ISGC 2019 May 13rd - 17th

N°643 / OC
TOPIC(s) : Clean reactions / Alternative technologies

Electrochemical and Decentralized Production of Hydrogen Peroxide

AUTHORS

Dusan BOSKOVIC / FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT, JOSEPH-VON-FRAUNHOFER-STR. 7, PFINZTAL
Angelika EBERHARDT / FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY, JOSEPH-VON-FRAUNHOFER-STR. 7, PFINZTAL
Alexander MENDL / FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY, JOSEPH-VON-FRAUNHOFER-STR. 7, PFINZTAL
Carsten CREMERS / FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY, JOSEPH-VON-FRAUNHOFER-STR. 7, PFINZTAL
Jan MAIER / FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY, JOSEPH-VON-FRAUNHOFER-STR. 7, PFINZTAL
Stefan LOEBBECKE / FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY, JOSEPH-VON-FRAUNHOFER-STR. 7, PFINZTAL

PURPOSE OF THE ABSTRACT

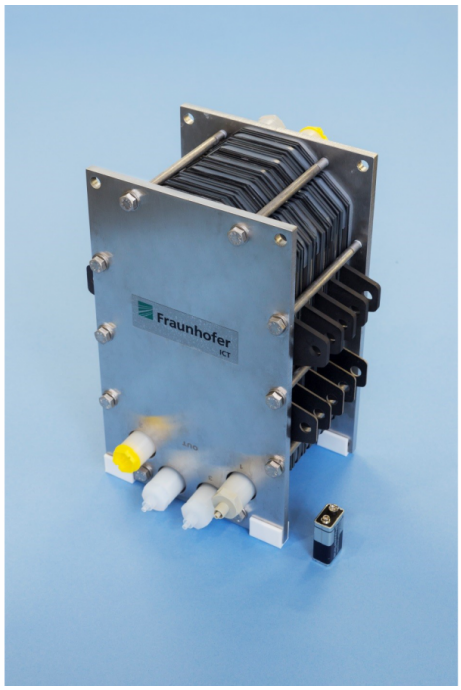
Hydrogen peroxide is considered a versatile and powerful chemical oxidant for a wide range of chemical reactions. It is environmentally friendly, selective and also highly active for various oxidation processes including chemical reaction, paper and pulp bleaching, waste water treatment or disinfection processes. Currently, hydrogen peroxide is prevalently produced in world-scale production facilities consuming not only huge quantities of energy and organic solvents but also generating substantial quantities of waste. Moreover, large scale production processes of hydrogen peroxide require significant logistical effort concerning transport, storage and safety.

We present a small-scale process for decentralized point-of-use production of H2O2 with the aim to avoid transport, storage and handling of huge amounts of highly concentrated hydrogen peroxide. H2O2 is generated by electrochemical synthesis by cathodic reduction of oxygen in a continuous reactor by employing tailored catalysts and electrodes to enhance selectivity and restrain decomposition reactions. The cathodic partial oxygen reduction is performed at optimized gas diffusion electrodes with ultrathin platinum active layers. The synthesis is conducted in an acidic electrolyte which is separated continuously by membrane distillation and fed back to the electrochemical reactor.

The decentralized H2O2 synthesis unit is aimed to be directly connected to subsequent chemical processes where hydrogen peroxide solutions are required. Usually the concentration of the electrochemically generated H2O2 solution needs to be increased for the subsequent chemical process. Therefore, we have developed a second membrane distillation step in the downstream process to concentrate the solution to the 1 ? 5 % range as it is suitable for fine chemical oxidation. A continuous oxidative desulfurization procedure was realized as an exemplary subsequent process

All processing steps are combined in a fully automated small-scale demonstration setup which includes inline measurement of the H2O2 and electrolyte concentrations by multipoint Raman spectroscopy at all necessary steps along the entire process chain.

FIGURES



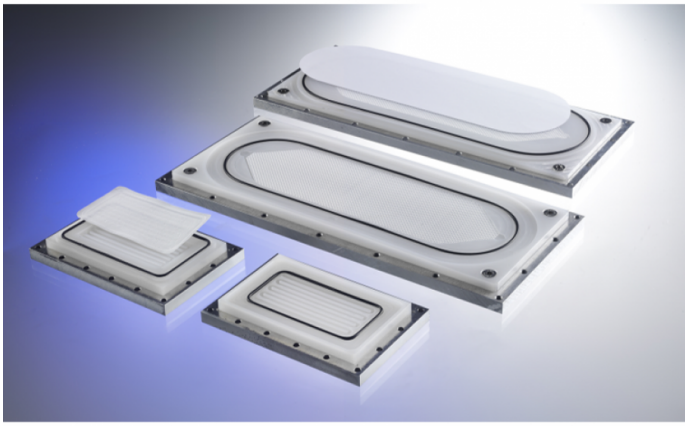


FIGURE 1

Reactor stack for electrochemical production of hydrogen peroxide via partial oxygen reduction reaction

FIGURE 2

Membrane distillation modules for electrolyte separation and hydrogen peroxide concentration

KEYWORDS

hydrogen peroxide | electrochemistry | low-carbon power | decentralized production

BIBLIOGRAPHY