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A NEW HIGH POWER EFFICIENT ELECTRONIC CONVERTER FOR FUEL CELL APPLICATIONS

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ABSTRACT

Sustainable development requires a sustainable supply of clean and affordable energy resources that do not cause negative social impacts. The continuous drop in crude-oil production and the gradual increase in oil prices have emphasized the need for suitable alternatives to our oil-based economy. Clean and efficient technologies based on renewable energy sources must consider addressing this issue. In this context, the fuel cells can provide a clean energy for the future, as they produce electricity from hydrogen through an electrochemical process, which is virtually free of emissions and noise and only water and heat are the by-products. In addition, the fuel cells have several advantages such as; silent, high potential for cogeneration applications, adaptable to a wide range of power and applications.

The design and implementation of power generation systems based on fuel cells require careful selection of both the fuel cell model and the power converter. Therefore, a semi-empirical model of the PEM fuel cell is proposed in this thesis. In this context, a method to extract the parameters that characterizes the PEM fuel cell is secondary but also an important objective.

This thesis also proposes a new efficient high power converter to improve the performance and optimize the hydrogen consumption. The converter follows a resonant approach that provides low component stresses, high frequency operation, soft-switching commutation, and operation under a wide range of input and output conditions.

The control is divided into two parts, namely: i) the voltage controller, which is responsible for keeping constant the output voltage of the converter under loading variations and ii) the PEM controller, which is responsible for improving the performance by keeping the PEM fuel cell in its optimal operating point.

The experimental setup composed by a DC-DC converter and a PEM fuel cell were developed and the obtained results were analyzed. The results confirm the simulation ones that were performed using the MatLab/Simulink software.

In addition, the setup experimental allows us to extend the analysis to new loading conditions such as electrical vehicles and renewable energy sources like solar energy.

This thesis provides an accurate and useful tool for future research on these types of energy conversion systems.