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# Use of computational fluid dynamic to compare the pressure loss between a parallel flow field plate with 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**

This research provided CFD tests to verify and understand the reagents fluid dynamic behavior in the channels of the new parallel-baffle flow field plate during a direct ethanol proton exchange membrane fuel cell (DE-PEMFC) operation. The results showed that. The results showed that the fractal plate showed a similar behavior normal plate and a repetition through fractals, the fluid dynamic behavior.



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## 1. Introduction

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]. Improvements in cell design and manufacturing have further increased power, while reducing manufacturing costs, which is essential if the fuel cell is to compete with the internal combustion engine [3].

The channels design and its pattern considerably affect the effectiveness of mass transport as well as electrochemical reactions inside the cell.

Computational fluid dynamics (CFD) modeling is the most common approach to creating simulations of ethanol alcohol within a direct ethanol proton exchange membrane fuel cell (DE-PEMFC) [4]. The pressure loss in the DE-PEMFC flow field plates decrease the power density and the fuel cell performance. Within parallel flow channels the reactant gas speed is low relative to serpentine flow fields which may lead to local flooding, particularly under the lands, where the pressure gradient is a minimum [5].

The basic idea of interdigitated flow fields is to force the total mass flow through the land area to improve the local cell performance [6]. However, here the excessive pressure drop from the gas inlet to the gas outlet of the flow field requires additional parasitic power [7].

The aim of this research was project a new flow field design, with PFFP and IFFP characteristics, a parallel-baffle flow field plate (PBFFP).

The result showed that in the PFFP all channels suffered with pressure loss but in the PBFFP, the interdigitated channels pressure loss stabilized and it was concentrated only in the channel connected to the outlet (lower pressure), improving the fuel cell performance.

Following the basic structure of the plate, stege this research was created new connections between each PBFFP channel by fractals. 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.

## 2. Objective

The objective of this research was to design and characterized the related pressure loss behavior with a new design DE-PEMFC flow field, with parallel flow field plates (PFFP) and a parallel-baffle flow field plate (PBFFP). And then the behavior analysis of these plate with the use of fractals.