بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

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HANAA ALY

MODELING AND SIMULATION OF ALKALINE ETHANOL-AIR FUEL CELL STACK

By

Shimaa Mohamed Ali Abdela Obaid

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

Modeling and simulation of alkaline ethanol-air fuel cell stack.

Key Words:
Modeling of fuel cell; ethanol-air fuel cell stack ; alkaline alcohol fuel cell .

Summary:

- Ethanol-air fuel cell is a new technology for energy-conversion which provide high efficiency with pollution –free operation. The performance of alkaline ethanol-air fuel cell stacks was simulated using simple model based on thermodynamics, kinetics and mass transfer considerations. The mathematical model is tested by experimental data used in a previously published paper.
- In mathematical model, the increase in concentration of electrolyte with constant concentration of the fuel, the cell performance increases initially then decrease. This result is close to the experimental data. In mathematical model, the increase in concentration of fuel with constant concentration of the electrolyte, the cell performance slightly changes because of the consumption of fuel with increase in current density isn't taken into consideration .The result in experimental paper, the maximum power density =50mW/cm2 at current density at 17 mA/cm2 but The result in mathematical model, the maximum power density =46.5mW/cm2 at current density at 20 mA/cm2

DISCLAIMER

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in reference section.

Name:

Signature:

Date**: …/.... /2020**

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TABLE OF CONTENTS

List of Tables

List of Figures

Nomenclature

Symbol	Quantity
V	Real voltage
E	Ideal Voltage
A_p , A_R	Activity of products , Activity of reactant
n	Number of electrons
F	Faraday Number
P_i ,P_t	Partial Pressure Of substance (i), where i=Water, Carbon Dioxide and oxygen, Total pressure.
X_i	Mole Fraction Of substance (i), where i=Water, Carbon Dioxide and oxygen
C_i	Concentration Of substance (i), where i=Water, Carbon Dioxide , oxygen and Ethanol
η_{Act}	Activation over potential
η_{Conc}	Concentration over potential
η_{Ohmic}	Ohmic over potential
AFC	Alkaline fuel cell
PEMFC	Polymer electrolyte membrane fuel cell
MCFC	Molten carbonate fuel cell
SOFC	Solid oxide fuel cell
PAFC	Phosphoric acid fuel cell (PAFC)
PTFE	Poly tetra Fluoro Ethylene

Abstract

Ethanol-air fuel cells are emerging new technologies for energy-conversion which provide high efficiency, modular structure and pollution –free operation. The performance of alkaline ethanol-air fuel cell stacks was simulated using simple model based on thermodynamics, kinetics and mass transfer considerations ,and the model was tested using published experimental data " Development of a Direct Alkaline Fuel Cell Stack"[1]. The effects of ethanol concentration, potassium hydroxide concentration, current density and temperature, on cell stack voltage and power density were studied. The calculated cell potentials and power densities match well with experimental data within reasonable accuracy in spite of the simplicity of the model. The model can be used for both design, optimization and process control. The model in spite being simple and taking into consideration the experimental error and the model assumption, it can be used within reasonable accuracy for estimation of optimum operating condition and maximum power output.