Water and Environmental Technology (WET) Center

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Advanced Oxidation Processes (AOPs) for Water and Wastewater Treatment

Advanced Oxidation Processes (AOPs) generate highly reactive species (e.g., hydroxyl radicals) for the oxidative destruction of target pollutants in water and wastewater. The WET Center has been researching a number of technologies that can be used to generate hydroxyl radicals. The Center AOPs (ozone, UV, ultrasound, hydrogen peroxide and their combinations) have been successfully applied for the removal of wide range of ECs including: steroid hormones, pesticide, pharmaceuticals, 1,4-dioxane and BPA. Comparative life cycle analysis (LCA) and life cost analysis (LCC) is used to evaluate, optimize and determine the environmental impacts of AOP technology. The best AOP is selected for a given application according to the efficiency of ECs removal, technical feasibility, energy consumption and costs.

A pilot-scale, skid mounted water treatment system has been acquired for testing at several global locations. This highly automated AOP pilot plant supplied by ITT (a Center member company) consists of an oxygen generator, ozone generator, low intensity UV lamps, and peroxide feed pump. This unit is also equipped with inline ozone monitors to measure ozone in air, water, and atmospheric phase, UV sensor, degassing unit, and catalytic ozone destructor. This system uses three proven treatment technologies (Ozone, UV, and hydrogen peroxide) in six different ways to eliminate organic pollutants. It has a capacity to treat 2,500 to 25,000 gallons per day of water and wastewater.

Economic Impact: The AOPs are gaining attention in the market and have tremendous application potential for drinking water, municipal wastewater, industrial wastewater, and groundwater treatment. A member company estimates revenue generation of $30 million in five years, as well

as the creation of new jobs from the application of this technology. The global water industry is estimated to be about $500 billion.

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Real-time Detection of Contaminants in Potable Water Distribution Systems

The WET Center has developed a Real-Time Sensor Laboratory at the Water Village within the University of Arizona. Multiple sensors in parallel allow for instantaneous detection of both chemical and microbial contaminants. However, currently there are no real-time sensors available for human pathogenic viruses. Therefore, we utilized next generation thinking to ensure the safety of potable water for consumers. Essentially we have utilized advanced oxidation processes (AOP) such as UV/H_2O_2 to oxidize both chemical and microbial contaminants effectively destroying them. The validity of this process was evaluated with real-time sensors and in the case of viruses, cell culture. Data showed that neither trace organic contaminants nor human pathogens survived AOP. Therefore, AOP can ensure the removal of contaminants found in potable water because of inadequate treatment, accidental intrusion events via broken distribution pipes, or deliberate intrusion through acts of bioterrorism.

Economic Impact: Since water is delivered to consumers via distribution systems in every town and city within the U.S., the economic impact of this proof of concept for the nations could involve billions of dollars annually.

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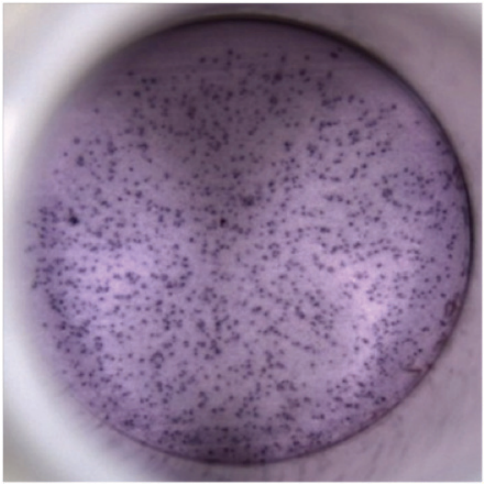
Survival of Infectious Prions during Wastewater Treatment

Transmissible spongiform encephalopathies (TSE) are a group of neurological prion diseases of mammals. In humans these include Kuru, Creutzfeldt-Jakob disease (CJd), sporadic Creutzfeldt-Jakob disease (spCJd), and variant Creutzfeldt-Jakob disease (vCJd). In animals TSE includes scrapie in sheep and goats, bone spongiform encephalopathy (BSE) in cattle, and chronic wasting disease (CWD) affecting deer, elk, and moose.

Normal prions found within humans have a tertiary structure involving the alpha helix. In contrast, infectious prions have a beta sheet structure. Of interest is the fact that when an infectious prion encounters a normal prion it converts the normal prion to the infectious mode, ultimately resulting in disease. One route of exposure to infectious prions is through raw, contaminated wastewater via animal rendering and meat processing operations due to prion-infected cattle or sheep. Recently published research documented that prions can survive wastewater treatment. However, Western blot technology was used in this study which only looks at the amino acid sequence and does not distinguish between infectious and normal prions.

Researchers at WET developed a new assay that only detects infectious prions. They used this assay to study of the fate of prions during wastewater treatment. Data showed that prions are actually inactivated during mesophilic or thermophilic anaerobic digestion negating the possibility of prions surviving wastewater treatment. This is significant in that if prions had survived wastewater treatment, they could have been found in biosolids and subsequently land applied with a potential for infecting cattle.



Economic Impact: The outbreak of "mad cow disease" in Britain in the 1990s resulted in the slaughter of hundreds of thousands of animals and many millions of dollars in damage. The new assay should make it possible to avoid or at least substantially reduce such losses in the future.

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