DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Lifetime Investigation of PEM Electrolyzers under Realistic Load Profiles

Location: Pontoppidanstræde 111, room 1.030/1.031

Time: Friday 18 January at 13.00

PhD defendant: Steffen Frensch

Supervisor: Professor Søren Knudsen Kær

Moderator: Associate Professor Mads Pagh Nielsen

Opponents: Associate Professor Thomas Condra, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Jens Oluf Jensen, DTU
Dr. Marcelo Carmo, Forschungszentrum Juelich, Germany

All are welcome. The defence will be in English.

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Abstract:

In order to increase the share of renewable energy sources connected to the grid further, the most crucial obstacles to solve are long-term energy storage and grid stability. Energy storage is needed to tackle the mismatch between energy production and demand that comes naturally with unpredictable energy sources such as wind and solar. Grid stability on the other hand is challenged by their fluctuation, but has to be maintained at all times to ensure security of supply. One technology that may address both issues is hydrogen production through polymer electrolyte membrane water electrolysis (PEM WE). Hydrogen produced by PEM WE can act as an energy carrier for long-term storage, and when directly coupled to the grid, electrolyzers can provide grid stabilization services. One example of such an installation is the HyBalance project, which was inaugurated in September 2018 in Hobro, Denmark. The major obstacle for the technology at the moment is the high cost, which is mostly due to expensive materials and uncertain lifetime under dynamic operation. This work investigates degradation of PEM WE to evaluate their potential under the presented conditions.

The main outcomes are the identification and separation of the major degradation mechanisms involved and the quantification of ionomer loss and membrane thinning. Long- and short-term experimental investigations revealed significant ionomer loss and membrane thinning to be a lifetime limiting factor. Together with a computational model, the impact of operation mode was thoroughly analyzed and operation recommendations were derived.