EVALUATİON OF SOUND ABSORPTİON PROPERTİES OF COTTON/POLYPROPYLENE NON-WOVEN FABRİCS

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The sound absorption properties of cotton/polypropylene blended fabrics were evaluated in this work which is rarely considered in the literature. Fabrics were made using the needle-punching method. Three different variables were taken into account: The blend ratio, the number of punching, and the frequency. Experimental results showed that the sound absorption is reasonable in frequencies less than 1000 Hz which is in the range of vehicles noise pollution. The maximum sound absorption achieved in the blend ration of cotton/polypropylene (30/70). The results showed that two times of punching is the optimum condition which resulted in the increasing of the absorption coefficient.

Keywords: Acoustic absorption, Non-woven, polypropylene, Impedance tube

1. Introduction

Noise pollution is one of the most important phenomena that has affected people's life and sound absorption is an essential requirement of today's life. There are different kinds of materials that are used for insulation like metals and fibrous materials in different fields including vehicles, buildings, auditoriums, and noisy environments. However, metals send back to the environment some of the reached sounds. Moreover, metals are heavy and they are not suitable for the automotive industry. The efficiency of sound absorption materials is based on damping sound wave reflection and fibrous materials, especially non-woven fabrics are of interest in this area owing to their porous structures, easy production, and low prices. Acoustic absorption of fibrous materials was investigated by many researchers. Because non-woven fabrics are known as the cheap materials to produce a commercial acoustic absorbing shield, scientist pay attention to these materials in their works from different aspects. Fiber size, the shape of the cross-section, resistance to airflow, porosity, thickness, density and etc. [1] are the parameters which are investigated in many studies. Sound waves move on thin fibers easier than thick ones. So when fibers diameters reduce sound absorption coefficient increases [2]. Studies show that acoustic absorption related to the cross-section area. By increasing the cross-section area, acoustic absorption increases. They also announce that jagged cross sections have more acoustic absorption than circle cross sections [3, 4]. Number, size, and kind of pores are important characters of porous materials in the field of acoustic absorption. For high sound absorption coefficient should have high porosity [5]. The other parameter influences acoustic absorption is density. Low density and open structure lead to absorption of sound waves by low frequency (500 Hz) and dense structures will perform better at frequencies above (2000 Hz).

2. Experimental

Materials

Two types of fibers were used in this study as listed in table1.

Table 1. Fiber properties

Fiber	Fiber fineness (den)	Fiber Length (mm)

Cotton	1.33	25
poly-propylene	1.75	35

Cotton fibers and polypropylene staple fibers were blended in three parts in blow loom. Fibers relaxed for 24 hours in 75% humidity. Anti-static percentage to water was 2.5 to 7.5 and oil percentage to fibers was 3% (table 2).

Table 2. Added materials in each part

	pp-cotton (%)	Oil (cc)	Anti-static (cc)
Part 1	30-70	90	360
Part 2	50-50	150	600
Part 3	70-30	210	840

The non-woven fabrics were produced by the needle punching process. The cleaned fibers were fed to a carding machine to make a non-woven web. Carding web was ready for needle punching after tow drawing process. The fibers were fed to the needling machine in three layers to enhance the uniformity. Layer one and three were fed parallel and layer tow was fed perpendicular to them. The specifications of the produced non-woven fabrics are listed in table 3.

Table 3. Specification of non-woven fabrics produced

Specimen	Thickness (10^{-2} mm)	Air penetration (ml/s.cm^2)	Weight (gr)	pp-cotton (%)	Needle punching repetition
H1	1.39	19.87	2.09	70-30	1
H2	1.17	28.57	2.08	70-30	2
H3	0.84	47.15	1.39	70-30	4
M1	1.34	23.60	2.20	50-50	1
M2	1.10	29.78	1.96	50-50	2
M3	0.83	48.39	1.55	50-50	4
L1	1.30	22.33	1.90	30-70	1
L2	1.15	33.50	1.57	30-70	2
L3	0.95	45.90	1.39	30-70	4

Methods

In this study, the measurement of sound absorption of the non-woven fabrics was taken based on the impedance tube technique (ASTM C384 - 04). This method was developed to determine the ability of materials for absorbing the normal incidence of sound waves.

The effect of frequency was determined using five different frequencies. The frequencies tested are 250, 500, 1000, 2000, and 4000 Hz.

3. Results and discussion

Experimental results showed that the sound absorption is perfectly reasonable in frequencies less than 1000 Hz which is in the range of vehicles noise pollution. The noise absorption coefficient (NAC) decreases significantly at the frequency of 4000 Hz. (Figure 1)

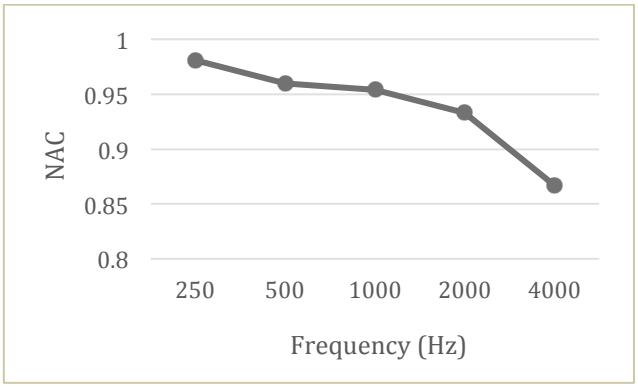
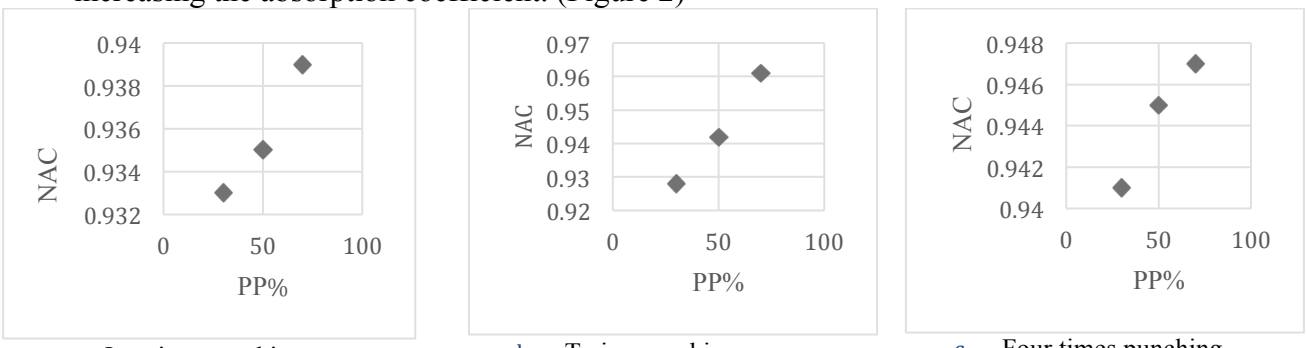


Figure 1. Average of noise absorption coefficients in different frequencies

The experimental results showed that when the blend ratio of cotton/polypropylene is 30/70 the maximum amount of sound absorption was reported. It is due to the low density of polypropylene fibers which affect the sound absorption ability. The number of fibers in a definite unit areas increases with decreasing density. Therefore, surface friction increases which resulted in energy loss. The end results indicated that the optimum sound absorption can be achieved with two times of punching. When the number of punching increases, the produced fabrics become thinner. The increasing of the thickness causes the increasing of the absorption coefficient. Moreover, the increase in air penetration into the fabrics results in increasing the absorption coefficient. (Figure 2)



a. One time punching b. Twice punching c. Four times punching

Figure 2. Noise absorption frequencies of cotton/poly-propylene non-wovens

4. Conclusion

The sound absorption properties of cotton/polypropylene non-woven fabrics were studied in the present work. Three different variables were selected in order to investigate their effects namely the blend ratio, the number of punching, and the frequency. The measurements of sound absorption of the non-woven fabrics were taken based on the impedance tube technique. The results showed that the blend ratio of cotton/polypropylene is 30/70 is the best blend ratio. It is due to the low density of polypropylene fibers which affect the sound absorption ability. Since the number of punching affects the thickness of the produced fabrics and also sound absorption properties, it was concluded that two times of punching gives the optimum thickness and sound absorption for the desired application. The experimental results showed that that the sound absorption is perfectly reasonable in frequencies less than 1000 Hz which is in the range of vehicles noise pollution.

5. References

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