Verified Parameter Identification for Solid Oxide Fuel Cells

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Abstract

In the last decades, a lot of research in the area of decentralized energy supply systems has been focused on design and development of solid oxide fuel cells (SOFC). These devices convert chemical energy directly into electricity and represent an environmentally friendly alternative for the use as an auxiliary power supply unit. The advantages of SOFCs include high efficiency and flexibility with respect to the kind of fuel, whereas the main disadvantages are the complicated production process and the necessity for advanced control procedures to deal with instationary operating points. Contrary to this demand, most state-of-the-art control strategies for fuel cells cover stationary operating points only. Another difficulty is that many system parameters are influenced by significant uncertainty.

An important goal of a current joint project between the Universities of Rostock and Duisburg-Essen is to develop dynamic system models which accurately describe the instationary behavior of SOFCs. Here, one possibility to deal with parameter and model uncertainty is the use of interval analysis. Aside from providing a natural representation of bounded uncertainties, interval and similar methods guarantee the correctness of simulation results. We apply a verified global optimization algorithm based on that from Hansen and Walster (2004) to identify uncertain parameters of a dynamic SOFC model by Rauh et al. (2011). The model covers the effects of preheated air and fuel gas supply along with the corresponding reaction enthalpies on the thermal behavior. The parameters of interest describe the thermal resistances of the stack materials, the dependency of heat capacities on temperature, and the heat produced during the electrochemical reactions on the surface of each individual fuel cell. Because of the complex structure of the goal function, the optimization software has to be adjusted to the problem, which was one of the reasons we chose the solver UniVerMec by Dyllong and Kiel (2010) allowing for additional flexibility.

References

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