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Oil palm empty fruit bunch fibers as sustainable acoustic material

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ABSTRACT – Environmental issues such as pollutions have created awareness among the scientists to find sustainable and 'green' materials as alternative sound absorber to replace synthetic materials. Oil Palm Empty Fruit Bunch (OPEFB) is a biodegradable material and is available in abundance quantity as agricultural by-products. This paper discusses the use of OPEFB fibers as an acoustic absorber. Samples of raw OPEFB fibers with different mass and thickness are fabricated. The effect of fiber density and air gap are investigated through experiment to obtain the sound absorption coefficient. It is found that OPEFB fibers showed good performance as an acoustic material.

1. INTRODUCTION

Acoustic absorber is used to absorb a certain frequency range of sound wave to reduce noise level and to improve the communication between the speaker and audiences. Traditionally, synthetic materials are used widely as acoustic absorber. These synthetic materials such as glass wool, stone wool and foam plastics not only cause pollution and global warming, but can also harmful to human life [1]. Thus, researchers have changed the focus towards natural materials as the alternative way to replace synthetic materials. Nor et al. [2] tested the effect of compression on the sound absorption properties of coir fiber. The compression work on coir fiber can enhance the sound absorption at low frequency. Putra et al. [3] employed the sugarcane wasted fibers as acoustic absorption material and the results show the increase of fiber density improves the sound absorption performance. Experimental work by Putra et al. [4] on paddy waste fibers also show good sound absorption coefficient and is comparable with synthetic glass wool at the same thickness. Traditionally, oil palm empty fruit bunch (OPEFB) fibers are used as burning fuel, fertilizers, mulching material and reinforcement materials in polymer composites [5]. This paper discusses the acoustic performance of OPEFB fibers which according to the author's knowledge has not been investigated by other researchers.

2. METHODOLOGY

The OPEFB fibers were weighted for 1, 2, 3, 4, 5, 6 and 7 grams and fitted into a 33 mm diameter aluminium mold for sample preparation. By using hot compression molding, the OPEFB fibers were compressed into samples with thickness of 10 mm and 20 mm as shown in Figure 1.

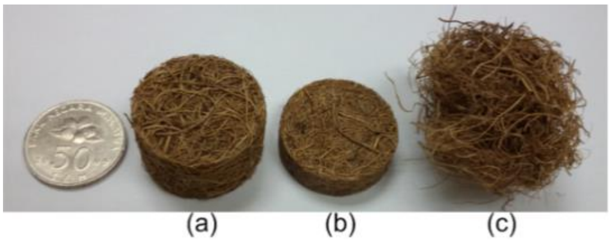

Figure 1 OPEFB: (a) 5 gram of 20 mm thickness sample, (b) 5 gram of 10 mm thickness sample and (c) raw fiber

The measurement of sound absorption coefficient was conducted using the impedance tube as shown in Figure 2 according to ISO 10534-2 [6]. The sample was fitted into the 33 mm diameter tube at one end while the other end was the location of a loudspeaker. White noise was generated from the computer through Audacity 1.3 Beta software and supplied into the tube through the loudspeaker. Two ½" pre-polarized free field microphones with ½" CCP pre-amplifier were located near the sample to record the built-up sound pressure. The two microphones were 22.5 mm apart. The loudspeaker was located 132.5 mm from the first microphone. The distance between the second microphone to the sample was 85 mm. The validity of the result was between frequency of 500 Hz to 4500 Hz due to the diameter of the tube. Range of the frequency was limited by the accuracy of the signal processing equipment and to avoid the occurrence of non-plane wave mode propagation [6].

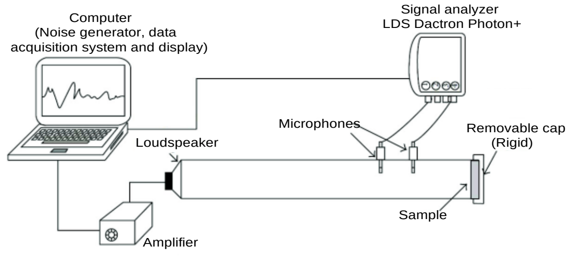

Figure 2 Experimental setup for measurement of sound absorption coefficient

3. RESULTS AND DISCUSSION

Figure 3 plots the absorption coefficient for samples with different densities at 10 mm thickness. At the same thickness, mass of 2, 3, 4 and 5 grams showed good absorption coefficient where $\alpha > 0.5$ above 2 kHz which is a typical frequency range for a fibrous type absorber. It can also be seen that increased the density or mass of the sample improves the absorption at higher frequency range. The increment in density contributes to increase of flow resistivity and tortuosity. Thus, more sound waves can be absorbed. However, too high density can limit the porosity in the sample and thus degrade the absorption performance. As shown in Figure 3, sample with mass of 6 and 7 grams showed absorption coefficient of less than 0.5.

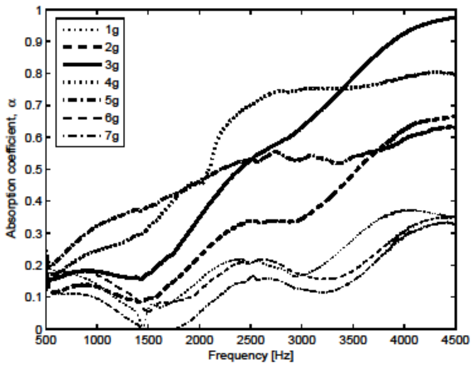

Figure 3 Absorption coefficients of OPEFB fibers with different masses

The effect of thickness can be seen in Figure 4. It is shown that the increase of thickness significantly enhances the absorption coefficient and shifts the peak of the absorption coefficient to the lower frequency region.

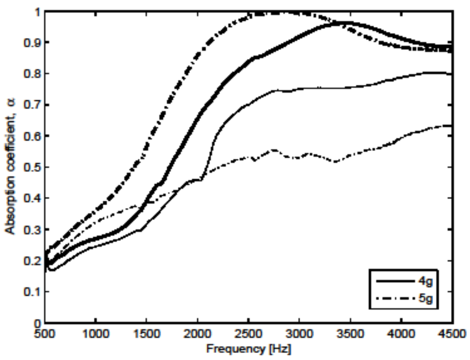

Figure 4 OPEFB fibers with two different masses and thicknesses of: 10 mm (thin line) and 20 mm (thick line)

The absorption coefficient at lower frequency can also be enhanced by providing the air gap behind the fiber sample. As shown in Figure 5, the utilization of air gap shifts the curve to the lower frequency. However, good absorption coefficient at lower frequency region was compromised with the reduction of absorption at high frequency.

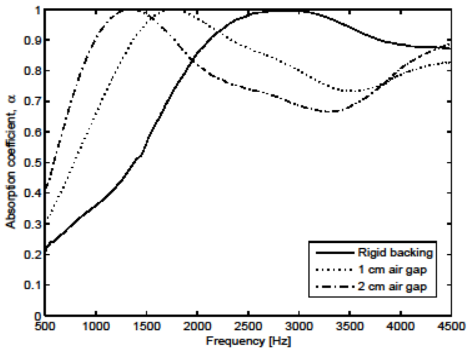

Figure 5 Absorption coefficient of OPEFB fibers with mass of 5 gram and 20 mm in thickness with different air gaps

4. CONCLUSIONS

The oil palm empty fruit bunch fibers are found to be good sound absorber and can be the alternative to the synthetic sound absorber. The increase of mass or density yields high absorption coefficient at high frequency region. For 10 mm samples with 4 grams fibers, the absorption coefficient can reach 0.75 in average above 2.5 kHz. For 20 mm, the average absorption coefficient increase to 0.9. Increment in thickness and application of air gap resulted in increase of absorption coefficient at lower frequency region.

5. ACKNOWLEDGEMENT

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