Voltage Singularity-Based Diagnostic for H2&CO2/O2 PEM Fuel Cell Stack designed for Operation in μCHP Units

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Impact of Quasi-Static Load Profile on PEMFC Durability for Automotive Application: Reference and Accelerated Stress Tests

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In automotive application, polymer electrolyte membrane fuel cells (PEMFCs) are operated through dynamic working conditions. Dynamic driving cycles are mainly composed by cold starting, sudden load variations, continuous load running, idle running, full power running, overload running, and start-stop repetitions [1-2]. These conditions if operated for long-time can severely impact the PEMFC lifetime. To solve this problem, a power balance strategy related to a PEMFC-battery hybrid structure is usually considered to improve the PEMFC durability [3]. As a result of the power balance strategy based on the battery state of charge optimization, a more beneficial quasi-static load profile is commonly obtained for the PEMFC operations. The aim of this work is to observe the effects of the quasi-static load profile on the PEMFC degradation. To this purpose a quasi-static reference profile was developed to separately investigate the impacts of both stationary conditions and load variations (from 0 h to 408 h) and start-stop conditions (from 408 h to 792 h) on the stack voltage degradation. A stack voltage reduction was observed after 408 h of operation, where the impact of the load variation was tested. Subsequently, the first recovering was found. Test results after 792 h also showed the start-stop impact on the stack voltage degradation. Particularly, considering the voltage variation with respect to the cumulated energy an higher voltage slope can be observed. An accelerated load profile was finally developed to study the influence of the number of repetitions in both load and start-stop cycles on the PEMFC voltage degradation; the results are then compared. Both reference and accelerated load profiles are reported below.

References:

[1] Lin R, Li B, Hou YP, Ma JM.,**Int JHE vol. 34**, pp. 2369-76 (2009).

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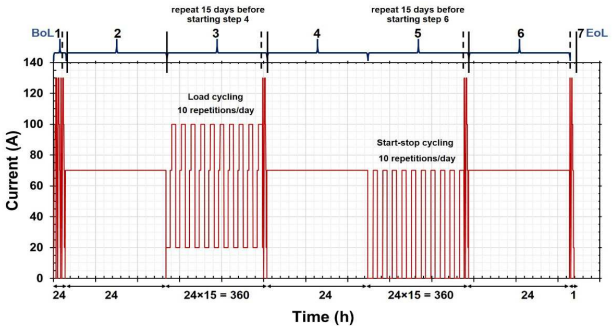
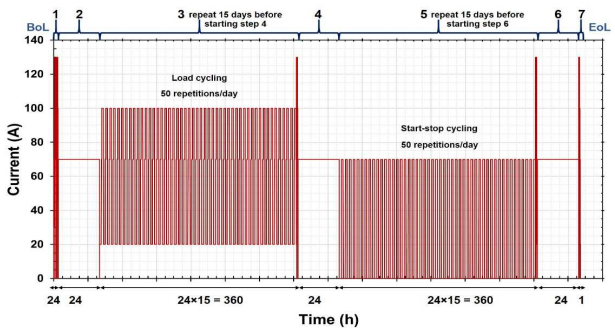
[3] Barelli L, Bidini G, Ottaviano A., **Applied Energy vol. 97**, pp.777–84 (2012).



Reference profile



Accelerated test profile