

“I hereby declared that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor Mechanical Engineering (Thermal-Fluids)”

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Date : 27 May 2006. ....

**STUDY OF FUEL CELL POWERED WHEELCHAIR**

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**A project submitted in partial  
fulfilment of the requirement for the award of  
the Degree of Bachelor of Mechanical Engineering (Thermal-Fluids)**

**Faculty of Mechanical Engineering  
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*Specially dedicated to my family, beloved, friends and companion..*

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## ABSTRACT

Wheelchair is currently limited in their range of mobility by the capacity of wheelchair battery and several hours of time required to refill the battery after discharge. This study presents the study of typical wheelchair uses in terms of battery replacement to fuel cell system applied to wheelchair. The study of characteristics of wheelchair and fuel cell had been done and many characteristics such as power source, reliability, availability and maintainability, weight and size, space and safety had been analysed. All these characteristics will be applied to power wheelchair in order to propose a power wheelchair based upon fuel cell system power pack. Hence patient can experience greater improvement day to day.

## ABSTRAK

Kerusi roda kini terbatas dari segi pergerakan disebabkan oleh kapasiti bateri dan jumlah masa yang diperlukan untuk mengisi bateri selepas nyahcas. Kajian ini telah mempersembahkan kajian mengenai kerusi roda berdasarkan penukaran sistem bateri kepada sistem "fuel cell" ke atas kerusi roda. Kajian mengenai sifat kerusi roda dan "fuel cell" telah dilakukan dan sifat-sifat seperti punca kuasa, "reliability", availability and maintainability", berat dan saiz, ruang dan keselamatan telah dianalisa. Kesemua sifat ini diaplikasikan ke atas kerusi roda elektrik untuk mencadangkan sebuah kerusi roda berdasarkan sistem "fuel cell power pack". Oleh itu pesakit akan mengalami pembaikan yang amat besar dari hari ke hari.

## TABLE OF CONTENTS

CHAPTER	CONTENTS	PAGE
	<b>SUPERVISORY VERIFICATION</b>	
	<b>DECLARATION</b>	ii
	<b>DEDICATION</b>	iii
	<b>ACKNOWLEDGEMENT</b>	iv
	<b>ABSTRACT</b>	v
	<b>ABSTRAK</b>	vi
	<b>TABLE OF CONTENTS</b>	vii
	<b>LIST OF TABLES</b>	xii
	<b>LIST OF FIGURES</b>	xiii
	<b>LIST OF CHARTS</b>	xv
	<b>LIST OF ACRONYMS, NOMENCLATURES AND SYMBOLS</b>	xvi
<b>CHAPTER 1</b>	<b>INTRODUCTION</b>	
	1.1 Overview	1
	1.2 Problem Statement	1
	1.3 Objectives of Project	2
	1.4 Scopes and limitation of the Project	2
	1.5 Literature Review	3
	1.6 Schedule of Task/ Gantt Chart	6



<b>CHAPTER 2</b>	<b>INTRODUCTION OF WHEELCHAIR</b>	
2.1	Introduction	8
2.2	Types Of Wheelchair	9
2.2.1	Manual wheelchair	9
	2.2.1.1 Rigid Frame Wheelchairs	9
	2.2.1.2 Folding frame wheelchairs	10
	2.2.1.3 Advantages and Disadvantages of Manual Wheelchair	11
2.2.2	Powered wheelchair (electric)	12
	2.2.2.1 Rear-wheel drive wheelchairs	12
	2.2.2.2 Front-wheel drive wheelchairs	12
	2.2.2.3 Mid-wheel drive wheelchairs	13
	2.2.2.4 Advantages and disadvantages of Power Wheelchair	14
2.3	Power Source of Wheelchair	15
	2.3.1 Power Source of Manual Wheelchair	15
	2.3.2 Power Source of Power Wheelchair	15
2.4	Wheelchair Characteristics Analysis	18
	2.4.1 Size and Weight	18
	2.5.2 Reliability and life	20
	2.5.3 Safety	21
	2.5.4 Availability and maintainability	21
	2.5.5 Space	22
	2.5.6 Standard Price between Manual Wheelchair and Power Wheelchair	22
<b>CHAPTER 3</b>	<b>INTRODUCTION OF FUEL CELL SYSTEM</b>	
3.1	Introduction	23
3.2	The Basic Structure of Fuel Cell	24
3.3	The Basic Function of a Fuel Cell	25
3.4	Types Of Fuel Cell	27

3.4.1	Alkaline Fuel Cells (AFCs)	27
3.4.2	Polymer Electrolyte Membrane Fuel Cells (PEMFCs)	29
3.4.3	Direct Methanol Fuel Cells (DMFCs)	30
3.4.4	Phosphoric Acid Fuel Cells (PAFCs)	33
3.4.5	Molten Carbonate Fuel Cells (MCFCs)	34
3.4.6	Solid Oxide Fuel Cells (SOFCs)	36
3.5	Comparison between Fuel Cell and Batteries	38
3.5.1	Characteristic Comparison	38
3.5.2	Costing Comparison	39
3.5.3	Power, Weight and Volume Comparison	40
3.6	Fuel Cell Performance	42
3.6.1	Ideal Performance	42
3.6.2	Actual Performance	45
3.7	PEM Fuel Cell Market	48
3.8	Technical Issues	50

## **CHAPTER 4 FUEL CELL SYSTEM FOR WHEELCHAIR**

4.1	Proposed System Design	51
4.2	Fuel Cell Stack	53
4.2.1	Selection Of Fuel Cell Stack	53
	4.2.1.1 Membrane Electrode Assembly (MEA)	55
	4.2.1.2 Humidifiers	57
	4.2.1.3 Flow Field Plates	57
4.2.2	Costing Consideration	58
4.2.3	Weight and Size Consideration	59
4.2.4	Proposed Fuel cell Stack	59
4.3	Fuel Management Subsystem	61
4.3.1	Selection of Fuel for PEM Fuel Cell	61

4.3.2	Selection of Hydrogen Storage System	62
4.3.2.1	Hydrogen Storage Technology	62
4.3.2.2	Hydrogen Storage Selection Criteria	65
4.3.3	Proposed Hydrogen Storage Canister	66
4.4	Thermal Management Subsystem	69
4.5	Air Flow Management Subsystem	69
4.5.1	Selection of the Air Flow System	69
4.5.2	Proposed Air Flow System	70
4.6	Costing of the Fuel Cell System	72
<b>CHAPTER 5</b>	<b>WHEELCHAIR SYSTEM</b>	
5.1	International Design Specification Standard	73
5.1.1	Wheelchair Dimensions	73
5.2	Wheelchair Parts	78
5.2.1	Frames	78
5.2.2	Upholstery	79
5.2.3	Seating System	79
5.2.4	Brakes	79
5.2.5	Wheels/ Tires	80
5.2.6	Footrests	80
5.2.7	Armrests	80
5.2.8	Controllers	81
5.2.9	Drive System	81
5.3	Wheelchair Frame Material	82
<b>CHAPTER 6</b>	<b>CONCLUSION</b>	
6.1	Summary	83
6.2	Fuel Cell System Design	83
6.3	Wheelchair System	84

6.4	Suggestion and Recommendation For The Future Development	84
	<b>REFERENCES</b>	86
	<b>APPENDIX A</b>	89
	<b>APPENDIX B</b>	90
	<b>APPENDIX C</b>	93

## LIST OF TABLES

NO	TITLE	PAGE
2.2.1.3-1	Advantages and Disadvantages of Manual Wheelchair	11
2.2.2.4-1	Advantages and disadvantages of Power Wheelchair	14
2.3.2-1	Comparison characteristics between Wet, Gel batteries and AGM batteries powered wheelchair.	16
2.4.1-1	Comparison Characteristic of Manual wheelchair	19
3.5.2-1	Cost Comparison to generate one kilowatt (kW) of energy	39
3.6.1-1	Electrochemical reactions in fuel cells	42
3.6.1-2	Fuel Cell Reactions and the Corresponding Nernst Equations	43
4.2.3-1	Proposed PEM Fuel Cell Stack for wheelchair	60
4.3.2.1-1	Metal hydride characteristic.	64
4.3.3-1	Proposed Hydrogen Storage Canister	68
4.5.2-1	Technical Information of Model VR-612 air delivery system	71
4.6-1	Cost implementation of PEM Fuel Cell System	72
5.1.1-1	A standard dimensions of wheelchair design	74

## LIST OF FIGURES

NO	TITLE	PAGE
2.2.1.1-1	Manual rigid frame wheelchair (courtesy of <i>National Transportation Safety Board</i> )	10
2.2.1.1-2	Manual folding frame wheelchair (courtesy of <i>SpinLife</i> )	10
2.2.2.3-1	Electric wheelchair (courtesy of <i>PhillConnection</i> )	13
3.2-1	Principle of A cell	24
3.2-2	A Fuel Cell Stack.	25
3.3-1	Electrolysis	25
3.3-1	Fuel Cell	26
3.4.1-1	Schematic diagram of an Alkaline Fuel Cell	27
3.4.2-1	Schematic diagram of a Polymer Electrolyte Membrane Fuel Cells.	29
3.4.3-1	Schematic diagram of a Direct Methanol Fuel Cells.	31
3.4.3-2	A DMFC supplies a mobile phone, the methanol is provided similar to ink cartridges	32
3.4.4 -1	Schematic diagram of a Phosphoric Acid Fuel Cells.	33
3.4.5-1	Schematic diagram of a Molten Carbonate Fuel Cells.	35
3.4.6-1	Schematic diagram of a Solid Oxide Fuel Cell.	36
3.5.3-1	Graph Watt Hours Versus Volume or Weight between fuel cell and battery.	40
3.5.3-2	Graph Volume Comparison between PEM and batteries	41
3.6.2-1	Ideal and Actual Fuel Cell Voltage/Current Characteristic	45
4.1-1	Fuel Cell System Design Diagram	52

4.2.1-1	PEM Fuel Cell Stack Assembly	54
4.3.3-1	MH Hydrogen Storage Canister (courtesy of APFCT)	66
4.5.2-1	VR-612 Air Delivery System	70
5.1.1-1	Side and top view of wheelchair dimension	73
5.1.1-2	The unoccupied device width.	75
5.1.1-3	The Unoccupied Device Length	75
5.1.1-4	The Armrest Height	76
5.1.1-5	The Handle Height	76
5.1.1-6	The Seat Height	77
5.1.1-7	The Eye Height	77

**LIST OF CHART**

<b>NO</b>	<b>TITLE</b>	<b>PAGE</b>
1.6-1	Progress of PSM 1	6
1.6-2	Progress of PSM 2	7
3.7-1	Total Number of PEM Units Installed Globally by Application	48
3.7-2	Fuel cell demand by Application	49
3.7-3	Fuel cell demand by types	49



**LIST OF ACRONYMS, NOMENCLATURES AND SYMBOLS**

<b>Anode</b>	The fuel electrode, where electrons are donated as the fuel is oxidized. It is the negative electrode in fuel cell.
<b>Bipolar plate</b>	A dense, electronic (but not ionic) conductor that electrically connects the anode of one cell to cathode of another. It is distributes fuel of air to the electrodes.
<b>Cathode</b>	The air electrode, where electrons are accepted and oxygen are reduced. It is the positive electrode in a fuel cell.
<b>Electrocatalyst</b>	A catalyst incorporated into both the anode and the cathode to promote the electrode reaction.
<b>Electrolyte</b>	A dense ionic (but not electronic) conductor. Each fuel cell type is distinguished by the nature of the electrolyte using within it.
<b>Stack</b>	An assembly of many individual fuel cells, complete with gas manifolds and electrical outputs.
<b>AFCs</b>	Alkaline fuel cells.
<b>PEMFCs</b>	Polymer electrolyte membrane fuel cells or proton exchange membrane fuel cells.
<b>DMFCs</b>	Direct methanol fuel cells.
<b>PAFCs</b>	Phosphoric Acid Fuel Cells.
<b>MCFCs</b>	Molten Carbonate Fuel Cells.
<b>SOFCs</b>	Solid Oxide Fuel Cells
<b>MEA</b>	Membrane Electrode Assembly

<b>Ramp</b>	Sloping device joining two different level.
<b>AGM</b>	Absorbed Glass Mat battery.
<b>DoD</b>	Depth-of-discharge
<b>H<sub>2</sub></b>	Hydrogen gas.
<b>H<sub>2</sub>O</b>	Water.
<b>O<sub>2</sub></b>	Oxygen gas.
<b>H<sup>+</sup></b>	Hydrogen ion.
<b>e<sup>-</sup></b>	Electron.

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Overview**

Wheelchair is a mobility device used by people whom walking is difficult or impossible due to illness or disability. There are many types of wheelchair such as manual wheelchair and power wheelchair which has their own advantages and disadvantages. But the most problem of power wheelchair is about the battery. Patients confined to power wheelchairs are currently limited in their range of mobility by the capacity of the wheelchair battery and the several hours of charging time required to refill the batteries after discharge. Hence the battery system should be replaced to fuel cell system in order to maximize the mobility of wheelchair.

#### **1.2 Problem Statement**

Wheelchairs are currently limited in their range of mobility by the capacity of wheelchair battery and several hours of time required to refill the battery after discharge. If battery is replaced with a fuel cell or fuel cell hybrid system, patients can experience greater improvement in day to day.

### **1.3 Objectives of Project**

The objectives of the study are:

- To propose a fuel cell system to wheelchair application based on the fuel cell power pack. The proposed system is based on weight, costing and size considerations.
- To compare the battery and fuel cell based on characteristic, costing, weight and volume.
- To perform a study of wheelchair system.

### **1.4 Scopes and limitation of the Project**

There are some scopes and limitations of the study. There are consists of:

- Study the types of wheelchair and its propulsion.
- Study the energy sources powered wheelchair.
- Study the fundamental of fuel cell system.
- Study the type of fuel cell.
- Replace the energy source using battery with fuel cell thus implementing the fuel cell system technology to the typical wheelchair.

## 1.5 Literature Review

According to Gary Karp (2001), a patient whom walking is difficult or impossible due to illness or disability need great strength and energy in order of manual wheelchair propulsion. Some people resist choosing a power wheelchair because it makes them feel "too disabled." It is important for patient to ask themselves how much of their daily energy they are willing to invest in pushing a manual wheelchair. If they have marginal upper body strength they could exhaust themselves just getting where they are going. Perhaps the path of the journeys that is on a sloping site or live in a hilly town or city. It can be a difficult decision; they must whether preferring to trade having more energy in the day against their public image as a power wheelchair rider. Lack of energy from pushing a manual wheelchair around might even make a difference in their ability to hold a job. Finally, patients must think about how the effort needed to operate a manual wheelchair will affect their health in the long run. Many manual wheelchair riders with twenty or so years of pushing behind them find that their shoulders begin to give out. Patients are better off using a manual wheelchair but not at the expense of their long-term health.

According to Axelson P, Chesney D, Minkel J and Perr A (2001), some people may not be able to manage wheelchair over obstacle such as a ramp this steep, while others can handle much steeper ones. Practice on ramps with railings in public places. Patient need to lean "uphill" in the direction of the slope to maintain balance. With experimentation, patient will learn how steep a ramp their can negotiate alone. Always use a spotter when practicing on ramps and when climbing a steep ramp for the first time. Climb increasingly steeper ramps until they find one that causes your front casters to lift off the ground. Experience the loss of stability, and remember the steepness of the slope that caused this to happen. Obtain assistance before climbing slopes this steep or steeper in the future. Before learning the skills, patient should be able to propel a wheelchair forward and backward, and maintain a seated position when your balance is challenged. They will be able to perform more techniques and negotiate steeper slopes if

they can pop a wheelie and move forward and backward in the wheelie position. If patient cannot master these skills, a powered wheelchair is suitable to meet their needs.

According to Rosemarie Cooper (1999), Ultra-Lightweight wheelchair is easier to propel. It is because it has less mass and better components. It is very comfortable to users, last longer, has fewer serious frame failures and more cost effective.

Cooper R A, Gonzales J and Lawrence B (1997) performed the experiment to compare the durability, stability, and cost effectiveness of three different lightweight wheelchair models: the Everest & Jennings EZ Lite, the Invacare Rolls 2000 and the Quicke Designs Breezy. Ultralight rehabilitation wheelchairs are the most effective in terms of the experiment aspects over the life of the wheelchair.

Amundson JS (1991) performed experiment to design and build a joystick based motor control for a child's wheelchair. The design is intended to allow a child with limited strength to control a wheelchair. There is a master power switch that can be turned on and off by an instructor in a classroom situation. The joystick is made from resistors that provide the input to the pulse width modulation (PWM) circuits. The motors for each back wheel are operated by an H bridge network. The controller is built but modifications are needed for it to work properly.

Cooper R A (1999) performed an experiment to compare the durability, strength, stability, and cost effectiveness of four different ultralight wheelchair models. There were differences in the fatigue life and value among the four models of ultralight manual wheelchairs tested. This indicates that ultralight manual wheelchairs are not all of equal quality. The fatigue life and value of the ultralight manual wheelchairs were significantly higher than those previously reported for lightweight manual wheelchairs. This indicates that ultralight wheelchairs may be of higher quality than lightweight manual wheelchairs. Clinicians and consumers should seriously consider selecting an ultralight manual wheelchair to meet their wheelchair mobility needs.

According to V. Mishra (2004), in a typical PEM fuel cell, a polymer membrane is inserted between an anode and a cathode electrode to form a membrane electrode assembly (MEA), which is further sandwiched between two bipolar plates housing the flow channel. A thin catalyst layer exists between each of electrodes and the membrane, referred to as the anode and cathode catalyst layer, respectively. The advantages of PEM fuel cells include the ability to provide high current densities at relatively low operating temperature and pressure, quick start-up, and pollution-free operation.

F. Yang (2004) discovered that water and thermal management are critical to the overall cell performance. To maintain ionic conductivity, the membrane in a PEM fuel cell requires adequate humidification, which raises the critical issue of water management. During practical operation of fuel cells, both the gas streams are humidified to ensure the proper membrane hydration. However, excessive water will accumulate in the electrode pores and result in the electrode flooding, which degrades the cell performance by preventing the reactants from reaching the catalyst.

### 1.6 Schedule of Task/ Gantt Chart

Activities	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
The PSM Title selection and confirmation of title															
Confirmation of title, scopes and objectives															
Research, data collection and study information															
Literature Review															
First Draft															
Power Point															
Presentation															

Chart 1.6-1 : Progress of PSM 1