Power sharing strategies for multi-stack air breathing PEMFC

Neigel MARX, Loïc BOULON, Frédéric GUSTIN, Daniel HISSEL, Kodjo AGBOSSOU
Université du Québec à Trois-Rivières, Trois-Rivières, Québec, CANADA
FCLab FR CNRS 3539, Femto-ST UMR CNRS 6174, Belfort, FRANCE,
neigel.marx@uqtr.ca

Keywords: Multi-stack, Air breathing PEMFC, Power sharing.

The decreasing fossil fuel resources and environmental concerns pushed the industry to turn towards other energy sources. Among these, hydrogen and its conversion to electricity without greenhouse gas emissions by fuel cells is considered as a relevant energy vector. As far as the transportation industry is concerned, multiple obstacles remain before large scale market penetration of fuel cells can be achieved. Cost, durability, performance, reliability and availability of the hydrogen are some of these obstacles. However some improvements can already be achieved through the multi-stack fuel cell architecture [1, 2].

In this paper, the performance of modular multi-stack PEMFC systems under different power sharing strategies will be presented. The contribution of the MFC architecture to the fuel consumption is established on a driving cycle accomplished on the laboratory's mobile platform. These experimental results have been obtained on a fully instrumented test bench composed of 4 x 500 W air breathing PEMFC from manufacturer HORIZON. Each fuel cell possesses a dedicated DC-DC converter to increase modularity and benefit from individual current control. Three strategies introduced in [3] have been tested. The first one distributes power equally between all fuel cells. The second one distributes power sequentially. The third one is based on an optimization algorithm aimed at maximizing the instantaneous efficiency of the system. A comparison of the algorithms is presented on figure 1. A 5% decrease in hydrogen consumption is achieved through the use of efficiency dedicated control compared to the single fuel cell equivalent.

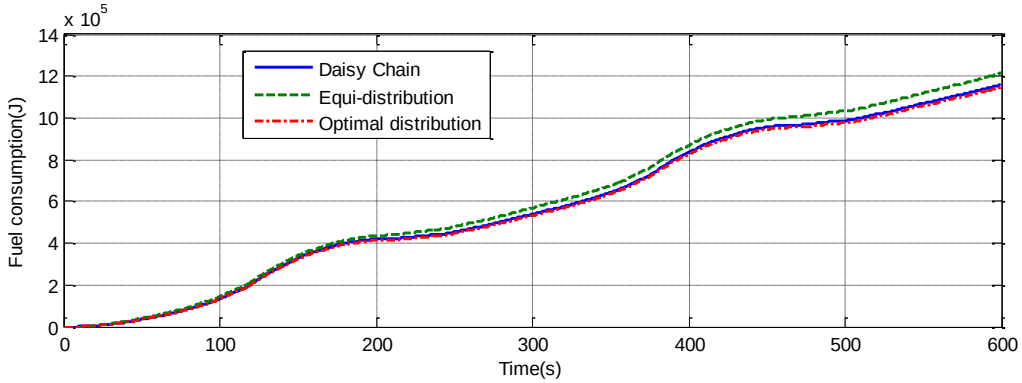

Figure 1. Hydrogen consumption comparison

REFERENCES

[1] N. Marx, L. Boulon, F. Gustin, D. Hissel, and K. Agbossou, A review of multi-stack and modular fuel cell systems: Interests, application areas and on-going research activities, Int. J. Hydrogen Energy, vol. 39, no. 23, pp. 12101-12111, Aug. 2014.
[2] A. De Bernardinis and G. Coquery, First approach for a fault tolerant power converter interface for multi-stack PEM fuel cell generator in transportation systems, in 2008 13th Int. Power Electron. Motion Control Conf. IEEE, Sep. 2008, pp. 2192-2199.
[3] J. E. Garcia, D. F. Herrera, L. Boulon, P. Sicard, and A. Hernandez, Power Sharing for Efficiency Optimisation into a Multi Fuel Cell System, in IEEE Int. Symp. Ind. Electron. Istanbul, 2014, pp. 1-6.