorganisms content were high, but this is not expected to be a significant barrier for use in most industrial applications.

The greatest barrier to the feasibility of using harvested rainwater appears to be the cost of rainwater storage. However, evidence suggests that competition and innovation in this market could reduce costs by 50% or more. Rainwater was not found to be feasible for the ISU steam boiler due to the large volume of steam that is lost in the campus system.

9:20 – 9:40am

### **The Asthma Slide Rule: A Tool for Managing a Child's Physical Activity During Air Pollution Episodes**

*Leah Arnold, Senior, Boise State University, ID*  
*Faculty Mentor: Dale Stephenson, PhD, CIH*

Rapid population growth, urban expansion, increased automobile traffic, and accelerating economic development in the Treasure Valley of Idaho has resulted in a reduction of regional air quality. Epidemiologic studies have demonstrated a strong correlation between increasing levels of ambient air pollution and mounting asthma illness. The purpose of the study was to use Idaho Department of Environmental Air Quality Data for the years 1997 to 2007 to evaluate the impact of Treasure Valley air quality on the ability of school children with asthma to engage in physical outdoor activities. To accomplish this study an Asthma Slide Rule was developed to recommend physical activity limitations associated with each of the six EPA Air Quality Index categories (i.e. green, yellow, orange...). The type of physical activity limitation was based on the CDC's restrictions for children exhibiting severe, moderate, and controlled asthma symptoms. Evaluation of the AQI health data revealed that during the ten year measurement period, a total of 3,034 days were classified as "good" (green), 874 days were classified as "moderate" (yellow), 60 days were classified as "unhealthy for sensitive children" (Orange), and 3 days were classified as "unhealthy" (red). Application of the Asthma Slide Rule to these results suggest that school children with daily asthma symptoms should not have been permitted to engage in vigorous outdoor physical activities at any time during the 10-year period. In addition, the same Asthma Slide Rule application revealed that there were 759 days that these same children should not have been permitted to engage in moderate physical activities and 3 days where they should not have engaged in light outdoor physical activities. These results suggest that air pollution in the Treasure Valley has a measurable health impact on the well-being of school children with asthma and other respiratory health problems.

9:40 – 10:00am

### **Evaluation of an Air Sampling Protocol for Nanoscale Particles**

*Michaela Hall, Senior, Western Carolina University, NC*

*Faculty Mentor: Tracy Zontek, PhD, CIH, CSP*

The purpose of this study was to evaluate the sampling protocol for nanoscale particles of the Department of Energy's (DOE) Nanoscale Science Research Centers (NSRC). In order to complete the air monitoring the following were used: TSI® Condensation Particle Counter (CPC) 3007, GRIMM Technologies SubMicron Aerosol Spectrometer Model 1.108, a high volume pump with a 0.45 MEC open face filter, and two SEM stubs.

Throughout the summer air monitoring was conducted for numerous nanoscale processes at Oak Ridge National Laboratory. A total of eight sampling campaigns used just the CPC and one incorporated the entire protocol. Background samples using the CPC were taken before each sampling campaign and in other areas where nanoscale materials may be present. An understanding of background measurements was found to be a crucial exposure assessment. Task level descriptive statistics were reported using the CPC data. No airborne particle concentrations were noted outside the background in eight out of nine sampling campaigns. Overall, an inference can be made that proper controls and good work practices contributed to the low particle counts. During the harvesting of nanohorns created by laser ablation, high particle counts were measured during the use of a 3M HEPA vacuum. This was the only incident observed that indicated a spike of particles outside the background levels.

It is recommended that the air monitoring protocol continue to be used as it is an effective method to identify processes/activities, inadequate controls, and poor work practices that can contribute to exposures. Additional monitoring techniques to consider in the future include surface area measurements as these may best link to current toxicological studies.

### **Graduate Presentations**

10:00 – 10:20am

### **Implementation of a Mosquito Control Program in Wayne County, North Carolina**

*Amanda Grantham, Graduate Student, East Carolina University, NC*

*Faculty Mentor: Alice Anderson, MS, PhD*

Mosquitoes continue to be a problem throughout North Carolina, especially in eastern North Carolina. One important part of a program in urban areas is to control domestic mosquitoes and to reduce human exposure to disease. Many counties in NC have mosquito control programs in place, some which include disease surveillance and management in their programs. Other states such as Florida have multi-million dollar programs with their own research laboratories.

Wayne County, North Carolina currently does not have a mosquito control program in place. The county is proposing to implement a program this upcoming fiscal year (2008-2009). Though several municipalities in Wayne County do currently have a mosquito-spraying program, the county will not use ULV machines to spray adulticides for mosquito management. Instead, in this citizen involvement project, they want to educate the public on how to reduce mosquito populations around their homes, while implementing important surveillance and survey prevention measures. Citizens and students from a local technical high school have been engaged in a new agreement to survey county citizens on attitudes and knowledge of mosquitoes, and to survey the actual mosquito populations in reported problem areas.

Three main goals for this project will be outlined and managed through a project charter. The first goal is to plan an integrated method for control of mosquito populations in Wayne County to reduce the likelihood of disease and the annoyance of mosquito bites. Secondly, the County will plan integration of mosquito control across municipalities, Seymour Johnson Air Force Base, and County Government. Thirdly, the County will educate and include the citizens of the county in their efforts of mosquito control. Seven tasks have been identified to include in the project.

10:20 – 10:40am

**Evaluation and Efficacy of the Biosampler Aerosol Collection Device for Collection and Retention of Various Particle Sizes and Maintenance of Bacterial Viability**

*Benjamin R. Wischmeier, Graduate Student, University of Washington, WA*

*Faculty Mentor: J. Scott Meschke, PhD*

Effectively measuring and identifying bioaerosols is vital for the assessment and control of risks from airborne infectious agents, allergens, and toxins. As a result, effective equipment for the sampling and detection of bioaerosols are important tools for public health professionals. The BioSampler (SKC Inc. Eighty Four, PA) is a swirling impinger designed to overcome some of the sampling limitations of other impingers by reducing particle bounce, re-aerosolization, evaporation, and short sampling periods. However in a study to collect and analyze bioaerosols, preliminary sampling at a Washington dairy farm using the BioSampler resulted in lower than expected microbial counts, which raised questions over the overall efficacy of the sampler. A laboratory study utilizing an aerosol test chamber was designed to evaluate losses from particle re-aerosolization and bounce, and also loss of particle viability. Initial tests were performed using aerosolized fluorescent microspheres, ranging in size from 0.52 to 7  $\mu\text{m}$ . The spheres were aerosolized in a 1 m<sup>3</sup> stainless steel chamber, and samples were collected by a BioSampler and control filter operated in parallel. Additionally, particle counts were determined at the inlet of the BioSampler using an Aerodynamic Particle Sizer (model 3300, TSI Inc., St. Paul, MN) to pinpoint collection efficiencies. To quantify collection efficiency of microspheres from the BioSampler, a filter was located in-line, between the BioSampler and the pump. Initial tests using 1  $\mu\text{m}$  microspheres show this method of sampling does allow limited particle escape when deionized water is the collection medium and smaller amounts of escape with mineral oil as the collection medium. Further tests are underway to quantify the particle escape from the BioSampler using various particle sizes over optimal sampling periods. Tests using parallel PCR and culture-based detection of *E. coli* and *Bacillus globigii* are being conducted to determine the effect of sample collection on bacterial viability.

10:40 – 11:00am

**Inactivation of the Coliphage MS2 by Sequential Disinfection with UV Irradiation and Free Chlorine**

*Leslie Leggett, Graduate Student, University of Washington, WA*

*Faculty Mentor: Gwy-Am Shin, MS, PhD*

There are over 100 enteric viruses that can be transmitted through water, some of which are highly resistant to both physical and chemical disinfection processes. Therefore, effective treatment strategies are needed to control those highly resistant viruses in drinking water. In this study, we investigated the effectiveness of sequential disinfection with UV irradiation and free chlorine against human enteric viruses using a surrogate virus, coliphage MS2. MS2 was suspended in phosphate buffered saline (PBS, pH 7.2) to give a concentration of  $\sim 10^6/\text{ml}$ . Five milliliters were aliquoted to a small cell culture petri dish and irradiated with a specific dose (15  $\text{mJ}/\text{cm}^2$ ) of either low-pressure (LP) or medium-pressure (MP) UV irradiation. After UV irradiation, the UV-irradiated MS2 was exposed to  $\sim 0.5 \text{ mg}/\text{L}$  of a free chlorine solution at pH 8.0

and 4°C in PBS for 30 minutes. A small volume was removed at various time points, serially diluted 10-fold, and assayed using the double agar layer method. Our results indicate that sequential inactivation with UV and free chlorine was very effective against MS2; approximately 4 log<sub>10</sub> inactivation was achieved with a UV dose of 15 mJ/cm<sup>2</sup> and 0.5 mg/L of free chlorine. Interestingly, inactivation of MS2 by free chlorine after UV disinfection was much greater than by free chlorine alone, with an average of 4.0 and 3.6 log<sub>10</sub> inactivation by free chlorine after LP and MP UV irradiation, respectively, compared to an average of 2.3 log<sub>10</sub> inactivation by free chlorine alone. These results were statistically significant according to ANCOVA analysis (p values <0.05). Overall, the results of this study suggest that sequential disinfection with UV irradiation and free chlorine may not only control viral contamination but may also lead to a synergistic inactivation of enteric viruses in drinking water treatment processes.

11:00 – 11:20am

**Estimation of Skin Permeability Coefficients for Aqueous Chloroform from the Gordon et al. *in vivo* Human Trials: Impact on Estimated Relative Contribution of Dermal Exposure**

*Kelly Stumbaugh, Graduate Student, University of Washington, WA*

*Faculty Mentor: John Kissel, PhD, PE*

Published estimates of water-skin permeability coefficients of organic contaminants found in potable water are highly variable due to differences both in experimental conditions and mathematical approaches. Human *in vivo* experiments are potentially the most credible sources of information about dermal absorption, but require relatively sophisticated mathematical models (e.g., PBPK models) to interpret resulting biomonitoring data. Within those models alternative mathematical representations of skin can yield substantially different estimates of the permeability coefficient from the same data. Gordon *et al.* (1998) conducted experiments at different water temperatures in which breath chloroform data were collected from bathing human volunteers. We have reevaluated their data using three PBPK models that differ only in the manner in which skin is represented. We estimated values of the water-skin permeability coefficient ( $K_p$ ) by Markov chain Monte Carlo (MCMC) fitting to observed breath concentrations from Gordon *et al.*'s trials. We found statistically significant differences in estimates of permeability coefficients across both temperatures and models. Lessons learned from this exercise are applicable to the larger question of the relative importance of ingestion and dermal exposures to water contaminants. A protocol given by the US EPA Office Solid Waste and Emergency Response (OSWER) leads to the conclusion that the dermal contribution is small compared to ingestion for chloroform and other trihalomethanes (THMs). However, an assessment published by the EPA Office of Drinking Water comes to a different conclusion, reporting that oral and dermal exposures to THMs are roughly equivalent. The latter conclusion is supported by our analysis. Disparate findings in these documents and prior publications are attributable to different modeling approaches and parameter assumptions. Factors that lead to underestimation of the contribution of dermal exposure include assumption of steady state absorption when unwarranted and failure to consider temperature effects on skin permeability and water quality.