ABSTRACT

Title: Hydrogen production from hydrochloric acid in modified PEM electrolyser

Author(s): Alen Rupnik[a,b], Blaž Likozar[a] , Miha Grilc[a,b]

Affiliation(s):
[a]Department of Catalysis and Chemical Reaction Engineering, National Institute of Chemistry, Ljubljana, Slovenia
[b]Materials graduate study program, University of Nova Gorica, Nova Gorica, Slovenia

Effective Hydrogen production is a necessary future demand, for carbon free source of energy and for successfully reaching net zero future as proposed by European Union [1]. There are various means of hydrogen production, from methane steam reforming (MSR), water gas shift reaction (WGS) all the way up to PEM electrolysis (PEMEC) using different electrolytes [2]. There is growing interest for electrolytes alternative to water, serving as a source of hydrogen. For instance, HCl, which is a by-product of polycarbonate or polyurethane production, could be used as a feedstock [3]. In this case onsite conversion of HCl into hydrogen and chlorine would be of great economic and safety benefits. As HCl is a strong acid and thus very corrosive, design of a stable-operating cell for electrocatalytic decomposition of the latter would demand careful selection of materials of construction. Electrolyzers nowadays can be built from HCl resistive materials, such as PTFE and similar, choosing the right electrode materials, PEM membranes and design is still a challenge. Not only materials can impact the cell efficiency, cell design and geometry have a great impact as well.

There are various commercial PEM electrolysers found on the market, where some are more suitable for chloralkali reactions, others can face extreme difficulties for such operation and some have low efficiencies. Therefore, we modified the commercially bought PEM cell into a zero gap PEM cell in order to increase the cells current density and therefore efficiency. In this work we also aimed for the stability study of components in the cell, such as Nafion and Aquivion membranes in relevant process conditions. The testing campaign was held using non-modified commercial cell from Electrocell which we compared to 'in-house' modified zero gap cell. Accompanying membrane stability tests were made in a batch setup experiment to determine degradation in fairly concentrated hydrochloric acid.

Electrolysis of HCl could solve the demand in search for sustainable utilization of oversaturated HCl by-product. As said before, choosing the right materials and the design for cell construction is most important and that is why the outcomes of this work are important as well, as they serve to build a material database for easy membrane selection for HCl splitting using electrolysis.

[1] IEA (2021), Net Zero by 2050, IEA, Paris https://www.iea.org/reports/net-zero-by-2050, (accessed on 28.04.2022)
[2] F. Dawood, M. Anda, G.M. Shafiullah, Hydrogen production for energy: An overview, Int. J. Hydrog. Energy, 45, 7,2020, 3847-3869.
[3] S. Bechtel, T. Vidakovic-Koch, K. Sundmacher, Novel process for the exergetically efficient recycling of chlorine by gas phase electrolysis of hydrogen chloride, Chem. Eng. J., 346, 2018, 535-548.

Submitted by: ***Alen Rupnik, National Institute of Chemistry, Slovenia***
Contact details: ***alen.rupnik@ki.si***