PERFORMANCE OF NONWOVEN CELLULOSIC COMPOSITES FOR AUTOMOTIVE APPLICATIONS

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Abstract

Finding methods to provide a quiet passenger compartment in a car are highly sought after by automobile manufacturers. The ability to reduce noise inside the vehicle enhances the perceived value of the vehicle to the consumer, and so, a competitive advantage to the manufacturer. Several methods to reduce noise and its sources are employed, one of which reduces noise in the passenger compartment using sound absorbing materials attached to various components such as doors, quarter panels, trunk sides and floors, headliners, and others. This study attempts to quantify the ability of several cellulosic - based nonwovens to act as efficient absorbers, reducing the overall sound level in the passenger compartment by using ASTM C-384 "Impedance and Absorption of Acoustic Materials by the Impedance Tube Method". The results of testing will demonstrate that each of the cellulosic - based nonwoven composites contribute to the absorptive properties of the components, and are effective for overall noise reduction in the vehicle. The individual acoustic characteristics of the various vehicles would determine the type and amount of material required to provide the best results.

Introduction

Various blends of cellulosic - based nonwovens , manufactured by the carding and needlepunch process are measured for their ability to absorb sound energy, and compared to known targets accepted by automotive manufacturers for use with vehicle interior trim components such as door absorbers, headliners, trunk liners, and others with the target of reducing the noise level in the vehicle.

Discussion

The ability of a nonwoven material to absorb sounds, or unwanted noise in the passenger compartment of the vehicle is based on dissipating the energy of the sound wave when passing through the material and being redirected by the fibers, and also by the changing some of the energy into heat. The amount of the original energy less the remaining unabsorbed energy results in the measurement we call the absorption coefficient. This absorption coefficient is often used to rank order the ability of different materials to reduce the noise level in the vehicle when attached to the various components in the car, such as the doors, pillars, headliners, and trunk compartments among others.

These components are typically placed between the sound sources such as the vibrating steel panels, windows passing air noise, and noise coming from tires, and the receivers, the occupants of the vehicle. While it is commonly accepted the most effective way to reduce sound is at its source, several issues, such as cost, smooth ride, and vehicle weight, for examples, make it necessary to use the sound absorbing materials as "bandages" for noisy interiors.

For this study, the low cost, renewability, and recyclability of the natural cellulosic fibers as the matrix materials, make them attractive as a potential sound - absorbing nonwoven. The carding / and needlepunch structuring process was chosen to make the samples because it has long been used to make padding that can be produced into shapes for attaching to the components in the vehicle. **(Table 1)**

The cellulosic fibers chosen for the nonwovens were flax, jute, kenaf, and cotton. Polypropylene was added as a carrying material in the carding and needlepunch process and can be varied in proportion with the cellulosic. The weight and thicknesses targeted were picked based on the normal practice for those in vehicles such as glass and synthetic - based materials. **(Table 1).**

After processing the samples, each were cut into parts and inserted into the impedance tube for rank order absorption testing against commonly accepted levels for such "absorbent" materials. While each vehicle may have unique noise characteristics, the rank ordering of the materials is a good precursor to subsequent, more detailed, engineering of the individual materials for specific components. **(Fig. 1).**

The ASTM C 384 impedance tube testing method utilizes a tube with the nonwoven test piece at one end, and a loudspeaker at the other.A microphone is moved along the length of the tube during the test, measuring the sound wave at various frequencies, calculating the amount of sound reflected by the sample compared to the original wave amplitude. The greater amount of sound absorbed results in a better material for noise reduction purposes in the vehicle. **(Fig. 2).**

The frequencies chosen for testing are those that are typically represented by the various types noise such as low frequency vehicle structural noise and high frequency wind or tire noise.

In each of the cellulosic - based samples tested, we see that the amount of absorption recorded, at the frequencies targeted, meet or exceed the targets, save for the flax- based and kenaf - based at the 1600 Hz frequency, and this by a

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relatively small (3-10 percent) amount. In practice, these minor differences are often made up by a small reduction in the amount of needlepunching to increase thickness (which often helps increase absorption). Other ways to increase the absorptive properties include using finer diameter fibers, lower modulus fibers, and various coatings or sizings.

Summary

By using the ASTM C 384 Standard Test Method for Impedance and Absorption of Acoustical Materials by the Impedance Tube Method, it has been shown that several cellulosic - based nonwovens can be produced that have sound absorbing properties suitable for use as noise reducing components. These components can be used in the manufacture of cars that provide a quiet interior passenger compartment desirable to the consumer.

References

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ASTM C 384 - 90a, Standard Test Method for Impedance and Absorption of Acoustical Materials by the Impedance Tube Method., ASTM 1916 Race Street., Philadelphia, PA.

Table 1. Cellulosic - based nonwovens produced by the carding / needlepunch process for measurement using ASTM C-384.

Description of Cellulosic - Based Nonwovens Produced for Study				
Sample	Material	Blend Ratio	Thickness	Weight
A	Flax/PP	50:50	12mm	698 gpsm
B	Jute/PP	50:50	12mm	686 gpsm
C	Kenaf/PP	50:50	12mm	670 gpsm
D	Cotton/PET/PP	35:35:30	11mm	770 gpsm

Table 2. Target absorption reference for automotive noise reduction nonwovens with results using ASTM C 384.

Acoustical Properties					
	Absorption	Material / Results			
Frequency	Target %	A	B	C	D
800 Hz	9	15	15	17	18
1000 Hz	16	20	20	20	25
1600 Hz	35	32	35	34	36
2000 Hz	51	53	66	63	52

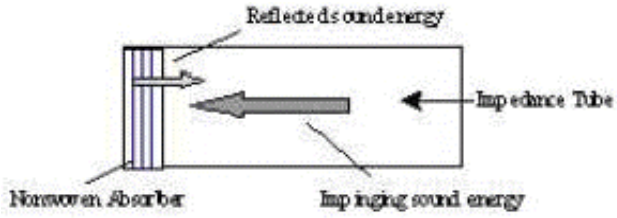

Figure 1. Impedance Tube for ASTM C-384 Sound Absorption Testing.