Response of a Planar Intermediate-Temperature Anode-Supported Direct Internal Reforming Solid Oxide Fuel Cell to Load Changes

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Abstract

In operation, solid oxide fuel cells (SOFCs) can be subjected to frequent load changes due to variable power demand. Knowledge of their dynamic behaviour is thus important when looking for suitable process control strategies. The present work investigates the dynamic response of a planar intermediate-temperature anode-supported direct internal reforming SOFC when a load step-change is imposed. A previously developed SOFC model, which consists of mass and energy balances and an electrochemical model that relates the fuel and air gas composition and temperature to voltage, current density, and other relevant fuel cell variables, is used. Dynamic simulations have shown that, after a positive current density step-change, the overall SOFC temperature increases and the intermediate period between the disturbance imposed and the new steady-state is characterised by an undershooting of the cell potential. In these simulations, the fuel and air flowrates follow at first any variation in load when a disturbance is imposed, keeping both the fuel utilisation and air ratio constant. A control strategy, where a typical PI feed-back controller varies the air flowrate to keep the fuel channel exit temperature within certain specified limits, has been implemented. Results have demonstrated that the fuel exit temperature can be successfully controlled although new control strategies, that consider the various failure conditions in a ceramic SOFC, need to be investigated.

Keywords: Solid oxide fuel cells, Dynamic modelling, Load changes.