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▶ **To cite this version:**

Djedjiga Benouioua, Denis Candusso, Fabien Harel, Pierre Picard. Voltage Singularity-Based Diagnostic for PEM Fuel Cell Stack designed for Operation in μCHP Units. FDFC 2017, 7th International Conference on Fundamentals & Development of Fuel Cells,, Jan 2017, STUTTGART, Germany. 1 p. hal-01830711

HAL Id: hal-01830711
https://hal.science/hal-01830711

Submitted on 5 Jul 2018

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Voltage Singularity-Based Diagnostic for PEM Fuel Cell Stack designed for Operation in µCHP Units

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A non-intrusive and without disturbance diagnostic strategy for a low temperature Proton Exchange Membrane Fuel Cell (PEMFC) designed to operate in µCHP units is proposed. The developed diagnosis strategy consists of two phases:

- ➔ In the first phase, an experimental campaign is conducted on a 12 cell PEMFC stack dedicated to stationary application. It is designed and marketed by Riesaer Brennstoffzellentechnik GmbH and Inhouse Engineering GmbH, Germany. Thereby, a database is built; it includes many physical signals measured from the stack and the testbench ancilliaries such as: gas pressures, flows, temperatures… and the voltage stack signal recorded with a sampling frequency of 3kHz for nominal and faulty operating conditions.
- ➔ In the second phase, the research of relevant indicators for the PEMFC State-of-Helath (SoH) is made by analyzing the stamped singularities in the stack voltage signal according to the various operating conditions.

The approved approach implements two data analysis steps:

- o A data pre-processing step based on the filtering of a voltage signal (acquired during 1 hour) to achieve the separating of its low and high frequencies components. Then, a Useful Voltage (UV) signal was obtained by computing the Root Mean Square 'RMS' on the windowed filtered voltage signal (with a window size of 0.066 s).
- o A data processing step that consists of computing a punctual singularity strength in the UV signals and summarizing all the founded singularities strength in the form of a singularity spectrum (SS). The signal processing method adopted in this study, namely the Wavelet Leaders-Based Multifractal Analysis (WLMA), has been published in previous works [1, 2] and showed high-performance results on a PEMFC designed for transport application.

The results of the SS features classification enable the identification of a wide range of operating failures for the studied PEMFC stack dedicated to µCHP application.

References:

[1] D. Benouioua, D. Candusso, F. Harel and L. Okhellou, Fuel Cells Vol. (?), 1-8 (2016).
[2] D. Benouioua, D. Candusso, F. Harel and L. Okhellou, International Journal of Hydrogen Energy Vol. (**39**), 21631-21637 (2014).