Ozone and Electrolysis for Synthesizing Surfactants from Oil and Grease Contaminants

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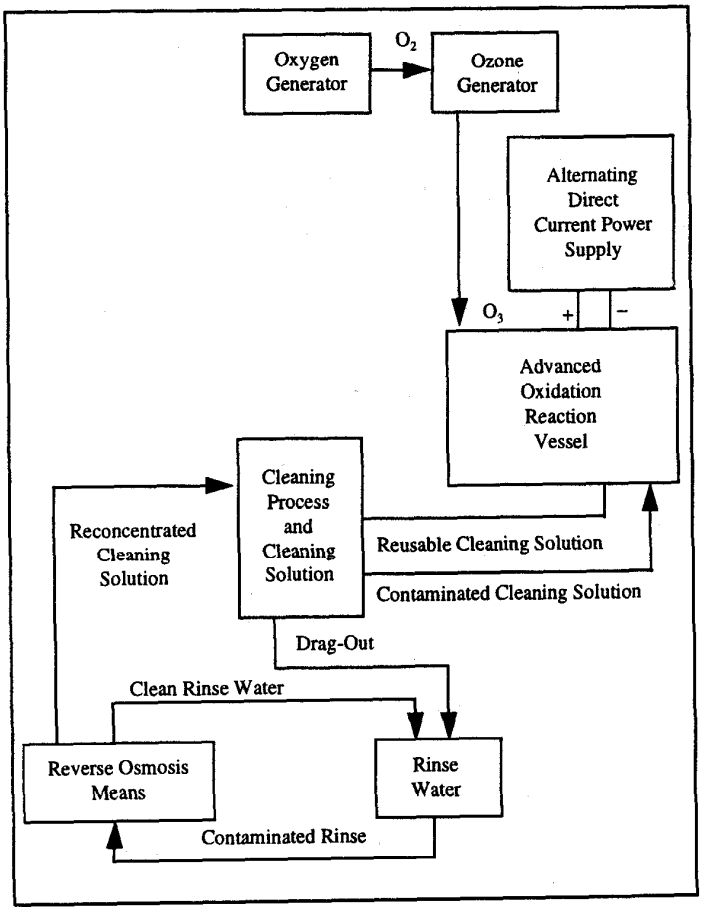

Ozone and Electrolysis Process

Introduction

Rinse water from various cleaning processes is one of the largest waste streams in industry. Reverse osmosis membrane water separation and purification systems have not been successful in most applications for rinse water recycling, primarily because the membrane surface rapidly fouls with oily, organic films that substantially reduce the membrane's flow rate.

New regulations are contributing to a major shift from solvent-based to water-based cleaning processes. However, increased use of water-based cleaning and rinse processes is increasing the waste water volume and treatment requirements. Systems for treating waste water do not eliminate pollution, but instead produce sludges that must be landfilled. Existing methods of extending the useful life of water-based cleaners include oil skimmers and ultrafiltration systems, but most are impractical and too costly to compete with current treatment and disposal methods.

Concept Description

Custom Process Systems has developed a process that will allow rinse water and cleaning solutions to be recycled indefinitely. The first stage uses a combination of ozone and electrolysis to oxidize oils and greases that have been left in cleaning

solutions. The oxidation process converts them into polar water-soluble surfactants that can be reused in the same cleaning process.

The concept combines reverse osmosis membranes with a regenerative cleaning solution process that Custom Process Systems developed earlier. The regenerative process uses advanced oxidation to partially oxidize organic compounds, thereby converting them into useable, water-soluble organic surfactants. This same conversion process also will allow the rinse water to be reused by using reverse osmosis membranes to split the rinse water from the cleaner. The membranes will not foul because they will be reconcentrating a regenerated cleaning solution that is essentially free of oil and grease. As the cleaner is reconcentrated in the reverse osmosis membrane, it will actually clean the membrane. All of the rinse water and cleaner can be continuously reused.

At the same time, existing surfactants and organic contaminants are oxidized into carbon dioxide and water. The only waste produced by the process is a very small amount of precipitated inorganic solids, which easily can be rendered nonhazardous or even recycled if they contain heavy metals such as lead.

The process uses a pressure-swing, adsorption oxygen generator, which feeds dry, high-purity oxygen to a corona-discharge ozone generator. The oxygen and ozone are generated and used as needed. Alternating dc current is fed to permanent electrodes immersed in the tank. The system can be activated with a start-up cleaning formulation that can vary with the application. In some cases, titration and addition of very small amounts of additives may be desirable throughout the year.

This new process reduces the amount of water and chemicals needed to maintain the cleaning process, and eliminates the cost of waste disposal because the water and cleaning compounds are reused. The process significantly reduces energy consumption by eliminating the energy used to treat and destroy waste from existing cleaning processes. This process also allows the cleaning bath to be maintained at the peak performance of a new bath, resulting in a more efficient and cost effective cleaning process.

Economics and Market Potential

Replacing a 40-kW water evaporator with a 1-kW water pump and reverse osmosis membrane would reduce the energy consumed by 98%. Industry is just now making a major shift from solvent-based to water-based cleaners and will need to decide how to deal with the rinse water in the next ten years. Industry has not made major investments in evaporative systems yet, although such systems are being heavily promoted and advertised. Over 100,000 new water-based cleaning systems are estimated to go online in the United States in the next 10 years.

The concept has potential for wide-scale use in both the commercial and defense sectors. Hundreds of different industries could benefit from the type of cleaning process offered by the concept, including

- manufacturing - new parts, parts washers, and paint lines
- electroplaters
- machine shops - parts washers
- general automotive repair
- vehicle washing
- food industry - process tank washing
- trucking - tank washing
- petrochemical industry - process tank and pipe washing/flushing
- labs - glassware washing
- industrial hygiene - respiratory washers
- medical industry - surgical instrument washing.

Key Experimental Results

A full-scale prototype system has operated successfully for two years on a heated, alkaline water-based spray washer.

Future Development Work

The aqueous cleaner recycling process using ozone and electrolysis was demonstrated with a full-scale system. Equipment is set up now to bring in experimental batches of used cleaning solutions from potential clients for treatment with the ozone electrolysis process. After treatment, the rejuvenated cleaner will be returned to the customer for testing in their cleaning systems.

Data need to be collected on the reverse osmosis concept's flux rates at various concentrations and feed pressures in order to properly size and cost reverse osmosis rinse water recovery systems. These data could be produced immediately after used sample cleaners are processed in the ozone/electrolysis process.

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