Advanced Chlor-Alkali Technology

Benefits

Advanced chlor-alkali reactors may substantially reduce U.S. electric power consumption and associated emissions.

- Potential energy savings.
- Decreased carbon dioxide emissions.
- Abatement of mercury emissions from mercury technology.
- Reduction in asbestos use by diaphragm technology.
- Operational cost savings with installation of the new ECR process.

Applications

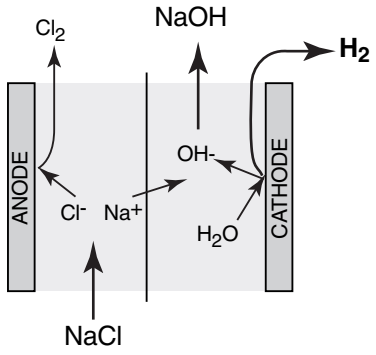
The technology will have applications in various industries, including

- **Chemical** and
- **Petrochemical.**

Chlor-alkali electrochemical reactors (ECRs) may reduce energy consumption by up to 40 percent

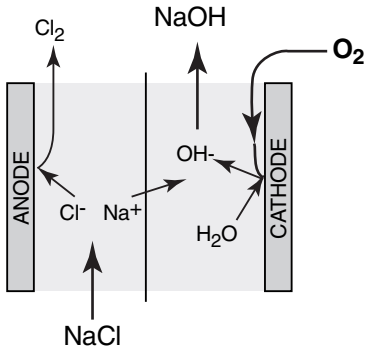
The project focuses on developing a process to replace the hydrogen-evolving cathode in chlor-alkali cells with an oxygen-consuming cathode and thus reduce the electrochemical cell voltage as well as eliminate hydrogen, a low-value by-product. The oxygen cathode is a gas diffusion electrode similar to those used in fuel cells. Its structure must satisfy two conflicting criteria, high gas permeability and low liquid permeability, in order to achieve the high performance required for commercial production. Maintaining a stable interface between liquid and gas within the active layer of the gas-diffusion cathode is the key to long-term operation. This task is especially challenging under harsh conditions of chlor-alkali electrolysis. Los Alamos National Laboratory takes advantage of its expertise in fuel cell technology to advance the research.

(a) Conventional Chlor-Alkali Cell



Typical V_{cell} = 3.2 V at 0.4 A cm^{-2}

(b) Chlor-Alkali Cell with Oxygen-Consuming Cathode



Typical V_{cell} = 2.3 V at 0.4 A cm^{-2}

A 30% lowering in cell voltage and, hence, a 30% lowering in energy consumption per unit product can be achieved in membrane chlor-alkali cells by replacing the hydrogen-evolving cathode by an oxygen-consuming cathode.

Project Description

Goal: Develop chlor-alkali electrochemical reactors to reduce energy consumption by up to 40% with a potential subsequent reduction in plant operating costs.

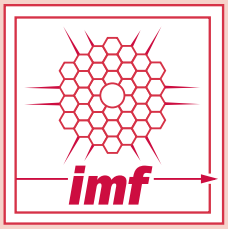
Issues: Existing chlor-alkali electrochemical reactors (ECRs) consume approximately 2% of the total electric power generated in the United States. Only 18% of chlorine is produced by the most energy-efficient (2500 kWh/t) membrane technology. The remaining 82% is generated in less energy-efficient diaphragm (70%, 2900 kWh/t) and mercury (12%, 3700 kWh/t) cells. While replacement of all the diaphragm and mercury cells in the United States with the most energy-efficient membrane cells would result in no more than 14% energy savings, much more significant savings, around 40%, would be expected upon replacement of all the cells with oxygen-consuming electrolyzers. One of the key R&D issues to be addressed in this project is to develop materials that can maintain a stable interface between liquid and gas within the active layer of the gas diffusion cathode in order to ensure long-term operation of the cell.

Approach: R&D for the project focuses on the areas of cell fabrication and testing. It consists of completing development of effective oxygen cathodes, optimizing cathode and anode structures for enhanced throughputs, and improvement of performance characteristics to match or exceed present industrial standards for state-of-the-art membrane cells. Accomplishing these tasks would bring the oxygen cathode chlor-alkali process to the point where it becomes attractive enough for the industry to invest in the process scale-up and eventually implement the technology.

Potential payoff: The new technology to be developed in this project will have a significant impact on the chlor-alkali industry as operating costs continue to be affected by the increased cost of energy and emission controls. To compete globally in this industry and to conform to possible future regulations, U.S. chemical companies require the development of energy-efficient electrochemical technology.

Progress and Milestones

- The peroxide by-product reduced to negligible levels.
- An invention disclosure submitted.
- Demonstration of stable current efficiency of 93% at 10 kA/m^2.
- Reduction of the cell voltage drift to a level of 0.1 mV per day.
- Determination of highest operational current density.
- Improvement of purity of caustic product.



PRIMARY

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PROJECT PARTNERS

(being developed)

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