UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL INVESTIGATION OF THE SOUND ABSORPTION COEFFICIENT OF OIL PALM WASTE FIBER

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (REFRIGERATION AND AIR-CONDITIONING SYSTEMS) WITH HONOURS

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A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning) with Honours

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2022

DECLARATION

I declare that this project entitled " Experimental Investigation Of The Sound Absorption Coefficient Of Oil Palm Waste Fiber " is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : Tiban

Name : Tiban A/L Ravichandran

Date : 26/01/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Air-Conditioning And Refrigeration) with Honours.

Signature : .....

Supervisor Name : Ts. Muhammad Nur bin Othman

Date : 27/1/2022

DEDICATION

I'd want to express my gratitude to Ts.Muhammad Nur bin Othman, my Project Supervisor, for his assistance. En. Nur's guidance, as an expert in mechanical systems theory and practice, was essential and contributed significantly to the learning experience, as well as helping me to successfully complete this project. Finally, I want to express my gratitude to my family and friends.

ABSTRACT

In this research, an experiment carries out to find the sound absorption coefficient of natural fiber extract from petioles of oil palm waste. For the past years, more synthetic fibers used in acoustic industry which give negative impact to the environment. The fiber will mix with silicone as a binder and make samples been testing to find out sound absorption efficiency. Many sound absorbers created using synthetic fiber and it causes of sound pollution to the environment. So, to avoid this problem the supervisor suggesting creating a sound absorber with natural fiber which eco-friendly to the environment. The aim of this research is been find out the sound absorption coefficient capacity of fiber which create from petioles of oil palm. Furthermore, the fiber will be test to find out the sound absorption efficiency in the presence of binder and without binder. This study mainly about determines ability of natural fiber in sound absorption coefficient. Other than that, develop a sample based on oil palm waste fiber and measure the sound absorption coefficient of natural fiber samples with binder for 1cm is 0.55, 2cm is 0.77, 3cm is 0.81, 4cm is 0.97, 5cm is 0.98, 6cm is 0.99 and without binder for 1cm is 0.82, 2cm is 0.88, 3cm is 0.96, 4cm is 0.98, 5cm is 0.99 and 6cm is 1.04 The fiber cut using mechanical retting process, extract the fibers from petioles of oil palm, wash and dry it under sunlight. Then blender the fiber until it gets softer. So, this is the process of extraction and creating fibers. At last, the sound absorption efficiency of oil palm fiber will be analyzed using an impedance test. Based on studies have been done, oil palm's petioles have the capacity to be an absorptive material in acoustic industry in future.

ABSTRAK

Dalam penyelidikan ini, eksperimen dijalankan untuk mencari pekali penyerapan bunyi serat semulajadi yang mengekstrak dari petiol sisa kelapa sawit. Serat akan bercampur dengan silikon sebagai pengikat dan membuat sampel telah menguji untuk mengetahui kecekapan penyerapan bunyi. Banyak penyerap akustik yang dicipta menggunakan serat sintetik dan ia menyebabkan beberapa jenis pencemaran kepada alam sekitar. Jadi, untuk mengelakkan masalah ini penyelia mencadangkan untuk mewujudkan penyerap bunyi dengan serat semulajadi yang mesra alam kepada alam sekitar. Tujuan penyelidikan ini adalah untuk mengetahui keupayaan serat yang dicipta dari petiol kelapa sawit. Tambahan pula, serat telah menguji untuk mengetahui kecekapan penyerapan bunyi dalam masa kini pengikat dan tanpa pengikat. Kajian ini terutamanya tentang menentukan keupayaan serat semulajadi dalam pekali penyerapan bunyi. Selain itu, membangunkan sampel berdasarkan serat sisa kelapa sawit dan mengukur pekali penyerapan bunyi sampel serat semulajadi dengan pengikat bagi 1cm adalah 0.55, 2cm adalah 0.77, 3cm adalah 0.81, 4cm adalah 0.97, 5cm adalah 0.98, 6cm adalah 0.99 dan tanpa pengikat bagi 1cm adalah 0.82, 2cm adalah 0.88, 3cm adalah 0.96, 4cm adalah 0.98, 5cm adalah 0.99 and 6cm adalah 1.04. Potongan serat menggunakan proses retting mekanikal, ekstrak gentian dari petiol kelapa sawit, basuh dan keringkan di bawah cahaya matahari. Kemudian pengisar serat sehingga ia menjadi lebih lembut. Jadi ini adalah proses pengekstrakan dan mewujudkan gentian. Akhir sekali, kecekapan penyerapan bunyi serat kelapa sawit akan dianalisis menggunakan ujian impedans. Berdasarkan kajian yang telah dilakukan, tangkai daun kelapa sawit mempunyai kapasiti untuk menjadi bahan penyerap dalam industri akustik pada masa hadapan.

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My utmost appreciation goes to my supervisor, Ts. Muhammad Nur bin Othman for all his support, advice and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered.

Last but not least, from the bottom of my heart a gratitude to my family members for their encouragements and who have been the pillar of strength in all my endeavors. I would also like to thank my beloved friends for their endless support. Finally, thank you to all the individuals who had provided me the assistance, support and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

Fe	-	Finite Element
GFRP	-	Glass Fiber Reinforce Plastic
STL	-	Sound Transmission Loss
CLC	-	Cellular Lightweight Concrete
CMOD	-	Crack Mouth Opening Displacement
EFB	-	Empty Fruit Bunch
GGBS	-	Ground-Granulate Blast Furnace
	-	

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of study

Nowadays the world is completely controlled by technology. Technology has given us some benefits but at the same time, it gave us some environmental issues that affect human's health. Environmental noise is one of it. It gives us bad health problem and effects humans comfort (Gerda Vitkauskaite and Raimondas Grubliauskas 2018). To avoid this problem a sample was planned to using oil palm waste fiber (petioles). By referring to many theses finally, find out the pros and cons of oil palm waste fiber and choose it as raw material for producing sample for increasing sound absorption coefficient.

For the past years, many samples regarding sound absorption coefficient were invented using synthetic fiber (T. Bohmann, M. Schlamp and I. Ehrlich 2018). After usage of those samples, its deficiency was exposed to the world. Usage of synthetic fiber in creating a sample for increasing sound absorption coefficient can cost high and high possibilities of polluting the environment is one of deficiency that the sample has. So, to fill up the deficiency, the sound absorption coefficient samples are planned to create using natural fiber such as sisal and waste tea fibers (Prabhu. L et al. 2019), jute fibers (L. Yuvaraj, S. Jeyanthi and A. Yogananda 2021), coconut fiber (Claudia Cilene Bittencourt da Silva et al. 2019) and date palm fiber (Ebrahim Taban et al. 2019). The purpose of this experimental investigation is to find out the ability of oil palm waste fiber in controlling sound absorption coefficient.

The reason for choosing oil palm waste fiber is the plantation of oil palm high all over Malaysia. The fibers are left on the land just like useless. So that those fibers can be

used in a good way by creating them as a sample for now maybe in future as a material. This material can used in every industry which releases extreme sound to the environment.

1.2 Problem statement

All-natural fiber samples for sound absorption coefficient create from natural fiber don't have the exact efficiency for sound absorption which synthetic fiber has. Even the cost of synthetic fiber is high, but it has its own specifications in the acoustic field. Of course, the natural fiber has its advantages and disadvantages in this acoustic field. To find out the capacity of natural fiber especially oil palm waste fiber in sound absorption, an experiment was carried out. Another thing is to get to know the efficiency of sound absorption whether in the presence of a binder (R.Belakroun et al. 2018) and without a binder (R.Belakroum et al. 2017).

Furthermore, need to find out whether the thickness, porosity, density, air gap, and compression influenced the sound absorption efficiency. If those specifications influence it then get to know the exact value which makes the oil palm waste fiber excellent in sound absorption coefficient. Based on those tests we can conclude whether oil palm wastefiber has the ability in sound absorption coefficient.

1.3 Objective

The main aim of this research to find out whether the oil palm waste fiber has the capacity of controlling sound absorption and what are the needs to make the fiber suitable as a sound absorption sample.

I. To develop a sample-based oil palm waste fiber for sound absorption
II. To find out the better sound absorption coefficient of natural fiber sample between with and without binder.

1.4 Scope of Research

Initiate the production of natural fiber from oil palm waste as a potential synthetic fiber alternative in the acoustic sector. To investigate sound absorption coefficient, make samples using oil palm waste fiber combined with silicone as a binder. Gathering information on the thesis, natural fiber, and other topics were among the tasks completed to perform the experimental inquiry. Begin by collecting fiber from oil palm waste petioles and preparing it for an impedance test to determine sound absorption efficiency. The sound absorption efficiency through impedance testing is one of the characteristics that must be observed for the experimental inquiry, while thickness and density are two other characteristics that must be controlled. Furthermore, one of the control criteria is the presence of a binder. Natural fiber preparation and resources will be the project's limits during this epidemic condition. This project will not contain acoustical metrics such as sound transmission loss and insertion loss.

CHAPTER 2

LITERATURE REVIEW

This figure 2.1 is the k-chart used to collect details for literature review. It mainly consists of acoustic, then it divided from noise control and sound absorption. For this part, natural fiber and oil palm fiber are important things in gathering information.

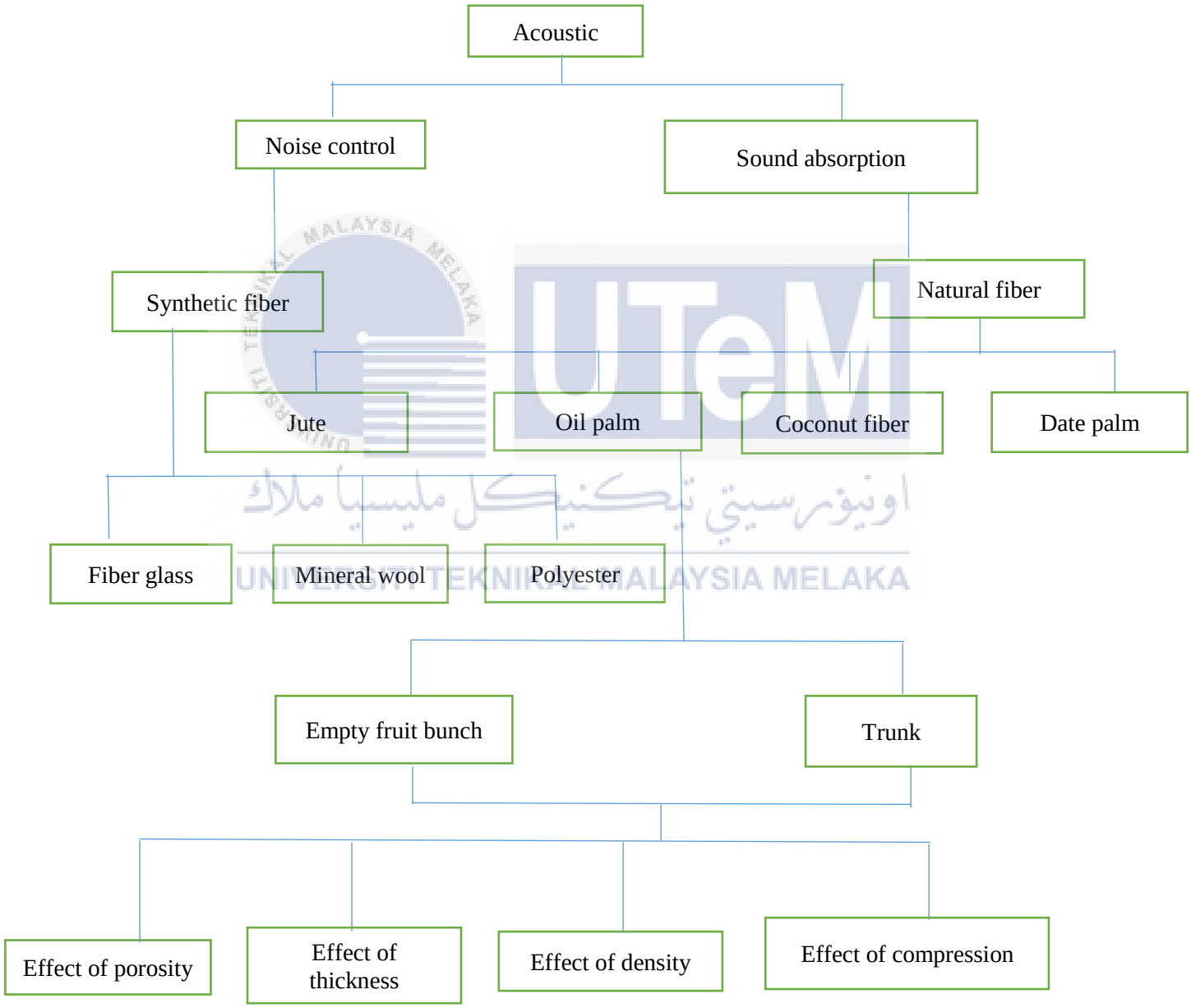


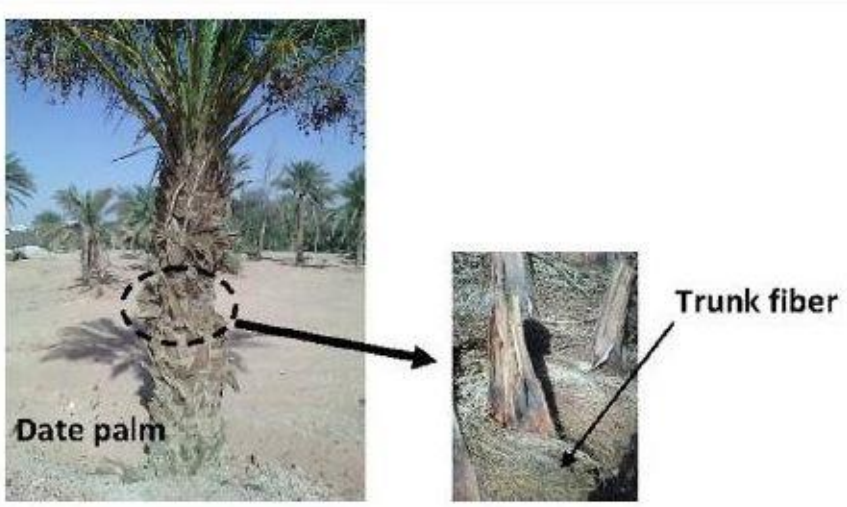
Figure 2.1 K-chart

2.1 Studies on acoustic

R.Belakroum et al. (2017) introduced an idea about new insulation building material which eco-friendly that less harmful to the environment. The material produced from trunk and petioles which produced from date palm fibers. To increase the acoustic absorption rate, lime and corn starch are used as binders. The rate ofsound absorption coefficient shows whether it is a good absorber or poor absorber of acoustic absorption. Impedance tube is used to determine sound absorption coefficient bymeasuring the pressure of two fixed points.

R.Belakroun et al. (2018) stated that every year huge quantities of date palm fibers (DPF) are produced and wasted all over the world. It would help to exploit naturalsustainable resources using natural fiber as raw material. According to this article, it investigates on using of new eco-friendly based material such as date palm fiber and lime. In addition, the use of dependable insulating materials and the integration of passive air conditioning systems are two actions that must be taken to transition to a more reasonable energy model. Researchers have invested in this area due to a desire to create incipient effective materials for thermal and acoustic insulation with little environmental impact.

Fiber products for vegetables are frugal and are present in most parts of the world. Its cost is minimal to the total cost of the composite. Two types of date palms exist in nature: feminine and male. Four parts of the date palm are also used to produce fibers: the branches or trunk, rachis, petiole, and palm fruits (Belakroum et al., 2018). In this study, for engendering the bio-composite, they utilize only the fiber layer that circumvents the trunk of the female palm tree (Figure 2.2)



(a) (b)

Figure 2.2 Date palm (a) and trunk fiber (b) R.Belakroum et al. (2017)

Zoba software was used to find acoustical properties of insulation materials buildings. (Gerda Vitkauskaite & Raimondas Grubliauskas, 2018). B&K Type 4206 impedance tube two microphone according to the standard ISO (10534-2) used to measure sound absorption coefficient (R. Belakroun et al., 2017). Nurul Izzati Raihan Ramzi Hannan et al. (2020) stated ISO 11654:1997 sound test find coal ash waste has the ability to absorb 30% sound. To get an accurate percentage of acoustic performance, a reverberation room test was carried out. The sampling place at the test chamber, occupy it with a loudspeaker at the right distance.

Gerda Vitkauskaite and Raimondas Grubliauskas (2018) declared some information and solution for control noise pollution. This mainly about researching the acoustic properties of perforated panels which are prepared to protect the buildings in urban to maintain the comfort zone of people who worked in urban. To clarify acoustic performance for modeling perforated panels, Zoba software was used. This software is used to predict the absorption coefficient for rooms and buildings. Regarding the software results, find out that

the open an area gets the most effective for sound absorption coefficient. The bigger diameter of perforated panels in open area and geometric shape makes a higher response in acoustic. The perforated panel which has an extra diameter and mechanism sound absorption will act as important things in acoustic. So, the perforated panel with open area, have a smaller hole on the panel, having right a shape with 0.5cm diameter and occupied extra 3cm layer of polyester will be the best material which can reduce all kind of noise pollution.

Valentin Gomez Escobar and Ruben Maderuelo-Sanz (2017) stated to create sample-based on cigarette butt which has the capacity of absorbing sound performance. The samples were prepared according to ISO 10534-2:1998. Impedance tube carried out sound absorption coefficient shown in figure 2.3. Panfeng Bai et al. (2019) exposed that porous metal will be used for acoustic absorption performance by compression and micro perforation. AWA6128A was used to detect the efficiency of acoustic. From the results can conclude that all the samples with different types of material and size are suitable for every frequency of sound if those samples have gone through compression. Chokri Othmani et al. (2017) mentioned that samples based on sugarcane waste material in a different kind of size, thickness, density, and so on. Extract juices from the sugarcane, crush and blend raw material of sugarcane, make samples withdifferent size, thickness, density, and resin content.

Regarding the measurement of acoustic absorption coefficient, impedance tube was used and the sample place in the middle of the tube and each side is mounted with loudspeaker and four microphones. After going through the process, find out that to control flow resistivity measurement decrease of fiber size and increase volume density will make increase the flow resistivity. For acoustic absorption coefficient, types of material will affect acoustic absorption coefficient. Increase the thickness of material gives better sound absorption especially in low frequency meaning that higher wavelength sound can be absorbed if the material is thicker. Even sound absorption coefficient increases by decrease

fiber diameterin high frequency and low frequency. This study mainly about the flow of resistivity and acoustic absorption coefficient of sugarcane wastes.

Figure 2.3 Impedance tube measurement ISO 10534-2:1998 Valentin Gomez Escobar and Ruben Maderuelo-Sanz (2017)

2.1.1 Studies on noise control

Julien Drant, Philipe Micheau and Alain Berry (2021) described for different disruption frequencies, successful control experiments were carried out shown below figure 2.4. With the external microphone pressure minimization technique, the effect is achieved at the external control microphone. The harmonics of the fundamental frequency have a significant appearance in the primary sound strain.