Use of computational fluid dynamic to compare the pressure loss between a parallel-baffle flow field plate and a fractal parallel-baffle flow field plate in a proton exchange membrane fuel cell

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ABSTRACT

Conventional fuels are main source of environmental pollution and will not last infinitely. It is clear that transition from these fuels to clean and non-exhaustible ones is unavoidable [1]. Fuel cells are expected to play a major role in the economy of this century. In order to reduce the impact of our energy consumption on the environment, fuel cells represent an attractive solution, for instance addressing the issue of intermittent behavior of renewable sources [2].

A basic proton exchange membrane fuel cell (PEMFC) stack is formed by MEAs, diffusion layers and bipolar plates. One of the most important and effective elements in the improvement of efficiency and power density of fuel cells are the bipolar plates. These components supply fuel and oxidants, remove generated water, collect produced current and provide mechanical support for the brittle membrane electrode assembly in fuel cell stack [3]. The pressure loss in the bipolar plate channels is one of the important parameters that affect the total system efficiency and fuel cell optimization. As decrease the pressure loss at the bipolar plate channels the fuel cell performance improve.

The aim of this research was the use of biological inspired to decrease the pressure loss in a parallel-baffle flow field plate and improve a PEMFC performance. There is an extraordinary complexity at the biological systems. Although, the fractals are parameters directly or indirectly connected to all Biology, in the human body or in a cauliflower.

In this research was created new connections between each PBFFP channel by fractals and was employed the SOLIDWORKS software 2013 with flow simulation tool in a computer model Alienware Aurora Desktop – BRH3171 (3.2 GHz, 8 MB L3 cache; 24GB DDR3 1333MHz memory (6x4GB)) with an high-performance liquid cooling (Alienware®), equipped with a Intel® Core™ i7-960. In the simulations both flow plates received a volume flow of 1 L/min (hydrogen) in the inlet with an environment pressure in the outlet.

The result showed that in both flow field plates the pressure loss behavior was the same, concentrated in the channel connected to the outlet (lower pressure) and the FPBFFP fractals with a similar pressure loss behavior. Meanwhile there was a decrease in the FPBFFP pressure loss because of the fractals. The pressure loss in the PBFFP was 73.52 Pa and the pressure loss in the FPBFFP was 73.45 Pa.

As a result we can conclude that the presence of fractals in a PBFFP decrease the pressure loss in a PEMFC, decreasing the diffusion overpotential and improving the fuel cell power density.

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