DEVELOPMENT OF A LOW COST HYDRAULIC OIL PURIFER

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Submitted to Faculty of Mechanical Engineering in Partial Fulfillment of Requirements for the Bachelor Degree of Mechanical Engineering (Thermal-Fluid).

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ADMISSION

" I admit this report is done all by myself except statement that I have already stated on each one of them"

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This work is dedicated to my beloved mother, father and 2 of my younger brothers. You all are the best...

To all my classmates, do remember our friendships. It was a happy moment to be with you guys in these past few years...

Lastly to someone special in my life, thank you for your encouragement. I Love You Very Much...

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ABSTRACT

Almost all machine uses lubrication to lubricate and smooth their components. The scope of this project is servicing the lubrication fluid of a machine especially turbine and hydraulic oils. Writer has made a study on filtering concept, oil purifying concept and found it is feasible to build using a lower budget. The oil purifier can function similarly to the existing oil purifier. The building cost for the simple hydraulic oil purifier plant is calculated at RM500 where reduction from 75 % to 85 % can be achieved. Hydraulic pumps, electric motor, filters and some other parts are used to develop an oil purifier at lower cost. A simple process of oil filtration utilized by the existing oil purifier plant is such as surface filtration and magnet filtration. It can efficiently remove particles of size range from 35μm to 20μm. Some tests and analysis had shown good result. Color test, PH test, viscosity test and particles count test had been conducted. Comparison had been done between the existing oil purifier and my own oil purifier based on these four results. The efficiency of the oil purifier was found to be at 9.5 NAS level out of 12 which means 20% of efficiency.

ABSTRAK

Setiap mesin menggunakan pelinciran dalam sistem bagi mengelakkan kejadian-kejadian yang tidak diingini. Pelincir digunakan untuk melincirkan dan melancarkan pergerakan bahagian-bahagian didalam sistem yang bergerak didalam mesin. Skop projek ini adalah untuk menservis minyak pelincir didalam mesin terutamanya minyak hidraulik.Penulis telah menjalan kajian terhadap konsep sistem penapisan minyak dan mendapati ianya seusai untuk dibangunkan. Mesin penapisan minyak hidraulik yang akan dibina boleh berfungsi sepertimana sistem yang telah sedia ada dipasaran. Pembinaan projek ini telah menelan belanja sebanyak RM500 yang mana , ia dapat dikurangkan sebanyak 75 % hingga 85 %. Pam hidraulik, motor elektrik, penapis dan beberapa bahagian lain digunakan dalam projek ini. Penulis telah membuat keputusan untuk menggunakan beberapa proses iaitu penapisan permukaan dan penapisan magnet. Kecekapan mesin ini dalam menapis minyak telah mencapai tahap 35 μm hingga 20 μm. Beberapa ujian dan analisis telah dijalankan dan menunjukkan keputusan yang baik. Ujian yang dijalankan adalah terdiri daripada ujian warna, ujian kelikatan, ujian PH dan ujian pengiraan partikel. Setelah itu, data yang diperoleh akan direkodkan untuk tujuan perbandingan dengan mesin-mesin penapisan yang sudah sedia ada. Kecekapan mesin penapis minyak didapati berada pada tahap 9.5 dari 12 ataupun 20% kecekapan.

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SYMBOL	DEFINITION
g	gravity
N_U	Number of particles before filtration (Upstream)
N_D	Number of particles after filtration (Downstream)
d	diameter of sphere

GREEK SYMBOL	DEFINITION
τ	shear stress
μ	constant velocity (for stokes law equation)
σ	density of the sphere
ρ	density of the fluid
ν	kinematic viscosity of the fluid.
β_X	Beta ratio

SUBSCRIPT	DEFINITION
D1.6	diameter of sphere at 1.6 mm
D4	diameter of sphere at 4 mm

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CHAPTER I

INTRODUCTION OF HYDRAULIC OIL PURIFIER PLANT

General hydraulic/turbine oil purifier is developed by vacuum evaporation technology, coalescing technology, separating engineering technology and refined purification technology. It can eliminate water, gas, impurities, colloid, dielectric etc. rapidly and effectively in high vacuum situation and make the waste oil reuse.

The lubrication of hydraulic/turbine or other equipments which has lubrication system need be replaced frequently because of vapor, water and other impurities mixed with it. Otherwise, oil deterioration would result in breakdown of machinery or affect the normal running of machinery.

Hydraulic/turbine oil purification plant series is particularly suitable for purifying hydraulic/turbine lubricating oil. It also applies to treat hydraulic, coolant oil and other lubrication in which contain large of water, vapor, impurities, sludge, dielectric and colloid. Oil filtration plant can eliminate them effectively and efficiently.

Turbine oil filtering series will result in the improvement of the properties of turbine oil, other lubrication and extend the maintenance period of turbine or other equipment which has lubrication system and keep them operate in good condition.

1.1 Problem Background

Nowadays, hydraulics and pneumatic system has become an important force medium on delivering/replacing the man capability on doing heavy work. A lot of improvements were made from day to day in order to maintain the system/machines. In Malaysia, author has found no company has developed machines to maintain the hydraulic system especially in term of hydraulic oil. This statement was obtained from the internet and magazines

Almost all machinery today uses lubrication to smooth the operation of the machine, and one of the most important medium in hydraulic oil. Hydraulics oil are specially used in high delivering pressure output such as lifting a load with a forsklift, excavator, power plant system and others .

Lubrication is made of oil generally due to its effectiveness to smooth machine part contact surfaces and protect it from rust. As an example in car engines contains many type of metal gears that are contact each other. As they touch each other by surface contact, even a hard metal can have a wear on it. The wear particles will mix up with the lubrication and that makes the lubrication becomes dirty and non effective to the system itself. Installed oil filter on the car engine only filter wear particles that range from 15μm to 40μm (depends on oil filter that is used).

In Malaysia writer found no company has built a machine to repair oils instead of buying new oils. The reason is cost to buy the machine is too high and the effect is less company and workshop not able to buy it and use it economically. Foreign inventors have developed a machine to repair or maintaining the lubrication quality as we can see in market todays. Every oil purifier developer company has their own ways to repair, filter and maintain the lubrication quality. Some uses evaporation technology, magnetic filtration, by-pass filtration, surface filtration and others. These machines are built to fulfill one purpose, that is clean the oil from raw particles that may sized from millimeters to 1μm or more.

1.2 Problem Statement

Burden on buying oil purifying machines at an expensive cost maybe a reason to small companies did not use them. The performance of some purifiers are depends on design of a purifier. Below are shown some hydraulic oil purifier developers with their own technology used and National Aerospace Standard (NAS) 1638 result. The NAS number shows the smaller the NAS number, the more quality the purified oil.

Table 1-1 Hydraulic/turbine oil purifier developer and technology used

Manufacturer	Technology/description	NAS 1628/1638 level
Chongqing Huaneng Oil Purifier Manufacture Co., Ltd	Stereo evaporation technology, fast water dehydration tech (w/out heating), diaphragm evaporation and sprayed drying.	6
Sino-NSH Oil Purifier Manufacturer Co.Ltd	Fast water dehydration with heating, magnetic filteration and straining, diaphragm evaporation.	3-4
Huaneng Oil Purifier Group Co.Ltd	-NA-	6
Pall Corporation	Removes all free water, free gases, dissolved water (up to 90%) and dissolved air (up to 80%).	4 - 6
Enervac	-NA-	5
Alfa Laval	Fast water dehydration with heating, stereo evaporation technology	3 ~ 6

This problem has inspired author an idea to develop an economic oil filtering machines that can achieve the function of existing oil filtering machines. The outcome of the project can filter any types of lubrication especially the hydraulic oil.

1.3 Important Of Study

Petroleum is used in every production of oil-based fluid especially in lubricating and fuels. As we know nowadays the petroleum is decreasing days by days. Methods and procedures are created to prevent the petroleum from dry out. In oil purification plants fields, the plant itself help to maintain the problem by extend the fluid life. With extension of fluid life the cost on buying new oil can be reduced.

Improving the productivity is another important of the study where some oil purification plant uses direct flow to the plant and purifies the oil as the system works. As an example, in hydro power plant industries the hydraulic system is used almost every hour of operating time. Time is money. If the system stopped just to change the hydraulic oil it causes less productivity of electricity. To prevent the problem occurs some oil purifier developer has come out with inline or direct oil purification plant.

One of the main things on every oil purification plant is to purify the used oil. By passing some level of purification the oil can be used directly after passing a few of lab tests such as particle count, water content, viscosity level and acidity level. The purification level depends on machine type and developer as stated in Table 1-1. Less frequent fluid disposal also become an important of the study. Disposal of the fluid can be reduced in order to respect nature.

The corrosion in fluid system can be minimized to prevent from any serious and major damage to system. Corrosion and particles in the used oil can be filtered out and used back again. Some oil purifier plants are able to purify and filter to 1μm of particles makes it very clean oil as stated in International Standard Organization (ISO) table.

1.4 Objective

Based on the important of creating an inexpensive purifier stated, three objectives is been achieved in this study are;

1. Invent and build a low cost hydraulic oil purifier that can filter and purify particles at least to 25μm and follows the NAS 1628 table at class 8~10 (clean oil).

2. The output of the machine will be compared with other type of machine such as stated in Table 1-1.

3. To test the machine performance.

1.5 Expected Result

This project will use simple technology with small cost to fulfill the function of existed oil purifiers. While reducing the cost, this project will also consider and maintaining the quality and cleanness of the oil.

By the end of this project the machine should achieve the author main objective that is to reduce the cost of an existed oil purifier. The method is to use simple equipment that function similarly in existing oil purifier in order to reduce cost.

The machine will follows the rule of existing oil purifier which purifies oils from sized particle and separate water from the hydraulic oil itself. In form of hydraulic oil standard the purified hydraulic oil should get to NAS 1628 – class 8~10 or ISO16/14/11 – clean oil.

CHAPTER II

PURIFICATION OF HYDRAULIC OIL

2.1 Oil Maintenances

Maintenance is the largest single controllable expense in a manufacturing plant. With as many as 80% of all machine failures related to contamination in the oil, pro-active methods are saving industries considerable costs every year.[7]

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oil and other lubrication in which contain large of water, vapor, impurities, sludge, dielectric and colloid. Oil filtration plant can eliminate them effectively and efficiently.

Turbine oil filtering series will result in the improvement of the properties of turbine oil, other lubrication and extend the maintenance period of turbine or other equipment which has lubrication system and keep them operate in good condition.

2.2 Wear and tear in oil system

Any machine using oil for power transmission or lubrication will be affected by the condition of the oil. The oil comes into contact with all the other components in the system and should be considered the most important. Contamination in the oil is anything that should not be there, like solids and chemicals.

2.2.1 Mechanical Wear

Solid particles typically cause 50% of all failures and multiply by destroying the surface of even very hard metal. The most harmful particles are the ones trapped in the dynamic tolerance like in bearings. Refer Appendix B – Figure2.

2.2.2 Chemical Wear

Chemical contamination includes water and oxidation products and certain metals (e.g. copper). Water typically accounts for 20% of mechanical failures. It reduces the lubricity of the oil and results in corrosion and erosion. Furthermore, it acts as a catalyst in the oxidation of the oil, just as copper does. An oxidation product forms a sticky layer on metal surfaces and is often referred to as varnish. Hard

particles of all sizes get caught in the sticky layer, creating sandpaper like, grinding surface.

2.2.3 Oil Sampling

The purpose of oil sampling is to achieve the highest level of machine performance and reliability at the lowest possible cost. The initial samples serve to establish benchmarks and to identify the machines with critical levels. The routine sampling is done to document that goals are met and can also provide indication of abnormal wear that needs to be addressed. The quality of analysis results depends first on correct sampling and handling of the sample, secondly on the quality of the laboratory performing the analysis. The importance of the knowledge about where and how to take a sample is paramount and requires special attention.

2.2.3.1 Oil Sample Analysis

As stated by C.C Jensen Laboratory, a minimum of oil analysis should include:

a) A particle count
b) Water content in ppm (particle per million)
c) Viscosity
d) Acidity level

If the oil additive content is of interest a spectral analysis should be included. This test is best carried out by the oil supplier as they have the detailed knowledge of the initial additivation of the oil. It is recommended that the initial tests are performed by an independent laboratory with special knowledge on lubricants.

The ISO 4406/2000 classification of particle contents was introduced to facilitate comparisons in particle counting. Sudden break down in an oil system is often caused by large particles (>14 μm) in the oil while slower, progressive faults, e.g. wear and tear, are caused by the smaller particles (4-6 μm). This is one of the

explanations why the particle reference sizes were set to 4 μm, 6 μm and 14 μm in ISO 4406/2000. A typical sample from a wind turbine gearbox, for example, contains in every 100 mL of oil:

Table 2–1 Contamination classes according to the new ISO 4406/2000 standard

More than	Till	Class
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64,000	130,000	17
32,000	64,000	16
16,000	32,000	15
8,000	16,000	14
4,000	8,000	13
2,000	4,000	12
1,000	2,000	11
500	1,000	10
250	500	9
130	250	8
64	130	7
32	64	6

450,000 particles >4 micron

120,000 particles >6 micron

14,000 particles >14 micron

This sample has the contamination class of ISO 19/17/14

After being analyze we can refer the ISO table that is standardized by American standard. **NAS Classes** NAS 1628 is an American standard that translates approximately into ISO Codes. The NAS level were shown in Table 2-2