Dynamic Modeling and Fractional Order $PI^\lambda D^\mu$ Control of PEM Fuel Cell

Xueqin Lü^{1,*}, Xing Miao¹, Yang Xue¹, Liang Deng¹, Min Wang¹, Dongxia Gu¹, Xinyu Li¹

School of Automation Engineering, Shanghai University of Electric Power, Shanghai 200090, China

*E-mail: lvxueqin@shiep.edu.cn

doi: 10.20964/2017.08.12

Received: 30 January 2017 / Accepted: 24 May 2017 / Published: 12 July 2017

In order to improve the dynamic performance and efficiency of the proton exchange membrane fuel cell (PEMFC), a fractional order $PI^\lambda D^\mu$ (FOPID) controller is proposed. The electrical characteristic of PEMFC are described by the lumped parameter model, which is verified accurately in this paper. The controller uses the hydrogen pressure as the control variable to control the PEMFC output voltage. At the same time, an improved Oustaloup filter algorithm is adopted to approximate the fractional calculus operator ($s^r, r \in \mathbb{R}$) in the controller which is an extension of the Oustaloup method. Moreover, the performance of the PEMFC control system is carried out on a real-time virtual test system, which is based on the Labview simulation interface toolkit and MATLAB/simulink. The validation results show that, compared to the PID control method, the FOPID control method has the advantages of smaller overshoot, faster response, better stability, and the operation efficiency of the PEMFC has increased by 0.6%. In addition, the virtual test system is greatly shorter the test time, reflects the process of testing and has a high degree of visualization.

Keywords: PEMFC, FOPID control, Nonlinear system, Dynamic performance, Labview

[FULL TEXT](#)

© 2017 The Authors. Published by ESG (www.electrochemsci.org). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).