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CHARACTERIZATION OF SOUND ABSORPTION CO-EFFICIENT OF PUF AND COTTON FELT MATERIAL BY IMPEDANCE TUBE METHOD+

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ABSTRACT:

The sound absorption co efficient of the materials plays an important role in controlling noise in automotives. The materials tested for its absorption characteristics were NWF + FR PUF 80/25 (production) and Cotton Felt (HMCCP) 10mm + PVC 3mm. The impedance tube method is used for determining the sound absorption co efficient of the material. In this paper we studied the characterization of the two different materials and the samples analyzed. The sound absorption were calculated for the two different materials.

INTRODUCTION:

The absorption co efficient of a material is defined as the amount of sound energy stored by the material when incident sound impinges on it. The value of sound absorption co efficient is in the range of 0 to 1. Various methods are available for determining the absorption co efficient out of which the impedance tube method is simple and less spaced.

The impedance tube has two different methods for obtaining sound absorption co efficient.

i) Standing wave method ii) Transfer function method.

The absorption of sound results from the dissipation of acoustic energy into heat. The sound energy is converted into heat through frictional losses, momentum losses and temperature fluctuations. The sound waves, generally longitudinal wave are carries by air molecules. This air molecules when vibrate inside the material with the frequency of sound causes frictional losses, the change in flow of direction of sound waves through irregular pores in the material causes momentum losses, periodic compression and relaxation of air molecules causes temperature fluctuation [1].

INTRODUCTION TO IMPEDANCE TUBE:

The tube is made by rigid, transparent or opaque materials to confine the sound within the tube along one direction towards the direction of propagation. Thus it simplifies the three dimensional wave equations to one dimensional wave equation. The samples required are small compared to reverberation method.

The design specifications of the tube are given by ASTM E1090 standards [2]. The impedance tube have loud speaker at one end and sample holder with rigid determination. The microphones are placed between the loud speaker and the sample. For materials with low flow resistivity four microphone method is more suitable [3]. The loud speaker is driven by signal source and one dimensional wave carries the sound energy towards the sample. The standing waves are produced inside the tube due to its cylindrical construction. Based on the absorption co efficient of the material the material placed at the other end absorbs sound energy [4].The remaining reflected back sound energy forms the standing wave pattern.

EXPERIMENTAL SETUP:

The experimental setup includes loud speaker, audio amplifier, Impedance tube, microphones, and pre amplifier. The output can be obtained either from spectrum analyzer or CRO. The data acquisition system is used to acquire data from the tube and for analysis. The output of the microphone is connected to a data acquisition system which connected to a computer for data analysis using software.

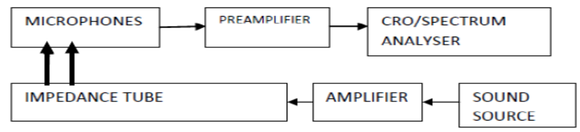

Fig 1.Experimental setup

SAMPLE PROPERTIES:

COTTON FELT (HMCCP) 10mm + PVC 3mm:

This felt is soft, porous, highly conformable, flexible and extensible; has adequate strength for many textile uses; and may be employed for many of the purposes for which wool felts are used. It comprises inter-curled and entangled cotton textile-length fibers having artificially-induced kinks, twists and bends. The Fig 2 shows the SEM structure of the cotton felt material.

Fig 2. SEM structure of Cotton felt

The vigor of the product, as in a wool felt, derives from the fact that the fibers have curled and kinked about each other, engendering an incipient and extensive fiber entanglement and interlocking which greatly increase the mutual frictional engagement of the fibers and hence the tensile vigor of the material. The same factors, coupled with substantially consummate fiber identity and liberation, though with an overall-minimizing of length due to kinking, convoluting and bending, accommodate to expound the high extensibility and flexibility of the material. The terminus products is soft because the fibers are not matted down nor interfused and have a loft such as that of most wool felts.

NWF + FR PUF 80/25 (PRODUCTION):

The properties of polyurethane are greatly influenced by the types of isocyanates and polyols used to make it. Long, flexible segments, contributed by the polyol, give soft, elastic polymer. High amounts of cross linking give tough or rigid polymers. Long chains and low cross linking give a polymer that is very stretchy, short chains with lots of cross links produce a hard polymer while long chains and intermediate cross linking give a polymer useful for making foam. The cross linking present in polyurethanes means that the polymer consists of a three-dimensional network and molecular weight is very high. Fig 3 shows the SEM structure of the Polyurethane foam.

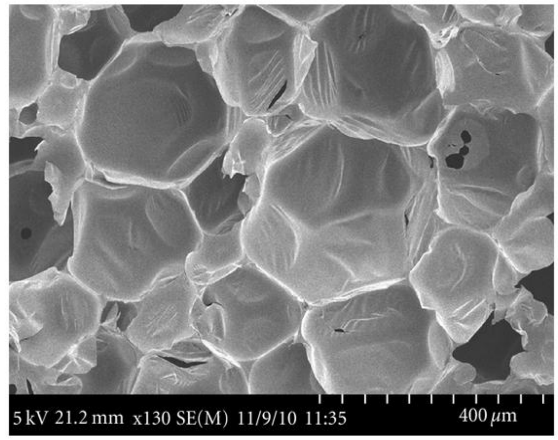

Fig 3. SEM structure of Polyurethane foam

In some respects a piece of polyurethane can be regarded as one giant molecule. One consequence of this is that typical polyurethanes do not soften or melt when they are heated, they are thermosetting polymers. The choices available for the isocyanates and polyols, in addition to other additives and processing conditions allow polyurethanes to have the very wide range of properties that make them such widely used polymers.

RESULTS AND DISCUSSION:

Both the materials were tested for its sound absorption co efficient in the existing tube and developed tube. The errors in percentage for the obtained values are calculated.

Table 1.Observed readings for NWF + FR PUF 80/25 (production)

FREQUENCY(Hz)	SOUND ABSORPTION CO EFFICIENT OF	SOUND ABSORPTION CO EFFICIE	ERROR(%)

	EXISTIN G TUBE(α)	NT OF DEVEL OPED TUBE(α)	
80	0.039	0.045	2.3
100	0.057	0.049	1.9
125	0.074	0.066	1.16
160	0.116	0.109	0.36
200	0.168	0.160	0.22
250	0.235	0.228	0.08
315	0.304	0.295	0.08
400	0.409	0.400	0.04
500	0.541	0.512	0.28
630	0.703	0.694	0.02
800	0.805	0.800	0.003
1000	0.699	0.725	0.13
1250	0.574	0.562	0.04
1600	0.458	0.450	0.03

Average error % = 0.33

Table 1 shows the readings obtained by both the existing and developed tube and the error for the obtained reading to the existing tube reading. Fig 4 shows the comparison of NWF + FR PUF 80/25 (production) by both tubes.

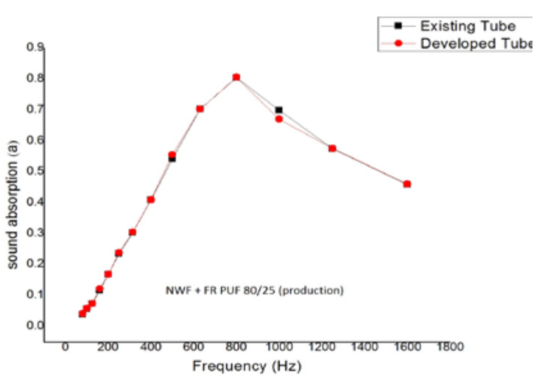

Fig 4.Comparison of readings obtained by both tubes for NWF + FR PUF 80/25 (production)

Table 2.Observed readings for Cotton Felt (HMCCP) 10mm + PVC 3mm

FREQUEN CY(Hz)	SOUND ABSORP TION CO EFFICIE NT OF EXISTIN G TUBE(α)	SOUND ABSORP TION CO EFFICIE NT OF DEVELO PED TUBE(α)	ERR OR (%)
80	0.037	0.029	4.6
100	0.039	0.032	3.2
125	0.032	0.025	4.7
160	0.035	0.028	4
200	0.039	0.030	4.9
250	0.054	0.048	1.2
315	0.083	0.076	0.7
400	0.138	0.130	0.33
500	0.224	0.216	0.12
630	0.214	0.220	0.07
800	0.198	0.192	0.09
1000	0.208	0.200	0.14
1250	0.259	0.252	0.07
1600	0.320	0.312	0.06

Average error % = 1.86

Table 2 shows the readings obtained by both the existing and developed tube and the error for the obtained reading to the existing tube reading. Fig 5 shows the comparison of Cotton Felt (HMCCP) 10mm + PVC 3mm by both tubes.

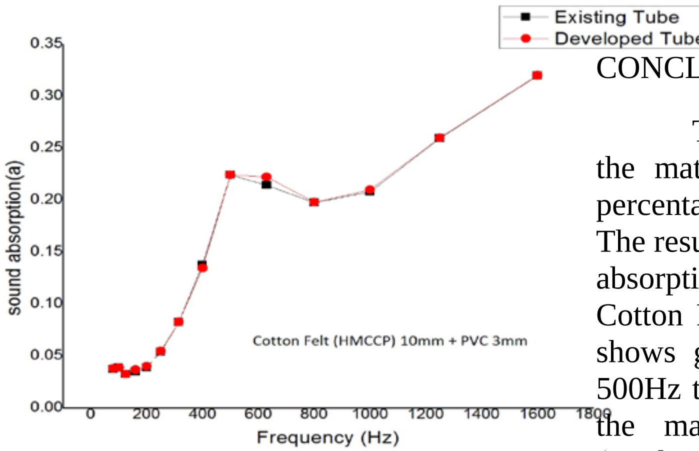

Fig 5.Comparison of readings obtained by both tubes for Cotton Felt (HMCCP) 10mm + PVC 3mm

CONCLUSION:

The sound absorption co efficient of the materials was obtained. The error in percentage for both the tubes was calculated. The result shows an average error of 5%.The absorption characteristics of the material Cotton Felt (HMCCP) 10mm + PVC 3mm shows gradual absorption in the range of 500Hz to 1000Hz and then it increases. For the material NWF + FR PUF 80/25 (production) it shows a maximum absorption at 800Hz and later the sound absorption decreases with increase in frequency.

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