NOISE REDUCTION PERFORMANCE OF THERMOBONDED NONWOVENS

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Abstract: *Acoustic insulation is an important requirement for the human life today, since noise affects the efficiency of day-to-day activities and even cause various health problems Materials based on fibrous structures show very good acoustic insulation properties, which however strongly depends on the type of structures used. The present paper reports the qualitative analysis of the acoustic insulation behavior of various thermo-bonded nonwoven fabrics. The results showed that the acoustic insulation of thermo-bonded nonwovens improves with their thickness. Also, nonwovens laminated with aluminum foil exhibited better sound reduction performance than other single layered nonwovens made from recycled fibres and even better performance than the nonwovens made from mineral wool, in the frequency range perceptible by human air.*

Keywords: *acoustic insulation, sound reduction, thermo-bonded nonwovens.*

1. Introduction

Noise is a very important subject of study, since it may determine the quality of human life. Noise greatly affects the day-to-day activities and even can cause various health problems. Therefore, acoustic insulation is an essential need for our houses in order to reduce noise related problems, leading to improved quality of life. Since fibrous materials have tremendous potential for acoustic insulation applications, a great deal of research has been conducted till date investigating various factors that influence their sound absorption properties. Factors such as fiber size, resistance to the passage of air flow, porosity, thickness and density have been analyzed. Sound absorption coefficient was found to increase with the decreasing fiber diameter and length and increasing surface area i.e. large surface area and shorter length increase the absorption of sound [1]. According to study carried by S. Sengupta [2], nonwoven structures show greater noise reduction than the wovens and there exists a negative correlation between the bulk density of non-woven fabric and sound reduction. It was also observed in that study that sound reduction increases with the distance between the nonwoven fabric and the sound source and this effect increases with the increase in the areal density of fabric. Studies have also been conducted to compare the sound absorption of thermo-bonded and needle-punched non woven fabrics and it was observed that these structures did not show any significant difference in the sound absorption performance [3]. The present study focuses on the qualitative analysis of the acoustic insulation properties of thermo-bonded nonwoven fabrics and comparing these with the most commonly used materials in terms of insulation in buildings.

2. Material and methods

2.1 Material

The nonwoven fabrics analyzed in this study were produced from mineral wool and recycled fibers, which was a mixture of polypropylene, acrylic, cotton, polyester and other fibers. The mass per unit area, thickness and density of the samples were different. One sample was laminated with an aluminum foil (A3) and another one (A4) was produced from mineral wool that is most currently used in the construction sector. The description of various samples is provided in Table 1.

Table 1: Details of various nonwoven samples

Samples code	Composition	Mass per unit area [g/m^2]	Thickness [mm]	Density [kg/m^3]
A1	Polypropylene, Acrylic, Cotton, Polyester, Other fibers	1891,75	19,72	95,93
A2	Polypropylene, Acrylic, Cotton, Polyester, Other fibers	892,72	9,14	97,67
A3	(Polypropylene, Acrylic, Cotton, Polyester, Other fibers)+ Aluminum	1608,71	15,00	107,25
A4	Mineral wool	1496,21	70,00	21,37

2.2 Methods

The qualitative analysis of sound insulation of produced non-woven fabrics was performed in an insulating box, as show figure 1, which has different measurement locations, where sound level meters are placed in order to measure the sound intensity. The sound insulation was measured in terms of reduction of sound level due to placement of sample, which was calculated by subtracting the decibel reduction without sample from decibel reduction with sample.

To calculate the sound reduction the following equation has been used [2]:

$$dB_{Sample}=(\text{Decibel reduction with sample})-(\text{Decibel reduction without sample}) \quad (1)$$
$$dB_{Sample}=(dB_S - dB_R)_{WS} - (dB_S - dB_R)_{WOS}$$

Where:

dB_{Sample}- Sound reduction due to sample
dB_S – Sound intensity at source
dB_R - Sound intensity at receiver
WS – With sample
WOS – Without sample

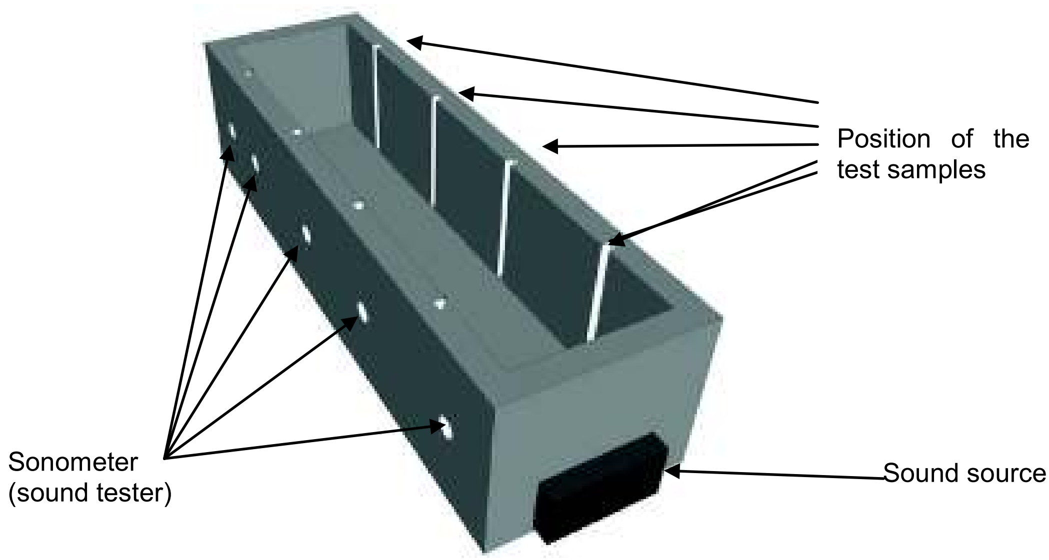

Figure 1. Insulating box for qualitative analysis of sound reduction performance

3. Results and Discussion

Figure 1 shows the sound reduction values achieved with different samples at various frequencies.

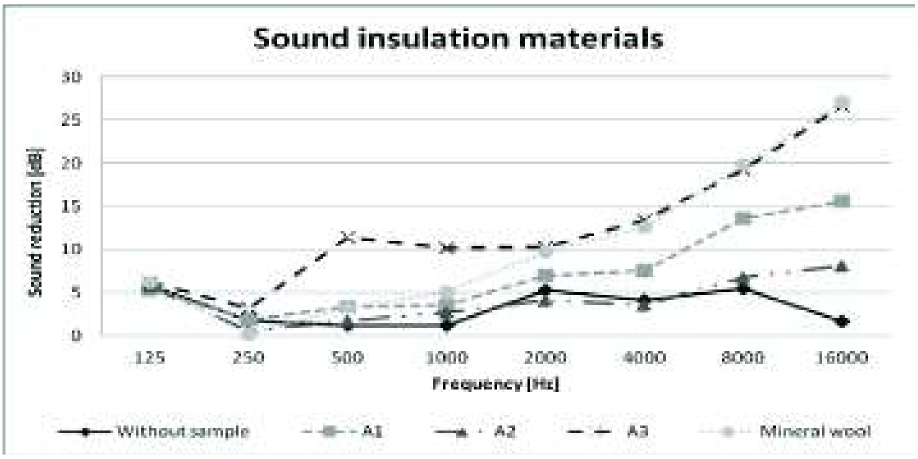

Figure 1: Comparison of sound reduction of diffrent samples

As shown in Figure 1, the non-woven made from mineral wool is better to reduce sound, but it is also demonstrated that the non-woven laminated with aluminum foil has a behavior similar to the mineral wool nonwoven in the higher frequency range (>2000Hz).

In the region of 500 to 1000 Hz, which is the area of perception of human ear, the non-woven that best reduces the sound is the one laminated with aluminium foil, whereas all other nonwovens show similar performance.

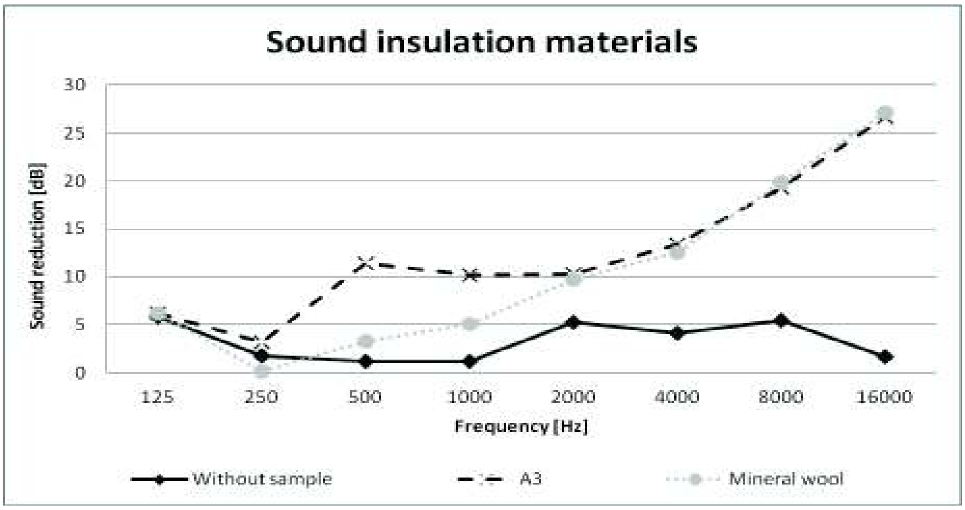

Figure 2.: Comparison of sound reduction of sample with aluminium foil and mineral wool

Figure 2 provides a comparison between the nonwoven laminated with aluminium foil and the one produced from mineral wool. It is clear that in high frequencies both nonwoven´s performance is similar, but in the regeion of human ear perception the nonwoven with aluminium foil exhibited more sound reduction efficiency.

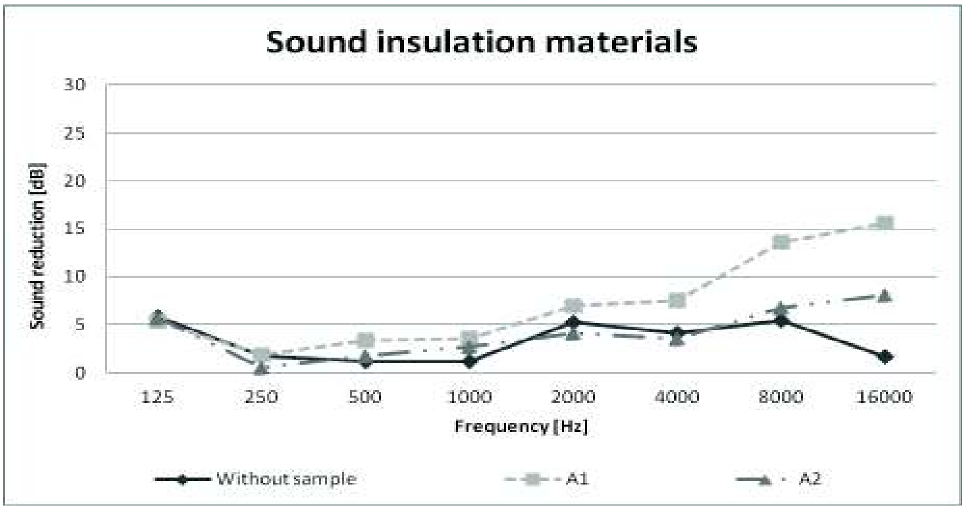

Figure 3. Comparison of sound reduction of samples with different tickness

The influence of sample thickness on sound reduction is shown in Figure 3, which shows that sound reduction efficiency increases with the thickness of the nonwovens. Although sample A1 had the same composition and similar density as sample A2, it showed better sound reduction than A2 due to higher thickness.

4. Conclusion

In conclusion, the acoustic insulation behavior of nonwoven fabrics strongly depends on their composition and structure. An improvement in sound insulation can be observed with the increase in nonwoven thickness. Moreover, lamination of a second material such as aluminum foil improves the acoustic insulation performance of thermo-bonded nonwoven fabrics considerably. Therefore, the thermo bonded nonwoven fabric with aluminum foil lamination was found to provide the best sound insulation performance than the other nonwoven samples and even shows better sound reduction efficiency as compared to the nonwovens produced from mineral wool, in the frequency range of human ear perception.

References

[1] Seddeq, Hoda S.: “Factors Influencing Acoustic Performance of Sound Absorptive Materials”, *Australian Journal of Basic and Applied Sciences*, **Vol. 3,** (2009), ISSN 1991-8178

[2] Surajit Sengupta, “Sound reduction by needle-punched nonwoven fabrics”, *Indian Journal of Fibres & Textile Research*, **Vol.35,** (2010), pp. 237-242

[3] Tai, Kou-Cheng, et al, Evaluation on the Sound Absorption and Mechanical Properties of the Multi-layer Needle-punching Nonwoven*, Advanced Materials Research*, **Vol. (123-125)** (2010), pp. 475-478,

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