FABRICATION A SMALL-SCALE FILTRATION UNIT FOR PRE-TREATED OIL SAMPLE

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A thesis submitted
in fulfillment of the requirements for the degree of
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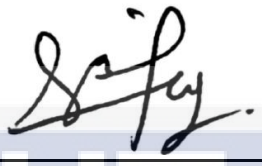
2022

DECLARATION

I declare that this project entitled “Fabrication a small scale filtration unit for pre-treated oil sample” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

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Signature : 

Supervisor Name : Dr. Muhammad Ilman Hakimi Chua Bin Abdullah

Date : 08/06/2022

DEDICATION

I dedicate this work to my beloved parents and my supervisor, Dr. Muhammad Ilman Hakimi Chua Bin Abdullah, who offered unconditional love and support and have always been there for me. Thank you so much for giving me strength to finish my Final Year Project.

ABSTRACT

Nowadays, the growing worldwide concern over a depleting mineral resources has made waste oil recycling a worthwhile research project to be invested in for the next decades. There are multiple researches involving the field of tribology on recycling waste engine oil that have been conducted. The standard process prior to each test is to filter the waste engine oil into a raw oil suitable for testing and study. ASTM D7317 is a standard process for filtering of waste engine oil that demonstrates good performance where the predicted filtered waste engine oil is free of contaminants and metals and serves as a benchmark for the development of portable oil filters. This thesis is to show the design, fabrication and analysis of this portable oil filtration unit designed to combat wastage of used oil. This thesis begins with the design development of a portable oil filtration unit by selecting the appropriate material and designing using various design modelling methods. This thesis then discussed solutions to technical problems encountered throughout the development of this concept of the portable oil filtration unit. The methods used to design, develop and fabricate the portable oil filter as well as analysing its performance was discussed in chapter 3 along with the computer aided analysis methods and usage of the software CATIA. This portable oil filtration unit was primarily designed to meet a vehicle's engine oil needs (about 5L) whilst allowing all types of oil to be filtered depending on the user's needs. It was constructed out of nylon, following the method of the standard process of filtration. The filter was made of cellulose paper due to its resistance to pressure and high retention rate. The probable analysis of this product was made using CATIA before fabrication and subsequent experimental testing was carried out. Experimental results with low volume of oil showed that the filter initially was able to slightly reduce time taken for filtration process. However, subsequent testing with higher volume of oil showed that the filter did not keep up with the filtration time of laboratory unit. Based on this finding, the design did not meet the required criteria to compete with the laboratory filtration unit.

ABSTRAK

Pada masa kini, kebimbangan yang semakin meningkat di seluruh dunia terhadap sumber mineral yang semakin berkurangan telah menjadikan kitar semula sisa minyak sebagai projek penyelidikan yang berbaloi untuk dilaburkan untuk dekad akan datang. Terdapat pelbagai kajian yang melibatkan bidang tribologi tentang kitar semula sisa minyak enjin yang telah dijalankan. Proses standard sebelum setiap ujian adalah menapis sisa minyak enjin kepada minyak mentah yang sesuai untuk ujian dan kajian. ASTM D7317 ialah proses standard untuk penapisan sisa minyak enjin yang menunjukkan prestasi yang baik di mana minyak enjin sisa ditapis yang diramalkan bebas daripada bahan cemar dan logam serta berfungsi sebagai penanda aras untuk pembangunan penapis minyak mudah alih. Tesis ini adalah untuk menunjukkan reka bentuk, fabrikasi dan analisis unit penapisan minyak mudah alih ini direka untuk memerangi pembaziran minyak terpakai. Tesis ini dimulakan dengan pembangunan reka bentuk unit penapisan minyak mudah alih dengan memilih bahan yang sesuai dan mereka bentuk menggunakan pelbagai kaedah pemodelan reka bentuk. Tesis ini kemudiannya membincangkan penyelesaian kepada masalah teknikal yang dihadapi sepanjang pembangunan konsep unit penapisan minyak mudah alih ini. Kaedah yang digunakan untuk mereka bentuk, membangun dan mengarang penapis minyak mudah alih serta menganalisis prestasinya dibincangkan dalam bab 3 bersama dengan kaedah analisis berbantukan komputer dan penggunaan perisian CATIA. Unit penapisan minyak mudah alih ini direka terutamanya untuk memenuhi keperluan minyak enjin kenderaan (kira-kira 5L) sambil membenarkan semua jenis minyak ditapis bergantung pada keperluan pengguna. Ia dibina daripada nilon, mengikuti proses standard penapisan. Penapis diperbuat daripada kertas selulosa kerana ketahanannya terhadap tekanan dan kadar pengekalan yang tinggi. Analisis produk ini dibuat menggunakan CATIA sebelum fabrikasi dan ujian eksperimen seterusnya dijalankan. Keputusan eksperimen dengan isipadu minyak yang rendah menunjukkan bahawa penapis pada mulanya dapat mengurangkan sedikit masa yang diambil untuk proses penapisan. Walau bagaimanapun, ujian seterusnya dengan isipadu minyak yang lebih tinggi menunjukkan bahawa penapis tidak menepati masa penapisan unit makmal. Berdasarkan penemuan ini, reka bentuk tidak memenuhi kriteria yang diperlukan untuk bersaing dengan unit penapisan makmal.

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LIST OF ABBBREVIATIONS

ASTM	-	American Society for Testing
PMA	-	Pugh's Matrix Analysis
HoQ	-	House of Quality
QFD	-	Quality, Function, Deployment
VoC	-	Voice of Customer
CR	-	Customers' Requirements
TA	-	Technical Attributes
AC	-	Alternating Current
DC	-	Direct Current
PA	-	Polyamides
VI	-	Viscosity Index
CNC	-	Computer Numerical Control
SLS	-	Selective Laser Sintering

CHAPTER 1

INTRODUCTION

1.1 Background

Since the industrial revolution first started hundreds of years ago, the world of industry became a necessity in every country to bring forth modernization. There is a sense of inevitability that society necessitates modernization as the world keeps on evolving. As we arrive in the Information Age, the period in which technological advances define social, economic, and political life, it is clear that urbanization is imperative to create a prosperous society. Malaysia's economic growth started in 1970 and has since started to adapt to the concept of urbanization which also resulted in population congestion. Because of congestion, there was a huge demand for lots of basic necessities nowadays which was once upon a time considered a luxury. To meet these demands, machineries must now be operating at optimum condition in order to create products in large quantities and of high quality. One of the ways to allow these machineries to optimally work is the usage of oil in more ways than one. Lubricating oil is used to lubricate a machine's moving parts, fuel oil is used primarily in steam boilers and hydraulic fluid, or hydraulic oil is used to transfer power within a hydraulic system of a machinery. Since oil is obtained by extracting crude oil from the oil well, there is limited access to oil and there is fear that one day oil will run dry. Used oil holds some potential value

and the disposal method is a major concern as a gallon of used engine oil has the potential to pollute millions of gallons of clean water source. One of the ways to slow down this pollution is to re-refine used oil such as engine lubricating oil, hydraulic fluids, and gear oils into lubricants, processed into fuel oils, and used as raw materials for the refining and petrochemical industries. By collecting and re-refining used oil, environmental problems such as pollution can be eased due to prevention of improper disposal. This can also lower the demand for crude oil whilst using what would be the cost of oil disposal as an investment. Refinery of used oil has found its way to be the ethically accepted method to deal with used oil. With the addition of various chemicals, it is possible to refine oil successfully and hence resuming or even improving the lubricating qualities of the previously used oil. However, the existence of numerous ash-forming contaminants that are difficult to remove from the used oil is the main impediment to reuse said oil which can cause instability. A standard to filter or remove any debris or impurities in used oil had been developed by American Society for Testing and Materials (ASTM) whereby paper filtration method has been proven to be effective in achieving this. Hence, this research study is done whilst utilizing this method to provide sustainability as well reusability of said used oil.

1.2 Problem Statement

Improper disposal of used oil can bring forth a lot of pollution to the environment and instability towards the ecosystem. This is due to the fact that a gallon of used engine oil has the potential to pollute million gallons of clean water source. Recycled oil is now commonly used in industry and apart from reducing pollution, using recycled oil can be beneficial as its usefulness can be found at every stage of the recycling process. Hence, usage of recycling oil should be encouraged, and its research and development need to be promoted. However, due to the time consumption of the filtration procedure, as well as the collection of these used oil is non-systematic, it has deterred users from collecting used oil.

By designing this portable filter, this study aims to tackle the lack of reusability of waste oil as well as providing an easier method to reuse oil. This portable filter is designed to collect, and filter used oil more conveniently than before. This is also done to encourage consumers to start reusing waste oil as a way to not only save up some money, but also use what would have been a waste to be put to good use which can only fuel their own economy.

1.3 Objectives

The objectives of this project are stated as below;

1. To design and fabricate a portable oil filtration unit.
2. To simulate the design product with the aid of software.
3. To test the actual performance of the portable oil filtration unit and compare to lab scale filtration process.

1.4 Scope of Research

The scope of this research are as follows:

1. Designing a portable oil filter with a CATIA software.
2. Fabricating the portable oil filter with suitable material and proces.
3. Analyse the durability of the material and performance of the filtration processusing the available tools in CATIA.
4. Testing the performance of the portable oil filter and analysing the designed product in the spec of structure and pump perforrmance using CATIA.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The importance of tribology research relating to mechanical machinery was never in doubt. Several methods need to be undergone before designing of this portable filtration unit can be commenced. This chapter discusses the theoretical study available to fulfil the design, fabrication, and analysis of the portable oil filter.

2.2 Design Modelling

Designing is one of the most integral parts in production of a product in any businesses. The importance in designing is such that not only it controls the aesthetics of a product, but it also determines the functionality as well as effectiveness of any product produced in the market. As such, it is crucial that any decision related to the design is made early in the designing process so that any potential flaws or inadequacy existing within a design can be rectified prior to fabrication whilst still enabling and easing the usability of its primary function. Research has shown that majority of the product life cycle cost are determined at the preliminary stages of a product design. It is found that about 80 percent of the product life cycle cost were involved in the early stages of designing, whereas the whole manufacturing effort account for only 20 percent in the design stage (Gu, et, al., 2009). This statement clearly shows that the importance

of the design process in a product development in ensuring that the product satisfies its target audience, meeting specifications required, and most importantly, functions as intended. Hence, there are multiple steps that need to be undergone before any product design can be taken into question. This section discusses multiple method that can be used to develop the design of this portable filtration unit.

2.2.1 Design Concepts Generation

This is one of the integral steps which requires lots of brainstorming for ideas and new concepts. While there are some products that are available on the market with the 'tried and tested' design, design engineers here are allowed to be as creative as possible to create a new design concept to facilitate the primary function of the product. This requires 'thinking outside the box' to allow the product to standout in a competitive market. In the book "The Evolution of Physics" (1938), Einstein and Infeld wrote "to raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science." This statement shows that problems have existed for a long time and there are a multitude of solutions to a single problem. These solutions are to be discovered by mankind through usage of creative thinking which can only be a positive in science advancement. In this process, at least three design concepts will be created to allow for generation of ideas. Numerous factors such as methods of filtration and materials used will be considered in designing this portable filtration unit. Figure 2.1 below shows the mind map for design concept generation of a portable filtration unit.

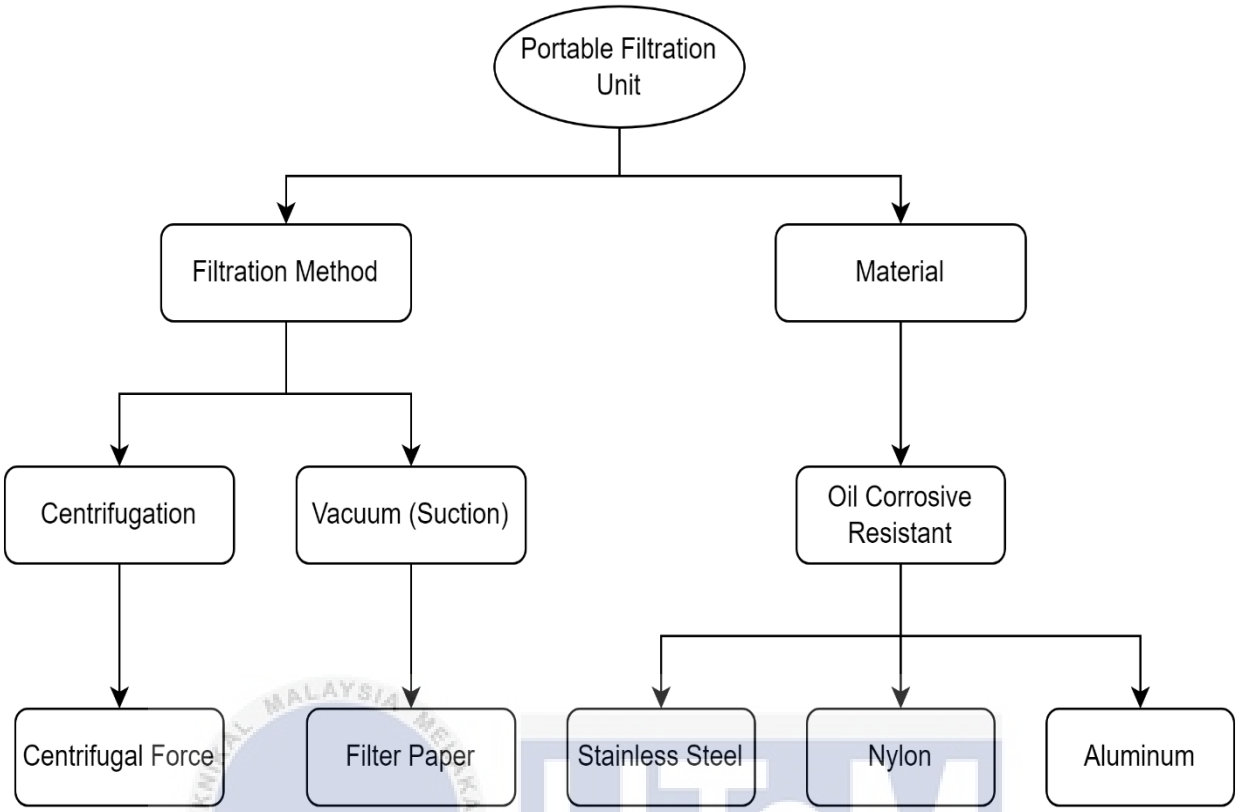

Figure 2.1: Mind map for design concept generation

2.2.2 Pugh's Method

Pugh's method is one of the most common methods used especially in designing a product nowadays in any industry due to its effectiveness in any project design. This method may be known as Pugh's method, Pugh matrix analysis (PMA), selection matrix or criteria-based matrix. The Pugh Matrix is a matrix used for decision making based on criteria that employs scoring to decide which of numerous potential solutions or alternatives should be chosen. It allows analysts to arrange and compare multiple criteria or aspects of a solution in an organised manner, allows for development of an optimal hybrid solution by considering other proposed solutions and facilitates concept generation and selection for a smooth and disciplined team-based approach. This approach is named after Stuart Pugh, who developed it. It is a highly recommended method to be used when criteria needed to be fulfilled is regarded as irreplaceable or when there is multiple alternative solution to be considered. Cervone et.al, 2009 stated that in a situation where a team is faced with an issue with several criteria, dimensions and factors, PMA is beneficial in becoming as a decision-making tool. Due to its effectiveness in decision making, PMA is a popular choice when ranking or selecting a design