Electrochemical, H₂O₂-Boosted Catalytic Oxidation System

This system offers several advantages over O₂-boosted systems.

Lyndon B. Johnson Space Center, Houston, Texas

An improved water-sterilizing aqueous-phase catalytic oxidation system (APCOS) is based partly on the electrochemical generation of hydrogen peroxide (H₂O₂). This H₂O₂-boosted system offers significant improvements over prior dissolved-oxygen water-sterilizing systems in the way in which it increases oxidation capabilities, supplies H₂O₂ when needed, reduces the total organic carbon (TOC) content of treated water to a low level, consumes less energy than prior systems do, reduces the risk of contamination, and costs less to operate. This system was developed as a variant of an improved waste-management subsystem of the life-support system of a spacecraft. Going beyond its original intended purpose, it offers the advantage of being able to produce H₂O₂ on demand for surface sterilization and/or decontamination: this is a major advantage inasmuch as the benign byproducts of this H₂O₂ system, unlike those of systems that utilize other chemical sterilants, place no additional burden of containment control on other spacecraft air- or water-reclamation systems.

This system produces H₂O₂ in an electrochemical/electrodialytic process that consumes only electrical energy and oxygen; that is, unlike some other systems, this system consumes no expensive chemicals. The system includes an H₂O₂ generator, an H₂O₂-pervaporation membrane, and an APCOS reactor.

Tests have verified that H₂O₂ can be easily transferred and delivered from a stream identical to that in the central compartment of an electrodialytic cell to a required process stream. Test results have also shown that at stoichiometric concentrations, H₂O₂ promotes the increased destruction of urea and of NH₃ (the chief byproduct of urea) in wastewater. Heretofore, NH₃ has been considered one of the more intractable contaminants for oxidation purposes. Data indicate that oxidation occurs at high rates at low temperatures — an important advantage in that the consumption of energy is reduced and safety increased, relative to prior oxygen-boosted systems that must operate at higher temperatures. Moreover, the ability of this system to oxidize highly contaminated wastewater was proved by the nearly complete oxidation of 500 mg/L of acetic acid (TOC = 200 mg/L). Considered together, these data are a convincing argument for using electrochemically produced H₂O₂ to boost APCOS oxidation rates in highly contaminated wastewater.

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Electrokinetic In Situ Treatment of Metal-Contaminated Soil

This is an alternative to excavation and to techniques dependent on hydraulic conductivity.

John F. Kennedy Space Center, Florida

An electrokinetic technique has been developed as a means of in situ remediation of soils, sludges, and sediments that are contaminated with heavy metals. Examples of common metal contaminants that can be removed by this technique include cadmium, chromium, zinc, lead, mercury, and radionuclides. Some organic contaminants can also be removed by this technique.

In the electrokinetic technique, a low-intensity direct current is applied between electrodes that have been implanted in the ground on each side of a contaminated soil mass. The electric current causes electro-osmosis and migration of ions, thereby moving aqueous-phase subsurface contaminants from one electrode to the other. The half reaction