

Electrochemical properties of proton-exchange membrane in process of hydrogen production.

DOI: 10.6084/m9.figshare.9889814

Monika Tkaczuk- Serafin^{1,*}, Artur Chorążyczewski²

¹ Faculty of Mechanical and Power Engineering, Department of Boilers, Combustion and Energetic Processes, Wrocław University of Science and Technology

² Faculty of Electronics, Department of Automatic Control, Mechatronics and Control Systems, Wrocław University of Science and Technology

* corresponding author: monika.tkaczuk@pwr.edu.pl

Keywords: electrolysis, proton exchange membrane (PEM), hydrogen production.

Electrolysis is considered as the cleanest way to produce hydrogen, when the required electricity is derived from renewable energy sources. Currently two main types of low-temperature electrolyzers exist, which have been developed on the market, namely alkaline and proton exchange membrane. The main difference is in electrolyte used inside a cell, accordingly liquid or solid polymer [1,2].

Single cell used for electrolysis in this research was built with Nafion117 catalyst coated membrane (CCM) [3]. Materials used for producing membranes are sulphonated fluoropolymers, in general perfluorosulfonic acid (PFSA), which is a result of substitution fluorine in fluoroethylene and sulfonation process (adding side chain ending with sulphonic acid). Membrane thickness is usually in range of 50 - 250 μm [4], one used in experiment had 183 μm .

The electrochemical properties of a PEM electrolyser were investigated at different temperatures, including hydrogen production rate for few current density values. The Faradic and electrical efficiencies were determined. The decomposition voltage values for both temperatures were obtained (Fig.1) as well as the polarization curves for two cases (Fig.2).

Degradation of hydrogen production rate was observed as a result of self-heating of cell which indicate a need for more complex control system for industrial scale electrolyzers (Fig.3).

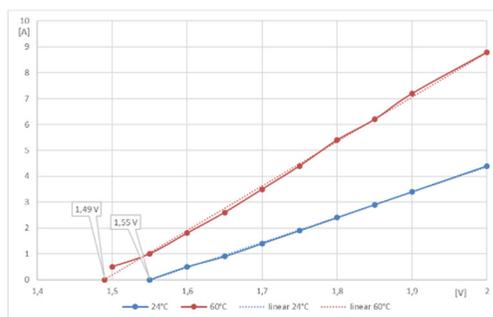


Fig. 1. Estimation of decomposition voltage of the PEM cell for two temperatures, namely 24°C and 60°C.

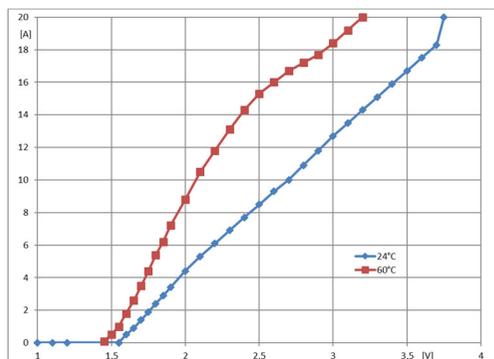


Fig. 2. Polarization curves for tested cell taken for two temperatures. Experiment was performed with constant current mode with current density up to 0.8 A/cm^2 (membrane surface was 25 cm^2).

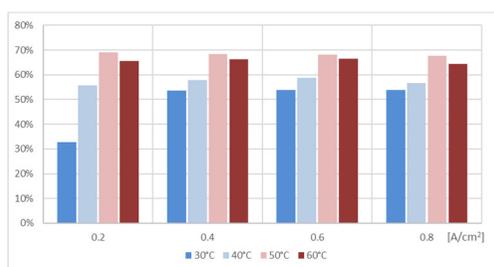


Fig. 3. Comparison of Faraday's efficiency of hydrogen generation of tested cell for different temperatures and current densities.

References

- [1] S. Siracusano, V. Baglio, N. Briguglio, G. Brunaccini, A. Di Blasi, A. Stassi, R. Ornelas, E. Trifoni, V. Antonucci, A.S. Arico, An electrochemical study of a PEM stack for water electrolysis. *International Journal of Hydrogen Energy*, 2012, 37, pp. 1939-1946.
- [2] Marcelo Carmo, David L.Fritz, Jürgen Mergel, Detlef Stolten, A comprehensive review on PEM water electrolysis, *International Journal of Hydrogen Energy*, 2013, Volume 38, Issue 12, pp. 4901-4934.
- [3] Md Mamoon Rashid, Mohammed K. Al Mesfer, Hamid Naseem, Mohd Danish, Hydrogen Production by Water Electrolysis: A Review of Alkaline Water Electrolysis, PEM Water Electrolysis and High Temperature Water Electrolysis. *International Journal of Engineering and Advanced Technology (IJEAT)*, 2015, ISSN: 2249 – 8958, Volume 4, Issue 3.
- [4] M. Paidar, V. Fateev, K. Bouzek, Membrane electrolysis – History, current status and perspective. *Electrochimica Acta*, 2016, 209, pp. 737–756.