BIO-BASED OIL AS A NEW RUBBER PROCESSING OIL IN DEVELOPMENT OF GREEN & SUSTAINABLE TIRE TREAD COMPOUND

MUHAMAD NUR IMAN SYAFAAT BIN DIN

UNIVERSITI SAINS

MALAYSIA

2022

SCHOOL OF MATERIALS AND MINERAL RESOURCES ENGINEERING

UNIVERSITI SAINS MALAYSIA

BIO-BASED OIL AS A NEW RUBBER PROCESSING OIL IN DEVELOPMENT OF GREEN & SUSTAINABLE TIRE TREAD COMPOUND

By

MUHAMAD NUR IMAN SYAFAAT BIN DIN

Supervisor:

ASSOC. PROF. IR. DR. NADRAS OTHMAN

Dissertation submitted in partial fulfilment of the requirements for the degree of Bachelor of Engineering with Honours

(Polymer Engineering)

Universiti Sains Malaysia

August 2022

DECLARATION

I hereby declare that I have conducted and completed the research work and written the dissertation entitled “Bio-Based Oil as A New Rubber Processing Oil in Development of Green & Sustainable Tire Tread Compound”. I also declare that it has not been previously submitted for the award of any degree or diploma or other similar title of this for any other examining body or University.

Name of student: Muhamad Nur Iman Syafaat bin Din Signature:

Date: 16.8.2022

Witness by,

Supervisor: Assoc. Prof. Dr. Nadras Othman Signature:

Date: 16.8.2022

ACKNOWLEDGEMENT

It is necessary for me to express my gratitude to those people who helped and contributed their precious time, leading to complete my final year project. First and foremost, I would like to express my grateful to Allah S.W.T and Rasulullah ﷺ because of His love and strength that He has given to me to finish my final year project and giving me a good health along this year.

Most importantly, I would like to express my sincere gratitude to my supervisor, Assoc. Prof. Ir. Dr. Nadras Othman for valuable guidance, patience, motivation and enthusiasm from the beginning up to the end of the writing. I deeply appreciate her continuous help despite her tight schedule whenever I encountered setbacks in my project and made it possible for this project to be success.

I am also taking this opportunity to express my deepest gratitude and special thanks to all the technician in latex and rubber laboratory, Mr. Mohd. Faizal B. Mohd. Kassim, Mr. Mohd. Suharudin B. Sulong and Mr. Shahril Amir B. Saleh for assisting me during conducting the laboratory works.

Also, to the Eversafe Rubber Sdn Bhd for letting me to conduct the research and testing in their laboratory, the CEO, Mr. Cheah Siang Tee, Mr. Anuar B. Atan (GM Eversafe). I would not forget my best Co-advisor, Mrs. Nur Raihan Bt. Mohamed, Mr. Rushdi B. Baharuddin, Mrs. Kasturi A/P Pachamuthu, Mr. Ahmad Azmi B. Idris and Mr. Sangaran A/L govindarajoo.

Finally, I would like to thank to my beloved family especially my parents, Mr. Din B. Yahya and Mrs. Zainun Bt. Mustapha. My sibling, Mrs. Nurul Syuhada Bt. Din, Mr. Mohd Zaidi Syauqi B. Din, Mrs. Nurul Syadia Taqwa Bt. Din, Mr. Muhammad Nur Khalis Syafi B. Din and also Nurul Natasha Aiza Bt. Pozai and friends for their

continual support, encouragement, patience, love and understanding during this busy duration of my project. I would not get to this far without them. Sincerely, Thank you.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

°C	Degree Celsius
%	Percentages
ML	Lowest Torque
T90	Cure Time
MH	Highest Torque
Ts1	Scorch Time
CRI	Cure Rate Index

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Material
BR	Butadiene Rubber
EPO	Epoxidized Palm Oil
EPO 1	Epoxidized Palm Oil 1
EPO 2	Epoxidized Palm Oil 2
EPO 3	Epoxidized Palm Oil 3
EPO 4	Epoxidized Palm Oil 4
FA	Formic Acid
FAME	Fatty Acid Methyl Ester
FTIR	Fourier transform infrared spectroscopy
GT 3000	Mineral Oil
HP	Hydrogen Peroxide
NR	Natural Rubber
OOC	Oxirane Oxygen Content
OPO	Olein Palm Oil
PAH	Poly Aromatic Hydrocarbons
PFA	Performic Acid
PHR/PPHR	Part Per Hundred Rubber
PO	Palm Oil
PVI	N-(Cyclohexylthio)phthalimide

RPO	Rubber processing oils
SA	Stearic Acid
SBR	Styrene Butadiene Rubber
SMR	Standard Malaysia Rubber
SSBR	Solution-Polymerized Styrene-Butadiene Rubber
TBBS	N-tert-butyl-2-benzothiazole sulfenamide
TMQ	2,2,4-Trimethyl-1,2-Dihydroquinoline
ZnO	Zinc Oxide

ABSTRAK

Penggunaan minyak pemprosesan dalam industri tayar telah menjadi kebiasaan. Matlamat kajian ini adalah untuk menghasilkan minyak pemprosesan bio yang boleh membawa kepada kompaun bunga tayar yang hijau dan lestari. Sifat mekanikal sebatian yang berbeza terdiri daripada pemprosesan EPO dan GT 3000 telah dibezakan dan dibandingkan. Proses sintesis minyak sawit membawa kepada bukaan cincin terbuka. Lebih banyak bilangan cincin epoksi yang dibuka, lebih besar potensi untuk penghubung silang. Pemprosesan berasaskan bio kemudiannya digunakan dalam proses pengkompaunan untuk menyiasat sifat mekanikal bersama dengan kompaun getah menggunakan minyak pemprosesan mineral (minyak hidrokarbon). Sebatian getah dibekukan selama 24 jam sebelum proses pemvulkanan bagi membolehkan sebatian getah mengalami kelonggaran rantai (getah dalam keadaan relax). Penggunaan minyak pemprosesan berasaskan bio pada kuantiti yang rendah merujuk sebagai Part Per Hundred Rubber (PHR/PPHR) memberikan sifat mekanikal yang tinggi berbanding minyak pemprosesan mineral (minyak hidrokarbon) perlu mempunyai jumlah phr yang lebih tinggi untuk mendapatkan nilai yang sama. Dari segi kekuatan tegangan, sampel 1 (EPO 5%) mempunyai nilai yang paling besar, 15.51 MPa, manakala sampel 4 (GT 3000 5%) hanya 13.17 MPa walaupun pada hakikatnya kedua-duanya mempunyai jumlah phr yang sama. Corak yang sama juga boleh diperhatikan dalam ujian kekuatan koyakan yang telah dijalankan. Pemanjangan pada nilai putus didapati berbeza secara ketara bagi sampel 3 (EPO 13%) dan 6 (GT 3000 13%). Ini kerana kesan plasticizer minyak pemprosesan getah pada sebatian getah, yang menjadi lebih ketara apabila lebih banyak minyak

pemprosesan getah dimuatkan ke dalam sebatian getah. Pemanjangan pada nilai putus didapati 649.45% bagi sampel 3 (EPO 13%) dan 636.07% bagi sampel 6 (GT 3000 13%).

ABSTRACT

The usage of processing oil in the tire industry is a common practice. The aim for this study is to produce bio-based processing oil that can lead to green and sustainable tire tread compound. Then the mechanical properties of the different compound consist of EPO and GT 3000 processing were compared, correspondingly. The process of synthesis palm oil lead to ring opening. The greater the number of epoxy rings that are opened as a result of the procedure, the greater the potential for crosslinking. Bio-based processing then being used in the compounding process to investigate the mechanical properties along with the rubber compound using mineral processing oil (hydrocarbon oil). The rubber compound were freeze for 24 hours before vulcanization process in order to let the rubber compound have chain relaxation. The usage of bio-based processing oil at low quantity refer as Part Per Hundred Rubber (PHR/PPHR) gives the high mechanical properties as the mineral processing oil (hydrocarbon oil) need to have higher phr amount to get the same value. In terms of tensile strength, sample 1 (EPO 5%) has the greatest value, which is 15.51 MPa, while sample 4 (GT 3000 5%) only has 13.17 MPa despite the fact that they both have the same phr loading. The exact same pattern could also be observed in the tear strength test that was carried out. The elongation at break value was found to be significantly different for samples 3 (EPO 13%) and 6 (GT 3000 13%), respectively. This is because of the plasticizer effect that the rubber processing oil has on the rubber compound, which becomes more noticeable as more rubber processing oil is loaded into the rubber compound. The elongation at break value was found to be 649.45% for sample 3 (EPO 13%) and 636.07% for sample 6 (GT 3000 13%).

CHAPTER 1

INTRODUCTION

1.1 Background Study

In the process of generating industrial goods derived from renewable feedstocks, the chemistry-based modification of vegetable oils is an important step. Generally referred to as triglycerides, the triesters of glycerol that are combined with fatty acids make up the majority of vegetable oils, which are also referred to as fats or lipids. Specifically, oils and fats of vegetable and animal origin represented the biggest share of current consumption of renewable raw materials in the chemical industry. These particular oils and fats provide applications that cannot be supplied by petrochemicals.

Because of the existence of olefinic bonds, which are necessary for the reaction, the desired element in the process of epoxidation of vegetable oils was unsaturated fat (unsaturated fats have carbon atoms with double or triple bonds). Epoxidation was achieved through the reaction of performic acid, also known as peracids, with olefinic double bonds, which resulted in the formation of an oxirane that is an epoxy group. Since palm oil is rich in triglycerides, it can be exposed to variety of chemical processes but in this research, epoxidation is the method were used. Unsaturated fatty acids, such as oleic and linoleic acids, make up 56.6 % of palm oil, while palmitic acid makes up 43.4 % of the oil's total composition. This research will be focusing more on the tire tread applications.

An epoxidized derivative of a mixture of esters of glycerol with various saturated and unsaturated fatty acids, epoxidized palm oil (EPO) is a type of palm oil that has been oxidized. The fact that they are derived from renewable, biodegradable, environmentally benign, and conveniently accessible raw materials makes them extremely valuable to a wide range of chemical companies.

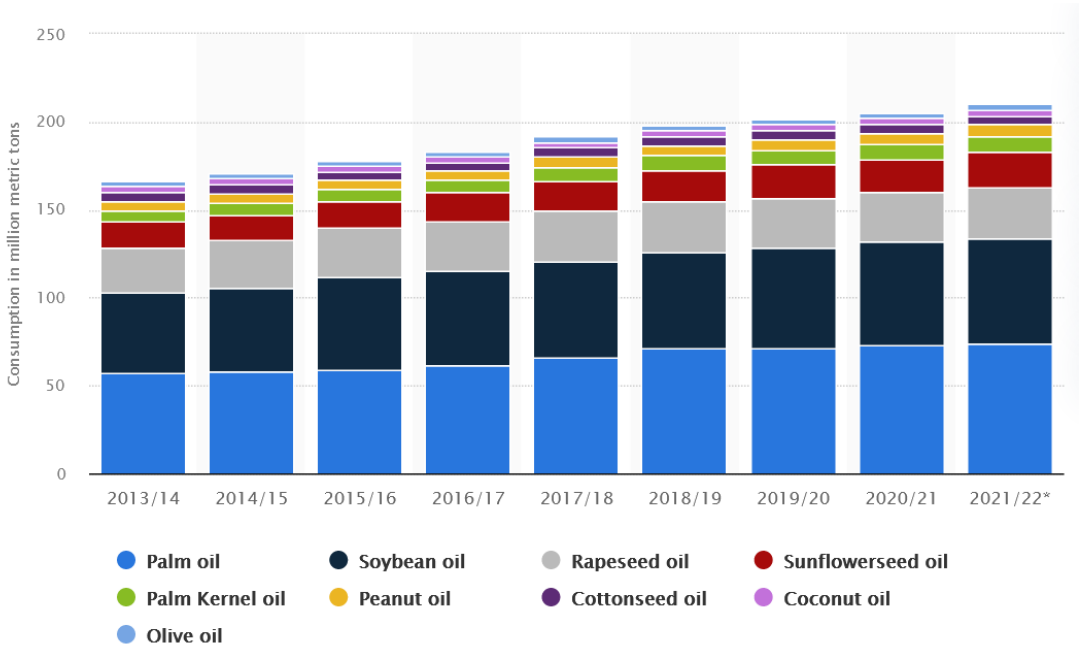


Figure 1.1: Consumption of vegetable oils worldwide from 2013 to 2022, by oil type

The relatively low iodine value of the oil as well as the poor compatibility of epoxidized oil with polymers are two of the factors that limit the use of EPO as a processing oil. Oils that are derived from petroleum, such as paraffinic, naphthenic, and aromatic oils, are currently used in the processing industry. These oils have a number of disadvantages, including a slower curing speed. Because of its carcinogenic properties, the aromatic oil does not contribute positively to the health of the

environment. Combustion of aromatic hydrocarbon oils can cause a significant risk to human health and influence awareness of environmental contamination during all stages of the tire life cycle, including manufacture, usage, and recycling. In this particular research project, the conventional processing oil, which is hydrocarbon oil will be compared with epoxidized palm oil (EPO), which is a bio-based oil that is better for the environment. After that, the substance will be put through a series of tests using a variety of methodologies, such as mechanical testing, physical testing, and evaluation of the strength that is provided by the rubber compound.

1.2 Problem Statement

Processing oil can reduce the viscosity of rubber when they are in the processing state. This can improve the processing properties of the rubber, such as filler dispersion and elasticity, while also reducing the amount of energy required for the processing. Hydrocarbon oil derived from petroleum frequently and extensively widely used in the production of tires. In addition, the aromatic oil that is used the most frequently contains significant concentrations of polycyclic aromatic hydrocarbons, which are known to cause cancer. When tires are produced, used, and recycled, aromatic hydrocarbon oils are released into the atmosphere. This can have significant effects on both the health of people and the environment. Researching environmentally friendly, renewable, and non-toxic tread rubber processing oil is essential in spite of the lack global petroleum resources and the possibility of petroleum shortage. Because of the negative effects that highly aromatic oils and PAH have on both human health and the environment, their use is currently being outlawed in a number of different nations. There is an oil presence level of between 5 and 6 % in a regular passenger

tyre. The concentration of aromatic species in an aromatic oil can be anywhere from 50 to 70 percent, which means that in a standard 16-inch tyre, there can be as much as 400 grams of oil-originated aromatic molecules.

Because particular polycyclic aromatics are the ones that cause the greatest damage, the amount that they contain is much more important. It is possible for there to be more than 250 parts per million of potentially hazardous polycyclic aromatics in an aromatic tyre oil. This indicates that there could be up to 400 mg of hazardous chemicals in your vehicle at any given time. PAH levels might be anywhere from fifty to one hundred times lower in naphthenic tyre oils. However, it is important to keep in mind that PAH-containing species can also originate from other types of raw materials used in the production of rubber, such as carbon black and resins. Because of this, companies that make tires have a responsibility to measure the amount of PAH molecules that are present in the finished product, and not just in the raw components individually.

1.3 Objectives

The specific research objectives are as follows:

I. To modify selected palm oil and replace it with current hydrocarbon based oil in the tire tread application.

II. To compare effect of hydrocarbon oil and synthesized EPO on mechanical and physical properties of tire tread application.

1.4 Thesis Organization

All chapters covered in this report consists of:

Chapter 1

In this chapter, it will start with an introduction to the thesis, which will include a background study, problem statement, research objectives, and an organization of all of the other chapters.

Chapter 2

Synthesis methods and parameters; rubber types, tire application, tire tread compounding components, testing in this study project are covered in this chapter literature review.

Chapter 3

This chapter is about the methodology and testing involve the rubber compound, the study will address the research process and testing involved, which includes the selection of raw materials used in tire tread compounding as well as equipment and instruments used.

Chapter 4

This chapter contains both the results of the research project as well as the discussions that supported them. The actual research project is made up of the research data, results, and discussions that are related to the study objectives that are outlined in this section. In this part of the article, every single explanation will be subdivided into the minimum possible detail.

Chapter 5

This chapter of the research will present a summary of the overall research project that was conducted for the thesis, as well as make ideas for more research.

CHAPTER 2

LITERATURE REVIEW

2.1 Rubber Processing Oil

Rubber processing oils, also known as RPO, serve as internal lubricants, enhance the blending of rubber formulations, support the formation of fillers and other additives, improve certain physical characteristics, and provide as low-cost additives. Rubber processing oils also improve certain physical characteristics. Rubber Process Oils are products that have broad use throughout a variety of sectors and are well-known for their reputation as being safe and beneficial to the environment. These oils are put to use in the production of a wide variety of rubber goods, including those made of natural and synthetic rubber. In Europe, the manufacturing of tires is strict on the use of lubricants with a high poly aromatic hydrocarbon (PAH) content. These restrictions have created an opportunity for new innovation to emerge into this industry.

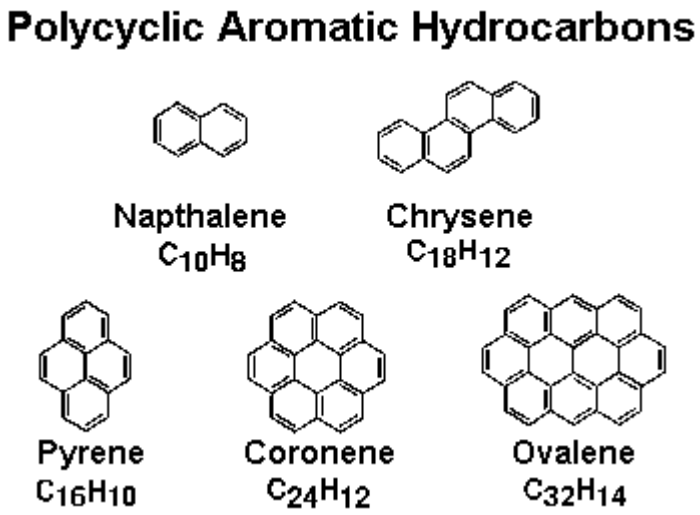


Figure 2.1: PAH structure (Salimon, J., & Ishak, A. A. 2012)

RPO either synthetic or organic, is used in mass production to manufacture a wide variety of goods, ranging from rubber bands to toys to enormous tires for a variety of vehicles, including in aviation sector. Throughout the mixing of rubber compounds, rubber process oils were required in the production. RPO is a type of oil that has a kinematic viscosity at 100 degrees Celsius that ranges from 25 to 50 centistokes (CST) and contains less than 3 percent of solids by weight. The production of rubber compounds, particularly aromatic rubbers, frequently makes use of polynuclear aromatic compounds as a process oil. The processing oil is suitable with aromatic rubbers however, in comparison to standard aromatic RPO, it has lower levels of hazardous polynuclear aromatic compounds. The usage of the stated oil composition allows for the production of rubber goods of a satisfactory quality. (Bock, I. N. S. (2004).

There are three distinct kinds of oils used throughout the production of rubber. Aromatic hydrocarbons can be identified by their existence of a double-bonded mix ring carbon configuration, which is one of their defining characteristics. Aromatic extender oil that is remarkable because of its viscosity, that satisfies the requirements of ASTM D-445 and the dynamic viscosity of both clear and opaque solvent. It comes in a variety of grades, the most well-known of which are heavy, moderate, and light viscous. (Basiron, Y., & Weng, C. K. (2004).

Paraffinic Oils is made up of straight-chained or branched hydrocarbon molecules with different viscosities. When the viscosity increase its indicate that the chain length is also increase the oil as well that is used in the manufacturing of rubber will significantly boost too. They were more stable than the most oil that have same

level of viscosity. The molecules that make up this class of hydrocarbons can either have branched chains or straight chain networks. Since total length of the chain are increasing, it will also cause an increase in the substance's viscosity, the RPO will eventually transform into a substance that has a greater degree of viscosity. Next, the naphthenic oil is the group of hydrocarbons commonly known as cycloparaffins includes naphtha as one of their elements. Despite the fact that their configuration is quite identical to that of an aromatic ring, these are single-bonded, which produces in a structure that is very stable.

2.2 Bio Processing Oil

When producing beneficial chemicals and substances, one frequently use were vegetable oils as a base that is both environmentally friendly and constantly sustainable. In replace of the petroleum products that are normally used in the manufacturing of synthetic polymeric substances, various types of oils can be used as raw materials. One of vegetables is the palm tree that produce palm oil. Both saturated and unsaturated fatty acids can be found in palm oil, with the unsaturated fatty acids often being broken down into polyunsaturated and monounsaturated. Through all the discovery of fatty acid methyl ester (FAME), palm oil has taken the place of diesel fuel derived from petroleum in common use. FAME is produced through a synthetic method named as transesterification, which involves the replacement of glycerol with short chain alcohol including methanol. This process is commonly referred to as biodiesel, which contains mono-alkyl esters of long chain fatty acids.

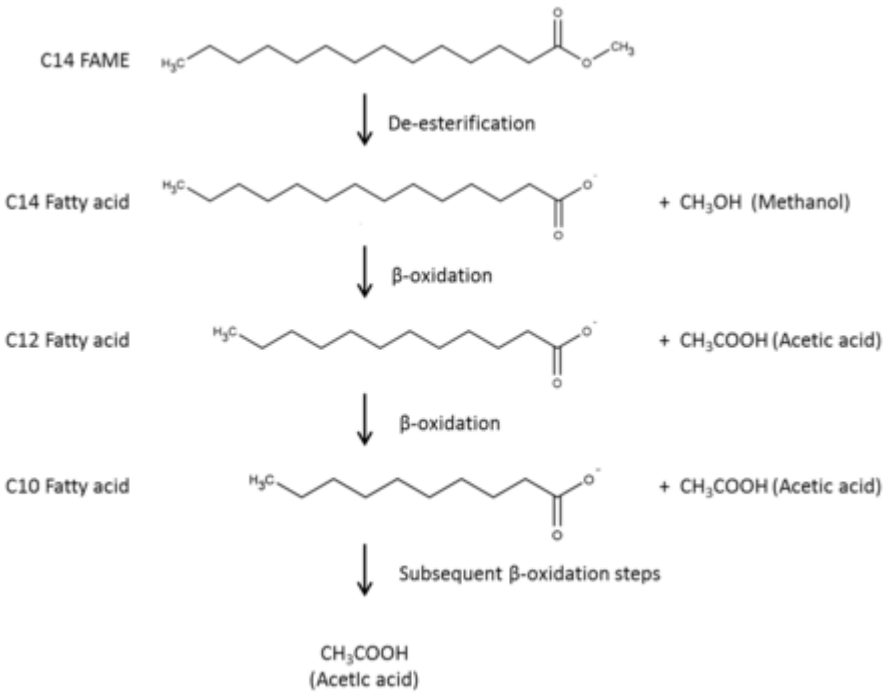


Figure 2.2: General pathway for metabolism of FAME (Flaris & Singh, 2009).

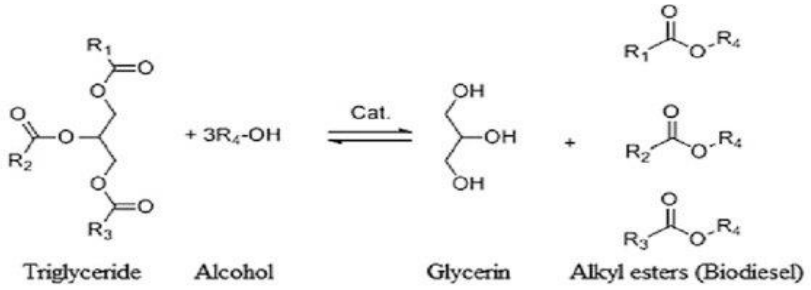


Figure 2.3: Typical transesterification reaction of triglycerides to mono alkyl esters conversion of fatty acids (biodiesel) (Flaris & Singh, 2009).

2.3 Palm Oil

Palm oil is a species of edible plant oil that is obtained from the pulp of the fruit of oil palm trees. Palm oil has a long history of use. The vibrant orange-red colour of palm oil can be attributed to the high level of beta-carotene included in the product. Palm oil has a great resistance to oxidation and heat when it is kept at a high

temperature for an extended period of time and exists in a semi-solid state when it is at room temperature.

Figure 2.4: Appearance of the palm oil

In today's world, canola oil and soybean oil have been displaced by the oil produced by this plant due to the facility's increased productivity and its more cost-effective operation (Weng, 2004). Both saturated and unsaturated fatty acids can be found in palm oil, with the unsaturated fatty acids being further broken down into monounsaturated and polyunsaturated subtypes. These saturated fatty acids include 39.389 percent palmitic, 3.915 percent stearic, 0.798 percent myristic, 0.243 lauric and 0.2 percent arachidic while unsaturated fatty acids include 43.829 percent oleic, 11.321 percent linoleic, 0.168 percent linolenic, 0.076 percent eicosenoic and 0.061 percent palmitoleic. The triglyceride structure of palm oil may be seen in Figure 2.3. It consists of glycerol, which has three chains of long, horizontal fatty acids connected to it.

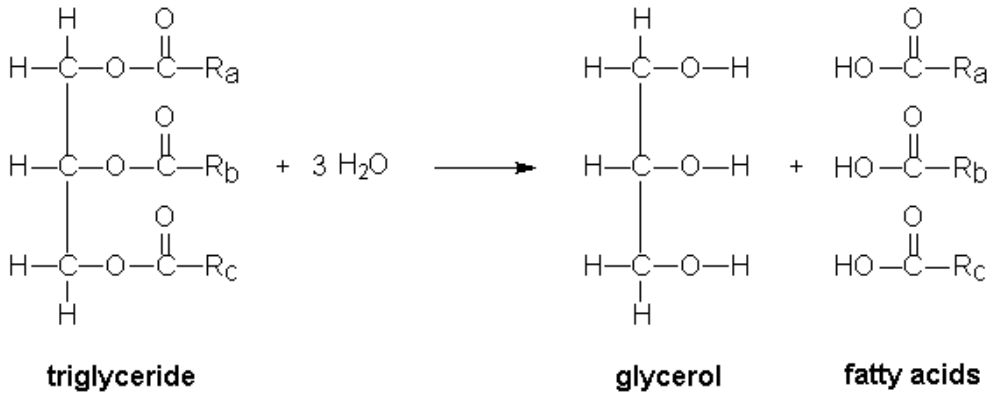


Figure 2.5: Triacylglycerol structure (Flaris & Singh, 2009).

Triglyceride molecules, which are comprised of carbon, hydrogen, and oxygen atoms, are the building blocks of palm oil. Because it has a significantly higher percentage of palmitic acid than other oils, palm oil can be distinguished from those other oils. It has levels of unsaturation that are either exactly half or even less than half of what soybean oil has. Because of the fatty acid structure of palm oil, it is capable of being fractionated either a high melting fraction refer as stearin or a low melting fraction refer as olein, and it is also accessible in this partially crystalline form. Because crude palm oil transforms into sediment at room temperature, particularly in tropical regions, fractional crystallization is required for the production of olein of a high quality. The majority of Malaysia's palm oleins have an iodine value that falls somewhere in the range of 56 to 58. (Guner, Yagci & Erciyes, 2006).

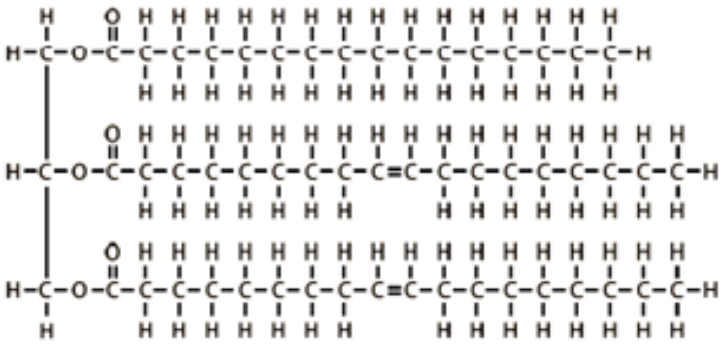


Figure 2.6: Structure of Triglycerides Commonly Encountered in Palm Oil (Flaris & Singh, 2009).

2.4 Epoxidation of Bio Based Oil

The most important double bond addition process, epoxidation, may frequently be carried out in situ with the help of the performic acid method and it is already manufactured on a considerable scale in industrial settings. However, in order for this procedure to be successful, the use of soluble mineral acids such as sulfuric acid is required. The presence of these acidic components results in a number of problems, including the following: It is difficult to separate acidic by-products, numerous neutralized salts are formed, which must be disposed of, there are side reactions caused by acid-catalysed epoxide ring opening, corrosion issues are caused by the strong acids used in the process. Because of these factors, the selectivity of industrial facilities to produce the required products does not really come close to exceeding 80 percent. In addition, the procedure is not only incompatible with the principles of green chemistry, but it is also hazardous to work with and results in a significant amount of trash.

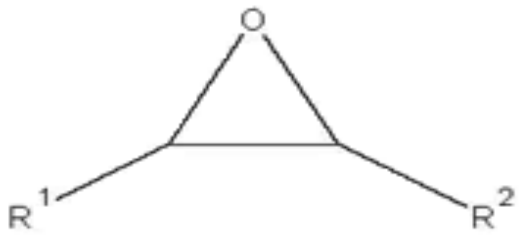


Figure 2.7: Epoxy Group Structure (Flaris & Singh, 2009).

Epoxides are a type of cyclic ether that contain an active three-membered ring and are also referred to as oxiranes. The bond angles are approximately 60 degrees, which results in the ring being extremely reactive and very stressed (Mungroo, 2008). When the epoxy glue hardens, the presence of these rings with high strain energy on the FA chains causes crosslinking to occur more easily. The greater the number of epoxy rings that are opened as a result of the procedure, the greater the potential for crosslinking, and the higher the quality of the plastic that is produced as a result of the process (Goud, et al., 2006).

Epoxidation is currently a very essential process since the epoxides that are obtained from the oil can be used as high temperature lubricants or as raw materials for chemicals such as alcohols or glycols. As a result, the epoxides that are obtained from the oil can be used in either application. It is generally accepted that epoxides with greater oxirane levels and lower iodine values represent higher-quality products. Epoxidation reactions are critical intermediates in the synthesis of a wide variety of chemical compounds. These reactions take place during the ring opening reaction, which can be started by nucleophiles or electrophiles and can be catalysed by either acids or bases (Goud, et al., 2006).

2.5 Rubber Compounding

Compounding refers to the process of combining unprocessed rubbers with the required components in order to produce a finished good with the desired properties. Compounding utilizes a wide variety of components, including, but not limited to, accelerants, activators, antioxidants, fillers and reinforcing agents, retarders, rubber process oils, softeners, and vulcanizing agents. It is necessary to use crosslinking agents in order to produce the crosslinks that will allow the molecules to interact at the molecular level, which will result in improved strength and elasticity. Elastomers that have not been synthesized act like they have a high molecular weight but a low elasticity and strength. (Princi, E. 2019)

By means of formulation, long-chain molecules are chemically bonded to one another, which results in the formation of networks and the material's transition from a viscous liquid to an elastic solid. This is what happens throughout the vulcanization or curing process, which ultimately results in an increase in strength and modulus while simultaneously resulting in a decrease in hysteresis. Vulcanization is typically accomplished with the help of sulfur. (Princi, E. 2019)

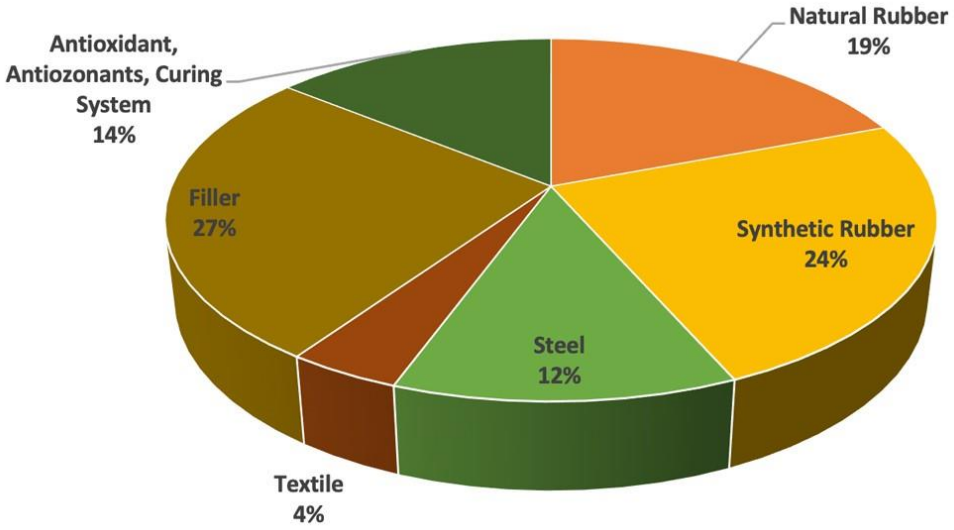


Figure 2.8: Substance Inside Tire Structure (Patrick et al. 2012)

Table 2.1: Example of Ingredient in Tire Compounding (Oleiwi, J. 2010)

No	Material	Function
1	Natural Rubber	Basic components in rubber compounding
2	Butadiene Rubber (BR)	Basic components in rubber compounding
3	Styrene Butadiene Rubber (SBR)	Basic components in rubber compounding
4	Filler	Used for reinforced or modifies the mechanical properties as well as to reduce cost
5	Silica	Lower rolling resistance, better wet grip
6	Carbon Black	Increases abrasion resistance and tensile strength significantly
7	Processing Oil	To ease the processing and to modify the specific properties
8	Accelerator	To promote vulcanization of rubber to occur more rapidly or at lower temperatures.

9	Zinc Oxide	Activates and promotes the highest number of crosslinks in the rubber chain imparting strength, stability and other useful properties in a finished tire.
10	Sulfur	Allows a more solid adhesion of the rubber, prevents the rubber from breaking apart and improves resistance to heat and tire wear
11	Anti-ozone	Provides an effective barrier against the penetration of ozone on the rubber surface

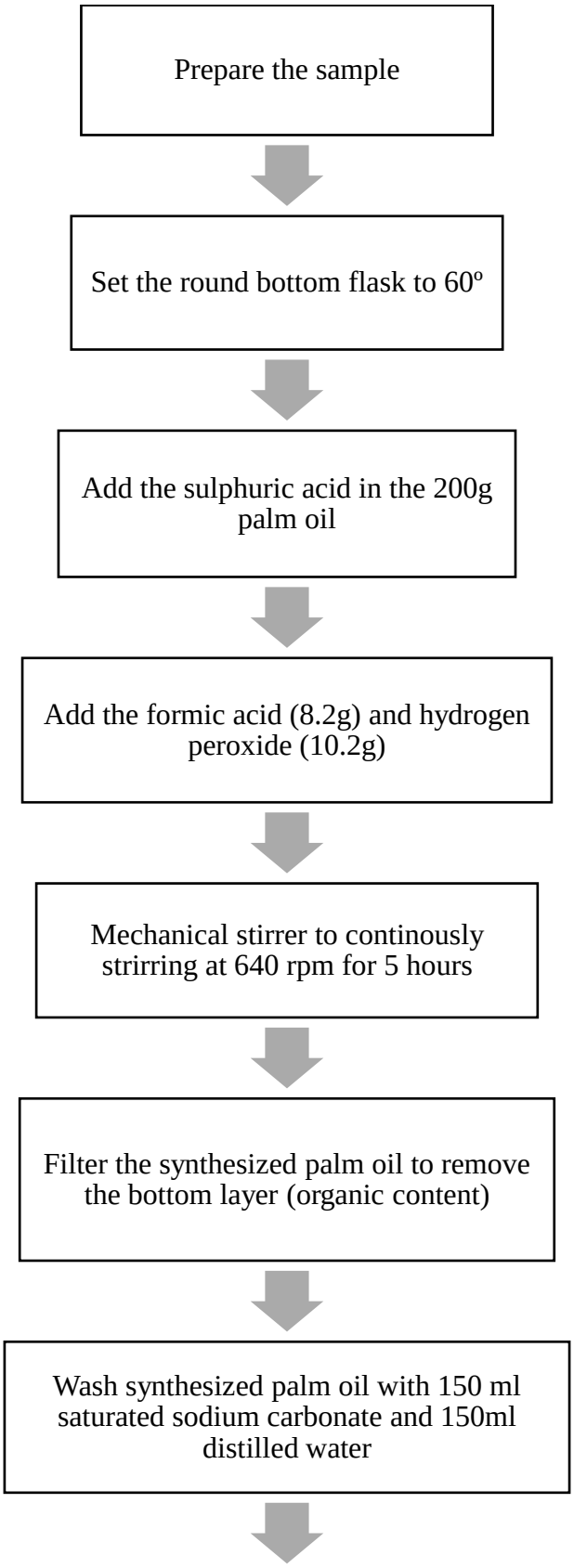
CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Introduction

This chapter describe about material, chemical and methodology for this research. In this chapter also will be include the testing and the sample preparation specify in this research. The investigation carried out in this research is to modify selected palm oil and replace it with current hydrocarbon based oil in the tire tread application. Moreover, this research also to compare effect of hydrocarbon oil and synthesized EPO on mechanical properties of tire tread application. Outline of the project's research process is provided here. This research is divided up into two phases, the first of which is Phase 1, which is seen in Figure 3.1. This phase includes the preparation of palm oil to produced epoxidize palm oil (EPO) by the use of a synthesis process in a round-bottom flask. The organic layer after being synthesis was filtered and remove and repeated until the pH reach 7.

In Phase 2, as seen in Figure 3.2, by using two roll mill the rubber compound was prepared by mixing all the ingredient in the formulation for tire tread and then freezing it for 24 hours to enable for the stress relaxion for the rubber compound. The rubber compound was subjected to a viscosity test as well as a cure characterization so that the rubber ability to flow and cure characteristics of the compound could be analysed, respectively. After that, the rubber compound was heated and pressed in order to cure it. Test for tensile strength, tear resistance, abrasion, and hardness were carried out in order to evaluate the vulcanizates' inherent mechanical properties.


Prepare the sample
Set the round bottom flask to 60º
Add the sulphuric acid in the 200g palm oil
Add the formic acid (8.2g) and hydrogen peroxide (10.2g)
Mechanical stirrer to continously strirring at 640 rpm for 5 hours
Filter the synthesized palm oil to remove the bottom layer (organic content)
Wash synthesized palm oil with 150 ml saturated sodium carbonate and 150ml distilled water

Continued from last flow chart

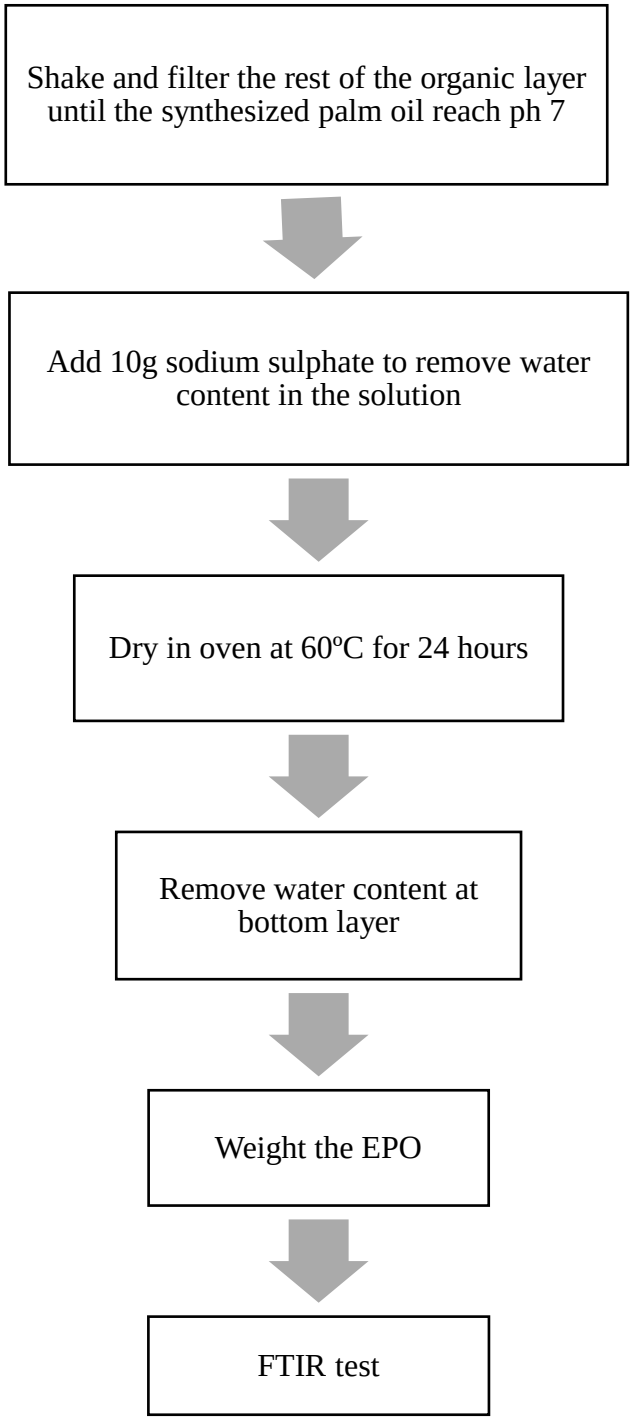


Figure 3.1: Flowchart for Phase 1:

Preparation of Synthesis Palm Oil

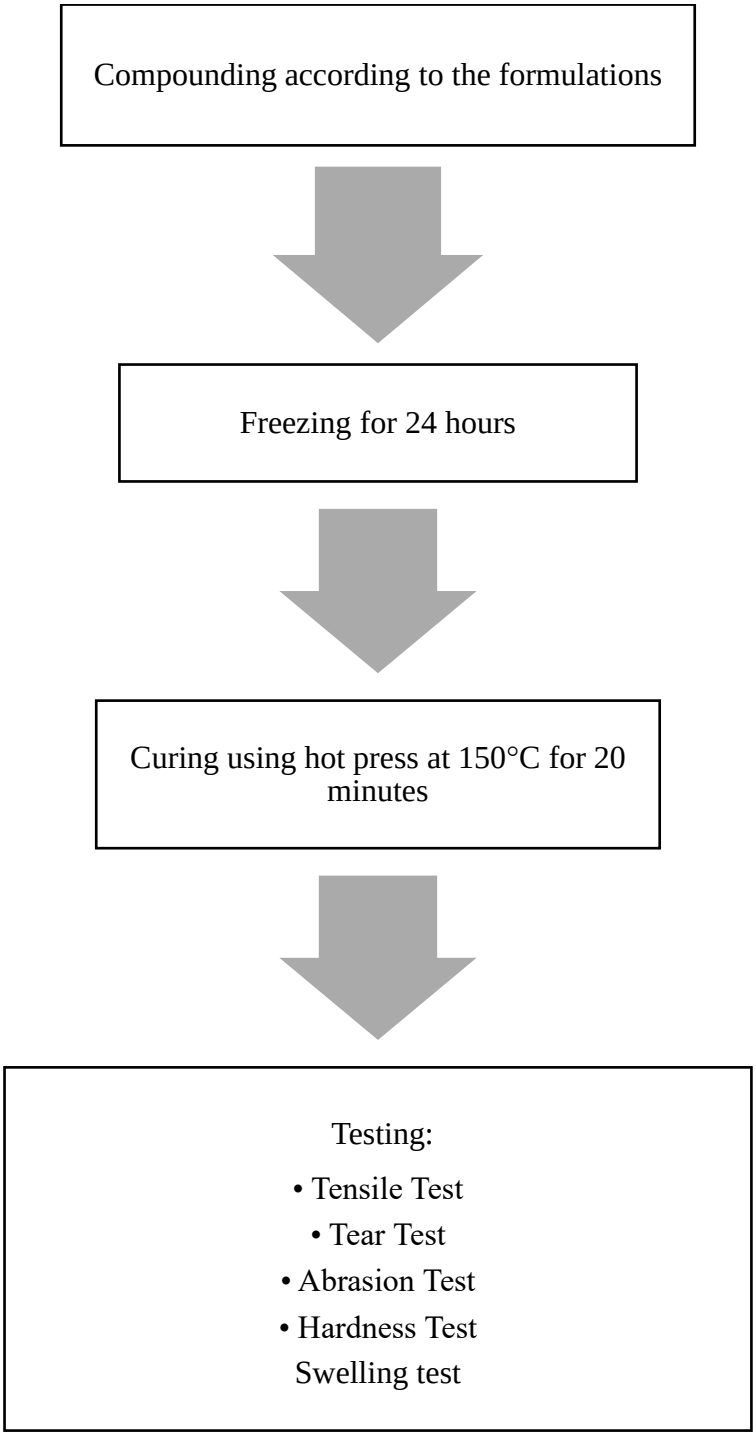


Figure 3.2: Preparation and compounding of sample using different type of processing oil with different phr loading

3.2 Material

3.2.1 Standard Malaysia Rubber (SMR 10cv)

The latex that has undergone processing, been dried and then produced in bundle form is known as natural rubber (SMR). This rubber colour is a bit dark yellowish. At the latex phase, 0.05 % sodium metabisulfate is incorporated so that the rubber does not become discoloured as a result of the action of an enzyme. The amount of Volatile matter found in natural rubber (SMR 10cv) is 0.8 maximum. This rubber has been supplied by EVERSAFE RUBBER SDN.BHD, Ipoh, Perak.

Figure 3.3: SMR 10cv appearance

3.2.2 Butadiene Rubber (BR, UBEPOL 150)

Possesses both a great capacity to be processed and an excellent physical characteristics. Contains an antioxidant that does not leave a stain. This rubber colour is silver and shining. BR has a great resistance to wear as well as its minimal heat build-up and high abrasion resistance and is mostly utilized in the production of tires

due to this attribute. EVERSAFE RUBBER SDN.BHD of Ipoh, Perak has been kind enough to supply us with this rubber.

Figure 3.4: Appearance of Br, Ubepol 150

3.2.3 Solution-polymerized styrene-butadiene rubber (SSBR)

The SSBR colour was bit white as the styrene foam. The superior technical features of the rubbers that are based on SSBR are the reason for their widespread application. The amount of Volatile matter found in SSBR is only 0.75 maximum. The initial mooney value for the SSBR is range from 52-55. This rubber was supplied by EVERSAFE RUBBER SDN.BHD of Ipoh, Perak.

Figure 3.5: Appearance of SSBR

3.2.4 Carbon Black N220

Carbon black N220 The is an amorphous solid known as reinforcing filler can come in the form of a black bead or granule. The heating rate of N220 is higher than 400 ℃ and it has an ash concentration that is lower than 0.5%. It is generally odorless, water soluble, non-poisonous, and it possesses a stable chemical ability, which leads in great weather and light fastness

It is proposed to utilize Carbon Black N220 in the tread rubber of tires for big trucks, conventional vehicles and for the rubber products that require high strength and high wear resistance. These include: The wear resistance intensity of N220 is 10–20 percent higher than N330, despite the fact that it is compatible with all types of rubber. In addition, N220 has the potential to produce a high stretching intensity, a high resisting avulsion intensity and a high electric conductivity, yet it is difficult to work with and readily gets heated. Manufacture by Hangzhou Epsilon Chemical Co. Ltd but was supplied by EVERSAFE RUBBER SDN.BHD.