PERFORMANCE STUDY ON THE EFFECT OF DIFFERENT EXHAUST LENGTH FOR MOTORCYCLE ENGINE

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ABSTRACT

This research provides an overview of the performance on the effect of the different exhaust length for motorcycle engine. The research also covers the effect in terms of emissions. The engine used was a motorcycle 125cc 4-stroke gasoline engine. There are two method was used; experiment and simulation. For experiment, load applied to the engine with different lengths of exhaust pipe. The engine speed of this study was controlled in the range of 800 – 1000 rpm. The test engine has been attached to the dynamometer. The engine specifications and measured components of exhaust system were used for modelling and visualization using GT-Power simulation software. The different length of exhaust will be used for the simulation. Brake power, brake mean effective pressure (BMEP) and brake specific fuel consumption (BSFC) of the engine are discussed as the performance of the engine. Besides that carbon dioxide (CO_2), carbon monoxide and hydrocarbon (HC) was discussed as the emissions of the engine. The performance test was conducted to investigate the different lengths of exhaust manifold will affect the engine performance and exhaust-out emissions.

ABSTRAK

Kajian ini dihasilkan bagi mendapatkan kesan perbezaan panjang ekzos motosikal terhadap kecekapan enjin. Kajian ini juga mengkaji kesan pencemaran yang terhasil daripada ketiga-tiga jenis ekzos. Enjin yang digunakan ialah enjin motosikal empat lejang dengan kuasa 125cc. Terdapat dua kaedah yang digunakan iaitu secara eksperimen dan simulasi. Bagi eksperimen, beban berbeza dikenakan pada enjin dengan pemasangan saiz ekzos yang berbeza. Kelajuan enjin dikawal pada keadaan 800 – 1000 putaran per minit. Enjin disambungkan dengan *dynamometer*. Bagi proses simulasi, spesifikasi dan saiz komponen bagi sistem ekzos dimasukkan ke dalam perisian GT-Power. Tiga jenis ekzos dengan panjang berbeza digunakan di dalam proses simulasi. *Brake power (BP), brake mean effective pressure (BMEP)* dan *brake specific fuel consumption (BSFC)* yang terhasil daripada keputusan eksperimen dan simulasi pada enjin merupakan elemen yang dikaji bagi menilai tahap kecekapan enjin manakala karbon dioksida (CO_2), karbon monoksida and hidrokarbon (HC) bagi menilai tahap pencemarana daripada enjin. Ujian penilaian kecekapan ini menunjukkan perbezaan panjang ekzos memberikan kesan terhadap kecekapan enjin dan kadar pencemaran daripada enjin.

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LIST OF SYMBOLS AND ABBREVIATIONS

$\dot{m}$	-	Fuel Flow Rate
n_c	-	Number Of Cylinder
V_d	-	Engine efficient volume
B	-	Size Of Bore
BMEP	-	Brake Mean Effective Pressure
BP	-	Brake Power
BSFC	-	Brake Specific Fuel Consumption
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
HC	-	Hydrocarbon
L	-	Length Of Stroke
N	-	Shaft Speed
O_2	-	Oxygen
PPM	-	Parts per million
RPM	-	Rotation per minute
T	-	Torque
UTHM	-	Universiti Tun Hussein Onn Malaysia

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Exhaust system is a part of vehicle components. Nowadays, there are a few types of exhaust system that already developed to provide a specific user's demand. Mohiuddin, Rahamn, & Dzaidin, (2007) stated, the exhaust. According to Mohiuddin et al., (2007), a well-designed exhaust system is one of the cheapest ways of increasing engine efficiency, and therefore increasing engine power. Dynamometer is a device for measuring force, torque, or power. Han-chi, Hong-wu, & Yi-jie, (2012) reported, GT-Power is the industry standard engine simulation tool, used by all leading engine and vehicle makers and their supplier. Many assumptions and simplifications were made to the system in order to complete the model. Then, data will be recorded for analysis and discussion.

1.2 Problem statement

The exhaust system is one of the components in the vehicle. The exhaust stroke is a system that works to remove the product of combustion from the internal combustion engine. Combustion residues through the exhaust valves and out into the environment. When the exhaust pressure occurs during the reversal of the exhaust process, it’s disrupted the level of efficiency of the engine. Therefore the size (length) of the exhaust is very important in ensuring the level of efficiency of the engine can achieve the maximum level.

1.3 Objectives

The objectives of this study are:

i. To determine the optimum length of exhaust manifold for achieving good performance using GT-Power software.
ii. To investigate the effect of different lengths of exhaust manifold to the performances of motorcycle engine.

1.4 Scopes of study

To ensure that the studies will be done accordingly, all the scopes related to the study must be focused on. Here is a list of the scopes of study:

i. This research focused on motorcycle engine with capacity of 125cc.
ii. Simulation and analysis study were carried out using GT-Power software.
iii. The engine was operated at steady state condition with variable dynamometer loads for experimental investigation.

1.5 Significant of study

The study is to provide a new information on the impact of size (length) of exhaust manifold for motorcycle engine with the engine capacity of 125cc. Exhaust size is important to improve the efficiency of the engine of the vehicle.

CHAPTER 2

LITERATURE REVIEW

One of the important components in a vehicle's is exhaust system. The exhaust system is designed to collect the exhaust gases from the engine cylinders, direct them to the muffler, where exhaust noise is reduced, and discharge them into the atmosphere. In addition, exhaust gases may be used to drive a turbocharger for improved air induction for combustion. The exhaust may also be used to eject dirt and dust from the air cleaner into the atmosphere. The exhaust is a component on the burning waste before the engine is released into the atmosphere. Combustion wastes discharged after-stroke exhaust complete operating in the engine.

At present, there are many different types of exhaust have been produced. This is to meet the needs of the production exhaust design that can improve the efficiency of the engine as well as the manufacturing cost. Mohiuddin, Rahamn, & Dzaidin (2007) explained, a well designed exhaust system is one of the cheapest ways of increasing engine efficiency, and therefore increasing engine power. Patil, Navale, & Patil (2014) stated that energy efficient exhaust system development requires minimum fuel consumption and maximum utilization of exhaust energy for reduction of the exhaust emissions and also for effective waste energy recovery system such as in turbocharger, heat pipe etc. from combustion engine system. Mamat, Fouzi, Sulaiman, & Alias (2010) stated that optimum engine cylinder charging was achieved by breathing of an engine dependent on the design of intake and exhaust system.

2.1 Stroke System

According to Mat & Salim (2011) studied, combustion is one of the chemical reactions that always happen in around the world especially in automotive vehicle. Today, different types of internal combustion engines are the most common used on vehicles such as cars, buses, trucks and motorcycles is the engine four-stroke, whether gasoline engines or diesel engines. One-stroke refers to the movement of the piston from the top to the fixed point fixed point or vice versa then the four-stroke engine gets its name from four-stroke each perform a function special entries, compression, procurement authority and the removal of the exhaust gas.

4-stroke engine, also known as Otto cycle engine start patented by Eric b. Davidson and Felice Matteucci in 1854, followed by the first prototype in 1860. They also conceptualized by French engineer, Alphonse Beau de Rochas in 1862 and independently, by German engineer Nicolaus Otto in 1876. Power cycle consists of compression, the addition of heat, expansion and removal of heat, represented by characters four strokes, or the movement of the piston in the cylinder fluctuation. Following are the order of stroke system for four-stroke gasoline and diesel engine :

i. Intake stroke
ii. Compression stroke
iii. Combustion/power stroke
iv. Exhaust stroke

2.2 Exhaust stroke

Exhaust system is designed to evacuate gases from the combustion chamber quickly and efficiently. V S N Ch, M Pradeep, & B Shyam (2014) explained exhaust gases are not produced in a smooth stream; exhaust gases originate in pulses. The exhaust process consists of two steps. Pilkrabek (2003) stated, the first step is blowdown and the second step is exhaust stroke. When the exhaust valve opens near the end of the expansion stroke, the high temperature gases are suddenly subjected to a pressure decrease as the resulting blowdown occurs. This process call blowdown process. A large percentage of the gases leaves the combustion chamber driven by the pressure different across the open exhaust valve. The pressure finally equalized after across the exhaust valve. Pilkrabek (2003) also explained, the cylinder is still filled with exhaust gases at the exhaust manifold pressure of about one atmosphere. The piston travel from the bottom dead center until top dead center and the pushed out the exhaust gases. This process call exhaust stroke.

2.3 Exhaust component

The main Components in engine exhaust system are as following sub-sections.

2.3.1 Exhaust manifolds or EKE

From the Application and Installation Guide, engine exhaust manifolds collect exhaust gases from each cylinder and channel them into an exhaust outlet. The manifold is designed to give minimum backpressure and turbulence. Reddy & Reddy (2012) stated, after completion of fuel combustion process in engine, high pressure gases are released. These gases are enters into the Exhaust manifold through pipes. V S N Ch et al. (2014) clarify, an exhaust manifold is a series of connected pipes that bolt directly onto the engine head. Figure 2.1 show the example of exhaust manifold.

Figure 2.1: The example of exhaust manifold (Reddy & Reddy, 2012)

2.3.2 Catalytic converter

Reddy & Reddy (2012) explained, it is a device used for convert harmful gases like carbon monoxide (CO), nitrogen oxides (NO) into harmless gases like CO_2 and N_2 etc., In present days "three-way" (oxidation-reduction) catalytic converters are widely used on diesel engines to reduce hydrocarbon and carbon monoxide emissions. Figures 2.2 shows details of three way catalytic converter.

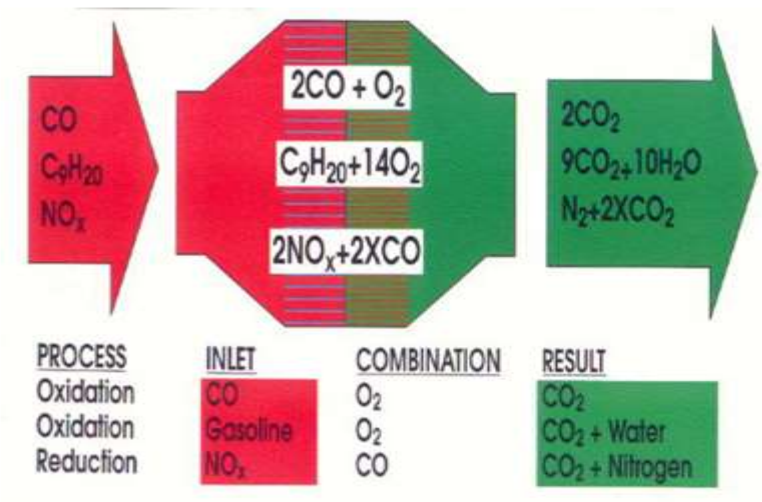

Figure 2.2: Details of three way catalytic converter (Reddy & Reddy, 2012)

2.3.3 Mufflers

Reddy & Reddy (2012) defined, the muffler is defined as a device for reducing the amount of noise emitted by a machine. To reduce the exhaust noise, the engine exhaust is connected via exhaust pipe to silencer called muffler. The various types of mufflers used in automobiles are:

i. Baffle type
ii. Resonance type
iii. Wave cancellation type
iv. Combined resonance and absorber type
v. Absorber type mufflers.

Purpose of Muffler:

i. to reduce the amount of noise emitted by a vehicle.
ii. use neat technology to cancel out the noise.
iii. installed along the exhaust pipe as a part of the exhaust system of an I.C. engine to reduce its exhaust noise.
iv. To reduces exhaust noise by dampening the pulsations in the exhaust gases and allowing them to expand slowly.
v. usually made of sheet steel, coated with aluminum to reduce corrosion. Some are made of stainless steel.

2.4 Exhaust System

A car exhaust system consists of several parts assembled together to move noxious gases from the inside of the car and release it outside. Aside from this, the exhaust system serves other purposes. First, it dampens the sound made by the engine and second, it transforms unspent fuel into spent fuel. Exhaust systems all work in the same manner, although there are many different variations and configurations. All types of vehicles, not just cars, have exhaust systems, and may vary slightly. According to Ahmet Selamet (1999) explained, a new automobile exhaust system reduces pollution and boosts engine power at the same time. The single design takes the place of multiple parts in the standard auto exhaust assembly, including the manifold, muffler and catalytic converter. Rynne (1994) clarify; the effect of vehicle exhausts system components on performance and noise in firing spark-ignition engine. Abraham JA (2010) stated, noise is an unwanted sound at amplitude which causes annoyance or interferes with communication. Noise has been known as menace that can cause a several serious health effect. According to Hultgren, (2011), the noise maybe generated by aerodynamic effects or due to forces that result from combustion process or may result from mechanical excitation of rotating or reciprocating engine components.

2.5 Types of Exhaust Systems

Nowadays, many type of exhaust produce to make various of exhaust. Different design of exhaust also want to increase performance of engine and reduce emission. Types of exhaust system below:

2.5.1 Single Exit Pipe

Based on Types of exhaust systems, (2001) explained, Single Exit Pipe also well-known as single side exhaust, is a standard type of exhaust system, used by auto manufacturers in vehicle production. As derived from the name, the system has one exhaust pipe to release the exhaust gases away from the engine. The tail pipe is commonly located behind the rear wheel on the passenger's side of a car, truck. Single side exhaust is a cost effective system that comes factory-installed on most cars and trucks. The-best-performance-exhaust-systems, (2011) stated, a single side exit exhaust has only one exhaust pipe located on one side of the car. The pipe for this type is often located at the back of the back wheel on the passenger side. It is one of the less expensive types of exhaust, but it generally provides lesser horsepower.

2.5.2 Dual Rear Exit

Dual Side Exhaust system has nearly the same design and location, as the single pipe exhaust system. The one and major difference is in the quantity of exit pipes. This type of exhaust systems is constructed with two pipes. Both pipes are located near each other on the same side of the vehicle behind the rear passenger's side. Depending on the diameter of the exit pipes the sound of system's performance may vary. When the diameter is smaller, the deeper sound will be produced. A dual side exit exhaust has 2 pipes located on the same part of the vehicle. If you want a louder sound than the single side exit, this is your best bet. It also provides less restriction on your car's exhaust system. The canister exhaust for this type is often larger than the actual size of the cylinder. With this type of exhaust, the pipes are located beneath the bumper and are not bent around the rear wheels. It is often said that a dual rear exit exhaust looks better than the other types.

2.5.3 Opposite Dual Exhaust

Dual Rear Exit Exhaust is a popular exhaust system among those vehicles owners, who want their car, truck or SUV look sportier and sound more aggressive. Like dual side exhausts system, this type has the same quantity of pipes. The difference is in pipes location. Dual rear exit exhaust system comes with two pipes that are fixed on the opposite sides under the rear bumper. Contrary to some other types of exhaust systems, the pipes are not bent around the vehicle's wheels. Comparing with the single exit pipe system, this type of exhaust is more efficient. Moreover, a driver will experience deeper sound, giving an impression of high-power engine under the hood. An opposite side dual exhaust is slightly different from the dual rear exit in terms of the location of the pipes. It provides the same sound and performance. For this exhaust, the two pipes wrap around on each side of the rear wheels. This type of exhaust is suitable for trucks or cars that often tow other vehicles. The downpipe and the exhaust pipe are generally made from stainless steel.

2.5.4 Dual Side Exhaust

Opposite Dual Exhaust is also called extreme dual exit exhaust. It is a variation of the dual rear exhaust system. Opposite dual exhaust is mainly used on vehicles that tow heavy cargo. In order to improve the filtering process, the length of the pipes is increased and they are bent around the wheels. This construction makes it possible to decrease the residue that is released on the object that is towed. Besides the length and location of the pipes there is no major difference towards the other exhaust systems.

2.5.5 High Performance Exhaust Systems

High Performance Exhaust is usually offered as an aftermarket add-on. The system is custom-designed to fit the exact make and model. High performance exhausts comparing to standard exhaust systems are more expensive though they have more advantages. They can improve the performance of the engine, as well as increase its efficiency. Moreover, this type of exhaust systems is a stylish option which offers radically different sounds. Installation of the high performance exhaust is one of the ways to customize the vehicle.

2.6 Performance exhaust analysis

This study focus on performance of motorcycle engine when the length of exhaust modified. According to Obodeh & Ogbor (2009) studied, engine performance is strongly dependent on gas dynamic phenomena in intake and exhaust systems. Han-chi, Hong-wu, & Yi-jie (2012) explained, performance of engine can be studied by analyzing the mass and energy flows between individual engine components and the heat and work transfers within each component.

To get better result for analysis exhaust, different condition of engine operate must be consider. From different condition the exhaust system can be develop with maximum utilization of available energy at the exhaust. Patil et al. (2014) stated, design of each device should offer minimum pressure across the device, so that it should not adversely affect the engine performance. In the exhaust stroke, the piston moves from bottom dead center (BDC) to the top dead center (TDC), pressure rises and gases pushed into exhaust pipe. Then, the power required to drive exhaust gases. This process called exhaust stroke loss. The power produce can increase in speed of the exhaust stroke loss. The output from engine per cycle is dependent on the pumping consumer and directly proportional to the backpressure. To reduce backpressure, the pumping work must be low as possible. The backpressure also effect to the exhaust diffuser system. Patil et al. (2014) explained, the shape of inlet cone of exhaust diffuser system contributes the backpressure. When the backpressure increase, fuel consumption also increase. Figure 2.5 show the variation in heat carried away by exhaust gases in % with backpressure on engine for different load conditions using exhaust diffuser system.

Nowaday, the exhaust system design with minimum back pressure requirements is the key factor for upgrading engine performance. Patil et al., (2014) advise, backpressure on engine cylinder is completely dependent on exhaust system design, its operating condition and atmospheric pressure. Based on the Mohiuddin et al. (2007) research, the indicates that the designed exhaust manifold is more efficient in terms of reducing the backpressure in the exhaust manifold pipe. Figure 2.6 show the result for varition of backpressure with engine speed. In addition to diameter, the actual design of exhaust pipe has a tremendous effect on performance. The more bends, kinks and rough edges inside the pipe, the greater the internal friction on the exhaust gasses and the less efficient the exhaust system. According to the Mohiuddin et al. (2007) researched, the newly designed exhaust manifold shows lower backpressure which ultimately result better performance of the engine. Speed of the engine also effect to the peformance of engine.

From the Mamat et al. (2010) researched, when the brake power achieves maximum point, the brake specific fuel consumption reached it lowest point. Figures 2.3, 2.4, 2.5 and 2.6 shows the different speed effect to the brake power and brake specific fuel consumption (BSFC). The brake power increased when the speed also increased but it decreased after achieved maximum power. The result shows different situation to the BSFC. The BSFC is still maintain when the speed increase until 2500 rpm and then decrease at 3000 rpm but increase after 3000 rpm.

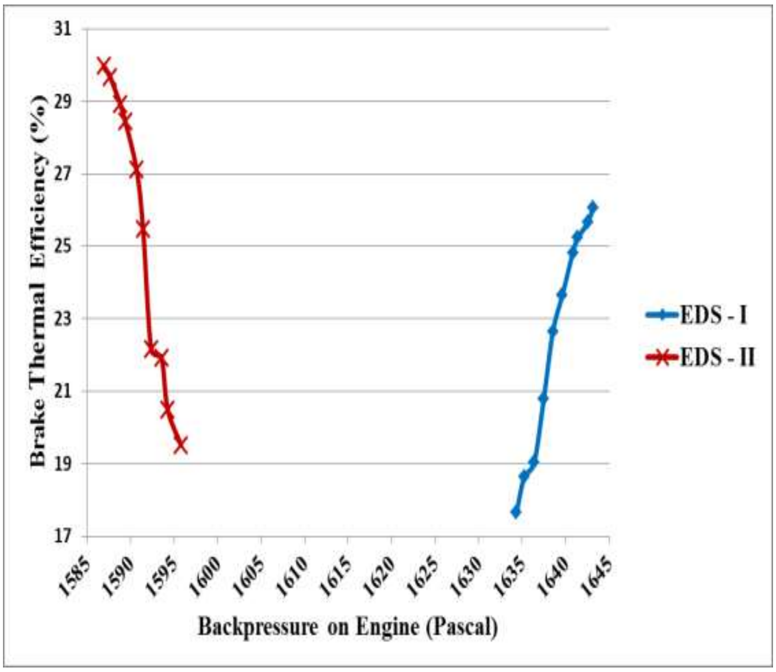

Figure 2.3: The variation in heat carried away by exhaust gases in % with backpressure on engine for different load conditions using exhaust diffuser system (Patil et al., 2014)

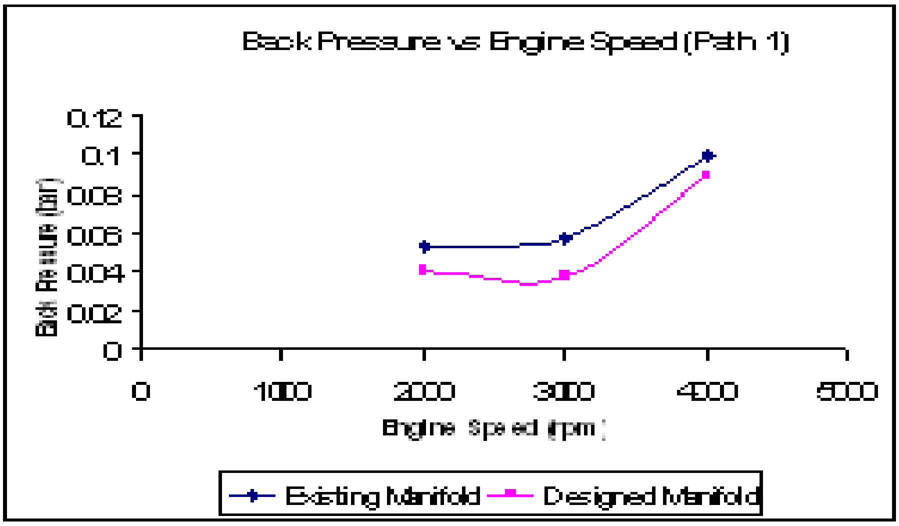

Figure 2.4: Result for varition of backpressure with engine speed (Mohiuddin et al., 2007)

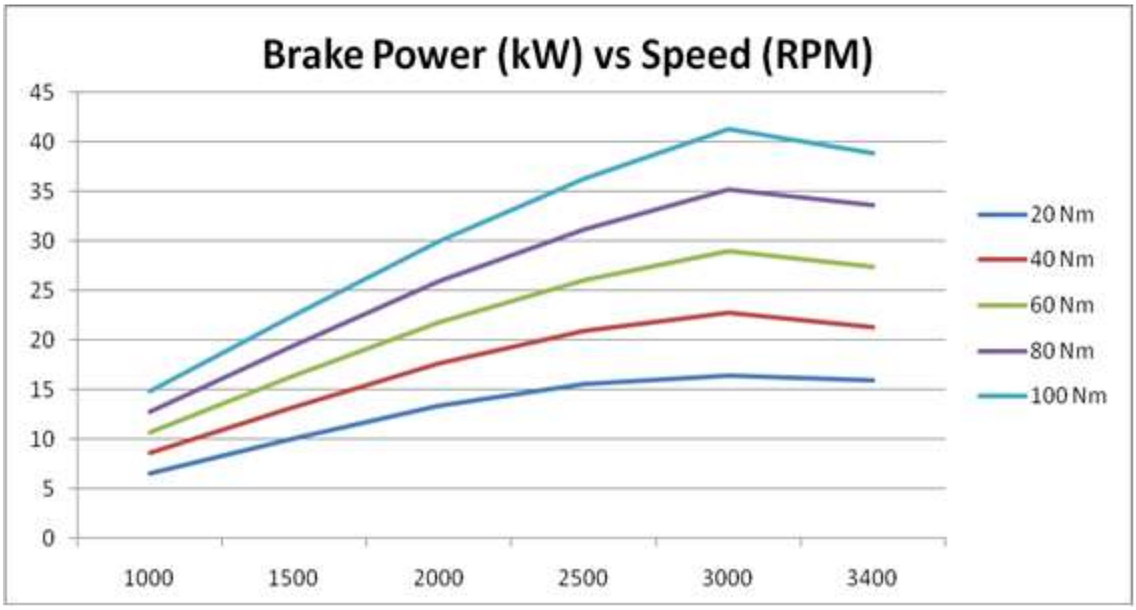

Figure 2.5: The different speed effect to the brake power (Mamat et al., 2010)

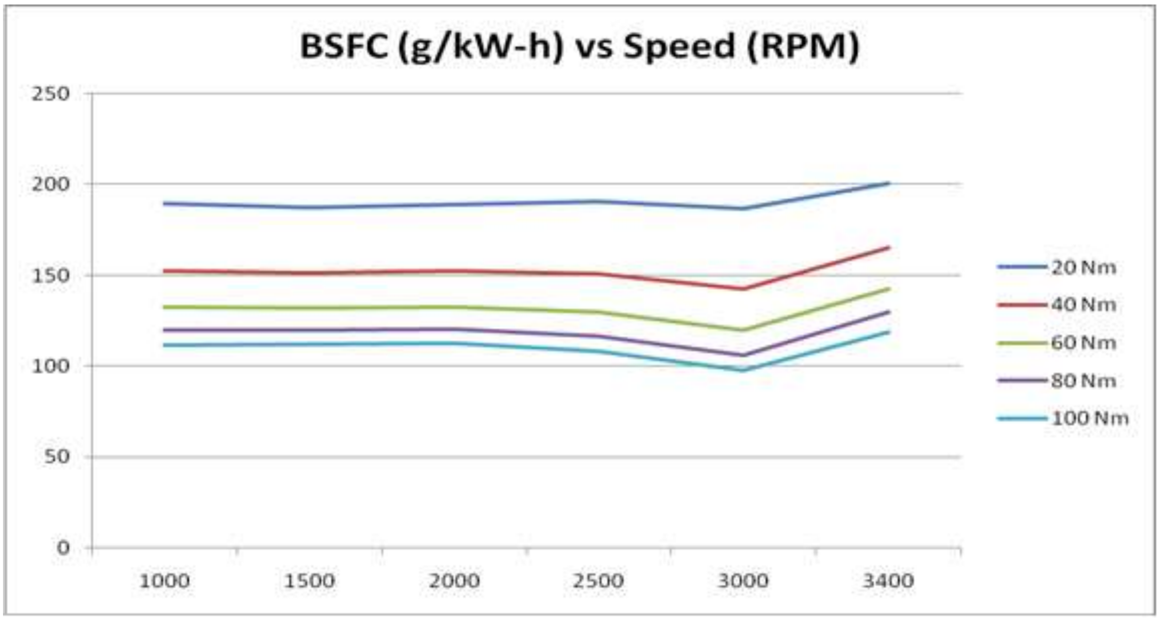

Figure 2.6: The different speed effect to brake specific fuel consumption (BSFC) (Mamat et al., 2010)

2.7 Motorcycle engine

Heywood (1988) explained, the purpose of internal combustion engines is the production of mechanical power from the chemical energy contained in the fuel. In internal combustion engine, as distinct from external combustion engines, this energy released by burning or oxidizing the fuel inside the engine. The burning process when the fuel and air mixture together before compress in the engines. The burned products are actual working fluids. The burned product produce high pressure impact to transfer power output directly to the mechanical components in the engine.

Faisal et al. (2010) studied, traditionally, small capacity engines employed the use of carburetor to control the amount of air and fuel that entered the combustion chambers. Small capacity engine also produce high power to weight ratio and create low emission. Generally for motorcycle, there are two types of stroke; two stroke and four stroke engines. This two types of stroke engine have advantages and disadvantages for the different condition. Basic different between two stoke and four stroke engine is the completion of stroke and the method how fuel is supplied to the combustion chamber.

2.8 GT Power

Mohiuddin et al. (2007) explained, GT SUITE is an integrated set of computer aided engineering(CAE) tools developed by Gamma Technologies, Ins. for design and analysis of engines, power trains and vehicles. GT SUITE is a complete software to design and simulate the product for analysis. From the Gamma Technologies, these tools are contained in a single executable form which is essential to its use in 'Intergrated Simulations'. GT SUITE devide to six solvers such as GT Power, GT Drive, GT Vtrain, GT Cool, GT Fuel and GT Crank. In GT SUITE also have GT-ISE is to model-bulding interface and GT-POST is a powerful of supporting tools. Mohiuddin et al. (2007) also say, GT-ISE provides the user with the graphical user interface (GUI) that is used to build models as well as the means to run all GT SUITE applications.

GT Power is industry-standard engine simulation tools, used by all leading engine and vehicle manufacturers and their suppliers. According to F1, NASCAR, IRL, etc all, is also used for ship and power generations engins, small two and four stroke engines and racing engines. GT Power provide for the user with various of components to model any advanced concept. Faisal et al. (2010) studied, GT-Power is a program that widely used in an automotive research area. From the GT Power user manual, among its advantages is its ease of use and its tight integration with the rest of GT SUITE, which give GT Power a virtual engine perspective.

To develop the GT Power model, all component from selected engine need to be assemble part by part. The engine specifications will be used for modelling and visualization using GT-Power simulation software. Han-chi et al. (2012) has simplified their exhaust system by modelled it as a straight pipe and did not consider the effect of silencer. Also, the pressure losses in the ports are included in the discharge coefficients for the valves. Mohiuddin et al. (2007) explained, modelling is started from pipe parts of air induction process.

Mohiuddin et al. (2007) have provided some steps for easier model the exhaust system. For the existing exhaust manifold, the pipes are discretized into eight stages for the exhaust manifold. This makes it easier to measure the angle of bend, radius of bend, and the exhaust length. All components are modelled with same specification and dimension with the real components. Figure 2.7 show the basic schematic of engine model in GT Power. From the Faisal et al. (2010) paper, In this GT Power simulation model, the engine will be built into several systems as shown in figure 2.8, there are intake system, engine and fuel injection system and exhaust system.

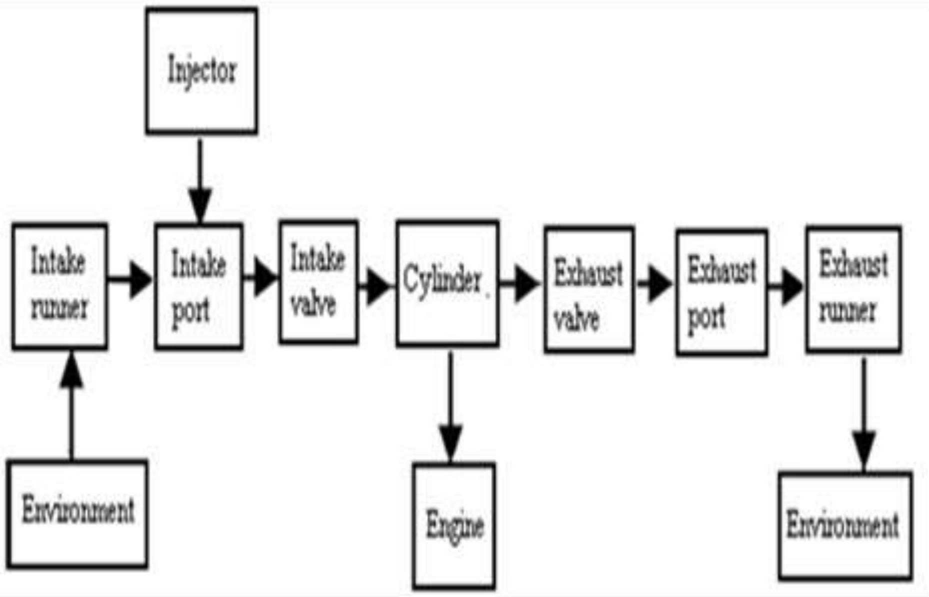

Figure 2.7: The basic schematic of engine model in GT Power
(Han-chi et al., 2012)

Figure 2.8: Systems model in the simulation modeling (Faisal et al., 2010)

2.9 Dynamometer

According to Gitano (2007), a dynamometer is a load device which is generally used for measuring the power output of an engine. Several kinds of dynamometers are common, some of them being referred to as “breaks” or “break dynamometers”: dry friction break dynamometers, hydraulic or water break dynamometers and eddy current dynamometers. Figure 2.9 shows the schematic of an Eddy Current Dynamometer. Dynamometers have several components attach together such as the shaft with bearings, the resistance surface, the resistance mechanism, a strain gage, and a speed sensor. Generally some method of cooling is also required, and this may require either a heat exchanger or air or water circulation. Dynamometer connect to the frame of the engine being tested. Dynamometer also connect to flywheel of motorcycle and then produce moment of inertia to simulate the mass of the motocycle and rider. Figure 2.10 shows the schematic of a speed controlled test of engine.

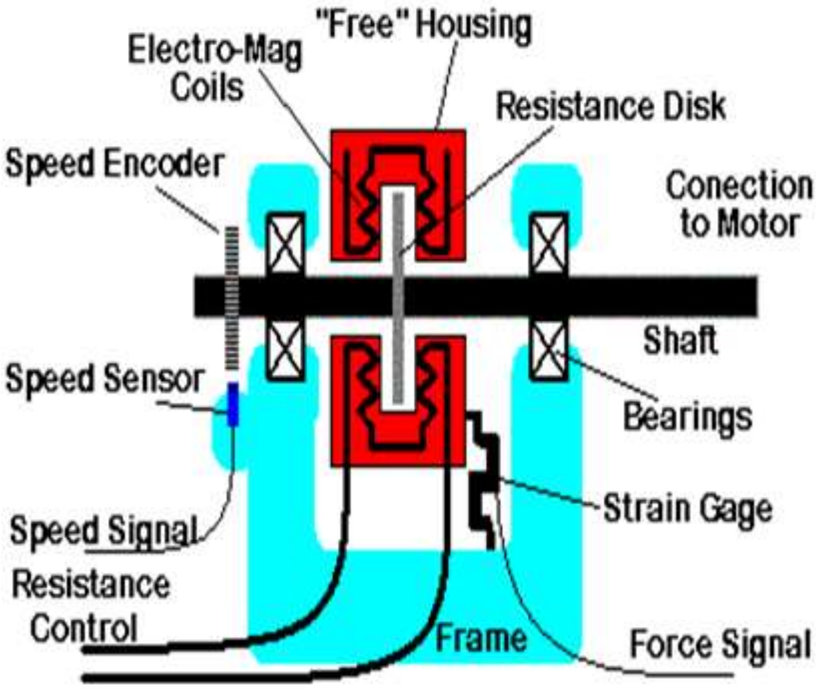

Figure 2.9: Eddy Current Dynanometer (Gitano, 2007)

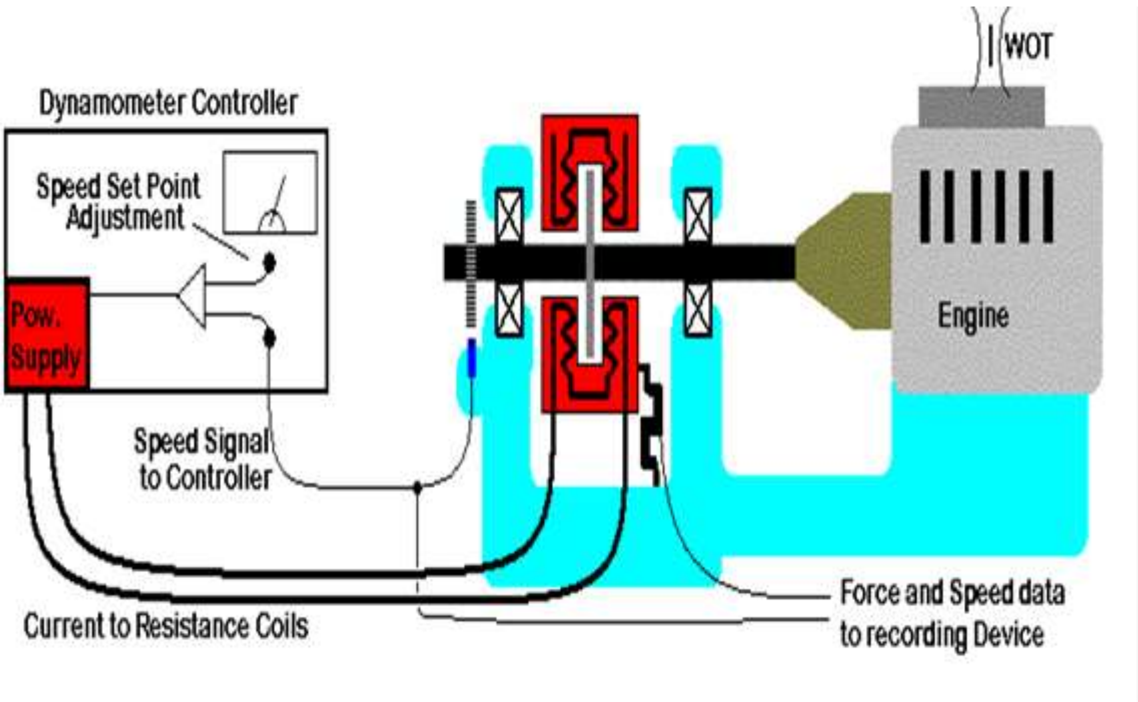

Figure 2.10: Schematic of a Speed Controlled test of engine (Gitano, 2007)

2.10 Pollution of gasoline engine

In Malaysia, air pollution and environment protection has drawn much attention. These problems concern since global environmental problem first emerged as a commom wolrdwide concern at the United Nations Conference on Human Environment in 1972. According to Mohsin & Majid (2013) studied, average emission of fine particulate is 77 μ/m^3 and this figure is above $50ug/m^3$ acceptable standard followed by Department of Environmental for Malaysia.

In the urban city as Kuala Lumpur, the number of motorcycle use rapidly expanded over past several years. Department of Transport Malaysia (2011) stated, the increasing number of motor vehicles is from 19,016782 in 2009 to 2125 milion in 2011. Motorcycle used gasoline fuel for the combustion in the engine. Gasoline fuel produce Carbon Monoxide (CO), Nitrogen Dioxide (NO) and unburned Hydrocarbons (HC) will react with sunlight in the lower atmosphere to form ozone. Figure 2.11 shows relation between exhaust emissions and air/fuel ratio for gasoline engines.

It is estimated that in 2010 the combined air pollutant emission load was 1,681,440 metric tonnes of carbon monoxide (CO); 740,006 metric tonnes of nitrogen dioxides (NO_2); 174,820 metric tonnes of sulphur dioxide (SO_2) and 26,964 metric tonnes of particulate matter (PM) (Department of Environment Malaysia, 2011). Mohsin & Majid, (2013) stated, in 2010 the emission load of HC and CO was estimated to be 372,924 metric tonnes and 1,597,955 metric tonnes respectively. Except for PM, there was an increase in emission load for HC, CO, SO_2 and NO_2 as compared to 2009. Figure 2.12 shows the estimated annual air pollutant emission loads of HC, CO, PM, NO_2 and SO_2 from motor vehicles for 2009 and 2010.

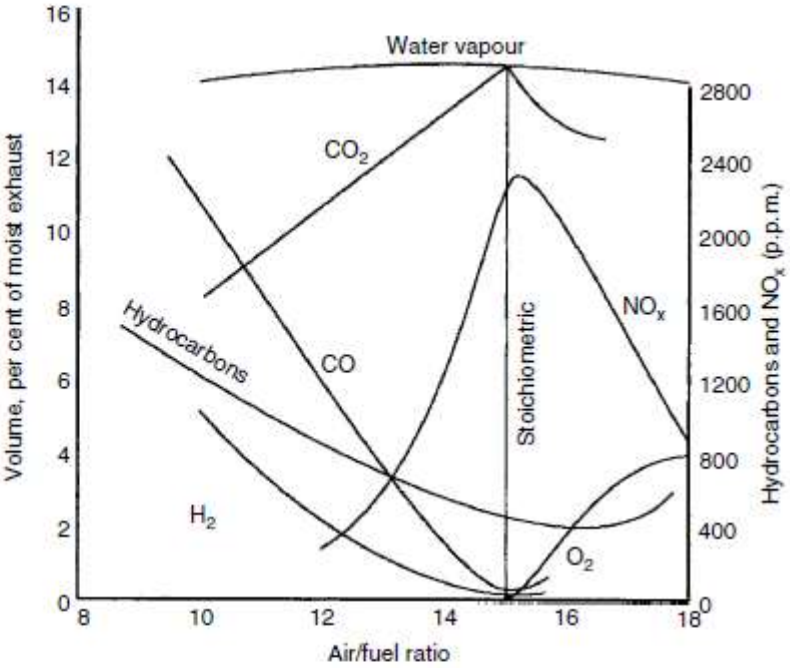

Figure 2.11: Relation between exhaust emissions and air/fuel ratio for Gasoline Engines (Martyr & Plint, 2007)

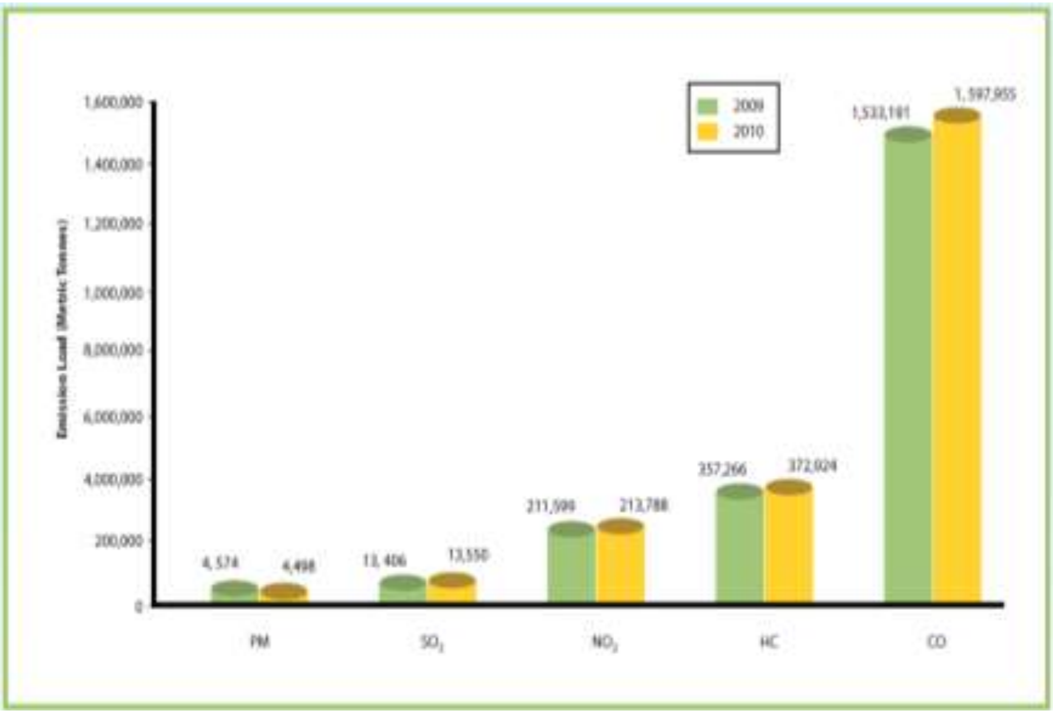

Figure 2.12: Estimated annual air pollutant emission loads of HC, CO, PM, NO_2 and SO_2 from motor vehicles for 2009 and 2010 (Mohsin & Majid, 2013).

Vehicle emissions are affected by driving patterns, traffic speed and congestion, altitude, temperature, and other ambient conditions; by the type, size, age, and condition of the vehicle's engine; and, most importantly, by the emissions control equipment and its maintenance. Faiz, Weaver, & Walsh (1996) explained pollutant emission levels from in-service vehicles vary depending on vehicle characteristics, operating conditions, level of maintenance, fuel characteristics, and ambient conditions such as temperature, humidity, and altitude. Many product produce to reduce level of emission. Faisal et al. (2010) stated, there are three ways to reduce emissions form spark-ignition engines which are; changes in engine design, combustion conditions, and catalytic after-treatment. Another factors affect to the level of emission is air-fuel ratio, ignition timing and turbulence in combustion chamber.

CHAPTER 3

METHODOLOGY

The flow of the study as a whole for this project is shown in Figure 3.1. For ease of description, a number of other flow chart shown in the appendix will be described later. It is important to understand in relation to the scope of the study has been given to ensure the review methodology does not conflict with the scope. This research is based on experiments for exhaust system conducted on motorcycle engine 125cc to get original data. Obodeh & Ogbor, (2009) stated, experimental test result were presented for power output, specific fuel consumption and engine test emissions. This chapter describes the process of measuring the exhaust system for the motorcycle engine 125cc, experiment and simulation setups. Figure 3.1 shows the flowchart for the research process.

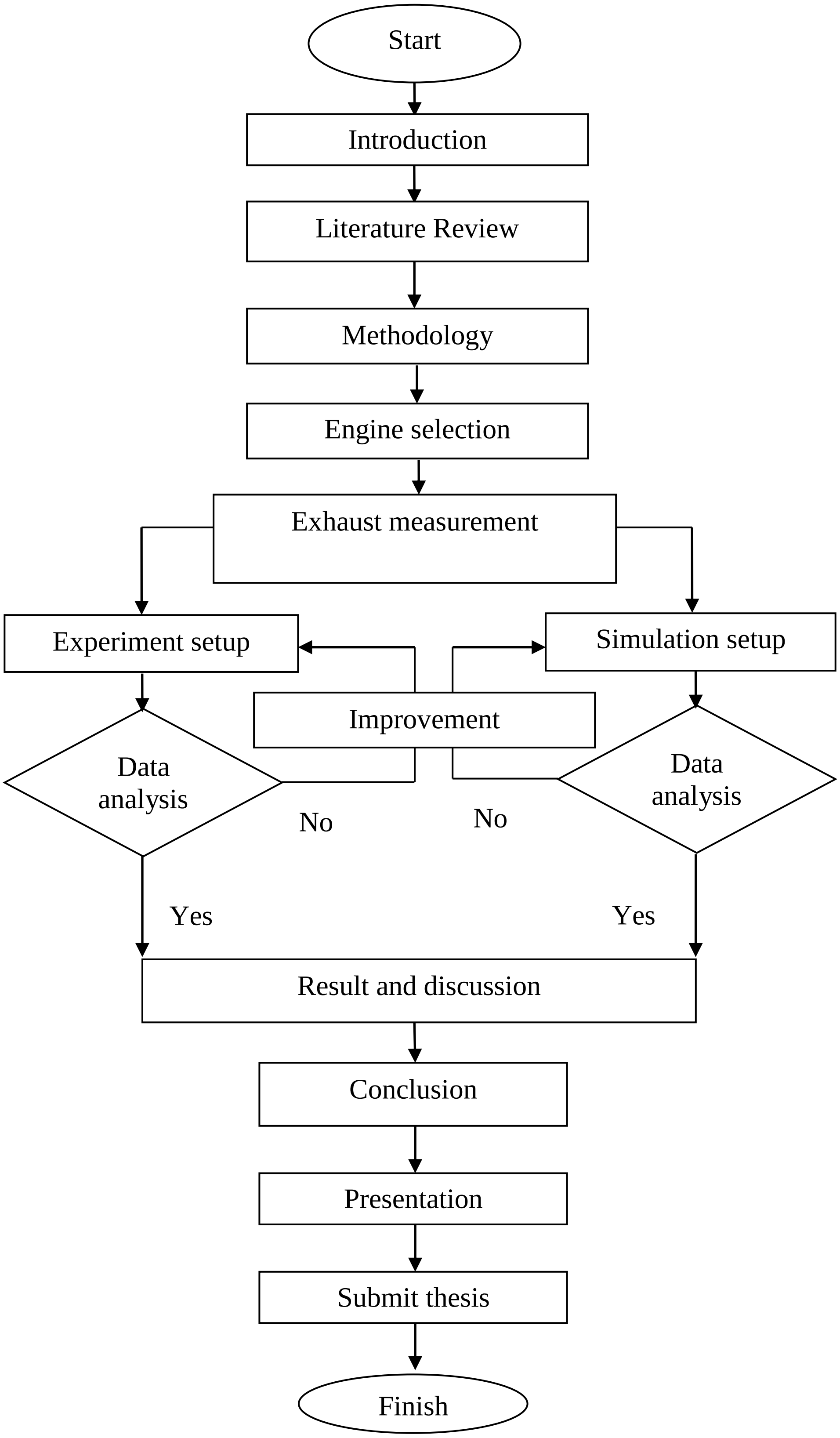

Figure 3.1: Flowchart for research process

3.1 Engine selection and exhaust measurement

The selected engine for this study is a motorcycle engine with engine capacity of 125cc. Table 3.1 shows the engine specification of 125cc four stroke motorcycle gasoline engine. Based on Mohd Faisal, Ahmad Jais, Hazlina, & Mohd Taufiq, (2013) research, four stroke spark ignition engine has been selected and are of interest because of they have the potential for very lean operation and they might operate unthrottled (or less throttled) at part load. Mohiuddin, Rahamn, & Dzaidin, (2007) stated, the major area of concern in the work is to focus on the engine of exhaust manifold instead of the whole components of exhaust system.

By using GT-Power software, the whole components of exhaust manifold must be considered to insert the parameters in the software for simulation and analysis because the exhaust manifold cannot perform by itself. The simulation and analysis process must have combination of all exhaust components. The components of exhaust system that will be measured are; exhaust manifold, catalytic converter, pipes, and muffler. The exhaust size for 125cc motorcycle engine take from the intake manifold to the end of pipe. Table 3.2 shows the different length of exhaust.

Table 3.1: The specification of 125cc four Stroke Motorcycle Gasoline engine

JUSTIFICATION	SPECIFICATION
Engine type	4 Stroke, SOHC, 2-valve
Cylinder	Single cylinder
Combustion system	Spark plug
Transmission	4 gear
Speed	125 cc
Piston	52 mm
Stroke	57.94 mm
Connecting rod	130 mm
Compression ratio	9.3:1
Maximum power	6.7 kW/7500 rpm
Maximum torque	1.05 kgf.m/5000 rpm
Top dead Centre	2
Bore	51.79 mm

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