The development of an innovative and optimized open cathode PEMFC stack: Design optimization

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Today, Green technology, driven by the imperative to mitigate environmental challenges, is at the forefront of transforming the energy landscape. Proton exchange membrane fuel cell stacks (PEMFCs) represent a key component of green energy due to their ability for hydrogen energy conversion. PEMFC is an electrochemical device that produces electricity in form of DC from an electrochemical reaction between hydrogen gas and air as an oxidant. During its functioning , it releases heat, water and unreacted gases as by-products. Due to its wide range of application, it is considered to eventually play a leading role as clean energy source for mobile, portable and vehicle applications. Especially, the one that require high-power/energy density. Design optimization of PEMFC stack is crutial for enhancing its overall performance especially, the cost efficiency and power/energy density and system integration. Producing high power/energy with a reduced size and price is challenging for the PEMFC stack technology. In the light of this vision, an innovative PEMFC stack with an optimized design of the bipolar plates is developed. The optimization study was performed by using advanced characterization techniques and computational modeling to understand and improve the properties of the stack. The optimization strategy consisted on the optimization of the bipolar plate of the fuel cell including the geometry, flow field, and material of construction. Interdegit flow fields were selected to improve the hydrogen distribution in the active area and the removal of water, without causing a pressure drop. Innovative materials are chosen for the development of the plates to target power density. Experimental results show an increase in power density from 0.23 kW/kg to 1.18 kW/kg and volumetric density from 0.22 kW/l to 0.60 kW/l. Simulation study followed the development of the prototype, and experimental validation was performed. The results obtained are promising. A comparison with commercial stacks is performed.

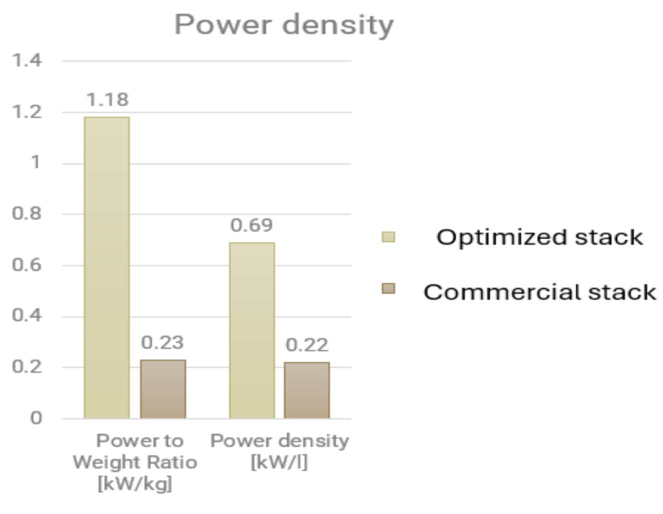

Fig (1)
Power density and volumetric density for fuel cell stack

Fig (2)
Air cooled fuel cell stack for portable applications.