D Benouioua et al., J Fundam Renewable Energy App 2016, 6:7(Suppl)
http://dx.doi.org/10.4172/2090-4541.C1.023

Fuel cell diagnosis based on stack voltage multifractal analysis; the question of the method portability

D Benouioua[1, 2, 4], **D Candusso**[1, 2, 4] and **F Harel**[3, 4]
[1]EFFICACITY, France
[2]IFSTTAR, France
[3]Université de Lyon, France
[4]FCLAB, France

In the era of renewable and clean energies, the demand for less polluting energy generation technologies has increased rapidly. Among these technologies, the Proton Exchange Membrane Fuel Cell (PEMFC) receives much attention, as it can convert the hydrogen chemical energy into electricity with high efficiency, and also produce water and heat. However, to make this technology commercially viable, some challenges still remain. Especially the extension of the fuel cell lifespan and reliability are identified as major concerns in the research and industry sectors. The lifetime and reliability objectives can notably be achieved by implementing a diagnosis tool capable of high performances, whatever the stack design and the operating environment. In this context, we propose a new tool based on the investigation of singularity measurements stamped in fuel cell stack voltage signals. Indeed, measuring local singularities on voltage signals provides suitable information about the evolving dynamics of non-stationary and non-linear processes involved in fuel cell systems. In our study, two PEMFC stacks are experimented to evaluate the portability of our diagnosis tool. The first one is an 8 cell stack designed for automotive applications and manufactured by CEA LITEN, France. The second one is a 12 cell stack dedicated to stationary application (micro combined heat and power - µCHP application). It is designed and marketed by Riesaer Brennstoffzellentechnik GmbH and Inhouse Engineering GmbH, Germany. The steps of our diagnosis strategy are as follows: Two PEMFC stacks are operated under a variety of conditions (nominal, and faults i.e. more or less severe deviations from the nominal conditions) using characterization testbenches developed in lab. The deviations from the nominal conditions refer either to single fault types or to combinations of different faults; The recorded stack voltages are analyzed using a Wavelet Leader based Multifractal Analysis (WLMA) in order to identify their singularity spectra as fault signatures; A feature selection method is used to select the most relevant singularity features and to remove the redundant ones; The selected singularity features are classified using Support Vector Machine (SVM) classifier according to the considered operating situations (faults and combinations of faults). The obtained results show that the proposed PEMFC diagnosis tool allows identifying simple operating failures and even more complicated situations that contain several failure types, for different stack sizes, powers and technologies for different power application environments.

Biography

D Benouioua has completed his PhD in Electronics in 2008 from Polytechnic School of Tours University, France and Post-doctoral studies in Fuel Cells Technology from French Institute of Science and Technology for Transport, Development and Networks, Fuel Cells system platform in Belfort since 2012 to 2014. She is currently a Researcher at EFFICACITY Institute for the Energy Transition in the City. Her main research activities include Fuel Cell systems characterization and diagnosis for automotive and stationary applications.

djedjiga.benouioua@ifsttar.fr

Notes: