



**Universiti Teknikal Malaysia Melaka**

**DEVELOPMENT AND ANALYSIS OF PORTABLE OIL  
FILTRATION OF RECYCLED WASTED ENGINE OIL**

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**Bachelor's Degree in Mechanical Engineering Technology major in Maintenance  
Technology**

**Faculty of Mechanical and Manufacturing Engineering Technology**

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**DEVELOPMENT AND ANALYSIS OF PORTABLE OIL FILTRATION OF  
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**LIM PEI SHAN**

**Thesis submitted in the fulfilment of the requirements for the Bachelor's Degree in  
Mechanical Engineering Technology major in Maintenance Technology**

**Faculty of Mechanical and Manufacturing Engineering Technology**

**UNIVERSITY OF TECHNICAL MALAYSIA MALACCA**

**2018**



## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor's Degree in Mechanical Engineering Technology (Maintenance Technology) with Honours.

Signature : \_\_\_\_\_  
Supervisor Name : \_\_\_\_\_  
Date : \_\_\_\_\_  
\_\_\_\_\_

## APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfilment of Bachelor's Degree in Mechanical Engineering Technology (Maintenance Technology) with Honours.

Signature : \_\_\_\_\_  
Supervisor Name : \_\_\_\_\_  
Date : \_\_\_\_\_  
\_\_\_\_\_

## **DEDICATION**

To knowledge and technology

## ABSTRACT

This thesis is about the development and analysis of portable oil filtration machine of recycled wasted engine oil. The increment of global concern on the mineral resources made recycling engine oil a valuable research in the near decades. Various tribology test and researches have been done on the recycling engine oil, the common procedure before every test is to filter the wasted engine oil into a raw oil usable in test and research. ASTM D7317 is a standard procedure on filtration of wasted engine oil which shows high performance where the expected filtered wasted engine oil is free of impurities and metals, which is also the benchmark of the development of the portable oil filter. The thesis started with the design development of the portable oil filter by choosing the right material and design with various design modelling method, countermeasure of the technical problem faced on the development of the idea of the portable oil filter is discussed. The concepts of methods used to develop and fabricate the portable oil filter is discussed in chapter 3 together with the computer aided analysis methods and software CATIA and AcuSolve. The portable wasted engine oil filter is basically designed to fulfil the engine oil filtration amount of a vehicle (approximately 5L), and made of polyvinyl chloride (PVC) and stainless steel with vacuum operation based on pump theory. The filter material use cellulose paper with high pressure resistance and high retention rate. The analysis using computer aid software are carried out before the fabrication of the portable oil filter, from the analysis from CATIA and AcuSolve, the design shows good average to reading 3 in factor of safety (FoS) and created a vacuum of 17.37kPa pressure drop that enabled the filtration process to carry out.

## ABSTRAK

*Tesis ini adalah tentang perkembangan dan analisis penapis minyak enjin terpakai yang boleh dibawa. Penambahan pengambilan berat oramg ramai terhadap sumber mineral yang akan pupus telah merangsangkan kepentingan pengitar semula minyak enjin terpakai. Pelbagai jenis ujian dan kajian Tribologi mengenai minyak enjin terpakai telah dijalankan di seluruh dunia, sebelum setiap ujian atau kajian, penapisan minyak enjin terpakai merupakan satu langkah yang menentukan kerjayaan ujian atau kajian tersebut. ASTM D7317 merupakan satu piawaian antarabangsa yang mengenai penapisan minyak enjin terpakai yang menunjukkan prestasi tinggi yang mana minyak enjin terpakai yang dilapis tidak lagi mengandungi kekotoran dan logam, piawai tersebut merupakan penanda aras bagi perkembangan penapis minyak enjin terpakai tersebut. Tesis ini dimulakan dengan reka bentuk penapis minyak terpakai dengan proses pemilihan bahan dan reka bentuk yang sesuai dengan menggunakan cara pemodelan reka bentuk yang berbeza. Di samping itu, tindakan balas terhadap masalah teknikal yang dihadapi waktu perkembangan idea penapis minyak enjin terpakai juga dibincang. Konsep kaedah yang digunakan dalam perkembangan dan pembuatan penapis minyak enjin terpakai telah dibincang dalam bab tiga serta dengan kaedah analisis yang mana termasuk software yang dipakai untuk analisis seperti CATIA dan AcuSolve. Pada asasnya, penapis minyak enjin terpakai yang boleh dibawa ini direka untuk memenuhi jumlah penapisan sebuah pengangkutan (5L), dan diperbuat daripada polyvinyl chloride (PVC) dan kekuli tahan karat dengan konsep operasi vakum yang berasakan teori pam. Bahan penapis yang bakal diguna adalah kertas selulose yang dapat merintang tekanan tinggi dan kadar penapisan yang tinggi. Analisis telah dijalankan sebelum pembuatan penapis minyak enjin terpakai tersebut dengan bantuan berbagai jenis software. Hasil analisis software telah menunjukkan produk tersebut mempunyai baccaan factor keselamatan yang bernilai 3, dimana adalah diterima. Analisis melalui software Acusolve pula menunjukkan rekacipta penapis ini mampu mewujudkan ruang vakum yang mempunyai perbezaan tekanan sebanyak 17.37kPa.*



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## LIST OF ABBREVIATIONS

ABBREVIATIONS	CONTENTS	PAGE
U.S.	United States of America	1
ASTM	American Society for Testing and Material	2
FR	Function Requirements	6
CAD	Computer-Aided Design	6
PMA	Pugh Matrix Analysis	7
MCDA	Multiple Criteria Decision Analysis	10
HoQ	House of Quality	10
QFD	Quality Function Deployment	10
CA	Customer Attributes	10
TA	Technical Attributes	10
Hp	Horsepower	19
cfm	Cubic feet per minute	19
MPa	Mega Pascal	22
TAN	Total Acid Number	27
TBN	Total Base Number	27
VI	Viscosity Index	27
TMP	Trans-membrane Pressure	36
e.m.f.	Electro Motive Force	39
CNC	Computer Numerical Control	41

FloEFD	Flow Experimental Fluid Dynamics	45
FTK	Faculty of Engineering Technology	46
SLS	Selective Laser Sintering	49
CFD	Computational Fluid Dynamic	52
BoM	Bill of Material	53

## LIST OF FORMULAS

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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Urbanization is an unstoppable phenomenon that happening around the world. As part of this evolution, Malaysia took part by showing its economic expansion starting from year 1970 till now. To adapt with the urbanization and congest the rising of population, transportation system of Malaysia faced a huge change. The population in urban area of Malaysia increased drastically and made public transport to seem poor to sustain the population need due to lack of proper planning and design. In the other hand, the economic expansion had provided the citizen an opportunities of high incomes, and hence, instead of incomplete public transport system, owning an affordable private vehicle had become the first choice of most people. With the growth of economic status in Malaysia, the private vehicle is rising in an escalating manner (Almselati et al., 2011). The increased of vehicle number had definitely caused the vehicle servicing and maintaining field to earn a fortune. To maintain the function ability of engine, engine oil of every vehicle is demanded to change at every 5000km or 10,000km depends on the type of engine oil used. Based on a research adopted on U.S. Navy vehicle, suggested that use oil analysis method as the main maintenance diagnostic tool for vehicle's engine. The data collected from oil analysis shows that out of every seven engines, only one needed service (Ellis, 1961). This research suggested the most cost saving maintenance method, at the same time, the truth that used engine oil still have its value is undeniable. Despite the potential value of used engine oil,



the disposal method of used engine oil is the concern of green environmental issue too. The act of collect and refine used engine oil solved the environmental problem with prevention of improper disposal and reduce the demand of crude oil in manufacturing of engine oil, at the same time, the costs of used engine oil disposal had turn into an investment. Refinery of used engine oil is a common research in Tribology's filed nowadays, additive of various chemical in refine engine oil had successfully resume or even improve the lubricants characteristics of the used engine oil. The major obstacle to reuse of used engine oil is the presence of various ash-forming impurities that hard to remove from used engine oil and the presence of those ashes affect the characteristics of the used engine oil. The characteristics of the used engine oil form by the ashes is not stable due to further decomposition or oxidation of the impurities in used engine oil (Dhuldhoya et al. 2003). American Society for Testing and Materials (ASTM) had developed a standard to filter or remove impurities in used engine oil filed ASTM D7317-07(2013): Standard Test Method for Coagulated Pentane Insoluble in Used Lubricating Oils by Paper Filtration (LMAO Method); which proven able to remove unwanted impurities in used engine oil and this aids the research study by providing used oil of stable characteristics. This thesis is about the development of a portable filter that fulfilled the filtration standard of ASTM D7317, and express the filtration process by transforming the lab scale filtration process into a single button. This thesis consists of 5 chapter which Chapter 2 is the literature review, Chapter 3 discuss about the methodology used in completing the research, chapter 4 is the result and discussion, and chapter 5 conclude the research.

## 1.2 Problem Statement

Engine Oil is always a topic of research in Tribology's field. Wasted engine oil and reusable of engine oil is one of the hottest research topic recently. The application of recycled engine oil in industry is encouraged world widely since it is eco-friendly and help to reduce pollution (Osman et al. 2017). A gallon of used engine oil has the potential to pollute million gallons of clean water source. Others than reduce pollution, recycling used engine oil is a good choice because it is very useful in every stage of recycled product; rough filtration convert the recycled engine oil into fuel or one-used lubricant; re-conditioned of the used engine oil make it suitable for one-used heavy duty lubricant; and if the used engine oil is collected and refined, the final product used less energy to produce but having the same quality as virgin oil (Wilson, 1997). Hence the study in recycle engine oil should be encouraged, however the laboratory filtration process is time taking, and the non-systematic collection method has discouraged the commercial user to collect the wasted engine oil. By the designing and fabrication of this portable filter, the filtration process can be expressed and combined with the collecting step.

### **1.3 Objective**

The objectives of this project are stated as below;

1. To design a portable oil filter with faster filtration process compared to lab scale filtration process.
2. To fabricate the portable oil filter with suitable filtrating material.
3. To analyse the designed product functionality and product safety with the aid of software.

### **1.4 SCOPE**

The scope of the project is developed based on the objectives of the project as below;

1. Designing a portable oil filter with CATIA and testing the durable of material and filtration process using the tools in CATIA.
2. Fabricating the portable oil filter with analysed suitable oil filtration membrane and light weight, oil-corrosive durable material.
3. Analysing designed portable oil filter in the spec of structure and pump performance using CATIA and AcuSolve.