UNITIZED REGENERATIVE POLYMERIC FUEL CELL MODELING

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Área temática del congreso: 9.2. Demanda de agua para la obtención de energía.

1. INTRODUCTION.

The research's objective is to have a single machine to function as fuel cell and electrolyser based and needs, that is to say, unitized regenerative fuel cell (when fed to the machine with electric power and water flows will be obtained and H_2 and O_2 and conversely when the machine is fuelled with H_2 and O_2 will get water, heat and electricity) The study focuses on polymeric fuel cells and polymeric electrolysers. The development of this machine will make a very significant cost reduction (currently to use hydrogen as an energy store needed the electrolyser and fuel cell) as a single machine may replace the fuel cell and electrolyser. The achievement of the objective mentioned above, have been going by completing a series of stages. The stages addressed in this work are:

- A first stage, which will be studied in detail the polymeric fuel cells and polymeric electrolysers, in order to see the similarities between the machines and to design the unitized regenerative fuel cell.
- A second stage of simulation, which will develop models to show the behaviour of the unitized regenerative fuel cell and compare results with those obtained from the theoretical.
- A third stage of model verification generated polymer fuel cells and electrolyzers polymer on the market.

2. EXPERIMENTAL

Detailed study of polymeric membrane fuel cells and polymeric electrolyzers: The research is focused on the following points for both fuel cell and electrolyzer,

- Chemistry and Thermodynamics (basic reactions, heat of reaction, theoretical electrical work, theoretical potential, effect of temperature, theoretical efficiency, effect of pressure, etc) [1].
- Electrochemistry (electrode kinetics, voltage losses, cell potential – polarization curve, distribution of potential across a cell, sensitivity of parameters in polarization curve, cell efficiency, etc).
- Main cell components, materials properties and processes (cell description, membrane, electrode, gas diffusion layer, bipolar plates, etc) [3]. Cell operating conditions (operating pressure, operating temperature, reactants flow rates, reactants humidity, cell mass balance, cell, energy balance, etc) [4]. Stack design (sizing of a stack, stack configuration, uniform distribution of reactants to each cell,

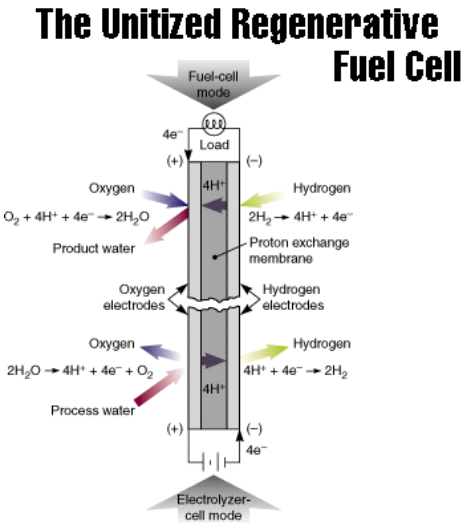
uniform distribution of reactants inside each cell, heat removal from cell stack, stack clamping, etc).Cell systems design (hydrogen – oxygen systems, hydrogen – air systems, cell systems with fuel processor, electrical subsystem, system efficiency, etc).

Simulation and development of models for polymer fuel cells and electrolyzers polymer: This stage, using the knowledge gained in the previous stage, is to simulate and model both the polymer fuel cell as the polymer electrolyzer in order to acquire sufficient knowledge and skill about simulation and modelling concerns. For the simulation and modelling using conservation laws of mass, momentum conservation, energy conservation, species conservation and charge conservation [2].

Verification of the model generated with polymeric fuel cells and polymeric electrolyzers on the market: At this stage, these results contrast the models generated with results of operations of commercial equipment in order to validate the model. To validate the model, at least be analyzed polarization curves, current interrupt, ac impedance spectroscopy, pressure drops as a diagnostic tool, current density mapping.

3. RESULTS.

The results obtained after completion of all the experimental part are: Thorough knowledge of polymer fuel cells and electrolyzers polymer. This insight is obtained as a result of detailed study, simulation and model development and verification of models. With the knowledge and experience gained in polymer fuel cells and electrolyzers refers polymer, is intended to address the design, balance of plant, model development, simulation models developed, the reversible polymer fuel cells. Once developed the model of reversible polymer fuel cell is to develop a prototype in order to validate the model. If the result is positive, will run several tests of all kinds, in order to optimize the design to subsequently address the commercialization of fuel cell reversible polymer which will require the design of the assembly line for manufacturing.



4. CONCLUSIONS.

The ultimate aim of the research is the design and manufacture of reversible polymer fuel cells in order to reduce costs, as at present, to use hydrogen as an energy storage are needed for a fuel cell side and on the other hand the electrolyzer (Figure 1).

Currently there have been studies and research on this subject, but none has become a marketing team. It is therefore considered to be the subject of vital importance for the development of hydrogen technologies and fuel cells and is what has motivated this study.

5. REFERENCES.

[1] PEM Fuel Cells: Theory and Practice.Frano Barbir.
[2] PEM Fuel Cell Modeling and Simulation Using Matlab. Colleen Spiegel
[3] Pre-investigation of water electrolysis. Technical University os Denmark.
[4] Fuel Cell Handbook. U.S. Department of Energy.