



A Study on the Relationship between the Thickness Of Nonwoven and Its Sound Absorption Capability

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Abstract

Nonwoven has got fast developed and widely used in the range of the world, while it is mainly used is as the auxiliary materials of perforated plate for its sound absorption capability in our country. In this paper, we summarized the relationship between the property parameters of the non-woven materials and their sound absorption capability. Experiments and theory analysis proved that the thickness of non-woven materials was the most influencing factor on their sound absorption capability.

Keywords: Nonwoven, Thickness, Sound absorption capability

1. Introduction

Sound absorbing materials have attracted much attention as the ambient noise impact people's lives greatly. The development of sound absorbing material has experienced natural fiber, such as cotton and ramie, and chemical fiber, such as mineralwool and glasswool, perforated resonance plate, micro perforated plate and membrane resonance structures. Applications of current sound absorbing materials have still some disadvantages, such as poor environmental adaptability, dust pollution caused by the brittleness, the inconvenience of construction caused by large volume (Zhou & Fan, 2004, p. 27). A new sound absorbing material is needed with the strengthening of people's environment protection consciousness. For its excellent properties, research on the sound absorption capability of nonwoven is of particularly importance.

Nonwoven is a kind of fabric material formed by fibers with orientation or random arrangement that compose into schistous matters, fiber web or wadding pad through friction, cohesion and bonding. It may need to be mentioned that paper, woven fabric, knitgoods, rufting goods, braided fabric with yam and felted texture made by wet method and milling are not nonwoven. The structure of nonwoven is three-dimensional netted and multiporous, which is very suitable for the application of sound absorption for its porosity, plasticity and elasticity. Besides, nonwoven has the advantages of wide raw material source, many varieties, simple production technology, high labor productivity, multiple process technology and wide field of applications. In this work, we studied mainly the relationship between the thickness of the needed nonwoven and its sound absorption capability.

2. Experimental Details

2.1 Material Preparation

Polyester needle-punched nonwoven was chosen to be our sample to avoid the influence of different fiber and different non-woven technology on the sound absorption capability. In our work, the thicknesses of the samples were 2.67 mm, 3.50 mm, 5.43 mm and 9.03 mm respectively.

2.2 Material Characterization

The thicknesses of the samples were measured by YG141 Fabric Thickness Gauge. The sound absorption capability of the samples is characterized by Digital Sound Lever Meter (TES-1350/ TES-1350A).

3. Results and Discussion

The sound absorbing capacity of a material is expressed by the absorption coefficient. In our present work, the absorption coefficients for the nonwoven with various thicknesses were measured in the frequency range from 125 Hz to 4000 Hz (Table 1 and Figure 1). Usually, materials with the sound absorption coefficient bigger than 0.2 can be named sound absorbing materials (Zhong, 2005, p. 46). According to the criterion, the nonwoven used in our experiment is of sound absorption property, which is associated with the porous structures. The surface morphology of nonwoven fibers is showed in Figure 2. Nonwoven is composed of orientated or randomly arranged fibers through friction, cohesion and bonding which might

include natural or chemical fibers, staple, filament, fibers formed on the spot (Guo, 2000, p. 16). The fiber components can be in parallel or in random distribution in two-dimension or three-dimension. The disordered structures introduce a lot of open pores into nonwoven that can absorb some incidental acoustic wave and scatter the others. The acoustic wave that enters into the open pores spreads in the fibers and thin space of the pores. The friction of this motion between the acoustic wave and the fibers dissipates a portion of acoustic energy by the viscosity and the thermal conduction.

Figure 1 shows the sound absorption coefficients of the four samples measured at different frequencies in a visualized way. The nonwoven thickness has a great impact on its sound absorbing qualities. It can be seen that the turning point of sample 1 and sample 2 is lower than 0.2. According to the criterion of sound absorbing material, if the thickness of nonwoven is less than 3.5 mm (sample 2), they have little sound absorption property. More thickness of the nonwoven means more loss of sound energy by the friction and vibration of the internal fibers. Sample 4, the thickness of which is 9.03 mm, has the best sound absorption performance in our experiment. The mechanism of nonwoven to “absorb” sound is considered to be the change of absorption acoustic energy into thermal energy. This results from the actions of friction between the vibration air that penetrated into the nonwoven and the inwalls of the pores. The viscosity resistance of air in pores makes the sound energy transformed into thermal energy. The process is repeated several times and result into the attenuation of acoustic wave. If the nonwoven is too thin, the times of the process repeat reduces and sound absorbed decreases. Situation on the contrary is that the thicker of the nonwoven, the more of the times of the process repeat and the more acoustic energy loss.

4. Conclusions

Nonwoven is used mainly as the auxiliary materials of perforated plate in sound absorbing materials. Carl Freudenberg (Germany) has developed a new inorfil sound absorbing material named SoundTex, which is made of perforated aluminium panel bonded with nonwoven. Laite Board produced by Wujiang Terelong Building Material Co., Ltd. is made of natural vegetable fibers and cement. Till now, nonwoven has not been used as a sound absorbing material alone. There is great importance and perspective of research on the sound absorption property of nonwoven, the thickness of which has the greatest impact on its sound absorbing qualities. Through the experiment and analysis above, the following results can be concluded:

- (1) Nonwoven is of sound absorption property as the sound absorption coefficient of which can be bigger than 0.2.
- (2) The thickness has a great effect on low-frequency sound absorption.
- (3) The turning point of sample 1 and sample 2 is lower than 0.2. It can be concluded that if the thickness of nonwoven is less than 3.5 mm (sample 2), they have little sound absorption property. Sample 4, the thickness of which is 9.03 mm, has the best sound absorption performance in our experiment.

Table 1. The sound absorption coefficients for the four samples with various thicknesses at different frequencies.

samples	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
1# (2.664mm)	0.18	0.12	0.14	0.11	0.22	0.23
2# (3.501mm)	0.17	0.25	0.11	0.03	0.12	0.06
3# (5.435mm)	0.23	0.28	0.12	0.25	0.26	0.31
4# (9.032mm)	0.27	0.52	0.32	0.24	0.39	0.52

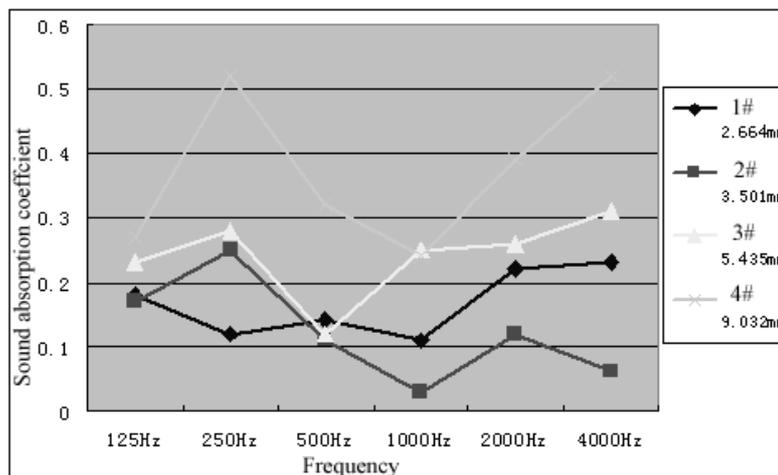


Figure 1. The sound absorption coefficients of the four samples at different frequencies

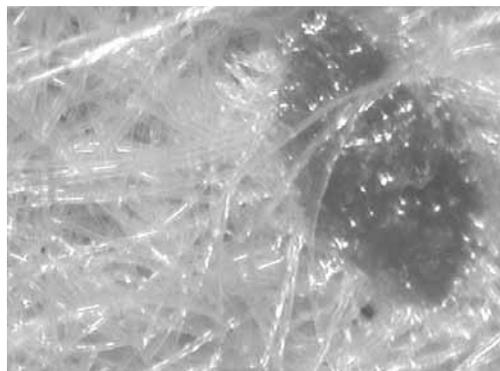


Figure 2. The surface morphology of nonwoven fibers

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