

Optimal design of hybrid and non-hybrid fuel cell vehicles

by
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ABSTRACT

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Fuel cells are under development as an alternative power source for automobiles, because of their clean and efficient power production. This emerging technology, however, still has many issues to be addressed for market acceptance. Several fuel cell vehicle concepts have been proposed and studied in terms of safety, robust operation, fuel economy and vehicle performance. Despite the relatively large number of models and prototypes, a model-based vehicle design capability with sufficient fidelity and efficiency is not yet available in the open literature.

In this study we develop an analysis and design optimization model for fuel cell vehicles that can be applied to both hybrid and non-hybrid vehicles by integrating a fuel cell vehicle simulator with a physics-based fuel cell model. The integration is achieved via quasi-steady fuel cell performance maps and provides the ability to modify the characteristics of fuel cell systems. Thus, a vehicle can be optimized subject to its own constraints, which include various vehicle performance metrics, safety, packaging and cost.

Optimal designs using the above modeling environment are compared in terms of fuel economy and vehicle performance. Parametric studies with respect to vehicle, fuel cell

and hybridization parameters are also presented. Even though hybrid vehicles provide increased freedom to designers, the benefit of hybridization of a fuel cell vehicle is not as big as that of a conventional one. Moreover, hybridization without proper power management control may reduce the fuel economy due to increased weight and reduced power generation. Therefore, an optimal control strategy also needs to be taken into account in the design phase of vehicle components.

To my family.

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TABLE OF CONTENTS

DEDICATION	ii
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	vii
LIST OF FIGURES	ix
CHAPTER	
I. INTRODUCTION	1
1.1 Literature Review	5
1.2 Thesis Overview	8
II. Background of Fuel Cells	10
2.1 Brief Description of Fuel Cells	10
2.2 Types of Fuel Cells	12
2.2.1 Polymer Electrolyte Membrane (PEM) Fuel Cell	12
2.2.2 Alkaline Fuel Cell (AFC)	14
2.2.3 Direct Methanol Fuel Cell	14
2.2.4 Phosphoric Acid Fuel Cell (PAFC)	15
2.2.5 Molten Carbonate Fuel Cell (MCFC)and Solid Oxide Fuel Cell (SOFC)	16
2.3 Design Challenges in Vehicular Application using PEM fuel cells	17
2.3.1 Hydrogen Storage and Refueling	17
2.3.2 Packaging and Safety	19
2.3.3 Cost and Weight	20
2.3.4 Durability	21
III. Fuel Cell System Model Explanation	22
3.1 Fuel Cell Stack Voltage Models	23
3.1.1 Typical Performance of the PEM Fuel Cells	25
3.1.2 Fuel Cell Open Circuit Voltage	26

3.1.3	Activation Loss	28
3.1.4	Fuel crossover and internal currents	29
3.1.5	Ohmic Loss	30
3.1.6	Mass transport and Concentration Loss	31
3.1.7	Cell Terminal Voltage	32
3.2	Development of a Quasi-static Fuel Cell System Model	33
3.2.1	Description of the Reactant Suppliers	34
3.3	Overall Mass Conservation and Pressure Balance	36
3.3.1	Fuel Cell Stack Flow Model	39
3.3.2	Compressor Model	42
3.3.2.1	Compressor Scaling	44
3.3.2.2	Surge	45
3.3.3	Cooler and Humidifier Model	46
3.3.4	Manifold Model	47
3.4	Membrane Hydration Model and Humidity Distribution	50
3.5	Fuel Cell Vehicle Model	53
3.5.1	Vehicle Parameters	55
3.5.2	Power Bus and Battery	56
3.6	Fuel Cell Controller	57
3.6.1	Fuel Cell	59
3.6.2	Motor	60
3.6.3	Drivetrain and Vehicle Dynamics	60
3.7	Process Integration	61
3.8	Fuel Cell VESim Simulations with Dynamic and Static FC models	62
IV. System Design Optimization		66
4.1	Objectives and Constraints in the Literature	66
4.2	Optimization Problem Formulation	70
4.3	Optimization Methodologies	73
4.3.1	Simulated Annealing	74
4.3.2	DIRECT	76
4.3.3	NOMADm	77
4.4	Optimization Results	78
4.5	Simulation Results	86
V. Parametric Studies		89
5.1	Vehicle Parameters	89
5.2	Fuel Cell Stack Parameters	90
5.3	Hybridization Parameters	92
VI. Effects of Regenerative Braking and Control Strategy on a Hybrid Electric Fuel Cell Vehicle		96

6.1	Hybrid Electric Fuel Cell Vehicle Model with a Regenerative Braking Module	97
6.2	Problem Statement	100
6.2.1	Design Variable Selection	100
6.2.2	Optimization Problem	102
6.3	Optimization Results for a Hybrid Electric Fuel Cell Vehicle with a Regenerative Brake	103
VII.	Conclusion	107
7.1	Summary	107
7.2	Model Development and Problem Formulation	108
7.3	Optimization and Parametric Study Results	109
7.4	Future Work	111
	BIBLIOGRAPHY	115
	APPENDICES	121
A.	Flow Calculation in Fuel Cell Stack Model	122