UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF PLANETARY TRANSMISSION SYSTEM FLYWHEEL HYBRID MOTORCYCLE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Type your Department's course here) (Hons.)

by

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TAJUK: **Analysis of Planetary Transmission System Flywheel Hybrid Motorcycle**

SESI PENGAJIAN: **2015/16 Semester 2**

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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 Engineering Technology (Automotive Technology) (Hons.). The member of the supervisory is as follow:

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(Project Supervisor)

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ABSTRACT

The internal combustion engine is a great invention that allows a wide range of engineering tasks that require great energy mechanical as moving vehicles and machinery. In this paper, the basic mechanisms of development and design concept of Hybrid Modules Mechanical transmission systems energy subsides displayed. The planet gear grinding or gear system used in this project. However, until now the engine is capable of converting heat energy from fuel combustion into mechanical energy efficiently. The value obtained will encourage efficiency hybridization process was conducted in an effort to improve the efficiency of the system for transmitting power boost. Therefore this study aims to find differences of power in every gear analysis. In addition, to develop a mathematical model of power transmission efficiency flywheel hybrid motorcycle. Further, the power transmission efficiency ratio is calculated motorcycles and made a difference in every gear. In conclusion, the flywheel as a second power source capable of supplying enough energy to drive a motorcycle and at the same time to optimize the use of energy, especially while driving.

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ABSTRAK

Sistem engin pembakaran dalam merupakan ciptaan agung kejuruteraan yang memudahkan pelbagai tugas yang memerlukan tenaga makanikal yang besar seperti menggerakkan kenderaan dan mesin. Dalam kertas ini, pembangunan mekanisma asas dan reka bentuk konsep sistem penghantaran Modul Hibrid Mekanikal reda tenaga dipaparkan. Sistem gear planet atau sistem gear kisar digunakan dalam projek ini. Namun sehingga kini sistem engin mampu menukarkan tenaga haba daripada pembakaran bahan api kepada tenaga mekanikal secara efisien. Nilai kecekapan yang diperolehi akan mendorong proses hibridisasi dilaksanakan dalam usaha meningkatkan kecekapan sistem untuk menghantar kuasa dorongan. Justeru kajian ini dijalankan dengan tujuan untuk mencari perbezaan power pada setiap gear yang dianalysis. Selain itu, untuk membagunkan model matematik kecekapan penghantaran kuasa motosikal hibrid roda tenaga. Seterusnya, nisbah kecekapan penghantaran tenaga motosikal dikira dan dibuat perbezaan pada setiap gear. Kesimpulannya, roda tenaga sebagai sumber kuasa kedua berupaya membekalkan tenaga yang cukup untuk menggerakkan motosikal dan dalam masa yang sama dapat mengoptimumkan penggunaan tenaga terutamanya semasa pemanduan.

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DEDICATIONS

This project and research work is dedicated to my beloved parents for their enthusiastic caring throughout my life, my loving siblings and also my friends for their encouragement and love

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LIST OF SYMBOLS AND ABBREVIATIONS

UDDS	=	Urban Driving Cycle
HWFET	=	Highway Fuel economy Driving schedule
FTP	=	Federal Test Procedure
CVT	=	Continuous Variable Transmission
ω_f	=	Flywheel speed
R_o	=	Flywheel radius outer
R_i	=	Flywheel radius inner
E	=	energy
I	=	Inertia
M	=	Mass
Þ	=	Density
V	=	Volume
ω	=	Angular velocity
ω_{max}	=	Maximum angular velocity
F_{rr}	=	Motorcycle’s friction force
F_a	=	Aerodynamics force
F_r	=	Friction force
F_{ws}	=	Wheel speed force

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$Þ_{wind}$	=	Density of wind
C_D	=	Drag coefficient
A_{front}	=	Frontal area
V_x	=	Velocity motorcycle
C_{rr}	=	Coefficient friction
M_i	=	Mass motorcycle and rider
g	=	Gravity (9.81 m/s^2)
Θ	=	Angle(°)
$P_{pulling}$	=	Motorcycle pulling power
$F_{pulling}$	=	Motorcycle pulling Force
ω_{wheel}	=	Wheel speed
η	=	Number of rotation
ω_{engine}	=	Engine speed
R	=	Wheel ratio

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INTRODUCTION

1.0 Introduction

Hybrid cars take conventional motoring technology and combine it with an electric propulsion system, hence the term 'hybrid'. These vehicles have lower emissions, help you save on fuel costs, and come with a government rebate for hybrid and electric cars assembled in Malaysia.

To be clear, hybrid cars not able to achieve the zero emissions rate that their all-electric counterparts do. Still, they generally produce lower emissions than its petroleum-based cousins, and they last longer than their electric counterparts. Although all-electric cars might be common place in the future, they are still not nearly as practical as petroleum-based cars.

All the same, hybrid cars are an appealing temporary solution; they combine the main advantages of both electric and petroleum vehicles. We're lucky that the Malaysian market offers consumers a decent selection of hybrid cars.

Hybrid vehicles which fall into her hybrid of electric and hybrid mechanical. Mechanical hybrid deployment is still less widespread than electric hybrids because of a mechanical hybrid has a low efficiency and save energy in a short amount of time.

1.1 Problem Statement

The biggest issue of indecision is the compact space of motorcycle. The issue arises when the flywheel hybrid module needs to be assembled on the motorcycle system. The flywheel hybrid module need to be placed in the most suitable parts so that the module can performance with low space needed. The motorcycle engine is already packed with the power and electrical system. Besides, the front side consists of the front brake and the front suspension system. Similarly, the rear side lays the rear

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brake and rear suspension system with the rear wheel attached to the engine system by chains.

Usually, a flywheel hybrid vehicles that can be seen in the high-tech, such example is Volvo and Jaguar are using a CVT transmission. CVT system is very complex and takes a very large room on the vehicle. Therefore, the delivery of medium and small size should be used to solve this problem by creating a CVT, which uses a simple and small.

By then, the planetary transmission system according to replace the CVT transmission to be mounted on a motorcycle.

1.2 Objectives

The objective of this study was to determine the velocity of the basic input on standard driving cycles. In addition, to determine the efficiency of the delivery of the planet for the analysis of experimental results and finally the analysis of transmission performance.

1.3 Scope

Study the concept and analysis of planetary transmission based on previous research and references.

I. To understand the velocity input base on standard driving cycle

II. To understand the operating mode

III. To understand the optimization technique

IV. How to analysis transmission performance planet in the flywheel.

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LITERATURE REVIEW

2.0 Introduction

Hybrid vehicles, i.e., vehicles that use a secondary power source, are a promising solution to the problem of reducing the fuel consumption and carbon dioxide emission of passenger vehicles. For the emerging vehicle market in, e.g., China, hybridization of vehicles is of great interest due to the increasing oil price and stricter environmental legislation. However, the additional cost of most hybrid transmissions, as compared to their conventional counterparts, is relatively high due to costly electrical components, such as large battery packs, high-power electronic power converters, and additional motor(s) and/or generator(s). Such high additional cost may not be acceptable in this cost-sensitive market.(Berkel et al 2011).

2.1 Increase Internal Engine Efficiency and Performance

Human used vehicle in order to move quickly to other place. The vehicle involves are vehicles on land, water and even on air. This research is about a two wheel vehicle which is motorcycle. For an internal engine, the usage of fuel is only 25%-30% from thermal energy exchange to mechanical energy the rest will be released to the surrounding. In addition, vehicle powertrain consist of two parts which are the engine and the driveline. There are several energy losses during driving the vehicles in urban or highway (Lagunoff 2008)

In the area of the engines, efforts are underway to develop direct injection gasoline and diesel engine technologies to improve fuel efficiency (Taymaz and Benli 2014). Direct injection gasoline is also known as GDI is fuel injection that is installed in modern two-stroke and four-stroke gasoline engines. GDI engines are more efficient

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compare to conventional fuel injected or carburater engine because the piston 'pumping losses' has been reduced due to no air throttle that no air throttle plate eliminating air throttling losses in GDI. (US DOE, 2005)

In addition, the engine development had been made in order to increase the engine efficiency. For example is variable valve timing actuation (VVT). These systems will alter timing and lifting of the valve in order to get an optimum setting for the engine speed. These methods had been improving the fuel efficiency by 5%. Other example is turbocharging and supercharging. Both used fans that are used to force compressed air into engine cylinder. A turbocharger is powered by exhaust gas from engine through exhaust manifold while supercharger powered by its own fan. Both allow more air compressed and fuel inject to the engine in order to increase the engine performance. This method increases the engine efficiency by 7.5% (US DOE, 2005).

Hydrogen and carbon are two main elements that are exist in the fuel. It will mix with the air to burn and will produce heat energy. The heat energy is converted to mechanical energy. The development of fuel had been made in order to increase the engine efficiency to burn the fuel. The fuel had been added by additives in order to increase its efficiency. It will make the fuel easy to vaporize, quick to start at cold wheater, smooth acceleration and give maximum power. High quality of fuel will increase the engine efficiency (Li 2007)

2.2 History

Powertrain: The concept of flywheel hybrid powertrain is originated from kid’s toys car. It is used small metal disk known as flywheel to store the kinetic energy transmitted from the wheel during the push action. When release, the store kinetic energy inside the flywheel is transfer back to the wheel and propel the toys car forward. Two concepts gathered from these simple innovations which are the regenerative braking concept and the power propulsion concept. Above all, it does not involve any chemical and electrical concepts. It is totally harnesses the power of mechanical energy. Therefore the same concepts is used in full scale motorcycle to reduces internal combustion engine contribution in propel the motorcycle forward. Furthermore, the

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concept of using flywheel as alternative power source in vehicle is parallel with global initiative to reduce harmful carbon release to atmosphere.(Manaf, et al, 2013)

Hybrid powertrains use a secondary power source to improve the fuel consumption of the primary power source, which is usually an internal combustion engine. The secondary power source is able to store energy from the engine and to exchange energy with the propelled vehicle. The power flows between the engine, the secondary power source, and the vehicle are controlled at powertrain level by an Energy Management Strategy (EMS), which aims at minimizing the overall fuel consumption. For the overall EMS design, it is useful to know the globally optimal solution for a pre- defined driving cycle, as it provides a benchmark for the fuel saving potential of the hybrid powertrain and gives insights in the optimal utilization of the secondary power source . Most EMS designs described in the literature assume that the hybrid powertrain is already at its operating temperature at the start of a driving cycle, when the combustion and transmission efficiencies are already relatively high. The warm start conditions may be realistic after driving a few kilometers, but obviously not when the car has been parked for a few hours.(Berkel et al. 2013)

To greatly expedite the investigation of hybrid powertrain control, a rapid prototyping hybrid powertrain research platform based on a transient hydrostatic dynamometer is proposed. On the one hand, the combustion and emission behavior of the engine is too complicated to be modeled with a low-order approximation; on the other hand, the dynamics of the alternative power sources, hybrid transmission, driveline and vehicle load can be described with well-developed models. Thus, this research platform employs a high-bandwidth hydrostatic dynamometer to emulate the dynamic behaviors of the hybrid power sources (e.g., electric motor/generator) and vehicle loads, and interact with a multi-cylinder IC engine. The engine fuel efficiency and emissions can be measured and hence, the associated benefits and limitations of various hybrid powertrain architectures and control methodologies can be precisely quantified and systematically investigated by experiments, even without building a physical hybrid system.(Wang et al. 2011)

The pay- back period becomes even more attractive when anticipating in- creasing fuel prices and longer utilization of the passenger vehicles that is more than the service life of 150 000 km. When considering the same CVT in the reference

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powertrain (instead of the AMT) for topologies 3 and 4, the relative payback period even reduces to 21%–26%.

However, it is important to realize that these results are optimistic as the fuel saving is based on optimal control, warm start conditions, and without constraints on possibly uncomfortable driving mode switches. One of the main challenges is the design of a powertrain controller, suitable for implementation in real-time hardware that controls the energy dynamics with a close-to-optimal fuel economy performance, and the torque dynamics with a quick, smooth, and consistent response for all driving modes and driving mode switches.(Lagunoff 2008).

2.3 Flywheel

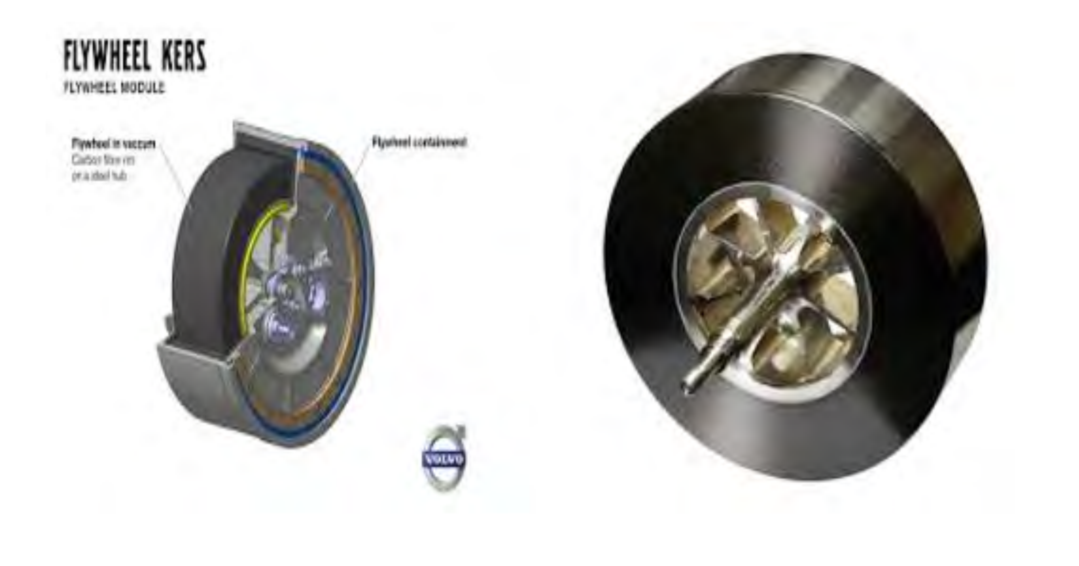

Figure 0.1: Flywheel

Flywheel energy storage systems operate by storing energy mechanically in a rotating flywheel. Electrical energy is stored by using a motor which spins the flywheel, thus converting the electric energy into mechanical energy. To recover the energy, the same motor is used to slow the flywheel down, converting the mechanical energy back into to electrical energy. Flywheels have higher power densities, higher efficiency, longer lifetime and a wider operating temperature range than batteries. Although flywheels have lower energy densities than batteries, their energy density is

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high enough to meet the requirements for many high power applications and still realize performance benefits over batteries.(Tsao et al. 2003)

2.4 Basic hybrid concept

System hybrid used 2 different power sources to move a vehicle. For example, an electric hybrid vehicle such as Toyota hybrid Prius. It can move using an internal combustion engine and using the electric that had been stored in battery. Internal combustion engine is a normal system for normal car that used fuel. Electric that had been stored in battery can be used as secondary power source. This system has increase the fuel efficiency by 80%.

Internal combustion engine has 2 types which are petrol engine and diesel engine. There are 4 types of hybrid that used electric energy stored in battery which is hybrid electric vehicle, plug in hybrid vehicle, electric extended range vehicle and electric battery vehicle. Mild hybrid, medium hybrid and fully hybrid car are the types of hybrid car exist nowadays. There are 3 component exist in hybrid technology which are motor, generator and energy storage. There are 3 hybrid class which are series hybrid, parallel hybrid and series-parallel hybrid (Lagunoff 2008).

2.4.1 Parallel hybrid drivetrain

Parallel hybrid drive train consists of battery, converter, electric motor, and internal combustion engine. Variety of power source can be combined or used one power source in order to move the vehicle. Battery and engine are connected with the energy transfer system. Basically, motor electric is used to help the internal combustion engine.

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