UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Effect of Palm Oil Trunk Dust To Polyurethane Noise Reduction Properties

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

by

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DECLARATION

I hereby, declared this report entitled "Effect of Palm Oil Trunk Dust to Polyurethane Noise Reduction Properties" is the results of my own research except as cited in references.

Signature	:	………………………………………….
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Pada masa kini, industri kelapa sawit telah menjana sejumlah besar sisa pertanian di Malaysia seperti batang kelapa sawit (OPT), pelepah kelapa sawit (OPF), dan tandan buah kelapa sawit (EFB). Baki terdiri daripada biojisim ini dapat membangunkan komposit bahan baru, di mana (OPT) yang digunakan sebagai pengisi dan Termoplastik Poliuretana (TPU) sebagai matriks. Kajian penyelidikan telah dijalankan untuk mengkaji kesan batang kelapa sawit (OPT) habuk dan Termoplastik Poliuretana (TPU) terhadap bunyi redaman. Sebelum difabrikasikan, pengisi dari batang kelapa sawit (OPT) telah dirawat dengan 2% natrium hidroksida (NaOH) dan dikeringkan dengan menggunakan drum mesin pengering pada suhu 100 °C selama 6 jam. Sampel komposit dengan jumlah isipadu pecahan yang berbeza dari batang kelapa sawit telah difabrikasikan oleh (0% berat, 10% berat, 20% berat, 30% berat, dan 40% berat). Sampel ini telah disediakan dengan kaedah pengacuan mampatan. Pekali penyerapan bunyi (SAC) dan kehilangan penghantaran bunyi (STL) nilai komposit akan diukurdengan menggunakan tiub galangan merujuk kepada ASTM E1050-98 dan ISO 10.534-2, untuk menjalankan Sistem ACUPRO. Ketumpatan Sampel 1 adalah tertinggi kerana poliuretana termoplastik tulen dengan 1.146 g / cm3 ketumpatan dan sampel 5 adalah paling rendah kerana lebih tinggi memuatkan debu dengan 1.004 g / cm3. Hasilnya, sampel 5 mempunyai koefisien penyerapan suara yang lebih tinggi pada 2000Hz-4000Hz, dapat menyerap bunyi sampai 30% dan sisanya 70% adalah refleksi suara dibandingkan dengan sampel lain. 5dB. Walau bagaimanapun, keputusan STL untuk sampel 5 memberikan kehilangan penghantaran bunyi yang lebih rendah iaitu 15.9dB. Jadi ia terbukti berkesan dalam pengurangan bunyi.Kesimpulannya, kandungan debu tertinggi memberikan ciri-ciri yang lebih baik untuk pekali penyerapan bunyi (SAC)dan kehilangan penghantran bunyi (STL)

ABSTRACT

Recently, an oil palm industry in Malaysia has generated a large among such as oil palm trunk (OPT), oil palm frond (OPF), and oil palm fruit bunch (EFB). The remaining consist of biomass can develop new material composite, where the (OPT) used as a filler and Thermoplastic Polyurethane (TPU) as a matrix. This study to investigate the effect of oil palm trunk (OPT) dust to noise reduction damping of Thermoplastic Polyurethane (TPU). Prior to fabrication, the filler was treated with 2% sodium hydroxide (NaOH) treatment and dried using drum dryer machine at 100°C for 6 hours. Composite sample with five different volume fractions of oil palm dust was fabricated, (0 wt%, 10wt%, 20wt%, 30wt%, and 40wt%). The samples were prepared by a compressive molding method. The sound absorption coefficient (SAC) and sound transmission loss (STL) value of the composite were measured by using the impedance tube according to ASTM E1050-98 for conducting the ACUPRO System. The density of Sample 1 is highest due to pure thermoplastic polyurethane with 1.146 g/cm^3 of density and sample 5 is lowest because of the higher of dust loading with 1.004 g/cm^3. For SAC result, sample 5 have higher sound absorption coefficient at 2000Hz-4000Hz, it can absorb the sound until the 30% and the remaining 70% is sound reflection compared to others sample. 5dB. However, STL result for sample 5 giving a lower sound transmission loss which is 15.9dB. So it was proved effective in sound reduction. As a conclusion, the highest dust content give a better properties sound absorption coefficient (SAC) and sound transmission loss (STL) properties of the thermoplastic polyurethane.

DEDICATION

To my beloved family

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Alhamdulillah, thank our God for giving me the strength to complete this Final Year Project. I have learned a lot and really enjoyed while working on this final year project. Firstly, I am extremely grateful to Dr Abdul Munir Hidayat Syah Lubis my supervisor for guiding and helping me in order to finish this final year project. Thanks to my beloved family for moral and financial support in completion of this study. To all of my friends and everyone that has been contributed by supporting my work and for helping me during the final year project till it was fully completed.

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ASTM	-	American Standard Testing Machine
ASHRAE	-	American Society of Heating Refrigerating and Air-Conditioning Engineers Inc.
CMCs	-	Ceramic Matrix Composites
EFP	-	Oil Palm Fruit Bunch
MMCs	-	Metal Matrix Composites
NIOSH	-	National Institute For Occupational Safety And Health
NVH	-	Noise, Vibration, And Harshness
OPF	-	Oil Palm Frond
OPT	-	Oil Palm Trunk
PC	-	Personal Computer
PMCs	-	Polymer Matrix Composites
POME	-	Palm Oil Mill Effluent Palm
SAC	-	Sound Absorption Coefficient
SEM	-	Scanning Electrode Microscope
SPL	-	Sound Pressure Level
STL	-	Sound Transmission Lost
TPU	-	Thermoplastic Polyurethane
TPU/c-OPT		Thermoplastic Polyurethane composite of Oil Palm Trunk
USB	-	Universal Serial Bus
Al_2O_3	-	Aluminum Oxide
$BaSO_4$	-	Barium Sulfate
$BaSO_4$	-	Barium Sulfate
$CaCO_3$	-	Calcium Carbonate

$CaSO_4$	-	Calcium Sulfate
dB	-	Decibels
g/mL	-	Grams per Milliliter
Hz	-	Frequency
kg/m^3	-	Kilograms per Cubic Meter
MgO	-	Magnesium Oxide
NaOH	-	Sodium Hydroxide
Sb_2O_3	-	Antimony Trioxide
Si_3N	-	Silicon Nitride
SiO_2	-	Silicon Dioxide
wtt%	-	Weight of Percentages
ZnO	-	Zinc Oxide

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Not a long ago, Malaysia is one the largest producers and exporters of palm oil in the world, according to Nagiah et. al, (2012) for 11% of the world's oils and fats production and 27% of the export trade of oils and fats is from Malaysia. Oil palm is an ancient tropical plant from the West African tropical rainforest region. It is still being cultivated there as well as across the tropics. Palm oil has been used as food and medicine throughout the ages. At present, 4.49 million hectares of land in Malaysia is under oil palm cultivation; producing 17.73 million tons of palm oil and 2.13 tons of palm kernel oil (Lai and Idris, 2013). However, oil palm industries produce a large amount of solid waste called biomass. Lignin and cellulose biomass which is produced from the oil palm industries includes oil palm trunks (OPT), oil palm fronds (OPF), empty fruit bunches (EFB) and palm pressed fibres (PPF), palm shells and palm oil mill effluent palm (POME).

According to Abdullah et. al, (2013), palm oil has made impressive and sustained growth in the global market over the past four decades, and it is projected in the period 2016 – 2020, the average annual production of palm oil in Malaysia will reach 15.4 million tons. The commercial exploitation of oil palm trunks (OPT) for a variety of products depends on a number of factors. These include a long security of sustainable supply, the economic system for handling them, and a reliable design of processing and manufacturing equipment to cater for their physical forms and sizes.

Sound absorption materials are essential components for most industries automotive and construction nowadays. They help reducing noise, e.g., those resulting in a room and those coming from external surroundings such as in a car. Generally, such materials are commercially available as panels or boards made of glass or mineral filler. Shedding of these materials can potentially result in health issues. Additionally, these non-biodegradable materials cause pollution to the environment during the production process (Eadkhong et. al, 2000).

As health and environment concerns arise, natural materials become of interest. In the last decades, various bio-based materials have been investigated for their acoustic characteristics—transmission loss and absorption.

1.2 Problem Statement

As industrial waste continuously accumulates, it is becoming a major problem for the environment as well as for public health. Another environmental problem, which is becoming an increasingly significant concern due to its negative impact on human health, is noise pollution (Arenas C, et., al. 2013) Oil palm is mostly harvested for cooking oil and recently bio-diesel. In general, the lifespan of oil palm is 25 years (Sulaiman *et al.*, 2012) after that replanting is required. As a result, there are great amounts of oil palm biomass unused and wasted. Vakili *et al.*, (2015) state that the biomass produced in oil palm industry, such as oil palm fronds, palm pressed fibers, palm kernel shells, empty fruit bunch, and liquid waste discharged from the palm oil mill effluent and others may lead to significant environmental concerns. The quantity of produced wastes by oil palm industry is increasing with the growth of this industry day by day. Therefore, the use of these wastes as compost is considered by researchers to overcome their negative impacts and recycle them to produce a useful by product for agriculture.

In order to address the potential of bio waste in the palm oil industry, consider to uses and disposal of palm mill residues. One of the aspects is waste, using oil palm trunks (OPT) as a filler in thermoplastic polyurethane (TPU) bio composite.

Noise, Vibration, and Harshness (NVH) are recognised as one of the major problems currently faced by the automotive manufacturers and their suppliers due to increasing consumer braking performance expectations, automotive OEM's and suppliers need the ability to predict potential problems and identify solutions during the design phase before millions of dollars have been spent in design, prototyping, and manufacturing tooling. Noise damping material is used to eliminate and reduce noise in vehicles, particularly cars and trucks caused by resonance and vibration. There are three different classes of acoustical materials absorbers, barriers, and dampers, and was are a different function from each other.

This study is intended for development of the acoustical materials for reduction of noise. Thermoplastic polyurethane (TPU) typically used as damping materials for shoes, tire and etc. because the soft materials. The soft materials are commonly used as a damper for absorption sound. So it is believed that TPU can be used for noise reduction.

1.3 Objective

i. To investigate the effect of oil palm trunk (OPT) dust to noise reduction characteristics of polyurethane.
ii. To test and characterise the sound absorption and transmission loss of TPU and TPU matrix composite.

1.4 Scope

In order to achieve the objectives, several scopes have been determined:

i. Pre-treatment of palm oil trunk dust

ii. Fabricate the TPU composite sample from Palm Oil Trunk dust (OPT) added into polyurethane.

iii. Testing the sample by using Impedance Tube for determining the sound absorption coefficient (SAC) and sound transmission loss (STL).

iv. Performing microstructural observation to the samples.

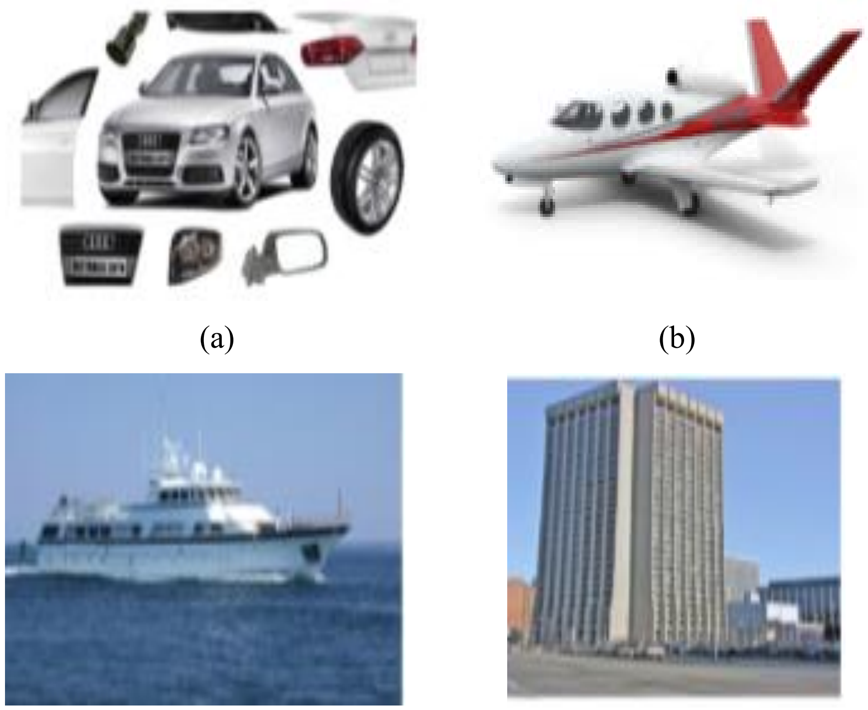
CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Composite material is a material made from two or more of a mixture or combination with significantly different physical or chemical properties. Composite are the result of embedding high strength, high stiffness fibers of one material in one surrounding matrix of another material (Adams, 1987). Composites can be broadly classified into natural composites and synthetic composites. Some of the examples of natural composites are wood, bone, etc.

Wood is a composite made of strong and flexible cellulose fibers in lignin matrix (Balasubramanian, 2014). Cellulose fiber has good strength and stiffness while soft lignin is polysaccharide lignin (Ashby et. al. 1980). For examples, composite materials are generally used for the manufacture of automobile parts, sports kits, building, aircraft, marine, etc (Tenney *et al.*, 2009).

Composite materials are comprising of at least one broken stages implanted in a ceaseless stage. The irregular stages are normally harder and more grounded than the persistent stages and are known as the "fortifications" or 'fortifying materials', though the nonstop stage is named as the "network" which is more pliable and less hard. The fortifications serve to reinforce the composites and enhance the general mechanical properties of the grid. Properties of composites are firmly subject to the properties of their constituent materials, their conveyance, and the communication among them. The composite properties might be the volume portion total of the properties of the constituents or the constituents may interface synergistically bringing about enhanced or better properties. The advantages of composites are given practically boundless potential to higher quality, solidness and erosion resistance over the unadulterated materials arrangement of metals, ceramic and polymers (Campbell, 2010).



(a) (b)

(c) (d)

Figure 2.1: Application of Composites; (a) Automobile parts, (b) Aircraft, (c) Marine, (d) Building (Tenney *et al.*, 2009).

2.2 Classification of Composite

Composites can classify on the basis of the type of matrix employed in them, for example, polymer matrix composites, metal matrix composites, and ceramic matrix composites. The details of these types are discussed below.

2.2.1 Metal Matrix Composite

Metal Matrix Composites (MMCs) are made out of a metallic matrix (aluminium, magnesium, press, cobalt, copper) and a scattered clay (oxides, carbides) or metallic (lead, tungsten, molybdenum) stage. Metal matrix has an advantage over the polymer matrix in a variety of applications that require long-term resistance to harsh environments, such as high temperature (Adams, 1987). On the other hand, this type of composite has high strength, fracture toughness and stiffness of metal matrix rather than their polymeric counterparts. Some of the desirable properties of MMCs include high specific strength and stiffness, better high-temperature performance, and low thermal expansion (Gofrey, et. al, 2000). Furthermore, metal matrix composite can withstand high temperatures in corrosive environments of polymer composites. Most metals and alloys can be used as a matrix and they need reinforcement materials to be stable and non-reactive temperature range as well.

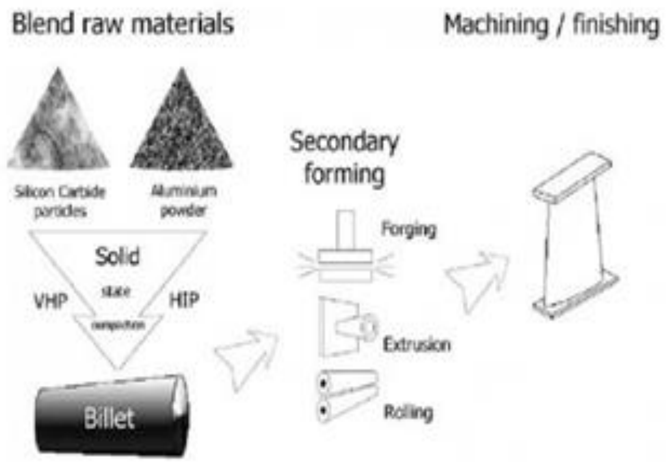


Figure 2.2: Aluminum Metal Matrix Composite Process Coupe (Calin et. al, 2012)

MMCs have disadvantages which are fabrication cost that has limitations on its application (Sankla, 2015). However, metal matrix composite gives many advantages in physical properties which are no absorption in moisture, non-flammability, reduce thermal conductivities and resistance to most radiations (Calin, et. al, 2012). Substantial progress in the development of light metal matrix composites has been achieved in recent decades so that they could be introduced into the most important applications. In traffic engineering, especially automotive industry, MMCs have been used commercially in fiber reinforced pistons and aluminium crankcases with strengthened cylinder surfaces as well as particle-strengthened brake disks (Kainer, 2006)

2.2.2 Ceramic Matrix Composite

Ceramic matrix composites (CMCs) are a subgroup of composite materials as well as a subgroup of technical ceramics. CMCs in general has very attractive properties such as high hardness and modulus, strength retention at high temperature, chemical inertness, and low density(John, 2011). Even then these materials are not very popular as metallic materials for engineering applications, mainly because of their low toughness. This type of brittle materials is prone to catastrophic failuresd its lack of tensile strength, impact strength and thermal shock resistance. These difficulties can be overcome by reinforcing ceramic matrix by suitable fiber materials. The common ceramic matrix composites include glass ceramics such as lithium alumino-silicate, oxides such as alumina and mullite, silicon nitride and silicon carbide (Tariq et. al, 2011)

(a) (b) (c)

Figure 2.3: The illustrative examples of the use of engineering ceramics: (a) silicon nitride (Si_3N_4) ceramic cutting tool inserts and components, (b) silicon nitride check valve balls ranging from around 20 mm to around 40 mm in diameter, and (c) silicon nitride – based experimental automobile valve (John, 2011)