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Robustness analyses of PEMFC systems on the production line

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Abstract

This paper discusses the robustness of 3 kW stationary proton exchange membrane fuel cell (PEMFC) modules on the production line, and discusses whether a controller designed for a PEMFC module can be directly applied to other modules. This problem is raised when our industrial partner, M-Field, implements controllers on the production line: Should we design different controllers for different PEMFC modules? We try to answer this question in three steps: first, we identify the models of five PEMFC modules with different operating ages, and analyze their system gaps that might be caused by model simplification and changes of operating conditions. Second, we design robust controllers for the PEMFC system to guarantee its stability and to improve system performance and efficiency. Finally, we implement the designed controllers on a system with different PEMFC modules to analyze system stability, efficiency, and performance. The experimental results confirm that all designed robust controllers can be directly implemented on different PEMFC modules because their stability margins are greater than the system gaps. In addition, the designed controllers can improve the hydrogen efficiency by up-to 1.4%, and reduce the root-mean-square error of the PEMFC voltage by about 93%; that is, a general controller can be implemented on all PEMFC modules on the production line for industrial applications.