Neural Network Predictive Control of a SOFC Fuelled with Ammonia


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The dynamic behavior and control of a tubular solid oxide fuel cell will be studied in this paper. The effect of fuel/air temperature and pressure will be investigated. Controlling the average stack temperature is the final objective of this study due to a high operating temperature of the system. In this case, temperature fluctuation induces thermal stress in the electrodes and electrolyte ceramics; therefore, the cell temperature distribution should be kept as constant as possible. A mathematical modeling based on first principles is developed. The fuel cell is divided into five subsystems and the factors such as mass/energy/momentum transfer, diffusion through porous media, electrochemical reactions, and polarization losses inside the subsystems are presented. Dynamic fuel-cell-tube temperature responses of the cell to step changes in conditions of the feed streams will be presented. A neural network predictive controller (NNPC) is then implemented to control the cell-tube temperature through manipulation of the temperature of the inlet air stream. The results show that the control system can successfully reject unmeasured step changes (disturbances) in the load resistance.

Keywords: ammonia fuel, neural network predictive control, SOFC, cell-tube temperature.

1. INTRODUCTION

Solid oxide fuel cells (SOFCs) have shown promise in the electricity generating sector for stationary applications in the mid-term future. This is due to the fact that the energy efficiency usually achieved in a SOFC is much greater than that obtained from conventional heat engines or any other types of fuel cells. SOFCs offer high power density, low cost, scalability, fuel flexibility, and superior durability. Although much experimental work has been done on ammonia-fuelled solid oxide fuel cells (NH₃-SOFCs) [2; 9-11; 17; 24], only few research studies are available on mathematical modeling of the NH₃-SOFC [12-15]. Also the experimental data reported in the literature doesn’t give full details