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Investigation on reed *Imperata Cylindrica* as sound absorber

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ABSTRACT – The particles from synthetic fiber that are commonly used in sound absorber are very harmful to human health and environment when exposed to the air. Thus, researchers is now focus towards finding the potential of natural materials as alternative sound absorber. This paper presents the use of hollow structure of natural reed as non-fibrous acoustic absorber. Impedance tube method was used to measure the sound absorption coefficient of natural reed. Reed of length 2 cm and 3 cm were arranged in two different configuration: axial and transverse arrangement. The results showed that reed layered with thickness 2 cm in transverse arrangement gives better sound absorption compare to others with absorption coefficient reaches almost 1 at around 1.8kHz. For transverse arrangement, introduction of microholes to the structure of reed only shifts the absorption peak towards lower frequency.

1. INTRODUCTION

The fabrication of sound absorbing materials made of synthetic materials (glass wool, rock wool, asbestos and foam glass) release more carbon dioxide into the atmosphere including issues in environmental pollution and health [1]. Several studies have therefore been conducted on natural materials to investigate their feasibility to be alternative acoustic absorbers. Fouladi et al. [2] studied the utilization of coir fibers as acoustic materials. It is found that the coir fiber with thickness 45 mm can have average absorption coefficient of 0.8 at frequency above 600 Hz. Sugarcane fibers (bagasse) have also been shown to reach average absorption coefficient of 0.7 above 1 kHz with optimum fiber density [3]. The fiber from the paddy waste as sound absorber has also been studied [4,5]. Here, the density of the fiber is found to affect the absorption coefficient and attachment of fabric at the front surface can significantly improve the absorption. The acoustic absorber can also be made into configuration of multiple hollow structures by utilizing the hollow path and gaps between structures to absorb sound. Oldham et al. [6] showed that hollow structures of reed with length of 8.5 cm, arranged with cross-section facing the incident sound can have high normal absorption coefficient reaching almost unity at frequency of 700–900 Hz. This paper also studies the performance of reed, but of different species from those in [6]. The samples were tested for different lengths of stem and also different hollow diameters. The materials were arranged in two different configurations as in [6] such that sound absorption mechanism is possible.

2. METHODOLOGY

2.1 Reed

Reed or cogon grass is categorized as weeds and invasive species because it disturbs ecosystem and reduces other tree seedling growth. However, it also carries some benefits where it can be used as medicine to treat urinary infection and to reduce high blood pressure. Common species of reed are Phragmites australis, *Arundo Donax* and *Imperata cylindrica*. The later is used in this paper as shown in Figure 1(a) and the anatomy of the reed is shown in Figure 1(b).

(a) (b)

Figure 1 (a) The natural reed *Imperata Cylindrica* and (b) anatomy of reed.

2.2 Material Preparation and Experimental Setup

The stem from reeds are utilized here where it was cut into 2 cm and 3 cm and micro-holes of 0.4 mm were introduced to the structure which were expected to allow more sound absorption. The sound absorption coefficient was measured using the impedance tube method according to ISO 10534-2:2001 [7] as shown in Figure 2. The sample was located at the end of the tube while the other end of the tube is a loudspeaker to generate white noise fed into the tube. The tube has diameter of 33 mm and hence the valid frequency range for the measurement is from 500 Hz to 4500 Hz. Two pre-polarized free field microphones were located in front of the sample to record the built-up sound pressure in the tube.

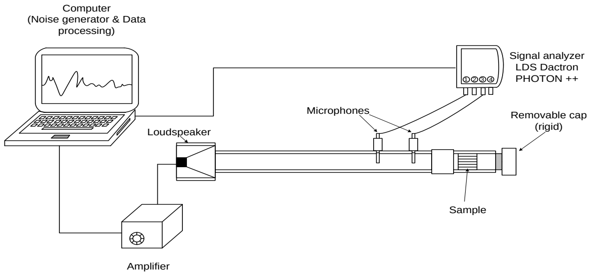

Figure 2 Experimental setup for absorption coefficient test.

3. RESULTS AND DISCUSSION

Result in Figure 4 shows that the reed with small diameter of length 2 cm can absorb more sound energy compared to the reed with large diameter. The absorption coefficient for the reed with small diameter can achieve 0.9 at high frequency around 3.6 kHz. This is because more amounts of reed are required to fit in the impedance tube thus, larger quantity of reed increase the absorption of sound energy.

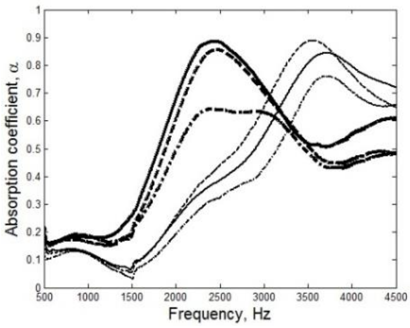

Figure 4 Absorption coefficient of reed in axial arrangement for length 2 cm (thin line) and 3 cm (thick line) length and diameter of : - - - 0.2 cm to 0.4 cm, ── mix diameter and -.-.- 0.5 cm to 1 cm.

Figure 5 and Figure 6 shows reed with introduction of microholes for both configuration (axial and transverse). For axial arrangement, it can be seen that reed of length 2 cm with micro-holes absorbs more sound energy compared to reed without micro-holes. However, the increment of absorption coefficient is not significant with only around 0.05 across the frequency range.

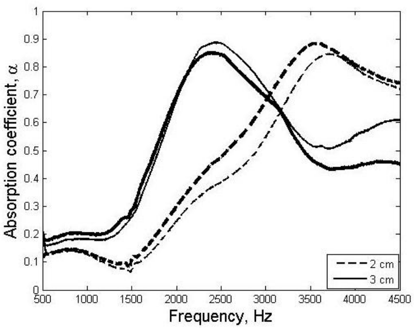

Figure 5 Absorption coefficient of reed in axial arrangement without micro-holes (thin line) and with micro-holes (thick line).

For transverse arrangement, the 2 cm thick layer can be seen to have absorption peak at 1.8 kHz and reaches almost unity. By increasing the thickness, this peak shifts to lower frequency. The introduction of microholes in the structure can also be seen to widen the frequency bandwidth around the absorption peak.

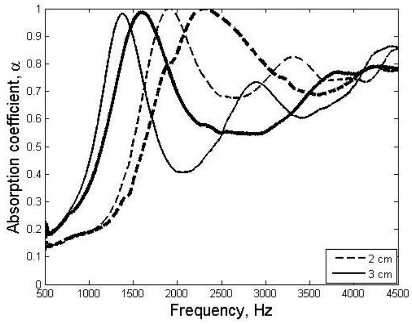

Figure 6 Absorption coefficient of reed in transverse arrangement without micro-holes (thin line) and with micro-holes (thick line).

4. CONCLUSIONS

For axial arrangement, the smaller the diameter of reed, the better the sound absorption but introducing microholes into the structure is found to not give significant improvement of sound absorption. For the transverse arrangement, the sound absorption performance is generally better than that from the axial arrangement where the absorption coefficient can reach unity while introduction of microholes in the transverse arrangement widen the frequency bandwidth around the absorption peak frequency.

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