UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXTENDED ELECTRIC MOTORCYCLE BATTERY MOUNT DESIGN, ANALYSIS AND INSTALLATION

This report submitted in accordance with requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor Degree In Mechanical Technology (Automotive)

by

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DECLARATION

I hereby, declared this report entitled “Extended electric motorcycle battery mount design, analysis and installation” is the results of my own research except as cited in references.

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Date : 25 MAY 2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive). The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Bateri merupakan komponen utama dalam sesebuah motosikal hybrid mahupun elektrik.Bateri sangat penting kerana ia merupakan sumber atau pembekal tenaga untuk penjanaan kuasa sesebuah motor. Dalam kajian ini, sebuah rekabentuk akan dibuat untuk memastikan bateri dapat berada dalam system dengan keadaan baik dan selamat. Justeru, sebuah tapak pemegang untuk bateri tersebut telah direka berdasarkan aspek tertentu. Beteri lithium phosphate ion (LiFePO4) telah dipilih dalam menjayakan projek ini berdasarkan kesesuaian untuk menjana kuasa motor. Dalam proses menghasilkan projek ini, bateri tersebut harus berada di belakang penunggang motosikal tersebut. Aspek keselamatan perlu diutamakan dalam hal ini kerana bimbang akan keselamatan penunggang yang berada di hadapan bateri yang berat. Untuk memastikan aspek keselamatan ini, penggunaan bahan yang betul sangat diperlukan. Justeru, besi yang kuat telah dipilih sebagai bahan utama dalam proses penghasilan tapak pemegang ini. Tapak ini perlu direka dengan ciri boleh ubah untuk memastikan bahagian bawah tempat duduk penunggang dapat dibuka dan ditutup dengan mudah.

ABSTRACT

The battery is a key component in an electric or hybrid motorcycles. The battery is very important because it is the source or provider of energy for power generation motor. In this study, a design will be made to ensure that the battery can be in a system with good and safe condition. Thus, a site for the battery mounting has been designed based on a specific aspect. Batteries lithium ion phosphate (LiFePO4) has been selected in this project for their appropriateness to generate power motor. In the process of this project, the battery must be behind the motorcyclist. Security aspects should be given priority in this regard due to concerns for the safety of the riders that were in front of the battery weight. To ensure safety, the use of the right materials is necessary. Thus, a strong iron was chosen as the main material in the production process. This mounting and bracket should be designed with variable characteristics to ensure the compartment under the rider seat can be opened and closed easily.

DEDICATION

To my supervisor Ir. Mazlan bin Ahmad Mansor and Sir Muhammed Noor bin Hashim. Special thanks for having spent a lot of time and energy in this project. Thanks also to the knowledge that was given to me. Do not forget also to my teammates who have helped, Sylvester Sulip and Mohd Shahril Ikhmal. Thanks also to family members who have been very supportive in this project.

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CHAPTER 1

INTRODUCTION

1.1 Project Introduction

The electric motorcycle is used one or more electric motor for the action of driving or pushing forward. It must consist of a generator to convert the fuel to the electricity. The generator converts the mechanical energy to electrical energy. The electric motor is an electric machine which is converts the electrical energy to mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electrical motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy. This motor runs by the current that supply from the battery. Battery is a main part in hybrid motorcycle. This project is about to design a battery mounting for the hybrid motorcycle.

1.2 Background Study

To design mounting bracket for electric motor hub battery with the controller and charging system on a motorcycle rear frame and perform the strength analysis. Fabricate the working bracket and mount on the bike.

1.3 Problem Statement

The electric motorcycle consists of a battery that is use as a source of electricity. This electric will run the motorcycle. There are a lot of designs of the battery mount for the hybrid motorcycle. This design must be comes out with many aspect including safety. The mount design must be adjustable according to the location of the battery which is at the passenger seat. This design must be adjustable to overcome the problem of opening the compartment under the motorcycle seat. The safety aspect must be takes in this case due to the heavy weight of the battery that is located behind the rider. The strength of the battery mount must afford to hold the heavy battery.

1.4 Objective

I. To design and fabricate a suitable design for battery mount for electric motorcycle
II. To analyze the strength of the design and ensure the effectiveness

1.5 Scope

I. To design a battery mount for hybrid motorcycle
II. To make the strong bracket for the battery mount
III. To make a suitable selection of element for the project
IV. To make an adjustable battery mount
V. Fabricate the complete mount design
VI. Analyze the strength of the model

CHAPTER 2

LITERATURE REVIEW

The literature review is written as a definition is a research study that has been made about a problem that has been identified and how to solve the problem. This review should describe, summarize, evaluate and clarify the project which including substantive findings, as well as theoretical and methodological contributions to a particular topic between literature and field research. The research can be found such as books, journal, web pages and other report. From these sources, the literature review can be interpreted as a review of an abstract accomplishment, organized around and the thesis results should be synthesized into a summary so that important areas can identified.

2.1 Hybrid Motorcycle

Motorcycles are hybrid plug-in electric vehicles (PEV) with two or three-wheel powered by electricity. The electricity is stored on board in a rechargeable battery. This motorcycle is drives with one or more electric motors. The (PEV) are any motor that can be recharged from an external source of electricity. The electric motor is an electrical machine that converts mechanical energy into electrical energy. The reverse of this process would be the conversion of mechanical energy to electrical energy and is done by electric generator.

The hybrid motorcycle basically uses the electronic-continuously variable transmission (e-CVT). This system has been globally accepted as a main architecture for developing hybrid electric vehicle (HEV). It consist of internal combustion engine (ICE), reversible generator, reversible driving motor and transmission component C-T. Chung, 86 (2014) 216-225.

In direct current motor (DC Motor), the starter field of permanent magnet is generated by the permanent magnet of the rotor. This will be an advantage because there is no need to supply additional electric power to generate magnetic field. In normal motoring mode, most electric motor operate through the interaction between an electric motor's magnetic field and winding current to generate force within the motor. In certain application, electric motor can be operating both motoring or braking to produce electric energy from mechanical energy Y-Y. Hsu (2010).

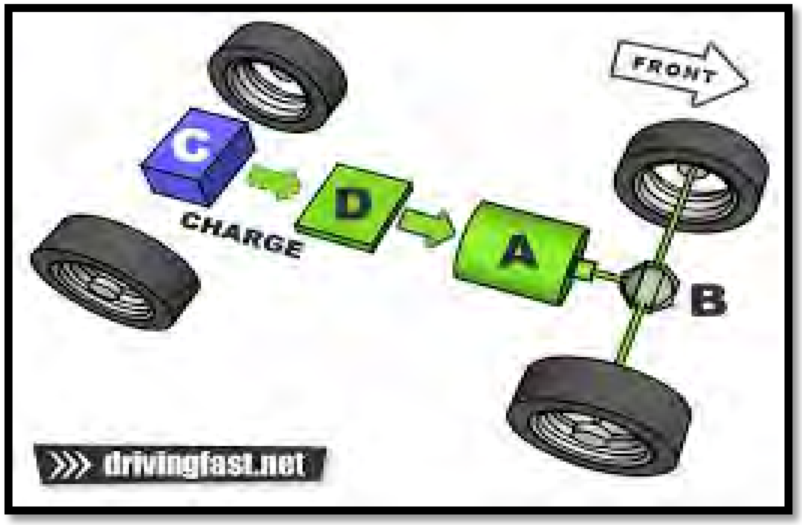

Figure 1 Hybrid system

2.1.1 Advantages of Hybrid Motorcycle

Hybrid vehicle have several benefits compared to the conventional combustion engine (ICE) vehicle. They have lower operating and maintenance costs, and produce little or no local air pollution. They reduce depends on petroleum and may reduce greenhouse gas emission from the on board source of power. This is depending on the fuel and technology use for electricity to charge the batteries. Hybrid vehicle capture most of these benefits when they are operating in all-electrical mode. Despite their potential benefits, market penetrations of plug-in vehicle (PEV) have been slower than expected as adoption faces several hardness and limitation. In 2013, PEV significantly are more expensive that conventional vehicle and HEV due to additional cost of their lithium-ion battery packs.

Other factor of discouraging the adoption of electric car is the lack of public and private charging infrastructure. The driver is fear of the batteries running out of energy before reaching their destination due to the limited range of existing charging place. The problem of PEV can be eliminated because the combustion engine works as a backup when the batteries are running out. The range is less compare to the other vehicle with gasoline tanks.

The fuel consumption of motorcycle is less than passenger car. This fuel economy is due to the motorcycle lighter weight. However, the fuel consumption per weight of motorcycle is much worse than the passenger car. Low output power of motorcycle in urban cause the incomplete combustion and more air pollution due to the low average speed and so many acceleration and braking (Energy Conversion and Management 71 (2013) 12–20).

2.2 Battery in Hybrid Motorcycle

The hybrid vehicles using both electric motors and internal combustion engines are examples of hybrid electric engine, and are not considered pure or all-electric vehicles because they cannot be externally charged and instead they are continually recharged with power from the internal combustion engine and regenerative braking. The concept of battery electric vehicles is to use charged batteries on board vehicles for propulsion. Battery electric cars are becoming more and more attractive with the advancement of new battery technology (Lithium Ion) that have higher power and energy density and higher oil prices. The battery in hybrid motorcycle is use as energy storage to generate the electric motor.

Thermal characteristics and thermal behavior of lithium batteries are important both for the batteries meeting operating life requirements and for safety considerations. Sandia National Laboratories has a broad-based program that includes analysis, engineering and model development. We have determined thermal properties of lithium batteries using a variety of calorimetric methods for many years. We developed the capability to model temperature gradients and cooling rates of high-temperature primary lithium thermal batteries several years ago. Work is now under way to characterize the response of ambient-temperature rechargeable lithium-ion batteries to thermal abuse. Once the self-heating rates of lithium cells have been established over a range of temperatures, the thermal response can be estimated under a variety of conditions.

We have extended this process to isolate the behavior of individual battery components and have begun to understand the chemical nature of the species responsible for heat evolution within the cells. This enhanced level of understanding will enable more accurate modeling of cell thermal behavior and will allow model-based design of safer, more abuse-tolerant lithium batteries for electric vehicles (EVs) and hybrid electric vehicles (HEVs) in the future. Progress toward this goal and key information still needed to reach it are discussed Daniel H Doughty 22 August 2002.

2.2.1 Selection of the Battery

The type of battery is grouped into two categories which are primary cells or non-rechargeable batteries and secondary cells or rechargeable batteries. The example of primary cells battery is alkaline battery, aluminum-air battery, aluminum-ion battery, dry cell and many more. In this case, secondary cell battery is use because the battery must be rechargeable for continuous use. The secondary cells battery includes zinc-bromide battery, lead-acid battery, lithium-air battery, lithium–ion battery and many more. The lithium-ion battery is selected in this project due to the advance in technology of the LiFePO4 battery.

2.3 Advantage of LiFePO4 battery

Lithium iron phosphate is novel and an important member of cathode material for lithium ion batteries. Numerous researches efforts laid the steady foundation of the development of LiFePO4. Several modifications and treatments of LiFePO4 have been used to improve the electrochemical performance for its large-scale manufacture. Carbon coating is an alternative method on enhancing the specific capacity and rate capability. Various carbon atoms have been implemented in previous researches. The conductive carbon coating on particle surfaces can improve the electronic conductivity of LiFePO4 and act as dispersion among the particles to prevent the particles growth.

LiFePO4 has attracted great attention in recent years as a pro- missing cathode material for rechargeable lithium-ion batteries based on environmental safety consideration and various attractive characteristics are associated with LiFePO4. Its low cost, non-toxicity and environmental friendliness make it particularly attractive as a potential replacement for the expensive, toxic and environmentally harmful LiCoO2 as cathode for lithium-ion batteries for consumer electronics applications. Moreover, the exceptional stability of LiFePO4 might enable safe, large lithium-ion batteries for large-scale applications such as hybrid vehicles and load-leveling. Many techniques based on the solid state and solution process have been used to prepare LiFePO4 powders. LiFePO4 electrochemical activities have become a good cathode material for use in lithium- ion batteries because of its advantages having high voltage (3.4V), large theoretical capacity (170mAhg–1), as well as its low cost, high safety, and non-toxicity. Unlike LiCoO2, this forms a solid solution during charge and discharge, and therefore demonstrates sloping charge and discharge curves. LiFePO4 undergoes a two-phase transition between LiFePO4 and FePO4 during charge or discharge with a rather flat voltage profile. Much attention has been focused on the cathode material development to avoid the toxicity, coast and safety problem from $LiCoO_2$ D.Rajeshetal (2015).

Figure 2 $LiCoO_2$ and $LiFePO_4$ battery

Currently people are looking for environment friendly cathode materials for electric vehicle and hybrid electric vehicle application. Olivine type $LiFePO_4$ was reported as a positive electrode material for electric vehicles, hybrid vehicles. $LiFePO_4$ thin-film based electrodes are very interesting electro- chemical devices for portable applications due to their high specific capacity, power density superiority in cost, safety, stability, low toxicity and high-rate performance and thermally stable due to its strong covalent P–O bonds in the tetragonal phosphate an ions. We promised that this sol–gel synthesis displays a great potential for large-scale production. The main advantage of this material having good stability and improved safety at high temperatures compared to the transition- metal oxides that lose oxygen on overcharging, which increases the probability of electrolyte decomposition at higher temperatures. Apart from increasing temperature, this can have a positive influence but is impractical for Li-ion batteries directed to a wide market.

Cathode material is crucial for determining the capacity. In case of cathodes many metal oxides has been consider such as $LiCoO_2$, $LiMn_2O_4$, $LiNiO_2$ and V_2O_5 are the most popular for lithium ion battery. Among the other materials $LiFePO_4$ is a promising cathode material comparing to other conventional cathode materials due to high theoretical capacity playing important role in lithium ion batteries, next generation electronic devices. Cobalt based materials are toxicant harmful to environment, Manganese based materials are good in low cost, low toxic but It will suffer from fading capacity during the cycle. So there is urgent need to develop a good cathode material J.M. Chen (2008).

2.4 Battery Mount

Mounting Bracket for :	Red Top 15	Red Top 25	Red Top 30	Red Top 40
Product Code	7300-0012	7300-0015	7300-0013	7300-0014
Internal Dims (LxHxD) mm	214x151x96	196x182x91	264x167x116	264x219x116
External Dims (LxHxD) mm	259x155x98	240x186x95	309x171x118	309x224x118
Grade of Aluminium	5251 – Good strength and high corrosion resistance			

Table 2.1 Size of Mounting Bracket

The use of battery mount is to protect your battery from damage caused by excessive shock and vibration. Nowadays, there are many companies that compete to make a new design of the battery mount that is lighter and strong. The Varley Red Top is the best product development in battery mount design. The new Varley Red Top battery bracket combines strong and lightweight aluminum with polyethylene foam padding. Unlike some other battery brackets on the market, the Varley Red Top bracket incorporates 10mm closed cell polyethylene foam padding to protect the battery from both excessive shock and vibration emanating from the engine, gearbox and track/road surface.

Slotted fixing points allow for easier fitting in tight and awkward places, permitting the simple loosening of some fastenings when removing or replacing the battery and or mounting bracket. Designed to be fitted in restricted spaces with fixing holes or slots to suit M6 fastening to the sides and base. Available in four different sizes, to suit the popular Varley Red Top 15, Varley Red Top 25, Varley Red Top 30 and Varley Red Top 40 batteries, the brackets offer a weight efficient, robust solution to securing and protecting a battery for racing (www.varleyredtop.com).

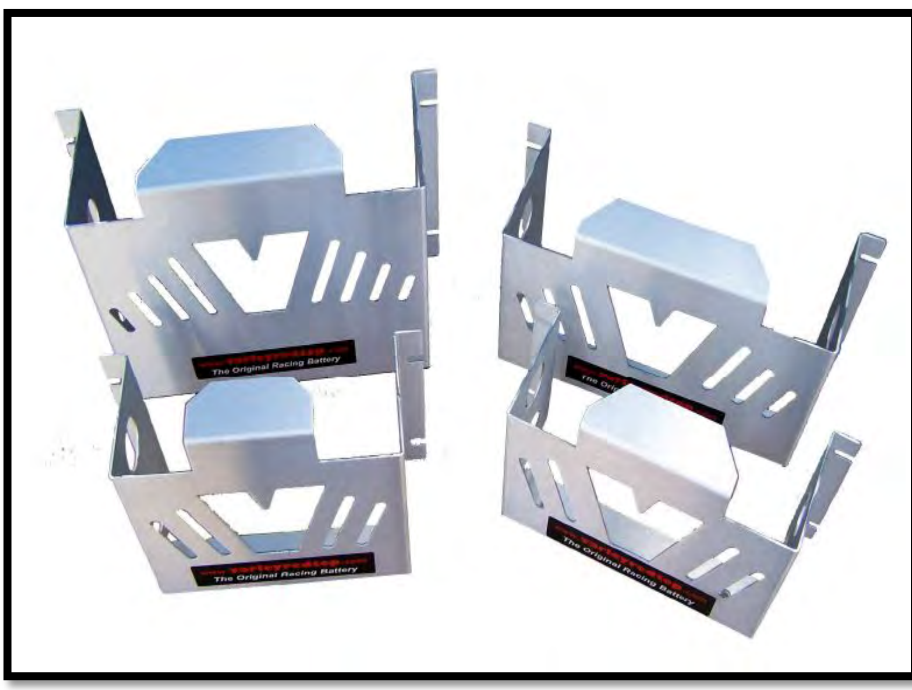

Figure 3 Red Top Mounting Bracket

2.5 Selection of Metal

The behavior and design of high strength steel box and I-section columns at elevated temperatures have been investigated. In this study, the high strength steel with nominal yield strength of 690 MPa was considered. Equations predicting the material properties and stress–strain curve model for high strength steel and mild steel at elevated temperatures have been proposed. A finite element model including geometrical and material nonlinearities has been developed and verified against the experimental results of high strength steel columns at normal room temperature and mild steel columns at elevated temperatures. In the finite element model, the material properties and stress–strain curves at elevated temperatures were obtained from the proposed equations in this study.

A parametric study on high strength steel box and I-section columns at elevated temperatures has been performed using the developed finite element model. The high strength steel column lengths ranged from stub columns to slender columns of 3450 mm, while the temperatures ranged from 22 to 900 _C. Furthermore, the direct strength method was also used to predict the high strength steel column strengths at elevated temperatures. Generally, it is shown that the direct strength method using the reduced material properties conservatively predicted the column strengths of high strength steel box and I-sections for stub and slender columns at elevated temperatures. The main objective of this paper is to study the behavior and design of high strength steel columns at elevated temperatures using finite element analysis.

In this study, equations predicting the yield strength and elastic modulus of high strength steel and mild steel at elevated temperatures are proposed. In addition, stress–strain curve model for high strength steel and mild steel materials at elevated temperatures is also proposed. The numerical analysis was performed on high strength steel columns over a range of column lengths for various temperatures. The nonlinear finite element model was verified against experimental results of columns at normal room and elevated temperatures J. Chen, (2008).

2.5.1 Mild Steel

Mild steel is one of the most versatile and resilient materials, and it forms the backbone of wide varieties of heavy machines as well as for various industries due to low cost and good mechanical strength. Various grades of mild steels have found wide spread usage in making ships, submarines, dry docks, floating docks; slip ways and offshore structures, where highly corrosive marine environment is experienced. Components made out of steel have to undergo wide varieties of manufacturing operations including machining before they are utilized in structural as well as non-structural applications. Machining operations involve removal of metal from a work-piece with the help of a tool made of material harder than the work piece. Turning operation is one of the simplest and most widely used machining processes. Nian et al. (1999) reported in their paper that proper selection of cutting parameters in turning operation is of high importance for generation of good surface finish Nian, C.Y., Yang 1999. Optimization of turning operations with multiple performance characteristic. J. Mater. 95.

Hussain et al. (2009) studied the pronounced effect of the quality of surface generated after the machining process on fatigue resistance. However, they found an increase in fatigue resistance of the samples with smooth surfaces as compared to the samples with scratches. Ghosh and Kain (2010) reported increased susceptibility to stress corrosion cracking of the machined samples as compared to that of the solution annealed stainless steel samples. Dubovska et al. (2014) presented a list of qualitative indicators to assess the integrity of the machined samples with most common surface