MAGNET DEVICE TO REDUCE DIESEL CONSUMPTION IN DIESEL ENGINE

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ABSTARCT

The objective of this thesis is to design and fabricate a simple and cheap magnet device to investigate the effect of magnets on fuel consumption and exhaust gas temperature. Permanent magnets are cheap, light in weight, safe and at the same time, it is environmental friendly. The magnet device is easy to attach on the fuel line because it is small. SolidWorks is used to design the magnet device before fabricate this device. The magnet device is then fabricated by using acrylic which not attracted magnetic field so that the magnetic field will be focused on fuel line. The magnets help to disperse the hydrocarbon cluster into smaller particles which will improve the efficiency of combustion. This will maximize the combustion and thus reduce the unburned hydrocarbon in the emission. Then, an experiment is conducted by using a diesel engine without load to determine the fuel consumption and also temperature. A graph is then plotted based on the readings to compare the effects of magnets towards the fuel consumption and temperature.

ABSTRAK

Objektif projek ini adalah untuk mereka dan membuat satu alat magnet yang kecil dan murah untuk menyiasat kesan magnet pada penggunaan bahan api dan suhu gas ekzos dalam engin diesel. Magnet kekal ialah murah, ringan, selamat dan mesra alam. Peranti magnet yang direka dengan mengunakan SolidWorks. Peranti magnet ini juga kecil dan mudah untuk mengapit pada tiub bahan api. Saya menghasilkan peranti magnet dengan mengunakan perspek supaya tidak tertaik kepada medan magnet. Hal ini dapat memastikan medan magnet tertumpu kepada aliran bahan api. Magnet membantu untuk menyuraikan kelompok hidrokarbon ke dalam zarah yang lebih kecil yang akan meningkatkan kecekapan pembakaran. Kemudian,uji kaji dijalankan dengan menggunakan enjin diesel tanpa beban untuk menentukan kuantiti bahan api yang digunakandan juga suhu ekzos. Graf diplot berdasarkan pada bacaan yang diperoleh untuk membandingkan kesan magnet terhadap penggunaan bahan api dan suhu.

TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

CHAPTER 3 METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The purpose of this chapter is to discuss about the project synopsis, project background, problem statement, project objectives, project scopes, flow chart of the project and also a Gantt chart to explain the flow of overall process for this project.

1.2 PROJECT SYNOPSIS

The title of my project is “Magnet Device to Reduce Diesel Consumption in Diesel Engine”. This project is basically about how to reduce diesel consumption in diesel engines with the use of magnets. Other than fuel consumption, magnet also helps in reducing unburned hydrocarbon in the emission. The magnet device clamped on the fuel line connected before the fuel injector and run the engine. The design is totally simple and light.

1.3 PROJECT BACKGROUND

The world is now moving on a track called money. Everyone checks the price tag first before going through the specification of the product. Thus, what we clearly can see is everyone wishes to save more money. At nowadays market, there are many type of device for reducing fuel consumption of an engine but the problems is expensive and leave some side effects on the engine performance.

In terms of emission, for every 1kg of fuel burnt, there is about 1.1kg of water vapor and 3.2kg of carbon dioxide produced (BP Australia Limited, 2000). Unfortunately, there is no automobile engines have 100% combustion and so there is also a small amount of products of incomplete combustion and these are carbon monoxide (denoted CO), unburned hydrocarbons, oxides of nitrogen, commonly called NOx and sulphur dioxide. This gaseous lead to hotter exhaust gas emission (Crouse & Anglin, 1993).

In market, there are various type of fuel saver and has its own advantages and disadvantages. The most common type of fuel saver is adding some chemical after filling up the fuel. The chemical is believed to improve the combustion and resulting in better output work.

1.4 PROBLEM STATEMENT

According to Consumer Price Index Malaysia January 2011 which released by the Malaysian National Department of Statistics, fuel prices in Malaysia are increased about 1.8% compared to previous year. The Malaysian Road Transport Department revealed that there were roughly 50000 new cars released each year. The fuel price rises simultaneously with the increasing of usage.

Intergovernmental Panel on Climate Change states that global warming is caused by greenhouse gases in which humans are emitting them in variety of ways. Automobile emission holding the biggest share. Unwanted emission is resulted from incomplete combustion such as carbon dioxide, sulphur dioxide and nitrogen dioxide. This contributes to hotter exhaust gas emission.

Thus, people are looking for fuel saving gadgets in order to reduce the fuel expenses but the problem is the fuel saving gadgets is very expensive which is 23.97 £ equivalent to RM 117.70 (FuelEX).

In order to solve all these problems, I design a magnet device and analyze it in term of fuel consumption and emission by considering the weakness of the currently marketed fuel saver.

1.5 OBJECTIVE

The main objectives of this study are:

i. Design and fabricate a simple and cheap magnet device.
ii. Investigate the effect of magnetism on fuel consumption and exhaust gas temperature.
iii. Fulfill people needs which is to save fuel expenses.

1.6 PROJECT SCOPE

The scopes of this project are:

i. Design the Magnet Device.
ii. Fabricate the Magnet Device.
iii. Theoretical analysis on the fuel consumption and exhaust gas temperature.

1.7 PROCESS FLOW CHART

Figure 1.1 shows the process flow of how this project is done.

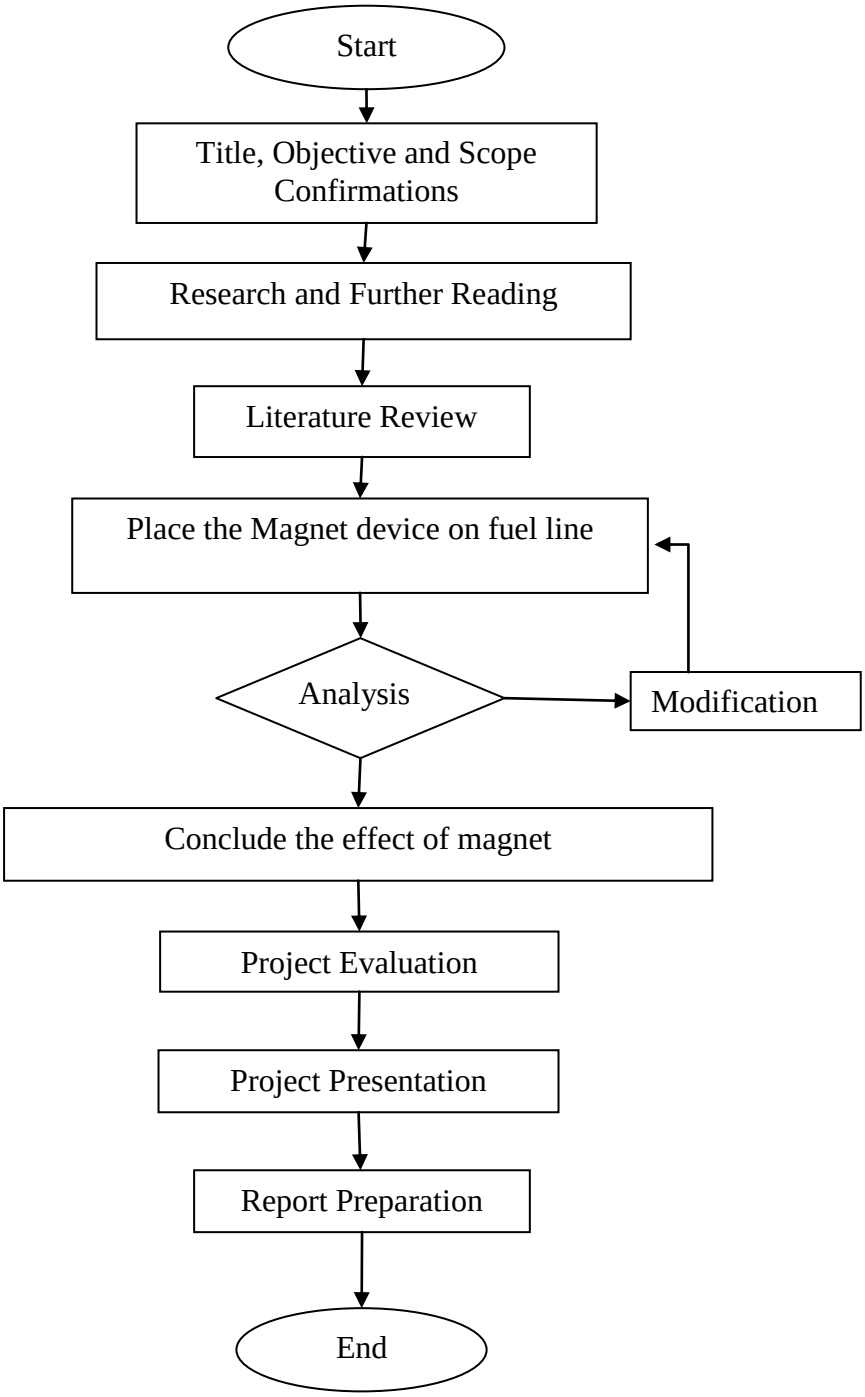

Figure 1.1: Process flow chart

1.8 GANTT CHART

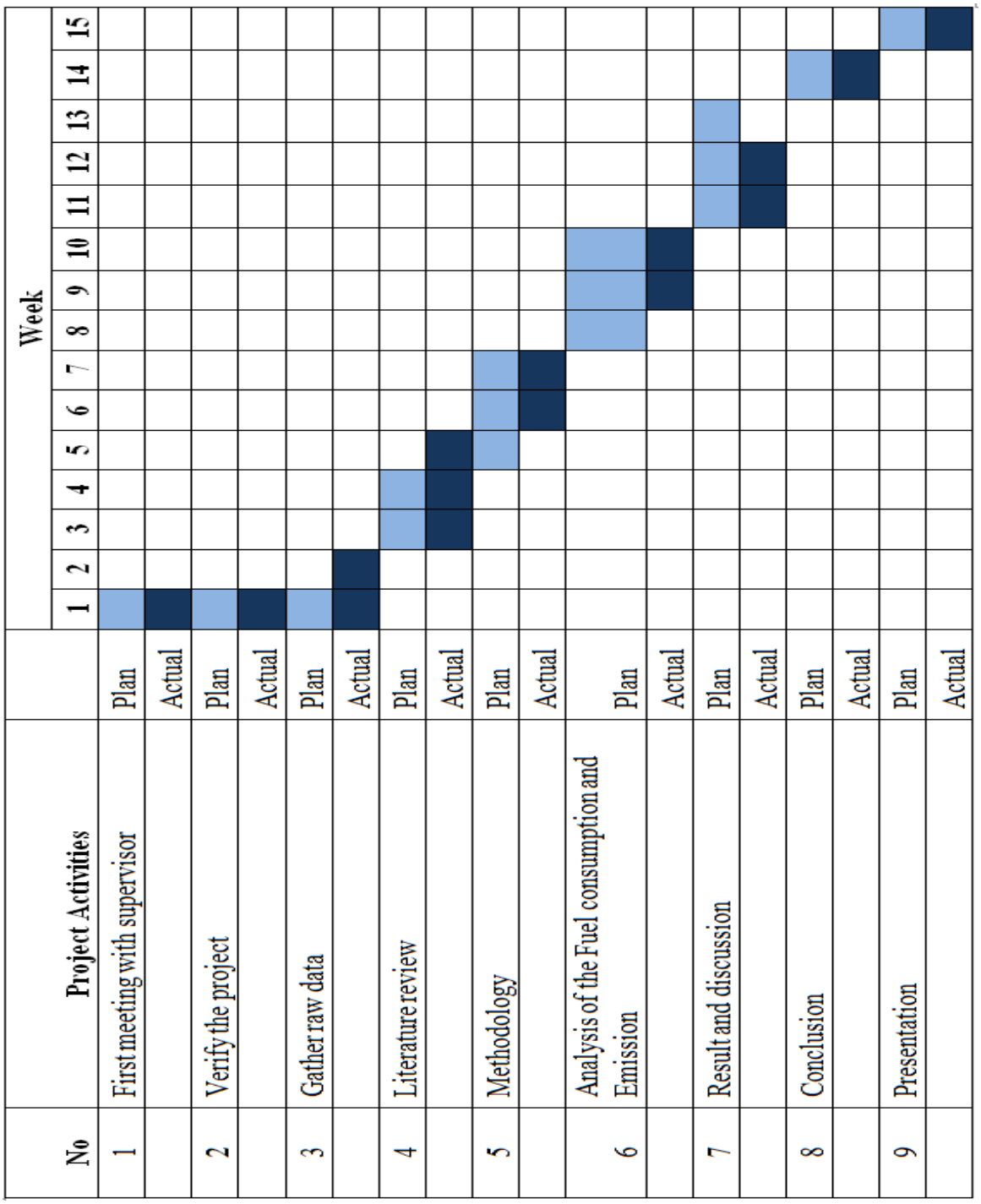

Figure 1.2: Gantt chart

1.9 THESIS ORGANIZATION

Chapter 1 will explain about the project introduction, project synopsis, project background, problem statement, objective, scope, project flow chart and project Gantt chart. This chapter is a basic understanding and planning for my project.

Chapter 2 which is the literature review mainly will explain about the diesel engine, diesel fuel, magnets, magnetic fuel saver and issues regarding fuel consumption.

Chapter 3 which is the methodology will explain about further research about this project which is on the fuel consumption and exhaust gas temperature. This chapter also explains about the flow of my project.

Chapter 4 which is the results and discussion will explains about the analysis of the fuel consumption and the emission.

Chapter 5 mainly explains about the conclusion and recommendation that can be made to the diesel fuel saver in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to review the critical points of the project such as the diesel engine, diesel fuel, magnets, magnetic fuel saver and fuel consumption related issues.

2.2 DIESEL ENGINE

2.2.1 History

Massachusetts Department of Environmental Protection states that diesel engine was invented in the year of 1892 by a German engineer, Rudolph Diesel. At first, Rudolph Diesel tried to come up with powdered coal as a possible fuel but he failed as it is difficult to inject into the cylinder and caused the prototype engine to explode. Then, Diesel discovered a stable byproduct of the petroleum refinement process which is “diesel fuel”. He was the first to prove that fuel can be ignited in high compression condition. Rudolf Diesel then come up with his prime model of a single 10-foot iron cylinder with a flywheel and operated by its own power for the first time at Augsburg, on August 10, 1893 shown in Figure 2.1.

Diesel again came with a new model of diesel engine with the theoretical efficiency of 75% and substitutes steam engines which only have 10% of efficiency at that time. Then, his engine was widely used in marine craft, trucks and factories.

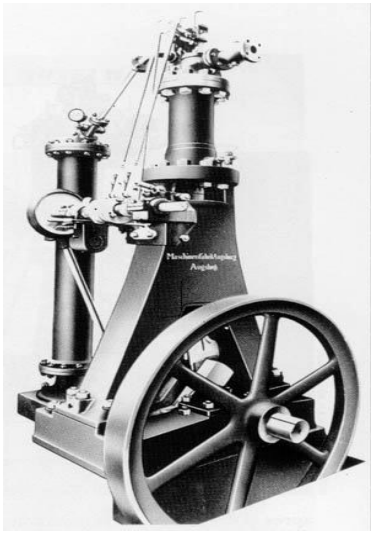

Figure 2.1: Rudolph Diesel's First Prime Diesel Engine

Source: http://www.uniquecarsandparts.com.au/history_diesel.htm

In 1970's, diesel engines were widely used in automobile industry especially in USA. Currently, almost 50% of all new car manufactured in Europe is diesel engine based.

2.2.2 Operation and Priciple

Diesel engine which also known as compression-ignition engine is a four-stroke internal combustion engine. Diesel combustion engine is different from gasoline engine as diesel engine does not use spark plug to ignite the mixture of fuel. The air in combustion chamber is compressed with a typical combustion ratio of 15 : 1 resulting in 4 MPa of pressure. The temperature at this situation is roughly 550 ℃. Mixture of diesel and air will be injected in this compressed region and resulted in combustion. The rapid expansion of combustion gases drives the piston downward and rotates the crankshaft. Force is created (Crouse & Anglin, 1993).

According to Rudolph Diesel's theory, higher compression leads to higher efficiency and power. A gasoline engine compresses at ratio of 12 : 1 have lower efficiency than a typical diesel engine. This proved that the theory is correct.

There are four strokes in diesel engine which resulted from two complete rotation of crankshaft. Figure 2.2 shows the 4 examples of strokes which are intake, compression, power and exhaust.

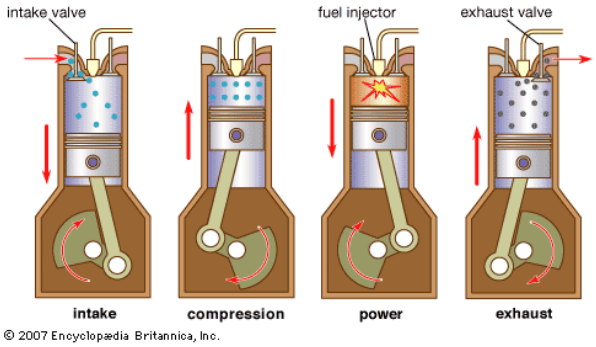

Figure 2.2: The 4 strokes of Diesel Engine

Source: http://www.britannica.com/EBchecked/media/19423/Four-stroke-diesel-engine-The-typical-sequence-of-cycle-events

2.2.3 Advantage and Disadvantage

In term of advantages and disadvantage, I would like to compare diesel engine with gasoline engine as both are internal combustion engine and widely used in automobile industry.

The main advantage of diesel engine is inexpensive diesel fuel. Gasoline is almost 20% more expensive than diesel fuel. Other than that, diesel engine also can produce more torque than gasoline engine. Generally, diesel engines having better mileage than gasoline engines (Matthew Wright). Diesel fuel did not explode like gasoline in case of accident. Thus, diesel engines are safer than gasoline engine. Another main advantage is diesel engine can run on alternate fuel which is bio-diesel

(non-petroleum based fuel) making it more versatile (Bury St. Edmunds, 2004). According to The International Energy Agency (IEA) in the year of 2009, the fuel will peak in the year 2037 at Saudi Arabia, Kuwait, Iraq and Iran. So, how the gasoline engine going to run the car after the fossil fuel comes to the end?

Nothing is perfect. Same goes for diesel engines. The emissions of diesel engines are considered to be the worst disadvantage. Diesel engine release carbon monoxide, nitrogen dioxide (known as NOx), sulphur dioxide and unburned hydrocarbon as the result of incomplete combustion. Sulphur dioxide can dissolve in rain water and resulted in acid rain. Dangerous emission cause the diesel engine to design with emission control system and this makes diesel engine more expensive than gasoline engine. Weather is another problem for diesel engine. During winter season, diesel can freeze in the engine compared to gasoline which is non-freezing (Bob Schmidt, 2007). Thus, longer period of warming up is needed. Maintenance and noisy are considered to be other minor disadvantages (Crouse & Anglin, 1993).

2.3 DIESEL FUEL

Diesel fuel is used to operate diesel engines. Diesel is referred to fossil fuel based product which obtained by refining of crude oil. The oil must have several properties such as proper viscosity, volatility and cetane number in order to be used as diesel fuel (Crouse & Anglin, 1993).

Volatility measures the tendency of a liquid to evaporate. Diesel fuel has lower volatility compared to gasoline. There are two grades of diesel fuel for automotive engines which is number 1 diesel and number 2 diesel. Number 2 diesel is most recommended fuel to be used in automobile industry as number 2 diesel have higher volatility and higher heating value.

Viscosity refers to a liquid's flow resistance. Liquid tends to flow more easily by having low viscosity value. Diesel fuel must have lower viscosity value in order to flow through flow-system lines and inject in the combustion chamber with less resistance. Oil with high viscosity will not break into fine particles when injected which results in poor combustion. Number 2 diesel having lower viscosity compared to number 1 diesel making it more versatile.

Cetane number measures the tendency of the diesel fuel to be ignited in the combustion chamber. Diesel fuel with lower cetane number takes more time to ignite which may cause excessive ignition lag. Higher cetane diesel fuel able to ignite as soon as it injected to the combustion chamber results in smooth pressure rise and prevent from combustion knock occurs.

2.4 MAGNETS

Magnet is an object that produces continuous magnetic field around it which is invisible but the effect of the magnetic field is notable. Magnets can attract all ferromagnetic materials such as iron and also can attract and repel with other magnet. There are many type of magnets in different range of dimension, shape and strength. The most typical magnet used in science laboratory is made up of ferrite and neodymium magnet.

2.4.1 Neodymium Magnets

This magnet also known as Neo magnet which is most widely used type of rare earth magnet and in bright silver colour. This is a permanent magnet which made from alloy of neodymium, iron and boron and this magnet considered to be the strongest magnet type among other permanent magnet. This magnet widely used in electronic based companies and also as motor in cordless tools. The magnetic strength measured in Gauss and permanent magnet has different strength at different region of the surface. The strength of permanent magnets usually measured with ranges for an example, in the project I use two neodymium magnets, one is around

1500 – 2000 Gauss and another is around 2500 – 2800 Gauss. The strength of magnets measured by an instrument called Gaussmeter or magnetometer.

2.4.2 Ferrite Magnets

Ferrite magnet is the compound of ceramic and Iron (iii) oxide. This is an example of permanent magnet and used as ferrite cores in the transformer. Generally, ferrite magnets are carbon black in colour and brittle because the present of ceramic particle in the chemical compound. Ferrite magnets also considered as strong magnets but not as strong as neodymium magnets.

2.5 MAGNETIC FUEL SAVER

2.5.1 How it works?

Magnetic fuel saver is used to maximize the mileage by using less diesel fuel. In other words, magnetic fuel saver able to reduce the diesel consumption in the diesel engine. Many people still wondering how could a magnet changes a non-magnetic liquid's properties. Magnetic effect on non-magnetic liquids is something we cannot see using naked eyes. Thus, the best method to identify the working principle is by setup an experiment.

Diesel fuels is in the form of liquid when it's in the oil tank and the important point is fuel will only combust when they are vaporized and mixed with the air. Thus, something has to be done to break the particles into finer tiny particles to improve the combustion.

Magnets help to ionize the fuel. Fuel is basically from the groupings of hydrocarbons. When the molecules of hydrocarbon flowing through a magnetic field, it changes their orientation in the direction opposite to the magnetic field. Thus, this results in changes of molecule configuration and weaken the intermolecular force between the molecules. In other words, magnetic field actually disperses the

molecules into more tiny particles and making the fuel less viscous. Figure 2.3 shows how magnets help to disperse the molecules.

Emission is another hot topic of diesel engine. Emission of dangerous gaseous such as oxides of nitrogen and oxides of sulphur is the result of incomplete combustion in the combustion chamber. Magnetic field can improve the combustion level. Thus, automatically the amount of dangerous gaseous can be reduced. The amount of unburned hydrocarbon also can be reduced as the combustion rate improved.

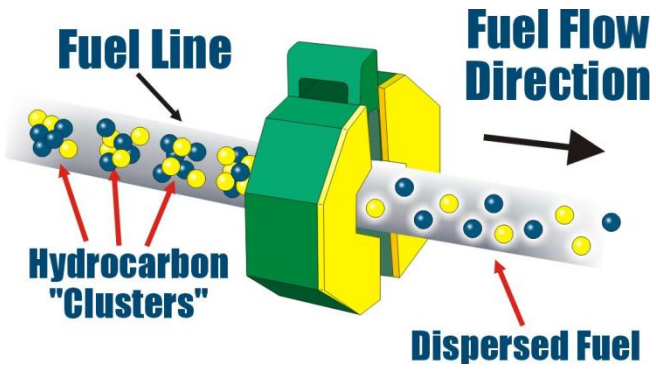

Figure 2.3: The changes in fuel after passing through magnetic field

Source: http://hotproducts.manufacturer.com/product/i877184-CKT+Fuel+Saver.html

2.6 FUEL ECONOMY

Fuel economy also related to the efficiency of the engine determined by distance travelled by an automobile for certain amount of fuel consumed (Crouse & Anglin, 1993). This fuel economy can be measure in both mile per gallon(mpg) and kilometer per gallon (km/L). Most of the Asian countries use kilometer per gallon (km/L).

2.7 EMMISION CONTROL

Diesel Oxidation Catalyst (DOC) is most preferred catalytic converter for diesel engines. This system uses oxygen from exhaust gas to convert carbon monoxide to carbon dioxide and hydrocarbon to water and carbon dioxide. The efficiency of DOC catalytic converter is about 90%. But the problem is this system is not active for oxides of nitrogen and oxides of sulphur (Bury St. Edmunds, 2004).

Additional Selective Catalytic Reduction (SCR) or Nitrogen Oxide Absorber can be fixed to the catalytic converter to trap oxides of nitrogen. Oxides of Nitrogen leave many dangerous health problems such as shortness of breath, eye and nose irritation.

Cryptomelane is a chemical compound which can used to absorb sulphur dioxide. This chemical compound fixed to the catalytic converter for better trapping of sulphur dioxide. Sulphur dioxide emission can be only found in diesel engine as diesel fuel contain small amount of sulphur.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will explain further about the fabrication process and also about how the analysis is conducted. This main objective of this chapter is to ensure the flow of the project is kept on the track. All the information and discussion related to the process of the project will be further explained in this chapter. A flow chart also included in this chapter to show the timeline of the project.

3.2 METHODOLOGY FLOW CHART

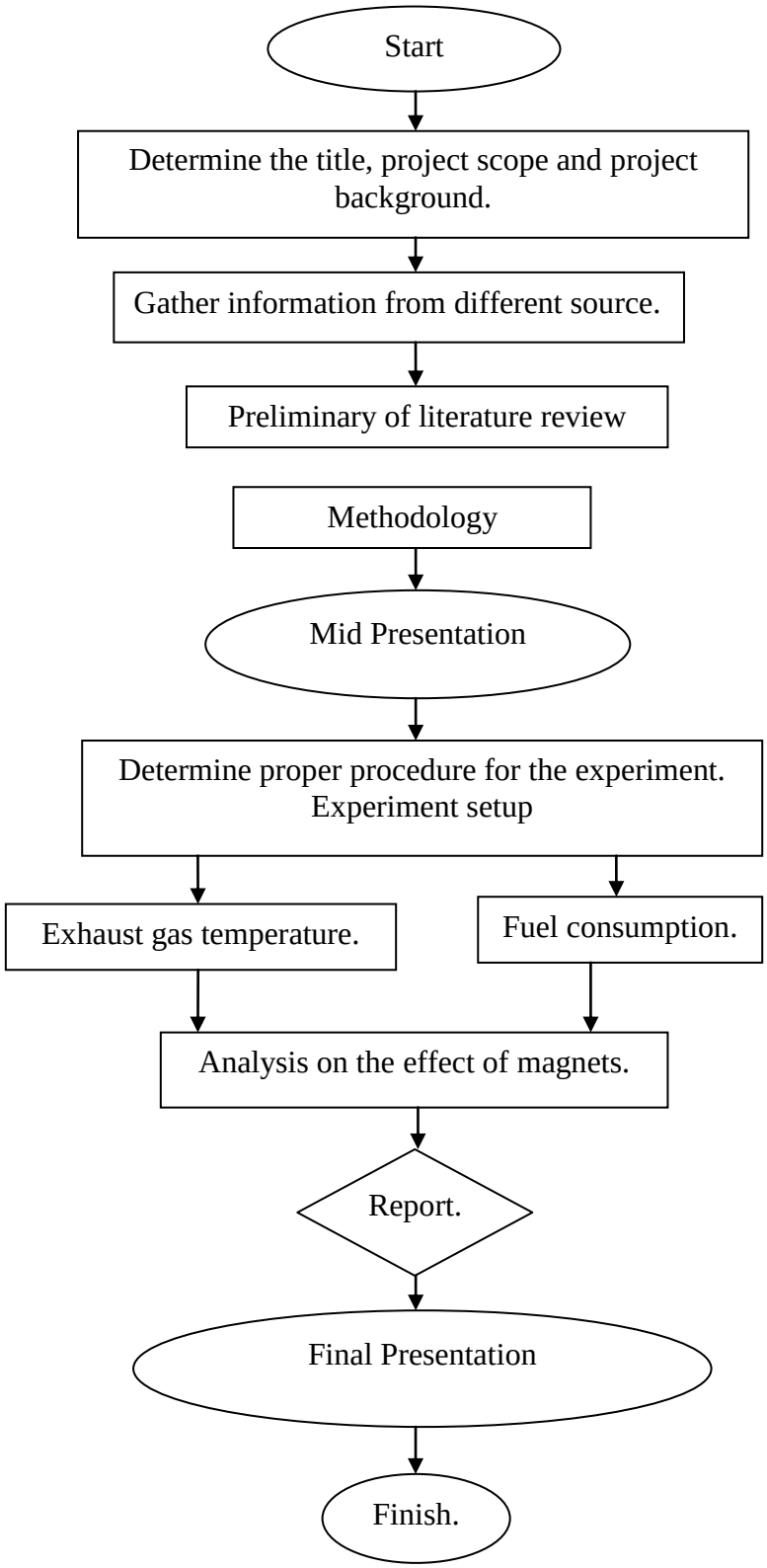

Figure 3.1: Methodology flow chart

Based on the methodology flow chart above, this project starts with determining the title, project scope and project background. Then, preliminary literature review is done by referring to the information gathered from many source such as journals and internet. Methodology is done after that which includes the fabrication of the magnet device. The progress is then followed up by Mid presentation.

After that, experiment setup takes place in order to analyze the effect of magnets on fuel consumption and exhaust gas temperature. The complete report regarding the data analyzed is done before the final presentation.

3.3 DESIGN OF MAGNET DEVICE

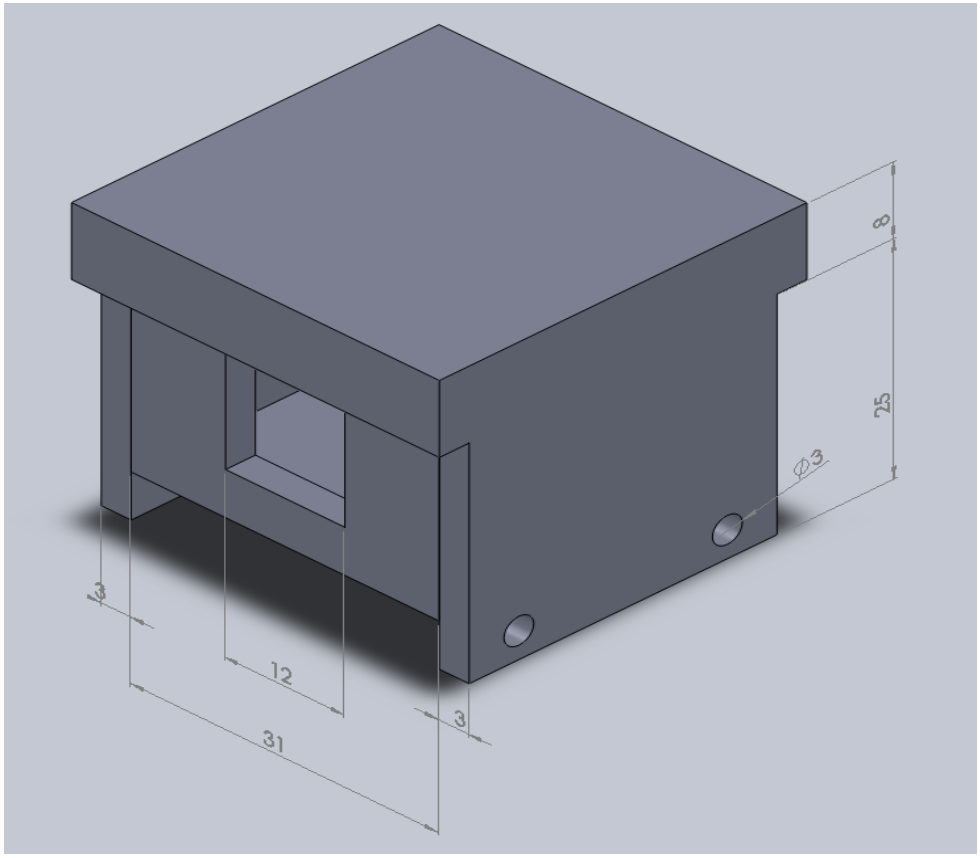

Figure 3.2: Design of the Magnet Device

There are many criteria taken in count before design the magnet device. The magnet device will be attached to the fuel line which connects to the fuel injection system. The figure 3.3 clearly shows that the front engine compartment is too compact. Thus, the magnet device must be designed to be small in size.

Figure 3.3: The interior look of engine compartment

Source: http://speedhunters.com/archive/2011/07/05/event-gt-gt-d1-sl-nikko-pt2.aspx

3.4 MATERIAL SELECTION

The magnet device must be designed from a material that doest attract to magnets. This is to ensure the magnetic field is totally focused on the fuel line and at the same time, the magnet device also must be able to withstand high temperature. This is because magnets may lose its strength if the magnet exposed to temperature of 260 °C. The magnet device also must be strong and rigid so that can protect the magnet from sudden shock and vibrations.

After analyze all the critical points, the best material that can be used to design the magnet device is Acrylic, commonly known as Perspex. This is because acrylic is cheap, not attracted to magnets, relatively high melting point, good insulator of heat,

easy to be shaped, excellent appearance, inert to chemicals and shockproof. The Perspex used in the fabrication process is 3.0mm thick.

3.5 FABRICATION OF MAGNET DEVICE

After the design of magnet device is made, the following process is the fabrication process. The fabrication process is all about converting raw materials into useful product.

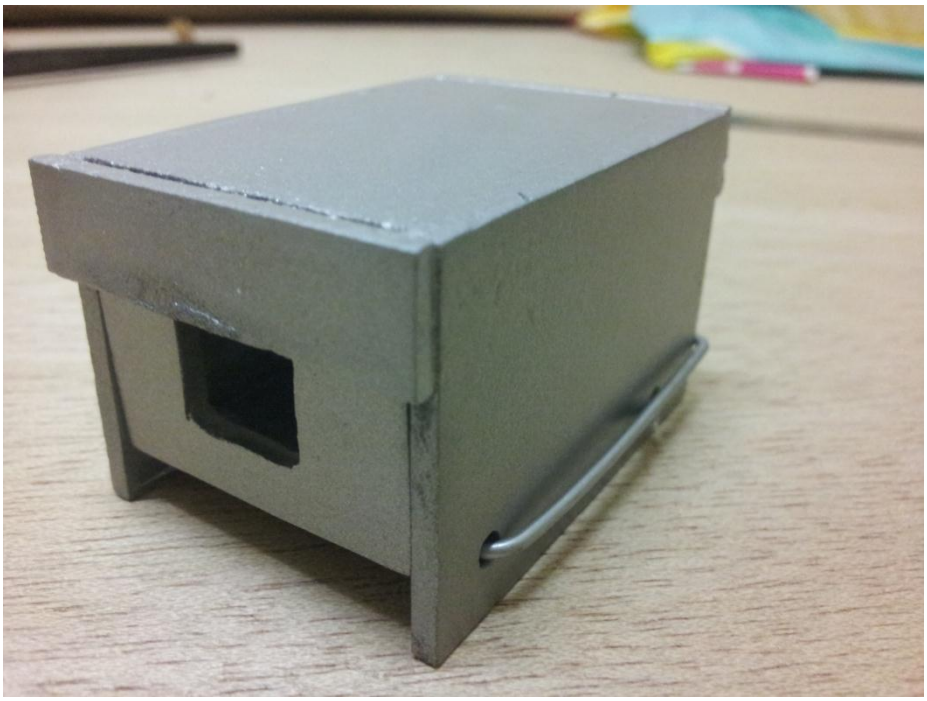

Figure 3.4: The fabricated magnet device

3.6 TOOLS

This project is totally based on analytical method. Thus, many apparatus have to be manually fabricated. There are many tools that have been used in order complete the fabrication processes like Perspex cutter, hacksaw, super glue and L-square. L-square is used in general marking and measuring purpose. L-square also used as a guide for drawing horizontal and vertical lines on the Perspex. Perspex cutter used to mark and cut large pieces of Perspex whereas hacksaw used to cut small pieces of Perspex. All the small Perspex pieces joined by super glue.

Figure 3.5: Perspex cutter

Figure 3.6: Hacksaw

Figure 3.7: Super glue

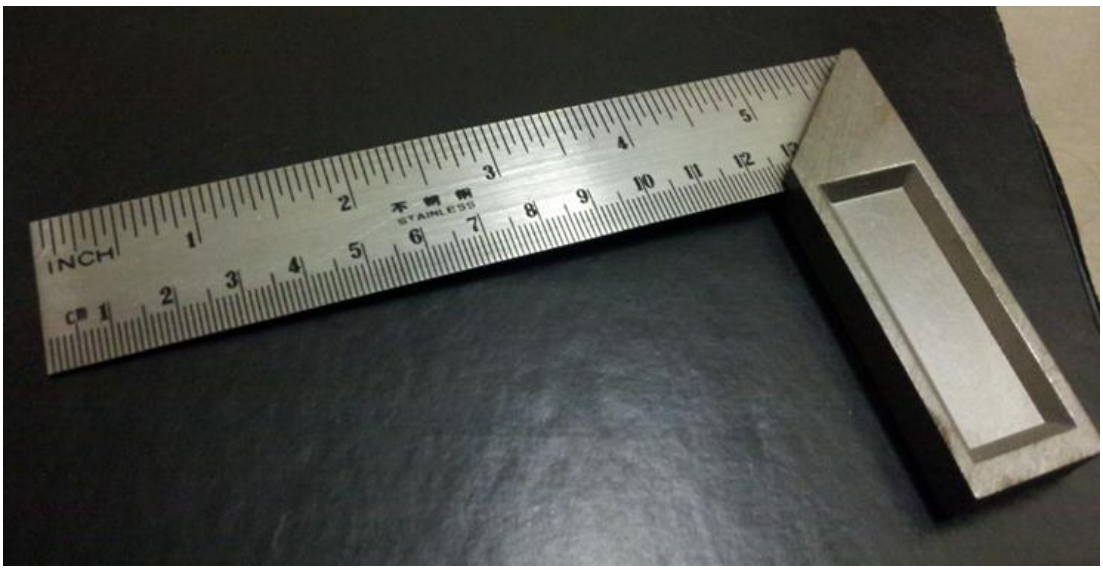

Figure 3.8: L-square

3.7 APPARATUS

3.7.1 Diesel engine

Figure 3.9 shows the diesel engine used in this project which is YANMAR TF120. The diesel engine is made from Japan. The specifications of the engine are as follows:

Brand & Model	: YANMAR TF 120
Displacement	: 636 cc
Size (L/W/H)	: 685cm/350cm/530cm
Weight	: 102 kg
Max Output	: 12 Bhp @ 2400rpm
Fuel tank capacity	: 11 liter
Cooling system	: Water cooled and radiator
Starting system	: Starter or manual cranking

Figure 3.9: Diesel Engine

3.7.2 Magnet

There are 2 types of magnet with 3 ranges of strength are used in this experiment. The two types of magnets are ferrite magnets and neodymium magnets. The three ranges of magnetic strength are 500-800 Gauss, 1500-2000 Gauss and 2500-2800 Gauss. Magnetic field on the surface are vary, and thus the strength given in ranges. The unit for magnetic strength is Gauss and measured by using Magnetometer.

Figure 3.10: 500-800 Gauss Ferrite Magnet

Figure 3.11: 1500-2000 Gauss Neodymium Magnet

Figure 3.12: 2500-2800 Gauss Neodymium Magnet

3.7.3 Air box

The intake of air affects the fuel consumption. Thus, the intake of air must be kept constant in order to measure the fuel consumption. Air box helps to supply constant amount air supply into the intake manifold by maintain the pressure inside the air box.

Figure 3.13: Airbox