Abstract for poster presentation

Simulation and modelling in a SOFC/GT hybrid power plant

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The continuously increasing demand for electrical energy requires the development of power plants with high efficiencies and low emissions. A hybrid power plant consisting of a solid oxide fuel cell (SOFC) system coupled with a gas turbine (GT) promises to fulfill these requirements and also has the advantage of offering a wide range of applications from several 10 kW to multi MW. Indirectly and directly coupled systems are possible, mainly distinguished by the higher operating pressure and reduced heat transfer losses of the directly coupled SOFC system. Since the directly coupled systems with elevated SOFC operating pressure promise to outperform the system efficiency of the indirectly coupled systems [1-2], the DLR has been investigating the corresponding fundamentals and requirements of a directly combined fuel cell and gas turbine power plant for several years.

An elementary kinetic SOFC stack model was developed and experimentally validated [3] in a wide range of operating conditions. This model was integrated into an existing model of a gas turbine [4]. The model is used to carry out stationary hybrid power plant simulations in order to investigate how variations in operating strategy and component characteristics influence the performance of the hybrid power plant as well as the operating conditions of the SOFC. Results show that varying electrical SOFC power while keeping electrical gas turbine power constant strongly influences the overall electrical efficiency of the hybrid power plant.

The experimental and simulation results are to be used to adapt the existing models from stationary to transient regime. This allows for future development of operation and control strategies. A pilot power plant is to be designed and commissioned to validate the transient model accordingly.

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[2] Zhang, X., Chan, S. H., Li, G., Ho, H. K., Li, J., & Feng, Z. (2010). A review of integration strategies for solid oxide fuel cells. Journal of Power Sources, 195(3), 685–702.

[3] M. Henke et al., Modeling and Experimental Study of Pressurized Solid Oxide Fuel Cells, ModVal 9, Campus Sursee, Switzerland 2012

[4] T. Panne et al., Themodynamic Process Analyses of SOFC/GT Hybrid Cycles, 5th IECEC, St. Louis, Missouri, USA, 2007