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Summary of Major Accomplishments:

The objective of this project is to develop porous hydrophilic membranes that are highly resistant to oxidative and corrosive conditions and to deploy them for recovery and purification of high tonnage chemicals such as hydrogen peroxide and other oxychemicals.

The research team patented a process for membrane-based separation of hydrogen peroxide (US Patent # 5,662,878). The process is based on using a hydrophilic membrane to separate hydrogen peroxide from the organic working solution. To enable this process, a new method for producing hydrophilic membrane materials (Patent # 6,464,880) was reported.

We investigated methods of producing these hydrophilic materials and evaluated separations performance in comparison to membrane stability. It was determined that at the required membrane flux, membrane stability was not sufficient to design a commercial process. This work was published (Hestekin et al., J. Membrane Science 2006).

To meet the performance needs of the process, we developed a membrane contactor method to extract the we surveyed several commercial and pre-commercial membrane materials. We identified pre-commercial hydrophilic membranes with the required selectivity, flux, and stability to meet the needs of the process. In addition, we invented a novel reaction/separations format that greatly increases the performance of the process.

To test the performance of the membranes and the new formats we procured and integrated reactor/membrane separations unit that enables controlled mixing, flow, temperature control, pressure control, and sampling. The results were used to file a US non-provisional patent application (ANL-INV 03-12)

Summary of Technology Transfer Benefits to Industry:

Hydrogen peroxide is widely used in pulp and paper applications, environmental treatment, and other industries. Virtually all hydrogen peroxide production is now based on a process featuring catalytic hydrogenation followed by auto-oxidation of suitable organic carrier molecules. This process has several drawbacks, particularly in the extraction phase. One general disadvantage of this technology is that hydrogen peroxide must be produced at large centralized plants where it is concentrated to 70% by distillation and transported to the users’ plant sites where it is diluted before use.

Advanced membranes have the potential to enable more efficient, economic, and safe manufacture of hydrogen peroxide. Advanced membrane technology would allow filtration-based separation to replace the difficult liquid-liquid extraction based separation step of the hydrogen peroxide process. This would make it possible for hydrogen peroxide to be produced on-site in mini-plants at 30% concentration and used at the same plant location without distillation and transportation. As a result, production could become more cost-effective, safe and energy efficient.
The membrane contactor method (INV-03-012) is available for licensing for either in situ or dedicated production of hydrogen peroxide. CRADA participants were notified of this Subject Invention.

Other Information/Results: (Papers, Inventions, Software, etc.)

Patent applications:


ANL INV-03-012 “MEMBRANE CONTACTOR ASSISTED WATER EXTRACTION SYSTEM FOR SEPARATING HYDROGEN PEROXIDE FROM A WORKING SOLUTION, AND METHOD THEREOF” Seth W. Snyder (Argonne), Yupo J. Lin (Argonne), Jamie A. Hestekin (Argonne), Michael P. Henry (Argonne), Peter Pujado (UOP), Anil Oroskar (UOP), Santi Kulprathipanja (UOP), Ravi Randhava (Unitel), filed by the U.S. Dept of Energy on September 30, 2006.

Publications


Presentations

Results from this project were presented at:

St. Martin, Edward “Membranes for Corrosive Oxidations” presented at the 2002 Spring AIChE meeting, New Orleans, LA

Snyder, Seth “Membranes for Corrosive Oxidations” presented at the 2005 Spring AIChE meeting, New Orleans, LA