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A NEURAL NETWORK ESTIMATOR OF SOFC PERFORMANCE FOR ON-FIELD DIAGNOSTICS AND PROGNOSTICS APPLICATIONS

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ABSTRACT

The paper focuses on the experimental identification and validation of a neural network (NN) model of solid oxide fuel cells (SOFC) aimed at implementing on-field diagnosis of SOFC-based distributed power generators. The use of a black-box model is justified by the complexity and the incomplete knowledge of SOFC electrochemical processes, which may be awkward to simulate given the limited computational resources available on-board in SOFC systems deployed on-field. Suited training procedures and model input selection were proposed to improve NNs accuracy and generalization in predicting voltage variation due to degradation. Particularly, standing the interest in condition monitoring of SOFC performance throughout stack lifetime, input variables were selected in such a way as to account for the time evolution of SOFC stack performance. Different SOFC stacks outputs were tested to assess the generalization capabilities when extending NN prediction to those stacks for which no training data were gathered. The simulations performed on the test sets show the NN ability in simulating real voltage trajectory with satisfactory accuracy, thus confirming the high potential of the proposed model for real-time use on SOFC systems.

Keywords: Solid Oxide Fuel Cell, Neural Network, Diagnosis, Degradation, Nonlinear Modeling

INTRODUCTION

In the last years solid oxide fuel cells have been gaining increasing attention, mainly for their potential use as stationary power generators as well as auxiliary power units (APUs) for transportation use (ground, marine, air). SOFC attractiveness lies on both the high energy conversion efficiency and the zero toxic emission levels (only the CO_2 released by the hydrogen production process is a concern). Other advantages include: modularity, fuel flexibility and

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