Electrothermal balanced operation - A new operation method for improved SOEC performance

Jensen, Søren Højgaard; Smitshuysen, Anne Lyck; Simon Araya, Samuel; Sahlin, Simon Lennart; Cui, Xiaoti; Graves, Christopher; Skafte, Theis Løye; Frandsen, Henrik Lund; Rizvandi, Omid Babaie; Hauch, Anne; Mogensen, Mogens Bjerg; Hansen, John Bøgild

Publication date:
2022

Electrothermal balanced operation - A new operation method for improved SOEC performance

Søren Højgaard Jensen (1,2), Anne Lyck Smitshuysen (1), Samuel Simon Araya (2), Simon Lehnart Sahlin (2), Xiaoti Cui (2), Chris Graves (3), Theis Løye Skafte (3), Henrik Lund Frandsen (4), Omid Babaie Rizvandi (4), Anne Hauch (4), Mogens Mogensen (4), John Bøgild Hansen (5)

(1) DynElectro ApS. Syvvejen 10, DK-4130 Viby Sjælland
(2) AAU, Department of Energy. Pontoppidanstræde 111, DK-9220 Aalborg
(3) Noon Energy Inc. 470 Ramona St., Palo Alto, CA 94301
(4) DTU, Department of Energy. Anker Engelunds Vej 1, DK-2800 Kgs. Lyngby
(5) Haldor Topsoe A/S. Haldor Topsøes Allé 1. DK-2800. Kgs. Lyngby

Tel.: +45 2132 7932
soren@dynelectro.dk

Abstract

The ongoing green energy transition increases the need for dynamic and efficient Power-to-X (PtX) systems to convert surplus wind and solar power to high-value products. The solid oxide electrolysis cell (SOEC) technology offers the highest energy conversion efficiency. However, operation at part-load, i.e. below thermo-neutral potential, creates thermal variations causing thermomechanical stress. Combined with limited lifetime this impedes commercialization of the technology. Here we present a novel operating method that alleviates temperature variations in the SOECs and decreases degradation.

A flat thermal profile across the SOEC is obtained by switching several times per second between electrolysis mode and brief pulses in fuel cell mode; the thermal mass of the SOEC prevents temperature fluctuations during the short switching period. The operation method is referred to as AC:DC operation.

In this presentation we present experimental results. The observed reduction in the degradation rate is believed to be caused by desorption of impurities that otherwise adsorb on the surface of the electrodes. Finally, we discuss how AC:DC operation can enable dynamic operation of large SOEC systems.