

**MODELING AND VALIDATION OF PLANAR SOLID OXIDE FUEL CELL
STACK OPERATING WITH SYNGAS**



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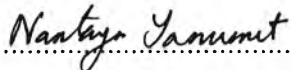
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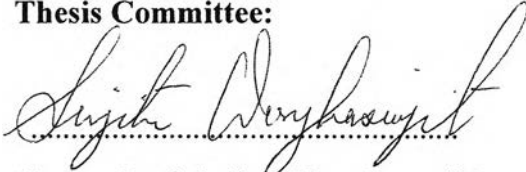
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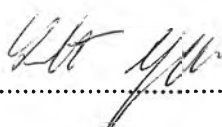
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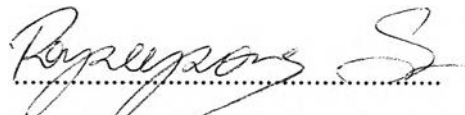
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ABSTRACT

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Solid oxide fuel cells (SOFCs) are considered as a promising energy conversion device because of their high-energy efficiency and low pollutant emission. One advantage of SOFCs as compared to other types of conventional power generator is that they can convert not only hydrogen into electricity, but also carbon monoxide. This leads to a possibility in using varieties kinds of fuels, such as syngas (H_2 , CO , CO_2 and N_2). In this work, steady state mathematic two-dimensional model of planar SOFC operating with various syngas compositions for co-flow patterns is developed to describe a concentration distribution and cell performance or current density inside flow channels. Mass, species and charge conservation coupled with chemical and electrochemical reactions are considered in the model. The developed model presents a good agreement (similar trend) with the experimental results. A simulation result of the concentration distribution indicates that a water-gas shift (WGS) reaction plays an important role inside the flow channel and CO_2 has the most negatively effect on the cell performance. Results from SEM and EDS show a change in morphology with some carbon deposition on the anode surface.

บทคัดย่อ

กุศลภัสส์ วัฒนา: การพัฒนาแบบจำลองของเซลล์เชื้อเพลิงแบบออกไซด์ของแข็งแบบแผ่นโดยใช้ก๊าซสังเคราะห์เป็นเชื้อเพลิง (Modeling and Validation of Planar Solid Oxide Fuel Cell Stack Operating with Syngas) อ. ที่ปรึกษา: รศ. ดร. สุจิตรา วงศ์เกษมจิตต์, ดร. สุมิตรา จรสโรจน์กุล และ ดร. รพีพงศ์ สุวรรณวารังกูร 62 หน้า

เซลล์เชื้อเพลิงแบบออกไซด์ของแข็ง (Solid Oxide Fuel Cell) เป็นทางเลือกใหม่ในการผลิตกระแสไฟฟ้า เนื่องจากมีประสิทธิภาพสูงและไม่ก่อให้เกิดมลภาวะ จึงสามารถนำไปประยุกต์ใช้งานได้อย่างหลากหลาย ประโยชน์ประการหนึ่งของเซลล์เชื้อเพลิงแบบออกไซด์ของแข็งเมื่อเทียบกับเซลล์เชื้อเพลิงชนิดอื่นคือ นอกจากจะสามารถเปลี่ยนก๊าซไฮโดรเจนให้เป็นไฟฟ้าได้แล้ว ยังสามารถเปลี่ยนก๊าซคาร์บอนมอนอกไซด์ให้เป็นไฟฟ้าได้อีกด้วย ดังนั้น ก๊าซสังเคราะห์ ซึ่งเป็นก๊าซผสมระหว่างไฮโดรเจน, คาร์บอนมอนอกไซด์, คาร์บอนไดออกไซด์และไนโตรเจน อาจจะนำมาใช้ได้ ในงานวิจัยนี้ จึงได้มุ่งเน้นศึกษาถึงผลของก๊าซชนิดต่างๆ ในก๊าซสังเคราะห์ที่มีต่อประสิทธิภาพของเซลล์เชื้อเพลิงแบบออกไซด์ของแข็งแบบแผ่น และพัฒนาแบบจำลองทางคณิตศาสตร์ขึ้นเพื่อจำลองการกระจายตัวของก๊าซ, อุณหภูมิ และประสิทธิภาพของเซลล์เชื้อเพลิงแบบออกไซด์ของแข็ง แบบจำลองถูกพัฒนาขึ้นบนกฎอนุรักษ์มวลและพลังงาน รวมถึงปฏิกิริยาไฟฟ้าเคมีที่เกิดขึ้นภายในขั้วไฟฟ้าของเซลล์เชื้อเพลิงแบบออกไซด์ของแข็ง โดยพบว่า แบบจำลองนั้นให้ผลสอดคล้องกับผลการทดลองเมื่อใช้ก๊าซสังเคราะห์เป็นเชื้อเพลิง ขณะที่ก๊าซคาร์บอนไดออกไซด์ให้ผลอย่างมากต่อการลดลงของประสิทธิภาพ ซึ่งเป็นผลมาจากการย้อนกลับของปฏิกิริยา (Water-Gas Shift, WGS) จากการตรวจสอบโดยใช้ SEM (Scanning Electron Microscope) และ EDS (Energy Dispersive X-ray Spectroscopy) พบว่า โครงสร้างของขั้วแอโนดมีการเปลี่ยนแปลงและมีคาร์บอนกระจายตัวอยู่บนผิวหน้า

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TABLE OF CONTENTS

PAGE		
Title Page	i	
Abstract (in English)	iii	
Abstract (in Thai)	iv	
Acknowledgements	v	
Table of Contents	vi	
List of Tables	viii	
List of Figures	ix	
 CHAPTER		
I	INTRODUCTION	1
II	BACKGROUND AND LITERATURE REVIEW	3
III	EXPERIMENTAL	14
	3.1 Electrochemical Cell and One-cell Stack	14
	3.2 Gas Controlling System	19
	3.3 Furnace and Temperature Control System	19
	3.4 Electrical Loading and Measurement System	20
	3.5 Operation and Testing	20
IV	MODEL DEVELOPMENT	21
	4.1 Modeling Approach	21
	4.2 Mathematical Model	22
	4.2.1 Model Geometry and Assumptions	22
	4.2.2 Flow Channel	24
	4.2.3 Electrolyte	31

V	RESULTS AND DISCUSSION	32
	5.1 Experimental Results	32
	5.1.1 Effect of Fuel Flow Rate	32
	5.1.2 Effect of Air Flow Rate	33
	5.1.3 Effect of N ₂ Dilution	34
	5.1.4 Effect of CO ₂ Dilution	36
	5.1.5 Effect of H ₂ /CO Composition	37
	5.1.5 Effect of Simulated Syngas	39
	5.2 Cell Inspection After Operation	41
	5.3 Modeling and Simulation Results	43
VI	CONCLUSIONS AND RECOMMENDATIONS	51
	REFERENCES	52
	APPENDICES	56
	Appendix A Transport Properties of Pure Gas and Multi-component Gaseous Mixture	56
	Appendix B Thermodynamic of SOFC Reactions	60
	CURRICULUM VITAE	62

LIST OF TABLES

TABLES	PAGE
2.1 Data of different fuel cell types	3
2.2 SOFC reactions and the corresponding Nernst's equations	9
4.1 Coefficients for rate expression of H ₂ oxidation and O ₂ reduction.	28
5.1 Compositions of simulated syngas. (% mol, dry basis)	39
5.2 Operating parameters.	45
A1 Value for molecular weight, σ and ε of gases	56
A2 Value of b_k	57
A3 Value of c_k	58
A4 Value of a_k	59
B1 Value of a_k	60
B2 Value of b_0, b_1, \dots, b_6	61
B3 Value of c_k	61

LIST OF FIGURES

FIGURE	PAGE
2.1 Operating principle of SOFC when using CO and H ₂ as fuels and O ₂ as the oxidant	5
2.2 Tubular type of SOFC	8
2.3 Planar type of SOFC	8
2.4 Polarization curves.	10
3.1 Schematic of experimental setup	14
3.2 Electrolyte Support Cell: (a) anode (b) cathode	15
3.3 A simple schematic diagram of a SOFC one-cell stack	15
3.4 The front view of (a) the plate and (b) its drawing	16
3.5 The front view of (a) the plate and (b) its drawing	16
3.6 The front view of the completed (a) opaque and (b) transparent plates	17
3.7 The back view of the completed (a) opaque and (b) transparent plates	17
3.8 One-cell stack fabrication steps (a)-(g)	18-19
4.1 Mechanistic modeling approach	21
4.2a Half PSOFC including one-cell stacks plates	22
4.2b Single-unit	22
4.3 Model geometry	22
4.4 Model geometry including electrochemical, chemical reactions and flow configurations.	23
5.1a Experimental co-flow cell performances for various fuel flow rates	33
5.1b Experimental counter-flow cell performances for various fuel flow rates.	33
5.2 Experimental cell performances for various air flow rate both	34

	co-and counter-flow.	
5.3a	Experimental co-flow cell performances for various H ₂ +N ₂ compositions.	35
5.3b	Experimental counter-flow cell performances for various H ₂ +N ₂ compositions	35
5.4a	Experimental co-flow cell performances for various H ₂ +CO ₂ compositions.	36
5.4b	Experimental counter-flow cell performances for various H ₂ +CO ₂ compositions.	37
5.5a	Experimental co-flow cell performances for various H ₂ +CO compositions.	38
5.5b	Experimental counter-flow cell performances for various H ₂ +CO compositions	38
5.6a	Experimental co-flow cell performances for various syngas compositions	39
5.6b	Experimental counter-flow cell performances for various syngas compositions	40
5.7	Anodic side of the one-cell stack after operation (a) anode and Pt mesh (b) anode surface	41
5.8	SEM images of anode surface at 7500 order of magnitude (a) fresh cell and (b) cell after experiment	42
5.9a	EDX spectrum of anode surface of a fresh cell	43
5.9b	EDX spectrum of anode surface of cell after experiment	43
5.10	The cell performances of simulated syngas for co-flow model	44
5.11	Comparison between the experimental cell performances and the validated model cell performance.	45
5.12	Gas concentration at the electrolyte/fuel channel interface at 0.7, 0.6 and 0.5 V.	46
5.13	Distributions of the concentrations of species (a) H ₂ , (b)	47-48

	H ₂ O, (c) CO, (d) CO ₂ and (e) O ₂	
5.14	Current density distributions at electrolyte/fuel channel interface at 0.7, 0.6 and 0.5V.	49
5.15	Temperature distributions at electrolyte/fuel channel interface at 0.7, 0.6 and 0.5V.	49