Enhancement on acoustical performance of reed 'Imperata Cylindrica'

F.A. Khair[1], A. Putra[1,2,*], M.J.M. Nor[1,2], M.Z. Selamat[1,2]

[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

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

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ABSTRACT – Common established work on finding the alternative sound absorbing materials are mostly focused on fibrous type of acoustic absorber. Here, the hollow structure of natural reed is utilized as non-fibrous acoustic absorber. This paper study on the acoustic performance of reed when covered with fabric. The sound absorption coefficient is measured using impedance tube method. Result shows that covering sample with fabric enhanced the absorption coefficient above 0.9 for both small and large diameter of length 2 cm and 3 cm.

1. INTRODUCTION

Synthetic fiber are good in sound absorption but it is found that the fabrication process produce carbon dioxide to atmosphere and from Life Cycle Assessment done by Asdrubali [1] also shows high value of global warming potential. This has brought concern of researchers in finding alternative sound absorbing materials made from natural material. Ismail et al. [2] studied Arenga pinnata fiber from palm sugar tree as sound absorber and made comparison with that of the coir and oil palm fibers. Results show that Arenga pinnata has better sound absorption coefficient which is 0.75-0.9 above 2 kHz compared to coir fiber, but slightly lower than the palm oil fiber. Ersoy and Kucuk [3] measured the sound absorption of industrial tea leaf fiber and found that thickness of 10 mm exhibits better sound absorption when backing with a single cotton cloth where the absorption coefficient increases to 0.8 at frequency above 3.5 kHz compared to polyester and polypropylene based non-woven fiber. However, most of the research are focused on the fibrous type of absorber. Thus, this paper presents the non-fibrous acoustic absorber from hollow structure of reed.

2. METHODOLOGY

The stem of the reed is hollow and inside the hollow stem contains porous white pith which can help to absorb the incoming sound energy. The stem of reed is cut into 2 cm and 3 cm and are grouped into small diameter which is between 0.2 cm to 0.4 cm and large diameter between 0.5 cm to 1 cm. The samples were arranged axially in the tube where the cross section of the sample was facing the sound incident as shown in Figure 1(a) tested with single layer of felt fabric with thickness of 0.2 cm that covered either front side or both sides of the reed as shown in Figure 1(b). The attachment of fabric as a facing surface for sound absorber is common in practice for performance, protection and artistic purposes.

The measurement of the sound absorption coefficient and the experiment setup is done according to ISO 10534-2:2001 [4] as shown in Figure 2. The tube has diameter of 33 mm diameter with sample located at one end of the tube while the other end is a speaker that generates white noise into the tube. Incident and reflected wave signal is recorded by two pre-polarized free field microphone that equipped with pre-amplifier. The sound wave signal is then converted to digital signal by RT Pro Photon analyzer.

(a) (b)

Figure 1 Sample of reed (a) in axial arrangement and (b) with attachment of felt fabric.

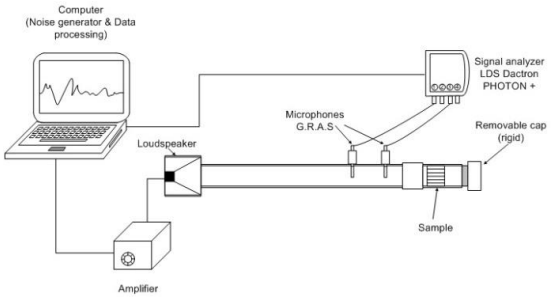


Figure 2 Experimental setup.

3. RESULTS AND DISCUSSION

In previous study by Khair et al. [5], it is found that reed of length 2 cm and 3 cm with small diameter have absorption coefficient almost 0.9 at frequency 3.6 kHz. Large diameter of reed of length 2 cm have absorption coefficient 0.76 while 0.64 for length of 3 cm. The samples were tested with single layer of felt fabric covered the front and back surface of the reed in order to observed any improvement on sound absorption coefficient. Figure 3 shows the comparison of absorption coefficient reed of small diameter with and

without fabric cover at front side only. Both the 2 cm and 3 cm lengths of reed have the same features of absorption coefficient where the absorption coefficient increase constantly over the frequency with the fabric covering the surface.

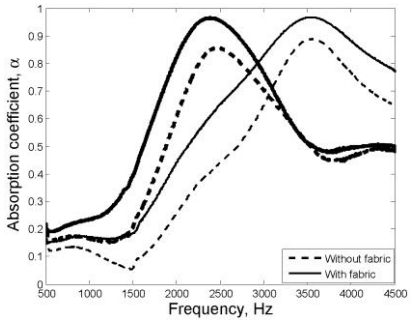


Figure 3 Absorption coefficient of small diameter of reed with attachment of fabric at the front side only with length 2 cm (thin line) and 3 cm (thick line).

Figure 4 shows the effect of sound absorption coefficient of large diameter of reed with attachment of fabric also at front side only which also shows the effect of the fabric to significantly improve the sound absorption. The same treatment has been shown to be successful in the existing works for paddy fiber [6].

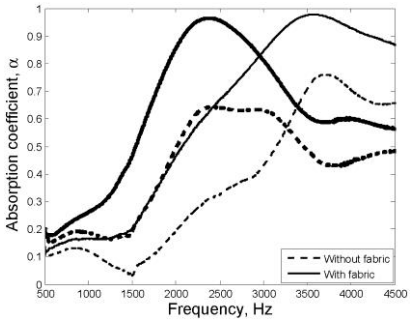
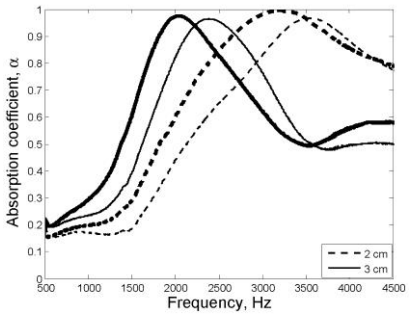


Figure 4 Absorption coefficient of large diameter of reed with attachment of fabric at the front side only with length 2 cm (thin line) and 3 cm (thick line).

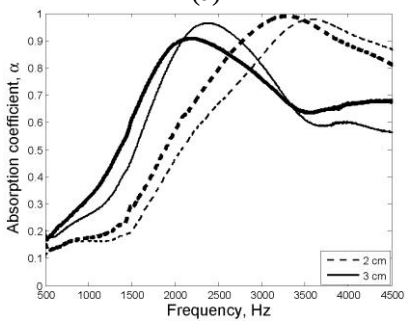
Figure 5 shows the results comparing the small and large diameter of reed with attachment of fabric at front side and also at both sides of the sample. It can be seen that no significant improvement can be obtained by adding the fabric to the back layer. Thus only single front layer is sufficient and improvement at lower frequency can be obtained by increasing the air gap between the reed and the back rigid surface.

4. CONCLUSION

Overall, reed itself shows good potential in absorbing sound. By covering the sample with fabric, it improves and enhance the sound absorption performance and also widen the frequency bandwidth. Only covering front side of the sample is sufficient to have absorption coefficient above 0.9.



(a)



(b)

Figure 5 Absorption coefficient of reed with attachment of fabric at one side (thin line) and both side (thick line) of sample with reed of (a) small diameter and (b) large diameter.

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