Proceedings of Mechanical Engineering Research Day 2016, pp. 202-203, March 2016

Natural coir fiber and kenaf fiber as multilayer sound absorber

Z.Y. Lim[1], A. Putra[1,*], M.J.M. Nor[1,2], M.Y. Yaakob[3]

[1)] Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[2)] Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[3)] Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: azma.putra@utem.edu.my

Keywords: Absorption coefficient; coir fiber; kenaf fiber

ABSTRACT – This paper studies the sound absorption performance of multi-layered natural fibers, particularly coir fiber and kenaf fiber. The effect brought by different layer arrangement these porous materials are studied and it is found that under the same thickness, the low frequency sound absorption is enhanced when kenaf fiber is layered as the first layer to receive the incidence sound. With kenaf fiber layered at the second layer, better absorption performance is seen at high frequency.

1. INTRODUCTION

Synthetic materials such as glass fiber and foam glass are commonly used as sound absorber, these materials are found to be harmful to human health when used as sound absorber. According to a Swiss Life Cycle Assessment (LCA) database, where the entire life history of a product is analysed based on the potential and impacts to the environment, the global warming potential of synthetic materials are seen to be very high [1]. Due to these negative impacts to the environment and human health, attentions are now being shifted to researches on sound absorption performance of natural materials. Fibrous natural materials such as oil palm empty fruit bunch fibers [2], and non-fibrous materials such as reed [3] are among the materials investigated and gave results showing good performance.

Fouladi et al. [4] analyzed the acoustical characteristics of both fresh and industrial treated coir fiber and suggested that approaches such as adding air gap and perforated plate to improve the weak absorption of industrial prepared coir fiber at low frequency. This suggestion was tested by Ayub et al. [5] by studying the effect of implementation of perforated plates and air gaps in coir fiber, low frequency absorption is enhanced through these approaches. Recently, Putra et al. [6] attempted to enhance the sound absorption of hard fiber by using soft fiber, absorption of the coir-kapok fiber hybrid sample with 15% of kapok fiber as content is proved to have achieved unity above 2 kHz with only 10 mm of thickness and 10 mm air gap. Kenaf fiber as soft fiber is previously studied on its sound absorption performance is found to be able to reach unity at 1.5 kHz with thickness of 30 mm [7].

2. METHODOLOGY

2.1 Preparation of sample material

Industrial prepared 10 mm thick coir fiber sheet and 5 mm thick kenaf fiber sheet are being cut into cylindrical shape of diameter 33 mm as shown in Figure 1 in order to fit into the impedance tube for measurement.

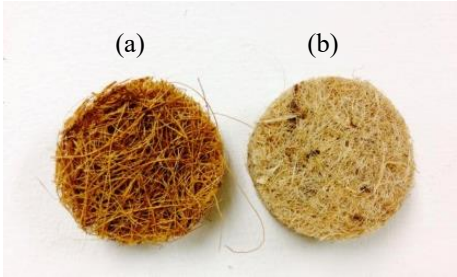

Figure 1 (a) Coir fiber ***and*** (b) kenaf fiber sample***s***.

2.2 Experimental set up

The impedance tube method was used to measure sound absorption coefficient of the samples. Figure 2 shows the measurement set up using impedance tube.

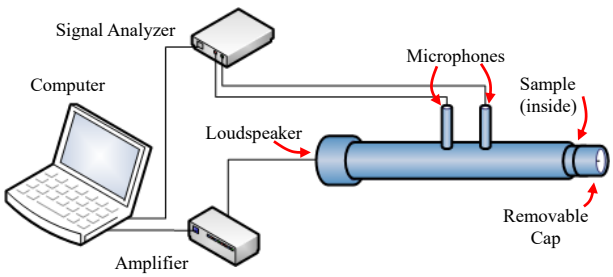

Figure 2 Diagram of absorption coefficient measurement set up.

Fibers were layered in the removable cap according to interested arrangement where the first layer is the surface to first receive the incidence sound, as shown in Figure 3 the first layer is coir fiber, second layer is kenaf fiber and third layer is coir fiber.

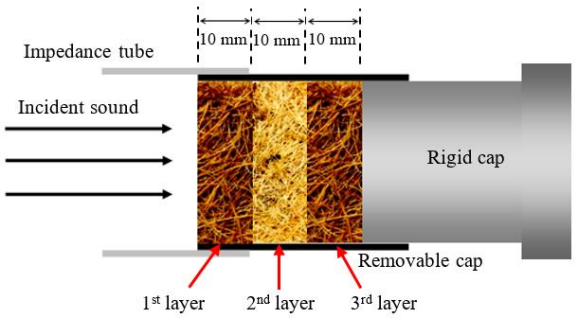

Figure 3 Layering of fiber in removable cap in the impedance tube.

3. RESULTS AND DISCUSSION

The sample layering is indicated with the initial of the fiber type, for example, k-c-c represents kenaf fiber as the first 10 mm layer, followed by 20 mm of coir fiber as the second and third layer.

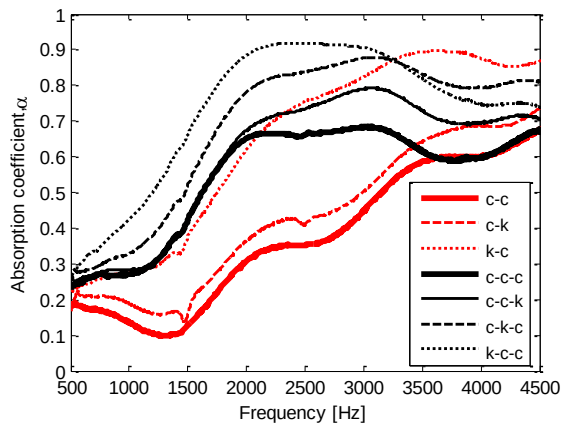

Figure 4 Sound absorption coefficient of 20 mm (red) and 30 mm (black) fiber sample with (thin) and without (thick) 10 mm of kenaf fiber substituted in different layer.

Referring to Figure 4, sample with 20 mm thickness with kenaf fiber substituted as the first layer gave better performance improvement compared to that as second layer. The increased thickness of sample from 20 mm to 30 mm affects the sound absorption by enhancing low frequency sound absorption.

Sound absorption improvement above 2 kHz is seen when kenaf fiber is substituted as third layer in a 30 mm coir fiber sample. As the position of kenaf is brought forward to second and first layer, the sound absorption is further enhanced throughout the frequency range. The sound absorption of 30 mm of sample with coir fiber and kenaf fiber layered at different arrangement is shown in Figure 5. Comparing the sound absorption of samples with coir fiber as first layer with that of samples with kenaf fiber as first, the sound absorption peak of the latter appeared at lower frequency, which is around 2 kHz. The effect of positioning kenaf fiber instead of coir fiber as second layer is improvement of sound absorption above 3.25 kHz.

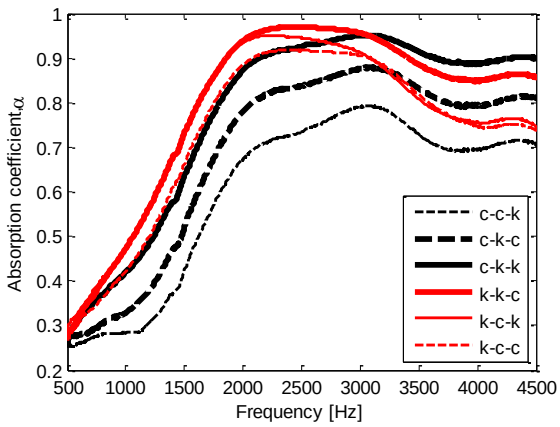

Figure 5 Sound absorption of 30 mm of sample with different layer arrangement of coir fiber and kenaf fiber. (red = kenaf as 1st layer, black = coir as 1st layer, thick = kenaf as 2nd layer, thin = coir as 2nd layer, dotted = one kenaf layer, line = two kenaf layer).

4. CONCLUSION

The implementation of kenaf fiber layer in coir fiber is found to be able to improve low frequency absorption. The peak of absorption is shifted from 3250 Hz to 2000 Hz when kenaf fiber is placed at the first layer. High frequency improvement can be seen when kenaf fiber is substituted as the second layer.

REFERENCES

[1] F. Asdrubali, "Survey on the Acoustical Properties of New Sustainable Materials for Noise Control," in *Euronoise 2006,* 30, 2006.

[2] K.H. Or, A. Putra, and M.Z. Selamat, "Oil palm empty fruit bunch fibers as sustainable acoustic material," in *Proceedings of Mechanical Engineering Research Day 2015*, 2015, pp. 99-100.

[3] F.A. Khair, A. Putra, M.J.M. Nor, and N. Atiqah, "Investigation on reed *Imperata Cylindrica* as sound absorber " in *Proceedings of Mechanical Engineering Research Day 2015*, 2015, pp. 91-92.

[4] M.H. Fouladi, Md. Ayub, and M.J.M. Nor, "Analysis of coir fiber acoustical characteristics," *Applied Acoustics* 72, pp. 35–42, 2011.

[5] Ad. Ayub, M.H.Fouladi, M. Ghassem, M.J.M. Nor, H.S. Najafabadi, N. Amin and R. Zulkifli, "Analysis on Multiple Perforated Plate Sound Absorber Made of Coir Fiber," *International Journal of Acoustics and Vibration*, vol. 19, no. 3, pp. 203-211, 2014.

[6] A. Putra, Z.Y. Lim, M.J.M. Nor and M.Y. Yaakob, "Enhancing Sound Absorption of Coir Fibers Using Kapok Fibers: A Preliminary Study," in *5th International Conference on Noise, Vibration and Comfort*, 2015.

[7] Z.Y. Lim, A. Putra, M.J.M. Nor and M.Y. Yaakob, "Preliminary study on sound absorption of natural kenaf fiber," in *Proceedings of Mechanical Engineering Research Day 2015*, 2015, pp. 95-96.