"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)"

Signature : ....

Name of supervisor : KOTHWAL ABDUL RAHEEM.

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
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May 2006

"I hereby declared that this thesis is my own work except the ideas and summaries which I have clarified their sources"

Signature : ....

Author : GILBERT ANAK GEORGE

Date : 27th MAY 2006

Specially dedicated to my family, beloved, friends and companion..

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My beloved, who kept me through it all,

Lecturers, staff and relevant personnel who helped in one way or other,

Friends and peers who are great companions in times of need.

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", availibility 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.

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LIST OF ACRONYMS, NOMENCLATURES AND SYMBOLS

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

Ramp	Sloping device joining two different level.
AGM	Absorbed Glass Mat battery.
DoD	Depth-of-discharge
H_2	Hydrogen gas.
H_2O	Water.
O_2	Oxygen gas.
H^+	Hydrogen ion.
e^-	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 re-fill 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 Quickie 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