ON THE PERFORMANCE OF THE MOTORCYCLE ENGINE USING FILTERED RECYCLE LUBRICANT OIL

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MAY 2018

This dissertation is submitted to

Universiti Sains Malaysia

As partial fulfillment of the requirement to graduate with honors degree in

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)

School of Mechanical Engineering

Engineering Campus

Universiti Sains Malaysia

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ACKNOWLEDGEMENT

Firstly, I am grateful to The Almighty God for establishing me to complete this thesis and project. I am grateful also for his blessing for providing me the strength, guidance and path to continuously work hard on this thesis writing. I would like to express our deepest gratitude for my EMD452 Final Year Project supervisor, Mr. Abdul Yamin Saad for his guidance and dedicated involvement throughout the decision and until the final phase. Besides that, I would also like to take this opportunity say thank you to the lab technicians and other lecturers for their cordial support, valuable information, and guidance which helped me in completing this task through various stages. There are still a lot to be of people that I would like to say thank you especially people that involved in contributing me the used oils to conduct the experiment including mechanic at workshop. Furthermore, I do appreciate the help and advice on the preparation of the engine from automotive lab technical, Mr. Zalmi who suggested on how the variables of the experiment can be arranged in the manner that would be easy for me to conduct and continue my experiment in near future. Plus, he has been really supportive by giving valuable information and suggestion which give me inspiration and idea to improvise my project. I also would like to thank Pn. Latiffah for helping me conducted viscosity analysis at School Chemical Engineering and Mr. Ayub Janvekar, Phd Aerospace student for helping me to get thermal imaging of engine cylinder during experiment. I would like to expand our deepest gratitude to all those who have directly or indirectly guided me in this final year project. Thank you.

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ABSTRAK

Apabila tempoh keberkesanan minyak pelincir tamat disebabkan penggunaan tertentu, kemerosotan adalah jelas kelihatan tetapi pada masa yang sama sebahagian besar minyak yang telah digunakan masih dalam keadaan baik dan boleh dijana semula. Terdapat pelbagai proses fizikal dan kimia yang telah dijalankan untuk memulihkan minyak digunakan. Dengan menggabungkan bahan yang sesuai ke dalam minyak pelincir terpakai yang diperbaharui, kebanyakan sifat-sifat minyak boleh diubahsuai untuk menghasilkan minyak siap yang mungkin mempunyai sifat-sifat yang sama seperti minyak asas. Selain itu, undang-undang alam sekitar negara tidak membenarkan pelupusan mana-mana jenis tanah, sungai, tasik, laut atau sistem pembetungan.

Dalam kajian ini, minyak enjin yang telah digunakan untuk beberapa jarak melalui proses penapisan untuk menghapuskan serpihan karbon dari pencemaran yang membawa kepada merosakkan omboh dan lain-lain komponen mekanikal dalam enjin. Kelikatan minyak pelincir setiap gred akan dibandingkan selepas proses penapisan dan seterusnya menganalisis haba terhasil dari silinder enjin. Minyak pelincir yang ditapis akan digunakan untuk mengkaji kesan kepada prestasi enjin, terutamanya tork dan kuasa enjin. Kesannya akan dianalisis sama ada selamat untuk digunakan atau tidak. Enjin dijalankan menggunakan pelbagai jenis minyak yang ditapis pada Wide Open Throttle (WOT). Graf prestasi akan dibandingkan dengan minyak enjin asas.

Keputusan menunjukkan bahawa terdapat sedikit penurunan dalam prestasi yang tork adalah dalam lingkungan sekitar 0.73% - 2.46% manakala kuasa adalah dalam lingkungan antara 0.9% - 3.2%. Minyak pelincir yang ditapis menunjukkan peningkatan tork dan kuasa brek berbanding minyak enjin terpakai. Ini adalah kerana minyak pelincir yang ditapis telah menapis deposit karbon yang seterusnya memberi kesan kepada kecekapan juga. Minyak pelincir yang ditapis dan asas minyak beroperasi di bawah suhu kira-kira 80 hingga 90 darjah celcius, manakala minyak mineral terpakai beroperasi di bawah suhu kira-kira 90 hingga 110 darjah celcius.

ABSTRACT

Once the service life of lubricating oil is over for a particular use, the deterioration is obviously there but at the same time major part of the oil remains in good condition and can be regenerated. There are many physical and chemical processes which have been employed valuable to recover the used oil. By incorporating suitable additives into the used lubricating oils, most of the properties of the oil can be modified to produce finished oil which may have same properties as that of the virgin oil. Moreover, the environmental legislation of countries does not allow their disposal in any type of soils, rivers, lakes, oceans or sewerage systems.

In this study, the engine oil that has been used for several mileages undergo filtration process in order to remove wear debris from contamination that lead to damaging piston and others mechanical component inside engine. The viscosity of each grade lubricant oil will be compared after filtration process and analyse heat build up. The filtered lubricant oil will be used to study the effect on the engine performance, particularly the torque and power of the engine. The effect will be analyses whether it is safe to use or not. The engine was run using different types of filtered oil at Wide Open Throttle (WOT). The performance graph will be compared with base engine oil.

Result showed that there were slight drop in performance which are the torque is in the range of around 0.73% - 2.46% whereas the power is in the range between 0.9% -3.2%. The filtered lubricant oil show high torque and brake power compared to used engine oil. This is because filtered lubricant oil has less carbon deposit which consequent affect the efficiency too. The filtered lubricant oil and baseline oil operates under temperature around 80 until 90 degree Celsius, whereas the used mineral oil operates under temperature around 90 until 110 degree Celsius.

CHAPTER 1 : INTRODUCTION

1.1 Introduction

Engine is the core of automobile vehicles. Engines performances are directly dependent on the condition of its components like piston, cylinder, cylinder head, crankshaft and another mechanical component. Thus, engine oil provides lubrication to reduce friction, prevent wear debris and contamination. It also provides cooling system to support the thermal control of the engine to ensure freedom of movement toward the mechanical engine part and protect again corrosion by neutralizing acid component and prevent sludge. However, lubricating oil properties exhausts in service life under certain conditions and oil become unsuitable for their intended purpose. Degradation of oil may be due to physical and chemical actions both and inside produces or outside contamination. Metals in lubricating oil can come from various sources, such as wear, contamination and additives. During the operation of the engine, wear occurs when the interaction between moving surfaces, which causes the formation of wear particles resulting in their continual degradation. Wear is an unavoidable phenomena of surface contact between engine parts.

Basically, the lubricant oil is measured by its viscosity, which is considered the thickness the oil. In general, oil must be thick enough to lubricate the machinery parts while thin enough for the oil to flow through machinery. The outside temperature also affected the viscosity of oil, and it must be able to maintain proper flow even in low temperature. Lubricant are much like any other substance. The colder it gets, the more solid they become. Sometimes, that means they work less effectively. So, the poor performance of lubricant at lower temperature is one of the reason why engines and transmissions less efficient before they have warmed up properly.

Servicing and doing the maintenance works on your vehicle is essential to ensure the condition and performance of the car is at optimum level. The reason behind the change of the lubricant oil is that to reduce the friction and wear in the engine. Basically, when the engine is running, all the mechanical parts of the engine is suffering friction. Friction will wear out the engine parts which eventually damaging the internal engine parts. To be

specific, there are many mechanical component work in the vehicle engine such as the piston, the crankshaft, the gear and many more. Every one of them rub against one another as it moves which eventually making noise, losing energy to friction, and gradually wearing out. In fact, the friction factor is only one of the reason while we lubricate the engine. Another good thing of lubricating the engine is also it can reduce heat that produce by the friction from the moving parts. For example, friction occur when two solid move roughly between one another then it will generate heat. Heat generated can be very fatal to the engine of the vehicle. So, it is very crucial to lubricate the engine while properly selected the type of lubricant to use because catastrophic failure may result in the future when we selected wrong lubricant oil. Therefore, we lubricated our vehicle engine to minimize resistance to movement and as a result, it can be reduced the amount of heat produced.

1.1.1 Significance of recycling lubricant engine oil

Lubricant react as coolant and it is also reducing the amount of wear that occurs during operation. It is because the oil lubricates and moving around the parts and it will cover up the contact between one part and another. However due to degradation of oil after service life is over, the lubricant cant reacts as the coolant and also reduce the friction. The cylinder of engine become hotter than normal operating vehicle temperature and the mechanical part may lose efficiency due to wear debris. Therefore, waste oil is a blend of combustion product such as water, fuel, road dust, wear metal and oxidation product which form complex and corrosive organic acids.

The recycling of used oil may be an appropriate and cheap alternative to and burn incineration. Different recycling techniques have been proposed for refining of used lubricating oils. During refining, the chemical, physical and mechanical impurities are removed with the following processes such as acidic refining, distillation, and clay treatment. These processes give different yield and product. Solvent extraction followed by adsorption is more effect processes for recycling of waste lubricating oils. It is aimed to conserving natural resources and recovering the lube oil. This is a mostly innovative cleaner technology. The filtration of used oil also another way to remove dirt and sludge from used oil. However, the filtration process only remove sludge but not re-refining the used oil to

become same properties like base oil. Mostly, 60% of engine wear is caused by particles between 5-20 microns and most Original Equipment Manufacturer (OEM) full-flow filters perform efficiently at 15-40 microns. Increased engine wear can occur when particulate matter under 15-40 microns is not trapped by the full flow filter. Therefore, the need additional filtration system or design new finer filtration system for vehicle to avoid damaging the engine in future.

1.1.2 Viscosity of oil

Viscosity is rated at 0° F represented by the number preceding the "W" stand for Winter and at 212° F represented by the second number in the viscosity designation. Therefore, 10W-40 oil has less viscosity when cold and hot than 20W-50. Motor oil become thinner when it heats and thickens when it cools. Hence, with the right additives to help it resist thinning too much, an oil can be rated for one viscosity when cold, another when hot. The more resistant it is to thin, the higher the second number. Within reason, thicker oil such as conventional oil generally seals better and maintains a better film of lubrication between moving parts. Other people say synthetic is the best thinner oil due to formulated improvement of viscosity by react lubricant consistently during cold and hot temperature. However, it depends on types of vehicle we used and your car's owner's manual recommends.

At the low-temperature end, oil has to be resistant to thickening so that it flows more easily to all the moving parts in your engine. Also, if the oil is too thick the engine requires more energy to turn the crankshaft, which is partly submerged in a bath of oil and tendency wear debris become higher. Excessive thickness can make it harder to start the engine, which reduces fuel economy. A 5W lube oil is typically what's recommended for winter use. However, synthetic oils can be formulated to flow even more easily when cold, so they are able to pass tests that meet the 0W rating.

1.1.3 Project background

People admit that servicing their vehicle either a car or motorcycle is essential to ensure the condition and performance motor vehicle always running at high performance. Typically, the owner will send their vehicle for maintenance to service center by referring vehicle manufacturer's recommended service interval that matches vehicle's operating conditions and driving habits. The basic services including the change of oil lubricant engine and oil filter for every 5000 miles or 6 month however its depend on the types of oil. The benefits change of engine oil is it could longer engine life, better engine performance, and reduce vibration. Based on Castrol website, engine oil typically consists of 80% base oil and 20% performance additives. The performance additives include anti-wear additives, antioxidant, dispersant and detergent that keep engine clean and viscosity index improvers that ensure the oil maintains an optimum viscosity throughout the engine's operating temperature range. In engines, there is some exposure of the oil to products of internal combustion, and microscopic coke particles from black soot accumulate in the oil during operation. The engine oil and especially the additives also undergo thermal and mechanical degradation which reduce viscosity. The engine oil at reduced viscosity is not capable lubricate the engine thus increase wear and chance overheating. Eventually, it becomes chemically unsuitable for further operation use and must be replaced with fresh oil. However, problem arises is what actually happened to used oil that has been flush out from the engine.

Used oil or sump oil should not be thrown away. Although it gets dirty, used oil can be cleaned of contaminant so it can be recycling again. According to Australian Government Department of the Environment and Energy website, it stated that there are many uses for recycled used oil. For example, used oil can be recycle by using filtering and demineralization to remove solid, inorganic material and certain additives. Another uses for recycle oil is re-refined base oil for use as a lubricant, hydraulic or transformer oil. According to American Petroleum Institute website, if we can recycle two-gallon oil probably it could generate enough electricity to run the average household for almost 24hours.

Therefore, we know that used lubricant oil can be recycle and re-refined into new lubricant oil. However, what will happen when used oil is directly utilized back in another engine without undergo cleaning and re-refined it. Logically speaks, of course used oil will get dirty and contained with burr and metal powder, and fill it back into engine would definitely affect performance of engine once it runs. It is because the used oil that already mentioned earlier become degraded and contaminant after vaporized by a previous heating process in engine. So, to use it back and fill into another engine would surely affect performance of engine unless we try to recycle again using filtration process to compare the different performance in terms of torque, power, and heat buildup the cylinder of engine.

In a nut shell, this project is all about the study of the performance of the motorcycle engine using filtered lubricant oil. Parameter such as power, torque and thermal differences at certain interval speed will be determined due to effect of using filtered lube oil as a lubricant in the engine.

1.2 Problem Statement

Generally, engine oil will be flushed out of the engine when it has been used for certain kilometers that required the owner to change the engine oil. The flushed oil will be collected by the mechanic for recycling purposes. Engine oil will flush out of the engine when it has been used for certain kilometers that required the owner change the oil. Many car manufacturer will notify their customer to send their vehicle services when mileage has reached 6000 to 10000 KM. There are many cases where the engine oil has been flushed out still good and can be use due to its condition. This surely would cost and burden the vehicle owner. Quality asides, this act also could be understood as the way of automotive industries doing their business. People will be forced out to change the engine oil although the vehicle rarely used which quite impossible for the engine oil to be degraded. Even the used oil degraded, there are another way to reused it again besides throwing the engine oil to the river and sewage system. Used oil can still be cleaned and reused by re-refined or undergo filtration process as lubricant oil which in return it could be benefits many people. Among the topics discussed above, there are very limited literature focusing on the performance of motorcycle engine using filtered lubricant oil and pinpointed their effect on wear, thermal, power and torque as a whole. Therefore, the main objective of the present

paper is to entirely compare the performance of the motorcycle using a base oil and filtered used oil, aiming for a better understanding of the influences of filtered lubricant oil on engine and other aspect that mention above.

1.3 Objectives

The objective of this study are:

- To determine the effect of using filtered recycle lubricant oil on engine's power
- To analyse viscosity lube oil and thermal different on engine using filtered lubricant oil
- To analyse differences performance of using base oil, filter oil and used oil.

1.4 Scopes and outline project

This project is mainly focused on the effect of using filtered recycle lubricant oil to the performance of the motorcycle engine. The engine will be lubricate using various grade of lubricant oil from mineral oil to fully synthetic oil. As stated previously, a different type of oil will give a different kind of output such as power, torque, and temperature differences. Performance graph of torque and power main will be compared to one another and the different will be discussed. In addition, the graph of viscosity and their effect to temperature differences of engine cylinder will be discussed.

This project involves the use of thermal imaging camera, and dynamometer as shown in Figure 1.1. Thermal imaging camera will analyse the temperature distribution of engine cylinder at certain interval speed. Meanwhile, Rheometer Brookfield DVIII Ultra viscometer at School of Chemical Engineering, USM is to perform viscosity of three types of lube oil by subjecting sample filtered lubricant oil, fresh oil and used oil to low and high temperature. Dynamometer with 20kW coupled with the motorcycle engine and the speed was controlled using a controller. Basically, the controller displayed the value of torque, engine speed, dyno speed and load. Dynamometer speed was calculated and set at the controller. The value of dyno speed is set at the controller and the throttle will be operating

at WOT (Wide Open Throttle) until the engine is at constant speed. The value of engine speed is set at various point with interval of 500 which starts from 1000RPM to 5000RPM.

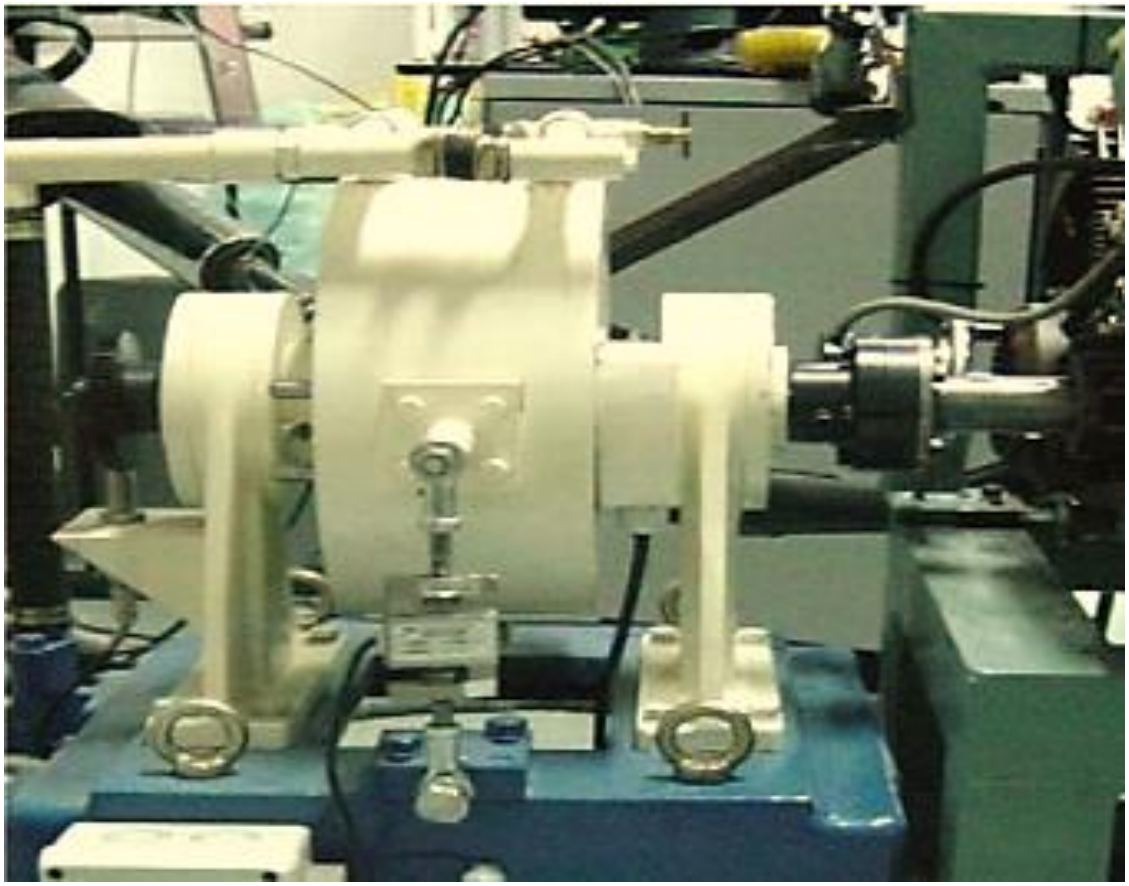


Figure 1.1: 20kW eddy current dynamometer

1.5 Outlines report

In this report consists of five chapter that explained the overall information and details from the introduction to conclusion of this project. Chapter 1 is the introduction of the project to the research background, problem statement, objectives and scopes of the project.

Chapter 2 is about the literature review and mainly about the research related to this project from the past journal, articles, books and webpages as references. Detail explanation about the research are describe in this chapter.

In chapter 3, methodology for carried out project in discussed here for more detail. The procedure experiment and calculations will be explained briefly on how they conducted and needed to be included in the project. Chapter 4 is discussed about the results and the discussion have been obtained after complete chapter 3.

Lastly, the chapter 5 is the conclusion of the project. The summary of the project implementation and achievement are included. The limitation of this project also included for next research to improve this system to be better in future.

CHAPTER 2 : LITERATURE REVIEW

2.1 Wear rate of internal combustion engine

There are lot of movement of the mechanical part in the engine itself which bring essential of lubricating the engine. The movement of mechanical part in cylinder lead to friction occur between the part which consequently produced a thermal energy which heat up the engine and vibration. This could potentially affect the performance of engine and mechanical efficiency of the engine. The friction of mechanical part engine would lead to wear debris. Wear occur when there is interaction between two moving solid surface which causes the formation of wear particles resulting in their continual degradation [1].

In fact, there are several studies were conducted to study the wear rate of engine components. V.Macia'n et.al. [1] In this paper, an experiment and analytical approach to determine wear condition from engine oil. The factor like oil consumption, oil composition, contaminant concentration is taken into account to analyse wear debris. In the year 2012 Om Prakash Sondhiya, Amit Kumar Gupta [2] studied about wear debris analysis of automotive engine lubricating oil using by Ferrography. Ferrography technique was developed in the 1970's and this method separate used oil sample and wear particles using strong magnetic field gradient. There are several parameter taken into account to diagnosis of the wear mechanism such as wear index, particle quantifier index (PQ) , contamination index and density index [2]. Particle Quantifier Index (PQ) could be highlighted for measurement of the wear debris filtered from the used oil. Gautam Yadav et.al. [3] In this paper, two used engine oil samples such as petrol oil and diesel oil collected by two different automobile vehicles. A sample of engine oil have been analysed by spectrometric oil analysis program and oil test center (kittiwake) for various properties in order to monitor wear metal, viscosity, water content, total acid number and total base number.

Nowadays, all equipment used to analyse wear debris in oil analysis present certain limitations. The most widely used analyse for wear debris in oil analysis is most probably spectrometry. The spectrometer can analyse the element content of each debris particle. [1]

However, in this present work four stroke, single cylinder, air cooled petrol engine is studied to determine the wear debris of engine oil before and after filtration. The methodology proposed uses viscometer to evaluate wear debris and viscosity from contamination after oil sample taken from oil sump. Finally, the evaluation of this wear is carried out using statistical data from various grade of lubricant oil. Another evaluation is considering another factor that could lead wear such as heat at certain engine part.

2.2 The significant of lubricating the engine

Engine oil is primarily used for lubricating the internal combustion engine. It can protect the engine from suffer a large fiction, high operating temperature and many more. However, there are effects on performance of engine using various condition of engine oil in terms of friction and efficiency. Many researchers also conducted experiment to analyse the effect of performance of engine when using various condition engine oil and most of wear occur caused by friction [4,8]. Plus, when there is a large friction occur between large cylinder and the piston, it would lead to vibration too. Engine will vibrate as piston moving upward and downward when there is no lubrication on the piston [5].

Klein [12]studied the effect of heat transfer through a cylinder wall on the work output of Otto and Diesel cycles. The maximum work or power and the corresponding efficiency bounds are derived. Chen et.al [12] derived the relations between net power output and the efficiency of the Diesel and Otto cycles with considerations of heat transfer through a cylinder wall.

In this thermal effect analysis, a comparative heat buildup through a cylinder wall of seven types of lube oil is carried out. Additionally, the effect of viscosity of oil that lead to thermal effect and performance of motorcycle will also be examined.

2.3 Regeneration of Used Lubricating Oils

Once the service life of lubricating oil is over for a particular use, the deterioration is obviously there but at the same time major part of the oil remains in good condition and can be regenerated. There are many physical and chemical processes which have been

employed valuable to recover the used oil. By incorporating suitable additives into the regenerated lubricating oils, most of the properties of the oil can be modified to produce finished oil which may have same properties as that of the virgin oil. Moreover, the environmental legislation of countries does not allow their disposal in any type of soils, rivers, lakes, oceans or sewerage systems. The used lubricant oil can be regenerated by various processes like centrifugal separation, magnetic separation, vacuum dehydration distillation, acid refining and solvent refining. These are briefly discussed as below:

M.A. Scapin et.al[13] have reported that the recycling process of the used mineral oils has been gaining a very important gap in the context of environmental protection. Among mineral oils from petroleum, the lubricating oils are not entirely consumed during their use; therefore, it is necessary to apply a treatment for regaining seeking their reuse. Moreover, the environmental legislation of countries does not allow their discard in any type of soils, rivers, lakes, oceans or sewerage systems. The conventional treatment has shown certain difficulties in the recuperation process for used oils. The ionizing radiation process is renowned in the industrial effluents treatments due to its high efficiency in the degradation of organic compounds and in the removal of metals and radicals.

Jesusa Rincon et.al.[14] have described that dense propane has been used as a solvent for the continuous countercurrent extraction of base oil from waste lubricant oil. The aim of the work has been to identify the best processing conditions to separate base oil suitable for the formulation of new lubricants, avoiding the co-extraction of waste-oil impurities such as oxidation products 20 and metallic compounds. Experiments have been performed during 6 h in a 1.7m extraction column operated counter currently at 30 kg/cm and using an oil flow rate of 0.5 g/min. The effects of operation variables such us solvent divided by used oil ratio, column packing, and column temperature gradient have been investigated.

Nabil M. Abdel-Jabba et.al.[15] have described that waste lubricating oil re-refining adsorption process by different adsorbent materials was investigated. Adsorbent materials such as oil adsorbent, egg shale powder, date palm kernel powder, and acid activated date palm kernel powder were used. The adsorption process over fixed amount of adsorbent at

ambient conditions was investigated. The adsorption/extraction process was able to deposit metallic contaminants from the waste oil to lower values.

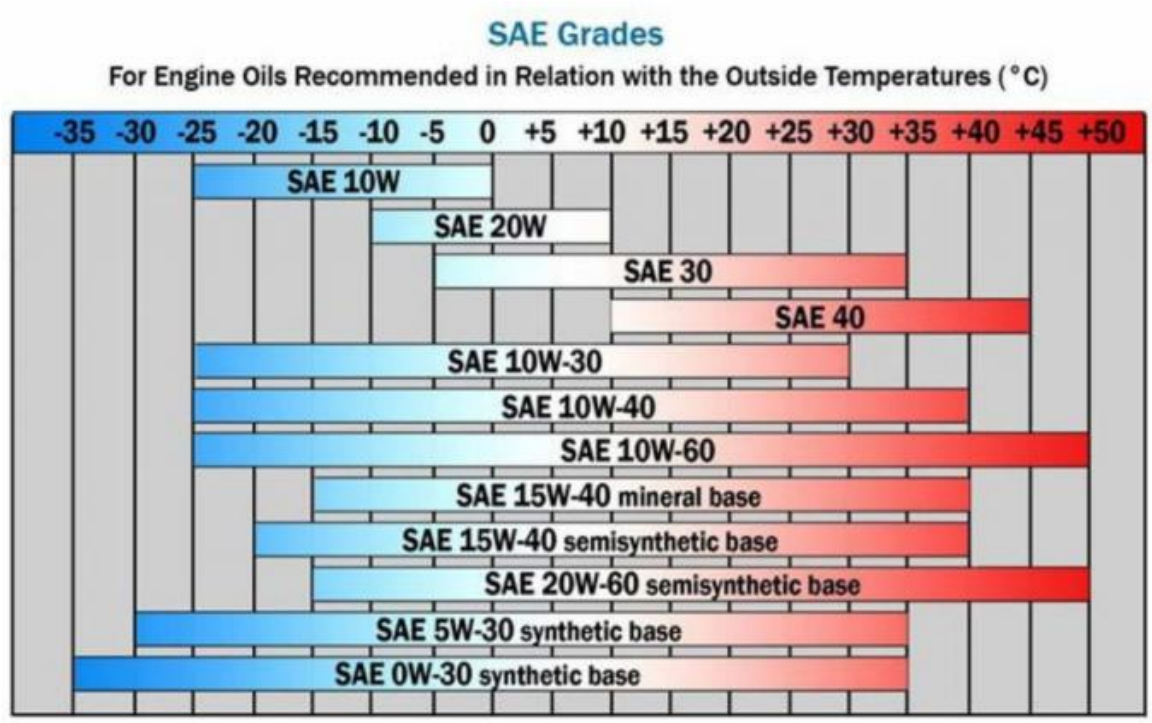
In this present work, due to limitation to get material for re-refining process, the filtration system made by using oil car filter at center of funnel, three filter cup, and one qualitative filter paper. Oil car filter impregnated media technology that provides fine micron efficiency. An oil filtration system is proposed to remove contaminants from engine oil, lubricating oil or transmission oil. The filtration of oil is improved by using additive to remove contamination and these properties of oil will analyses by using viscometer.

2.4. Types and grades of lubricant oil

Lubricant play a vital role in order to ensure the engine works properly. There are various type of engine oil and it is varying with the viscosity and properties of the oil behaving in certain temperature. The lubricating system perform the following function such as reduce frictional resistance of the engine to a minimum, protect engine against wear, contribute to cooling piston, and remove impurities.[16] The characteristic of engine oil as they get hotter, the oil become thinner. That is why there are numerous of grade of engine oils which show different behavior as the oils heat up. For example, 10W-40 grade oil. This synthetic oil behaves like 10 rated single grade oil when cold, but does not thin any more than 40-rated single grade oil when hot. W is stands for winter and the lower the W number, the thinner or less viscous of engine oil. So, it is easier flow inside the engine when cold climates. The number after W is hot viscosity rating whereas the number before W is cold viscosity rating. As the engine get thicker, the engine has to work to push oil throughout engine component, the vehicle pulls on your fuel supply to help power the engine and keep it running[17]. The harder the engine has to work to move oil, the more fuel consumption of vehicle uses. So, the thinner your engine oil, the better fuel efficiency is. Mostly, synthetic oil has lower viscosity compared to conventional lubricant oil. Synthetic oil ensures fuel consumption saving and enhance engine performance. However, many vehicle user look for high viscosity oil to provide full protection to their engine during hot weather. Plus, high viscosity of engine oil could also improve thermal or waste heat produced by engine, thus operating temperature of the car also get decrease[18]. However, the engine

oil could not be as thinner as the user wanted due to high viscosity at cold temperature. The high viscosity could probably lead to wear and damage during cold start.

Table 2.1: SAE Grades in relation with temperature (source: http://www.motorcycle.my/motorcycle-engine-oil/)



CHAPTER 3 : RESEARCH METHODOLOGY

3.1 Flowchart outline of the project

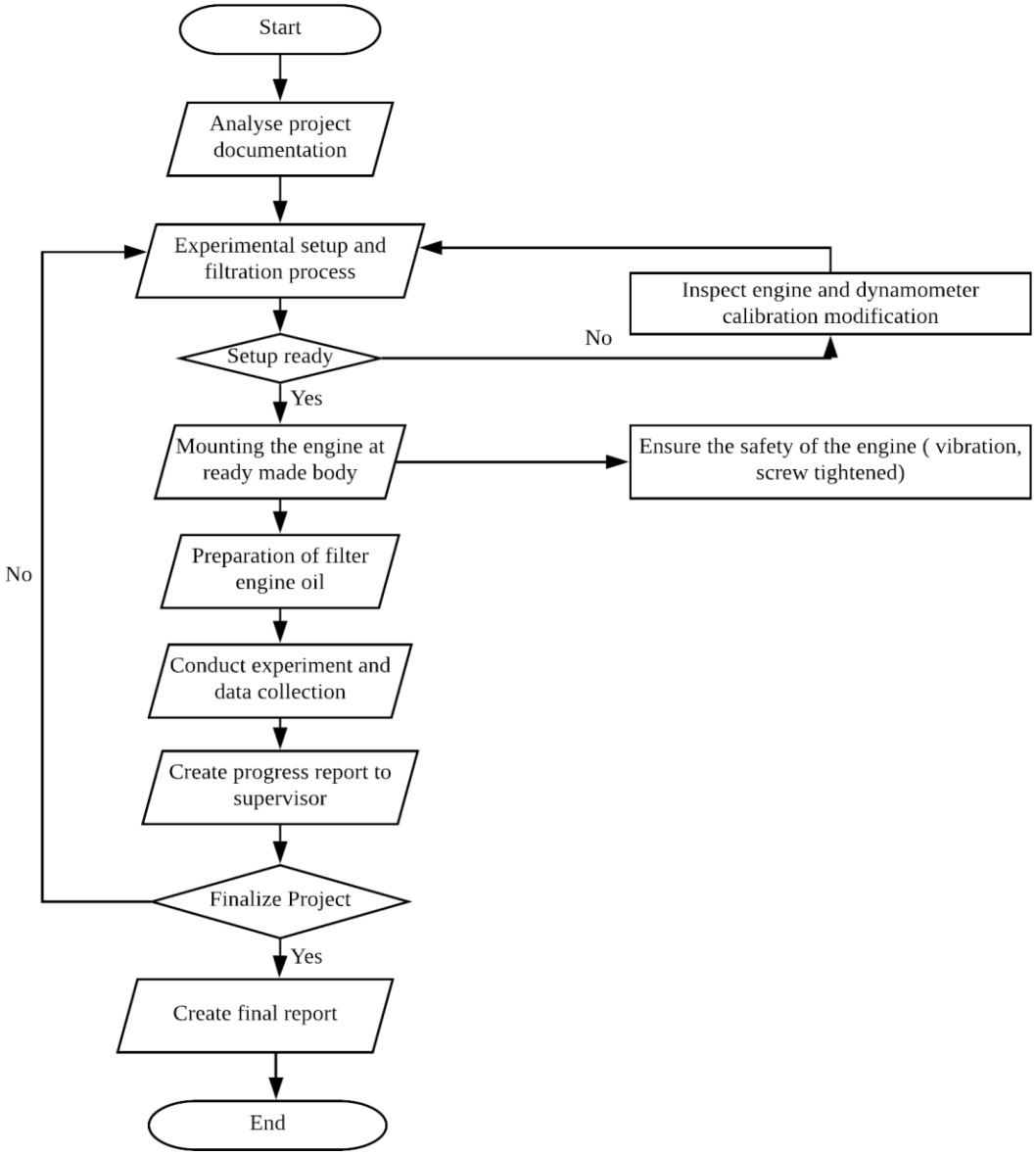


Figure 3.1: Flowchart outline of the project

3.2 Work flow of the experiment

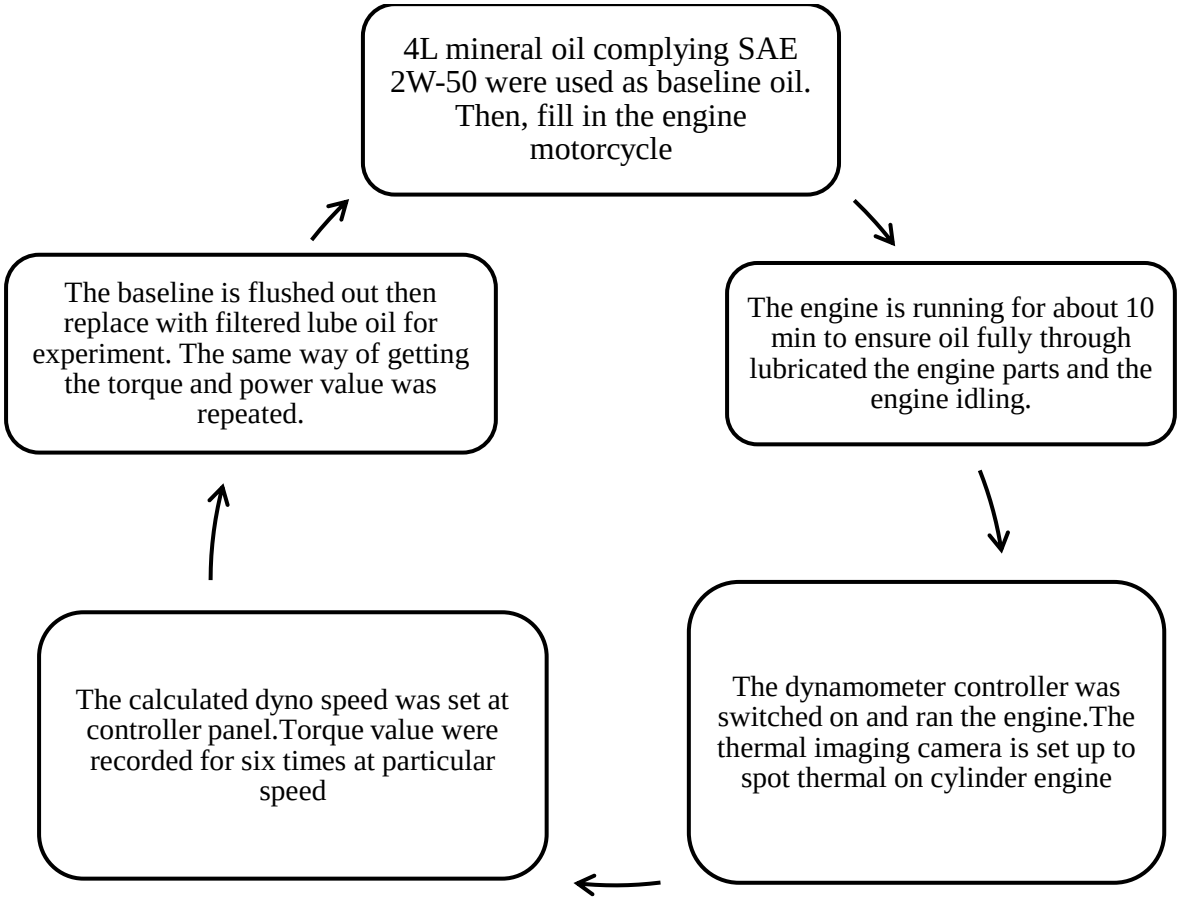


Figure 3.2: Work flow of experiment

Firstly, the mineral oil complying under SAE 20W-50 is filled in the engine. The oil used in brand new oil and consider as baseline oil. Meaning to say, for every variable of filtered oil use result will be compared to the baseline performance curve. The experiment conducted as standard procedure of wide open throttle torque curve and it is started at engine was ran with 1000 RPM of engine speed and then incremented by 500 for each step until it reached 5000 RPM. The reason of the speed range 1000 RPM to 5000 RPM were used as typical speed run by motorcycle user which not intentionally for high-speed performance. After baseline oil performance data were recorded, the baseline oil was replaced with used oil derived from vehicle user. The type of used oil available for experiment are AISIN Semi Synthetic SN/CF 10W-30, Enduro Synthetic SAE 10W-40 and Castrol Power 1 20W-50. For every type of used oil, the oil is filtered and experiment are

conducted three times to get average results so that the data is around the accurate value. After the experiment were finished for every type of oil used, the engine oil will be flushed out and left for air cooled until all the oil in the cylinder is extract from it. The mounting screws, engine body, and bolts were checked before running the engine for another type of oil to avoid any bad consequences during the experiment conducting. The thermal imaging camera is set up to demonstrate extreme-heat protection qualities for each oil. Analyse the heat exposure on each oil in terms of viscosity. As heat breaks oil down, the viscosity typically rises until it is significantly out of grade and must be changed. For each of oil, their performance will evaluate to demonstrating its outstanding resistance to thermal breakdown and its ability to provide excellent protection in the most severe conditions.

Figure 3.3: Thermal Imaging Camera

3.3 Engine motorcycle specifications

The engine motorcycle used to conduct the experiment is Modenas Kriss 110cc which the first national motorcycle ever made. The engine specification are listed as shown below.

Figure 3.4: Modenas Kriss 110cc

Table 3.1: Modenas Kriss 110 engine specification

Type	Four stroke, Single cylinder
Cooling system	Air-cooled
Bore and stroke	53.0 x 50.6 mm
Displacement	111 mL
Compression ratio	9:3:1
Max Horsepower	6.6 Kw @ 8500 RPM
Max Torque	9.3 Nm @ 4000 RPM
Carburetion system	Carburetor, KEIHIN PB18
Starting system	Primary kick, Electric starter
Ignition system	Magneto CDI
Lubrication system	Forced lubrication (wet sump)

3.4 Dynamometer and its controller

Figure 3.5: Engine Dynamometer

As shown in Figure 3.5, type of dynamometer use was eddy current dynamometer which have the maximum power input of 20kW. The dynamometer which held at USM Automotive Lab are basically use for various engine testing. A dynamometer is a load device used to measure an engine torque and speed by using procedure which can be adjusted using the controller. In this experiment, the standard procedure of Wide Open Throttle (WOT) is used to get the performance curve. The type of dynamometer used is engine dynamometer where the output of the dyno is coupled directly to the transmission of gear box of the engine motorcycle. The coupling mechanism is quick-connect coupling where it is connected to the sprocket of motorcycle as shown in Figure 3.6.

Figure 3.6: Quick-connect coupling

This type of coupling was already available in the Automotive Lab USM, it fits perfectly when attached to gear tooth of engine but by physically observed, the coupling was a bit older and there some corrosion on the metal fingers. The metal fingers still strongly attached to the rod, thus this coupling is safe to be use.

In terms of the controller used, the model of the controller is Focus Applied Technology D2ACP Dyno Controller Unit as shown in Figure 3.7. The controller is basically used to control the load. The set point (engine speed) can be setup manually or electronically generated. The controller has three modes of operating system which is open loop, speed control and torque control. In terms of this experiment, the modes used was speed control modes. The controller continuously measures the speed and adjusts the load of the dynamometer to maintain speed at desired set point. Plus, the controller is generally a full proportional integral derivative (PID) controller which makes it important to tune it for appropriate engine-dyno combination.

Figure 3.7: Focus Applied Technology D2ACP Dyno Controller Unit

The controller displayed the value of torque, engine speed, dyno speed and load. Dynamometer speed was calculated and set at the controller. The calculation as shown as follow:

$$\text{Dynamometer Speed} = \frac{\text{Actual engine RPM}}{\text{Primary Reduction Ratio}} \quad (1)$$

$$\text{Primary Reduction Ratio} = \text{Gear ratio of engine} \times \text{gear teeth of dyno} \quad (2)$$

Given:

Gear teeth of dynamometer = 66/60

Gear ratio of Modenas Kriss 110CC Engine = 64/21

The value of dyno speed is set at the controller and the throttle will be operating at WOT (Wide Open Throttle) until the engine is at constant speed. The value of engine speed is set at various point with interval of 500 which starts from 1000RPM to 5000RPM.Then, as all of output torque is obtained, the value for the power is calculated using formula as shown in equation 3

$$\text{Power} = 2\pi NT \quad (3)$$

Where:

N= Engine Speed in rev/second (RPS)

T= Torque of the engine

Below here shows the schematic diagram of the arrangement of the equipment of the whole setup and also the detailed mechanism of eddy current dynamometer.

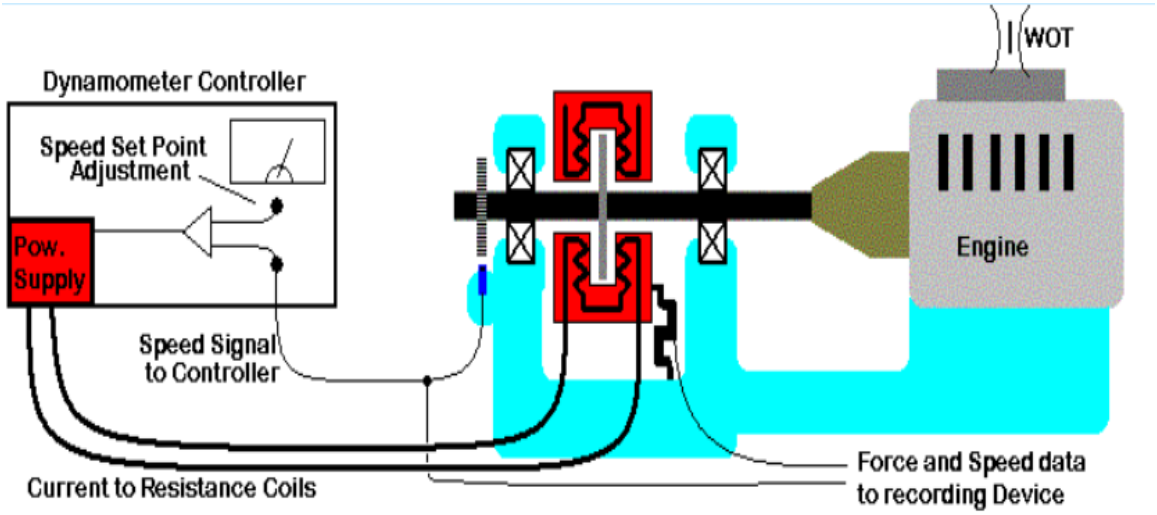


Figure 3.8: Completed set up experiment diagram

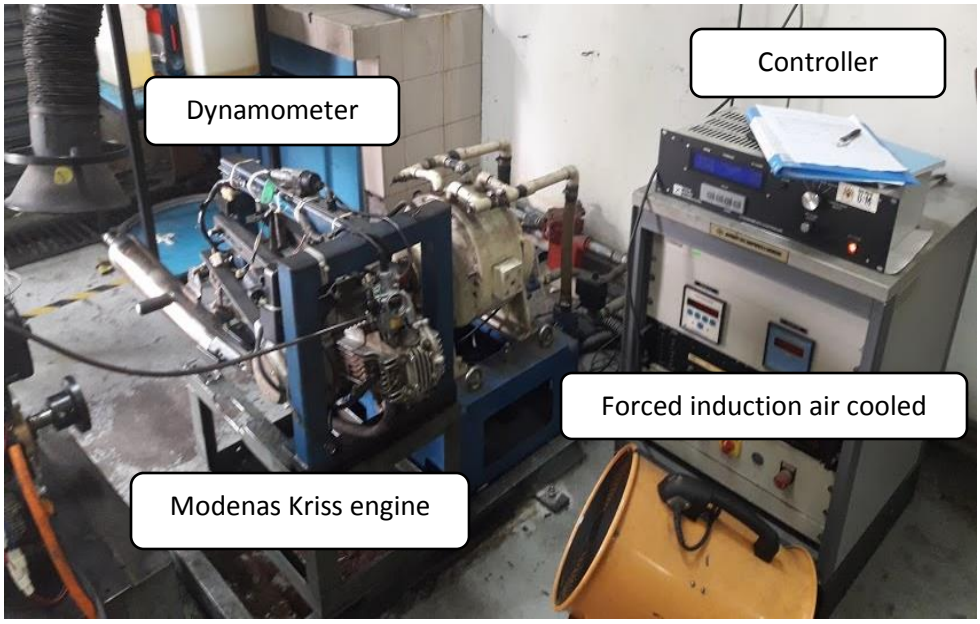


Figure 3.9: Experimental setup at the Automotive Lab USM

3.5 Gear engagement

Figure 3.10: Coupling connected to the gear tooth

The coupling connected to gear tooth of Modenas Kriss engine which commonly named as sprocket. Sprocket will spin as the gear in the engine was engage. As the throttle is slowly open, the sprocket will spin which consequently makes the coupling rotates too.

This motorcycle consists of four sets gear. Each gear represents different gear ratio and speed. In this experiment, the gear chosen are the third gear and fourth gear. The reason because the third gear and fourth gear are both having greater gear ratio which makes it suitable run on the dynamometer. As the engine speed that will tested are in between the range of 1000 rpm until 5000 rpm, the third gear and fourth gear are suits enough to be tested in the experiment whereas first gear and second gear could not sustain until 5000 rpm. Plus, the third gear and fourth gear are typical gear of any user of the motorcycle use in their daily life. Third gear are basically used to accelerate or overtake as the gear have higher torque compared to the fourth gear. Fourth gear are typically used to drive or ride in cruising condition.

3.6 Engine oils

Listed below shown the used engine oils before filtration used to test the engine performance. Basically, the condition of oil is black in colour and there are present of oil sludge. The viscosity of each oil is different as the oils used are different in grades, thus the performance of motorcycle will affect by viscosity of oil.

Figure 3.11: Used engine oil

As shown in Figure 3.11, these are the used car oils that use to analyse the engine motorcycle performance. Based on the Figure 3.11, the condition of the oils are black in colour which indicated that it is a used oils. The type of the engine used oil are AISIN Semi Synthetic SN/CF 10W-30, Castrol Power 1 20W-50, and Enduro Synthetic SAE 10W-40. Three type of engine oil was available at Automotive Lab and used by previous research student for engine performance. These oils undergo filtration process to analyse the engine motorcycle performance.

3.7 Filtration of engine oil

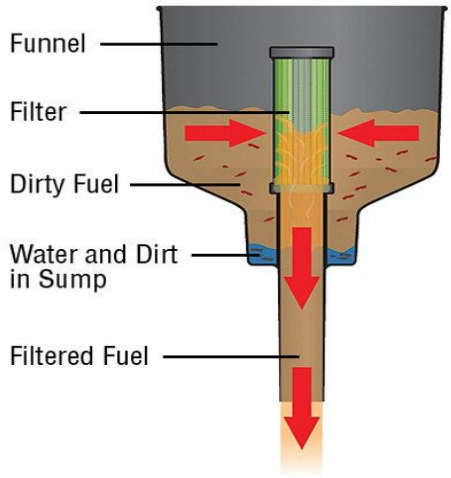


Figure 3.12: Conceptual of filtration engine oil

The filtration system made by using oil car filter at center of funnel, three filter cup, and one qualitative filter paper. Oil car filter impregnated media technology that provides fine micron efficiency. The filtration was done for three sample of oil which is mineral oil, synthetic oil and semi-synthetic oil. Mass for three sample of oil was taken before and after filtration. The filtration takes 3 day to full in 500ml beaker. An oil filtration system is important to remove contaminants from engine oil, lubricating oil or transmission oil. The presence of sludge and particulates in the oil between 3-5 micron are markedly harmful in the cylinder wall and piston ring area. Therefore, need additional oil filtration system to eliminate those particulate below 15-40 micron and keep equipment cleaner.

a) Filtration system b) crystalline filter paper for medium speed

Figure 3.13: Filtration Setup

3.8 Viscosity of oil

After filtration was done, the sample was taken to Rheometer for viscosity test. The viscosity of oil was tested using Rheometer Brookfield DVIII Ultra viscometer at School of Chemical Engineering. The output of viscometer were viscosity, shear rate, shear stress, and torque. In this laboratory, investigating the effect of temperature on the viscosity of motor oil. A rotary Brookfield viscometer,1 outfitted with a small sample adapter, will be used to measure the dynamic viscosity of the oil. The temperature of the oil sample will be controlled by circulating water from a Brookfield temperature controller through a water jacket assembly. The operating principle behind this type of viscometer is simple: It measures the torque required to rotate an immersed element (the spindle) in a fluid. This torque is directly proportional to the fluid viscosity and to the angular velocity of the spindle and depends on the size and shape of the spindle and fluid container. Spindle was set to 21 and speed was adjusted to 100 rpm for viscosity analysis.