Uses of Methods with Result Verification for Simplified Control-Oriented Solide Oxide Fuel Cell Models

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Keywords: *Methods with Result Verification; Optimization; UniVerMeC; SOFC.*

Abstract

Solid oxide fuel cells (SOFCs) are devices converting chemical energy into electricity using ceramics as the electrolyte. Working at high temperatures, they are sensitive to overheating, but can theoretically achieve the overall efficiency of up to 85%. Current research is aimed, for example, at the reduction of operating temperatures or a speed-up in the starting times. At least since 2010, developing efficient control-oriented models for the temperature of SOFCs has also been in the focus of ongoing research, see Huang et al. (2012), Rauh et al. (2014). The goal here is to devise (global) dynamic models valid for a wide range of operating conditions instead of obtaining (linear) approximations of the behavior only for a certain mode of operation. The use of methods with result verification helps to address the questions of reliability and to take into account bounded uncertainty.

Dynamic SOFC models are systems of differential equations, the parameters of which have to be fitted to the available sensor data (usually, thousands of measurements). Normally, such differential equations do not have analytical solutions. In Auer at al. (2015), we pointed out two simplification possibilities for which a closed form solution could be derived and assessed their performance. The simplified model variant with the specific heat capacities of gases approximated as polynomials linear in the temperature was demonstrated to be the most promising one. In this paper, we study the possibilities provided by this variant with respect to uncertainty handling. In particular, we explore the potential for overestimation reduction provided by result verification with dependency tracking (e.g. central forms) in this case. We address the problem of higher computing times by carrying out some of the computations in parallel on the GPU.

References

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