הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע"ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar
Lecture Hall 6, Wolfson Department of Chemical Engineering,
Wednesday December 27th at 1:30pm

Youri Gendel

Assistant Professor
Department of Civil and Environmental Engineering, Technion

Chlorine-free alkaline seawater electrolysis for hydrogen production

Today more than 70% of electrical energy is generated from fossil fuels. Concerns with global CO_2 emissions and increasing costs of fossil fuels motivate intensive research for the development of technologies for energy production from renewable resources such as wind and solar energy. Hydrogen gas is very attractive for energy conversion and storage applications due to its high gravimetric energy density and because H_2 is a "clean" fuel as the major product of its reaction with oxygen in internal combustion engines and fuel cells is water.

Seawater is potentially an endless source of water for electrochemical generation of hydrogen. Unfortunately, well-established technologies of water electrolysis can not be applied directly for seawater electrolysis due to the anodic chlorine evolution reaction and detrimental cathodic deposition of Mg^{2+} and Ca^{2+} species.

A new process for chlorine-free seawater electrolysis is proposed by our research group. The first step of the process is separation of Mg^{2+} and Ca^{2+} ions from seawater by nanofiltration. Next, the NF permeate is dosed into the electrochemical system. There it is completely split into hydrogen and oxygen gases and NaCl precipitate. The electrochemical system comprises an electrochemical cell operated at elevated temperatures (e.g. $\geq 50^0$C) and a settling tank filled with aqueous NaOH solution (20-40 %wt) that operates at lower temperatures (e.g. 20-30^{0}C). High concentration of hydroxide ions in the electrolyzed solution prevents anodic chlorine evolution, while the accumulated NaCl precipitates in the settling tank. The system was successfully operated at 467 mA/cm^2 with Ti/IrO_2-RuO_2-TiO_2 electrodes in NaCl-saturated solution of NaOH (30 %wt) for 12 days. During this period no formation of Cl_2 and ClO^{3-} has been observed and precipitation of NaCl occurred only in the settling tank. The performance of the system was stable during the operation as indicated by the insignificant fluctuations in the applied cell potentials and measured constant concentrations of NaOH(aq) and NaCl(aq) in the electrolyte solution. During 12 days of operation at ≈ 470 mA/cm^2 about 1.2 m^3 of H_2 and ≈ 150 grams of solid NaCl were produced in the system. Electrical energy demand of the electrolysis cell was 5.6-6.7 kWh/m$^3H_2$ for the current density range of 187-467 mA/cm^2.

Refreshments will be served at 1:15pm