HYDRUS TECHNOLOGY

ELECTROCHEMICALLY ENHANCED OXIDATION IN WATER TREATMENT

1. Introduction & Background

The presence of refractory organics in municipal and industrial wastewater significantly increases the difficulty of processing by conventional biological methods, such as activated sludge processes. This is due to their inherent thermochemical stability. Organic contaminants present in wastewater can substantially deplete dissolved oxygen (DO) levels, resulting in harming aquatic ecosystems. Wastewater characteristics are typically evaluated with respect to a range of physical, chemical and biological criteria. The key criteria by which contamination with carbonaceous organic material is measured are total organic carbon (TOC), chemical oxygen demand (COD) and biochemical oxygen demand (BOD). TOC is a direct quantitation of the amount of organic carbon present in the water, while COD and BOD indirectly measure the amount of material which may be oxidized, either chemically (COD) or biochemically (BOD), by directly measuring the oxygen demand of the reagents or organisms involved in the oxidation process.

2. Key Challenges in Wastewater Treatment

Conventional biological water treatment is generally highly effective at removing labile (BOD) organic contaminants. However, these treatments are often ineffective at removing the more stable, dissolved refractory organic contaminants. At the same time, processes such as anaerobic digestion are increasingly being used to treat industrial wastewaters due to their ability to recover energy (such as methane gas) from the waste stream. Depending on the waste stream, many resulting by-product chemicals display refractory properties to biological decomposition and require strong oxidants such as chlorine dioxide and ozone to degrade. The use of chlorine containing oxidants is increasingly falling foul of environmental regulators due to formation of trihalogenated methanes (THMs) and similar potential carcinogens.

In addition, reverse osmosis (RO), which produces water of a very high purity, typically removing up to 99 per cent of dissolved organic and inorganic material, has disadvantages. Namely, the fouling of membrane surfaces from a variety of contaminants, including suspended particulates, dissolved organic matter and dissolved solids, which significantly impacts long-term operations.

Conventional chemical methods for the abatement of organic contaminants in wastewater involve dosing the water with a strong oxidizing agent. Drawbacks of this approach include the use of costly reagents, relatively slow reaction rates under ambient conditions, and the generation of harmful by-products such as the chloramines frequently found in chlorinated water.

3. Technical Solution

Hydrus Technology has developed a series of ‘hybrid’ enhanced oxidation processes that demonstrate clear superiority to conventional chemical oxidation processes for the degradation of organic contaminants, offering both superior performance and energy efficiency. Hybrid methods generally comprise a chemical oxidizing agent, either in adjunct or generated in-situ, and promoted by energy

input from a photonic, ultrasonic or electronic source, the latter of which is the focus of Hydrus Technology's decade long research and product development strategy.

Electrochemically enhanced oxidation (treatment) processes are demonstrated to be highly effective at degrading refractory organics and may be implemented either stand-alone or integrated within a complete water treatment system.

Electro-Fenton (EF) chemistry is a powerful and environmentally benign tool for the remediation of wastewaters containing refractory organic contaminants. An extension of the EF reaction paradigm is the application of specific ions to the generation of hydroxyl radical species from precursors other than hydrogen peroxide. Oxidizing agents may be generated in-situ and activated by anodic reaction processes. Hydrus Technology has demonstrated this process for the degradation of strongly bio-refractory organics.

Direct anodic oxidation is a water treatment process whereby organic pollutants are oxidized after adsorption onto an anode surface. Oxygen is transferred to the pollutant using electrical energy via the electrochemical oxygen transfer reaction (EOTR). Unlike the Electro-Fenton process, EOTR does not rely on electro-dissolution of the electrode to facilitate the reaction. Rather, non-sacrificial electrodes are employed where the critical process-limiting step is the electrolysis of water and the current-dependent dissolution of 'active' oxygen into the oxide lattice of the electrode surface.

4. Benefits

Electrochemically enhanced oxidation processes (EEOP), already proven and being further developed by Hydrus Technology, feature many benefits over conventional water treatment technologies.

In-situ activation of oxidizing agents for example, has demonstrated clear superior performance towards COD/TOC abatement over conventionally dosed chemical oxidants, primarily in the areas of (i) enhanced mineralization, (ii) reduced treatment time, and (iii) lower energy input required for complete processing.

Direct anodic oxidation can effect complete mineralization of a very wide range of common refractory organic contaminants from wastewater in an energy efficient and environmentally benign manner, without the addition of chemical adjuvants. In-situ electrochemical generation of active oxygen species from components present in the water may also reduce capital and operating costs associated with wastewater treatment by eliminating adjunct chemicals and plant equipment from the process.

5. Conclusion

Many industrial processes produce wastewater heavily laden with refractory organics. Increasingly, synthetic organic compounds from plastic, textile, pesticide and pharmaceutical manufacturing, landfill leachate, and petrochemical effluents are refractory towards biodegradation. This is due to their inherent stability and/or toxicity.

Hydrus Technology has developed and continues to refine enhanced electrochemical processes for the oxidation and removal of these problematic refractory organics from a wide range of wastewaters.