SOLAR-HYDROGEN POWERED PROTON EXCHANGE MEMBRANE FUEL CELL (PEMFC) MODELING AND SIMULATION

A dissertation submitted to the
Department of Electrical Engineering, University of Moratuwa
In partial fulfillment of the requirements for the
Degree of Master of Science

by
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2010

Abstract

The main scope of this study provides a research insight on direct solar Hydrogen-proton exchange membrane fuel cell concept and the description of fuel cell operating principles is followed by a modeling and simulation of the current fuel cell technology together with issues concerning Hydrogen fuel. Appropriate applications for current and perceived potential advances of fuel cell technology are discussed.

Fuel cell modeling is helpful for fuel cell developers because it can lead to fuel cell design improvements, as well as, better, and more efficient fuel cells. The model must be robust and accurate and be able to provide solutions to fuel cell problems quickly. A good model should predict fuel cell performance under a wide range of fuel cell operating conditions. Even a modest fuel cell model will have large predictive power. The necessary improvements for fuel cell performance and operation demand better design, materials, and optimization. These issues can only be addressed if realistic mathematical process models are available.

Fuel cells are one of the cleanest and most efficient technologies for generating electricity. Since there is no combustion, there are none of the pollutants commonly produced by boilers and furnaces. For systems designed to consume hydrogen directly, the only products are electricity, water and heat. Fuel cells are an important technology for a potentially wide variety of applications including on-site electric power for households and commercial buildings; supplemental or auxiliary power to support car, truck and aircraft systems; power for personal, mass and commercial transportation; and the modular addition by utilities of new power generation closely tailored to meet growth in power consumption. These applications will be in a large number of industries worldwide.

The theoretical development of the proton exchange membrane fuel cell (PEMFC) is discussed with the areas under electro chemistry, thermal distribution, and pressure. The particular simulations and modeling are discussed by using modeling software.

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree

UOM Verified Signature

Sekarage Roshan Wickremaarachchi
16 December 2009

We/I endorse the declaration by the candidate.

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Acknowledgement

The undergraduate and postgraduate studies at Anna University in India and Katubedda University in Srilanka respectively were a specific condition for me to proceed with an useful research study of this type. Similarly the course materials of the study program were also helpful to make a successful access to this research study in Industrial Automation.

Most importantly, Close supervision and guidance enriched the movement in positive direction in line with the research proposal from the very start, without any complication although the said research study, to a certain extent was a difficult task. But because of the regular instructions and guidences of supervisor; Professor Lanka Udawatta and Eng.Anura Wijepala. It was possible for me to overcome the confronted barriers without any much effort.

In this direction, Professor. Lanak Udawatta and Eng.Anura Wijepala offered some unlimited discussions and sessions without considering the time factor, which in return created some friendly environment to sort out the relevant studies for the research.

Faculty of Engineering of University of Moratuwa, is categorically responsible for this academic research study. Contributions offered such like communication over the issues, unconditional access to any clarification, and instant guidance by the Electrical Engineering department are not that simple as far as the completion part of this research study is concerned.

This study demanded many sources and relevant material which were readily available firstly in library of Katubedda University which paved direction to mark the area of research proposal.

Lastly, I should thank many individuals, friends and colleagues who have not been mentioned here personally in making this educational process a success. May be I could not have made it without your supports.

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List of Principal Abbreviations

DMFC	Direct methanol fuel cell
EMF	Electromotive force
HHV	Higher heating value
LHV	Lower heating value
MCFC	Molten carbonate (electrolyte) fuel cell
MEA	Membrane electrode assembly
MOSFET	Metal oxide semiconductor field-effect transistor
NASA	National Aeronautics and Space Administration
PAFC	Phosphoric acid (electrolyte) fuel cell
PEM	Proton exchange membrane or polymer electrolyte membrane – different names for the same thing which fortunately have the same abbreviation
PEMFC	Proton exchange membrane fuel cell or polymer electrolyte membrane fuel cell
PTFE	Polytetrafluoroethylene
SOFC	Solid oxide fuel cell
CB&H	Carbon Black & Hydrogen Process
GE	General Electric
AFC	Alkaline Fuel Cells
GDL	Gas Diffusion Layer
PV	Photovoltaic