Project 1: **"Catalytic Electrode Coatings for Removal of Pesticides from Drinking Water in Ozonation/Electrolysis Treatment Systems"**

Area Coordinator:
Dr. Margaret J. Kupferle
Chair and Associate Professor of Environmental Engineering
Department of Biomedical, Chemical, and Environmental Engineering
College of Engineering and Applied Science
PO Box 210012
University of Cincinnati
Cincinnati, OH 45221-0012
Office: 770 Engineering Research Center
E-Mail: Margaret.Kupferle@uc.edu
Phone: (513)-556-3329

Sub-Area Coordinator:
Dr. George Sorial
Professor of Environmental Engineering
Head of Department of Biomedical, Chemical, and Environmental Engineering
College of Engineering and Applied Science
PO Box 210012
University of Cincinnati
Cincinnati, OH 45221-0012
Office: 701D Engineering Research Center
E-Mail: George.sorial@uc.edu
Phone: (513)-556-2987

Graduate Research Assistant:
Mr. Greg Saylor
Doctoral Candidate in Environmental Engineering & Science Program
Office: 750 Engineering Research Center
E-Mail: saylorgl@email.uc.edu
Phone: (859) 982-9866

Project Summary

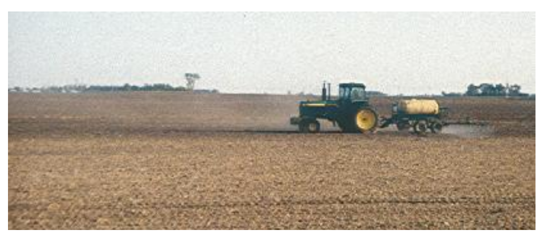
Figure 1. Run Off of Pesticides Used in Agriculture Impacts Drinking Water Sources *(image from http://toxics.usgs.gov/photo_gallery/ag_chemicals_all.html)*

Pesticide contamination of drinking water supplies is a worldwide problem, especially in the United States and China, the world's number one and two producers and consumers of pesticides [1]. Common drinking water treatment methods do not always completely remove these compounds, allowing them to pass through the system into the consumer tap water. To combat this problem, innovative technologies must be developed that are effective against pesticides and other emerging hard-to-remove water contaminants that have the potential to put entire populations at risk. Ozonation is an example of a technology that is being explored due to its effectiveness at degrading nearly any harmful toxin that can be found in water. Ozone, a reactive gas that can be dissolved in water, is an excellent oxidant because when used it will react quickly, leaving no ozone remaining in the water after a short time. Ozone on its own, however, may have limited reactivity with the compounds requiring treatment. For this reason, researchers are investigating combining ozonation with other processes that will increase the efficiency of the process. Recently, ozonation combined with electrolysis was demonstrated to produce a synergistic effect [2].

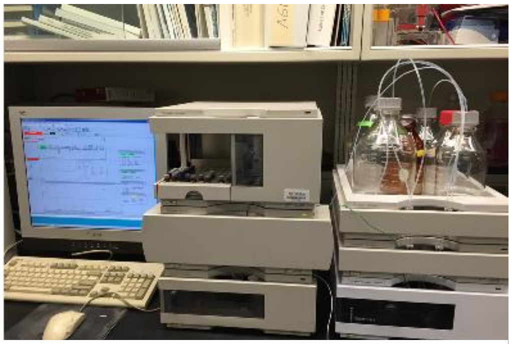

Figure 2. High Performance Liquid Chromatograph Used to Quantify Contaminant Concentrations

In this project, we are proposing to extend the work on combined ozonation and electrolysis by modifying the electrodes used in electrolysis from non-reactive metals to metals coated with catalytic materials that may further increase the electrolytic reaction efficiency. Manganese dioxide is a promising material, and has been shown in a number of studies to act as a catalyst with and without the presence of ozone [3-5]. Manganese dioxide, however, has not been evaluated for use as an electrode coating in combined ozonation/electrolysis systems, opening up a potential avenue for improving the efficiency of the reaction system.

The teachers who are selected as fellows for this project will explore methods for coating an electrode with manganese dioxide and evaluate electrode effectiveness at catalyzing the oxidation and removal of the herbicide atrazine. The two different methods for producing the coated electrode to be explored will be evaporative deposition [6] and electrodeposition [7]. In addition to coating method, the thickness of the applied coating and the presence/absence of dissolved ozone will be evaluated. A suggested experimental plan is shown in Table 1. Each of these experiments will take about half a day to conduct, but there will be electrode preparation, sample analysis and data exploration and interpretation time as well. The work has been designed to be integrated with the other training session provided by the RET program.

Table 1. Experimental Plan

Run	Coating Method	Coating Thickness	Dissolved Ozone
1	Evap	Thin	Yes
2	Evap	Thin	No
3	Evap	Thick	Yes
4	Evap	Thick	No
5	Electro	Thin	Yes
6	Electro	Thin	No
7	Electro	Thick	Yes
8	Electro	Thick	No
9	None	N/A	Yes
10	None	N/A	No

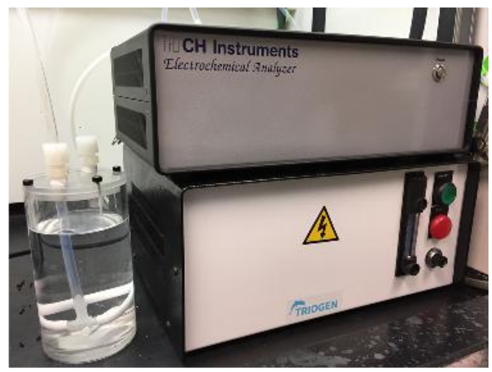

Figure 3. Ozonation/Electrolysis System Used for Treatment Studies

<u>Expected Outcomes</u>

The RET teacher team will be expected to complete the experimental plan in Table 1 after training with the AC, SAC and GRA. Their results will (1) identify the best method for preparing manganese oxide coated electrodes in terms of application method and coating thickness and (2) determine if a manganese dioxide electrode coating improves performance of electrolysis with and without ozone present. The RET teacher team will also be expected to complete all required RET deliverables as well as contribute to a peer-reviewed publication to be written by the entire project team.

Possible Ideas for Classroom Implementation

Teachers could use several aspects of this work as a basis for classroom units in science and/or math. For example, the principles of electrochemical contaminant destruction can be explored with salt water and food dyes, the principles of electro-coating can be explored using copper plating, or the principles of chromatographic separation can be explored with different food dyes in a science classroom. For math classrooms, graph preparation, rate computations, curve fitting, experimental design, exploratory data analysis, error analysis and simple analysis of variance could be illustrated with the types of data collection used in this project. To build relationships, the AC/SAC and/or GRA will visit the teachers' class to serve as source of information and/or to provide feedback on students design. Teachers and their students may be invited to tour the AC/SAC labs at UC.

References

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