بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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MONA MAGHRABY

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Mechanical Power Engineering

Thermochemical Performance Assessment of a Fuel Cell-Based Energy Conversion System

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Mechanical Engineering

by

Armiya Mourad Fahim Seiden

Bachelor of Science in Mechanical Power Engineering

Faculty of Engineering, Ain Shams University, 2012

Supervised By

Prof. Mahmoud Mohamed Kamal Abdel Aziz

Professor at Mechanical Power Engineering Department

Faculty of Engineering – Ain Shams University

Dr. Mohamed Sherif Al Kotb

Associate Professor at Physics Department

Faculty of Science– Ain Shams University

Cairo - (2020)

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Date:

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Mechanical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Publications

1. A. M. Seiden, M. S. Al-Kotb, A. Diab, N. A. Mahmoud, Theoretical Energy and Thermal Studies of Protonic Ceramic Fuel Cells, Egyptian Journal of Solids, ISSN: 1012-5566.

Thesis Summary

This study presents a mechanistic computational approach to model and optimize the protonic ceramic fuel cell (PCFC) performance. A planar single protonic ceramic fuel cell (PCFC) consisting of a dense protonic conducting electrolyte and mixed proton-electron conducting electrodes is used for this model. Analysis of the system`s electrochemistry, thermodynamics, voltage losses, charge transport, mass transport and heat control are conducted. The model is validated against experimental data reported in the literature, where the model results agreed well with the experimental data, which is a good evidence for the model validity. The model`s potentiality to investigate almost most of the PCFC design, microstructure and operation parameters made it flexible enough to study the system in various aspects. Impact of temperature, input pressure and excess air ratio are studied extensively. The effects of the pore size, porosity and diversity in pore forming shapes on the PCFC performance are investigated. Moreover, a performance comparison using different ranges of fuels is presented. Additionally, the analysis of doping nanoparticles in the dense ceramic electrolyte; which can have a dramatic effect on the ionic conductivity, is also introduced in the current study. A real case study is performed by substituting a natural gas fired gas turbine with a PCFC package of the same capacity, where a comparison between the main parameters of each system is presented; identifying the commercialization of fuel cells and their actual influence in the energy market. Fine modelling is our way to enhance the performance of fuel cells to help meet technical and commercial requirements of the market.

Key words:

Computational Modeling; Design Optimization; Electrochemistry; Heat Management; Mass Transport; Nanoparticles Doping; Power Generation; Protonic Ceramic Fuel Cell; Thermodynamics

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