Summary:

INVESTIGATION OF ELECTROCHEMICAL OXIDATION FOR TREATMENT OF LANDFILL LEACHATE

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In 2017, the Bill Hinkley Center for Solid and Hazardous Waste Management funded FAU Lab.EES to investigate the efficiency of a prototype of an electrochemical oxidation reactor to remove selected parameters of interest (such as COD/BOD, ammonia, heavy metals, color, turbidity) from landfill leachate for safe discharge or reuse of the treated leachate. The project will also explore the generation of byproducts (i.e. trihalomethanes, Haloacetic acids, chlorine gas, etc.) during treatment.

Landfill leachate is a liquid that drains from landfill and usually contains dissolved and suspended solids. Because of its high amount of recalcitrant organic material, color, ammonia, chlorides, and heavy metals such as arsenic, lead, and iron, it has become a significant threat to groundwater and surface water sources. It is also challenging to treat because of its variable composition depending on its age and the type of waste dumped in the landfill. According to a study by Dr. Daniel Meeroff and Dr. Teegavarapu in 2010, the amount of leachate produced from Class 1 landfill can be up to 7000 gallons per acre of landfill. This volume of leachate is either managed by deep-well injection, onsite treatment or by sewer discharge.

Many technologies have been proposed to treat landfill leachate and some including energized processes such as photocatalytic oxidation with titanium dioxide have been explored at FAU Lab.EES. Electrochemical oxidation method has emerged as a promising method for removal of pollutants typically found in leachate. In the last couple of years, it has been successfully used for treating wastewater from tannery, power plants, municipal areas, and landfills, and recent progress in development of next generation electrochemical oxidation technologies, particularly in China has led FAU Lab.EES to partner with two equipment manufacturers to test the latest prototypes.

The objective of the research is to investigate different pretreatment processes of landfill leachate along with electrochemical oxidation. Initially, a low-cost Advanced Oxidation Reactor preceding a Magneli Electrochemical Reactor will be tested. Subsequently, other pretreatments such as ozonation and Fenton application will be analyzed. The efficiency of the processes will be determined based on the removal of COD, ammonia, turbidity, and color, and other indicators, as necessary.

Electrochemical oxidation of landfill leachate may produce harmful byproducts in the presence of organics and chloride in leachate. Therefore, byproduct generation will be analyzed to determine if post-treatment is required.

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PROGRESS REPORT
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Project Title: INVESTIGATION OF ELECTROCHEMICAL OXIDATION FOR TREATMENT OF LANDFILL LEACHATE

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Methodology/Scientific Approach

- **TASK 1. Conduct Literature Review**: Md Fahim Salek has conducted a preliminary literature review to determine: 1) Major constituents of leachate, 2) Different methods for leachate treatment and expected efficiency, 3) Kinetics of electrochemical oxidation, and 4) Factors affecting electrochemical oxidation of landfill leachate. He is gathering additional information about ozonation as a pretreatment for electrochemical oxidation of leachate. The team is still continuing the literature review for process modification for increasing the performance efficiency and collecting cost information.

- **TASK 2. Perform laboratory scale experiments.** In partnership with the Solid Waste Authority (SWA) of Palm Beach County, FAU Lab.EES has collected leachate samples for testing various water quality parameters, specifically ammonia and COD. OriginClear and Magneli Materials (Figure 1) has provided two laboratory scale units (4-6 liter capacity) for preliminary testing. Initial testing with the electrochemical oxidation reactors has already been accomplished. Moreover, a set up to test ozonation as a pretreatment has been designed and built for testing (Figure 2). The reactor configurations are undergoing continuous modification to improve COD and ammonia process removal efficiency.

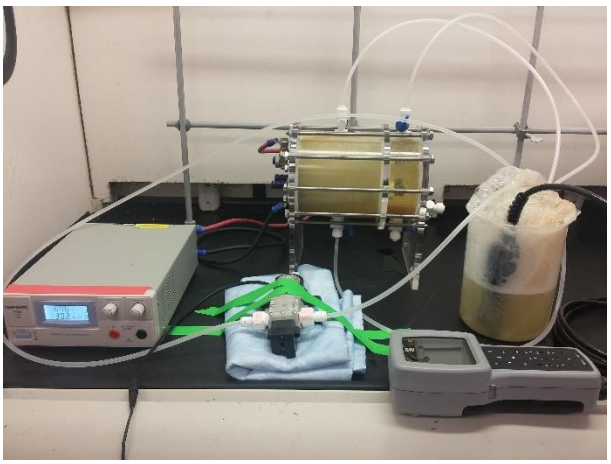

Figure 1: Magneli Reactor

Figure 2: Ozone Pretreatment Reactor

- **TASK 3. Assess treatment performance.** During these experiments, FAU Lab.EES has monitored COD, ammonia, turbidity, color, and chlorides to evaluate and optimize system performance. Additional parameters monitored as a part of the process include: energy consumption in the form of amperage and voltage, pH/temperature, and conductivity. The team has tested leachate collected from SWA with ozonation and subsequent electrochemical oxidation. Ozone was produced using a corona discharge ozone generator (Ozomax) having a maximum capacity of 20 g/h. In both processes, the sample was treated for 45 minutes. Figure 3 & 4 presents the COD and ammonia removal of the two processes.

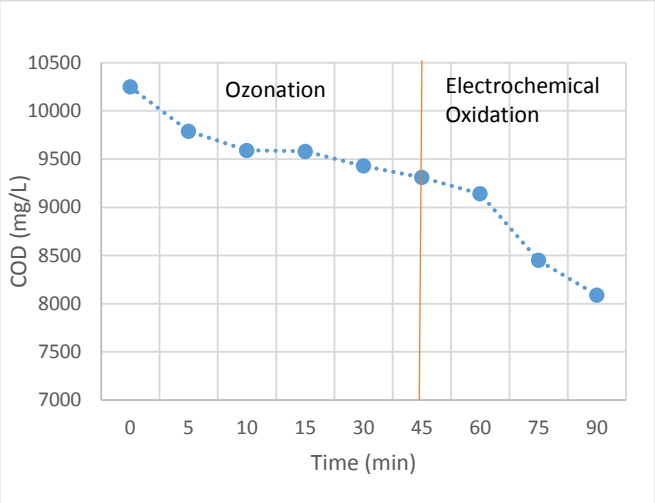

Figure 3: COD Removal by Ozonation & Electrochemical Oxidation

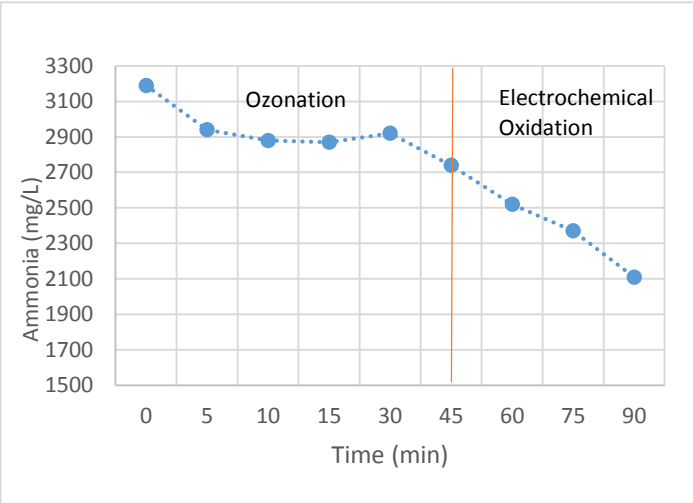

Figure 4: Ammonia Removal by Ozonation & Electrochemical Oxidation

- **TASK 4. Assess byproduct generation**. Treating landfill leachate can produce halogenated byproducts like THMs, HAA5s, chlorine gas, etc. due to the presence of organics and chlorides in leachate. Future adoption of electrochemical treatment requires minimization of undesired side reactions that reduce treatment efficiency and form potentially toxic byproducts. An important step will be to determine if halogenated byproducts are generated.

- **TASK 5. Develop final recommendations and preliminary cost analysis.** Using the data collected from Tasks 2 to 4, the appropriate reactor conditions needed to meet discharge water quality guidelines will be determined. A preliminary operating cost will be determined in terms of electricity consumption, operation and maintenance in dollars per gallon treated.