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AIR FLOW RESISTIVITY OF DIFFRENT TYPES OF SOUND ABSORBING MATERIALS

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Abstract

The acoustical properties of foam materials are mainly determined by the air flow resistivity. In this project model for calculating the air flow resistivity of different sound absorbing materials is presented. According to this model the air flow resistivity depends on the mean spacing of the material, the amount of resin bonding and the physical properties of air. Expressions for predicting the air flow resistivity of different types of sound absorbing materials are derived. It is demonstrated that the model gives predictions that are reasonably close to direct measurements.

1. INTRODUCTION

1.1Problem statement:

Porous materials are commonly used as sound absorber in buildings. The sound absorption of this material can be achieved if the flow resistivity properties are obtained. Therefore, flow resistivity instrument are used. Current flow resistivity instrument are sophisticatedly design and build for research purpose. Thus, the price for obtain this instrument worth of fortune. This analysis is about designing and fabricating flow resistivity instrument with low cost without compromising the results and data quality if compared to the commercial products.

1.2Objectives:

This analysis focus is to develop a low cost device. The low cost meant it can be obtain without costing a lot of money and everyone can build it. The specific objective of this analysis is ‘To develop a low cost flow resistivity device for different sound absorbing materials.

1.3Scope:

Several scopes been outlined for this re analysis. The scopes of this analysis are as follows:
i. To design and fabricate low cost flow resistivity device.

ii. To measure the flow resistivity properties of different sound absorbing materials through the experiment.

iii. To validate the measured result through of absorption coefficient.

2. LITERATURE REVIEW

Endo & Kim introducednoise is generally divided into two categories fluid and sound structure itself, in which the ideal approach is to take measures to prevent the direct or immediate. However, in the case of a structure involving the sound itself, measures to address the noise problem sounds very difficult to do in the real world because the acoustic energy produced is so small compared to mechanical energy. [4][5]

Mahzan et al described Many products have already appeared on the market today, the product of sound absorbing panels is becoming increasingly active in the commercialization in the open market. In practice, sound-absorbing material is used for the inner layer is applied as part of an accommodation such as apartments, condominiums, bungalows and not least of jamming in the studio for a young child playing musical instruments that produce loud sounds. In addition, the automotive industry, aviation, and other applications also use these sound-absorbing materials to use and give an advantage to reduce the reverb sound on parts or components of a machine.

Arenas & Crocker discussed Sound-absorbing material is a material that absorbs sound energy that is imposed upon them, making them extremely useful as a tool to control the sound. It is used in a variety of locations, each with different, sometimes where it is close to the sound source itself, no less close to the receiver itself. While most materials absorb sound event itself, the term used for this event is "acoustic material" and was applied to the material in which the main purpose of this is to be a sound-absorbing material with a high absorption rate. The main use of sound-absorbing material is to reduce the reverb sound, where the sound pressure itself and indirectly decrease the reverb sound in a place or in a room.[3]

Kelen stated that porous material in the solid is characterized containing two or more phases, one of which connects the space, thus generating a network of cells in which are filled with fluid. In the solid porous material, edges and surfaces of cells that contain fluid, wrought of solid matter. Porous solids can be 100 times lighter and it is useful to apply it to the construction of lightweight materials.[5]

3. AIR FLOW RESISTIVITY THEORY

This is a measurement system of flow resistivity which is the most important parameter of foam materials that characterize acoustical properties of those materials.

The flow resistivity of porous material is defined as the ratio between the pressure difference across a sample and the velocity of flow of air through that sample per unit cube.
Flow resistivity is one of the materials parameters for Biot model which represent flow rate of the porous materials. Sound is vibrations in the air, so it is easy to imagine that sound cannot easily propagate through materials which air can hardly pass through. This is a measurement system of the flow resistivity which is the most important parameter of Biot model that characterize acoustical properties of the poroelastic materials. A material such as iron and rubber etc. which air cannot pass through easily does not propagate the air-borne sound but propagate only the structure-borne sound (vibration).

To obtain the flow resistivity, you need to measure the air flow velocity and the differential pressure between the front and back (primary side and secondary side) of the material when passing the air through the material. The flow velocity when measuring is regularized to 0.5 mm/s in ISO 9053. This is the extremely low winds that is less than 1/1000 of the breeze. Therefore, differential pressure between the material is also extremely small and a highly accurate differential pressure sensor is needed. There are two kinds of measuring methods in ISO 9053, one is the direct current method (Direct method, DC method) and alternative current method (Alternative method, AC method). [1][2]

Noise can be defined as unwanted sound. There are many applications where reducing noise level has big importance. Loss of hearing is just one among the results of continuous exposure to excessive noise levels.Noise will interfere with sleep and speech, and cause discomfort and different non-auditory effects.Moreover, high level noise and vibration cause structure failures similarly reduction in life of manyindustrial equipments. As Associate in Nursing example up to the mark valves, the vibration caused by flow instability often defects the feedback to the system and leading to extreme oscillations. The importance of noise issue could be well understood by looking atregulations that have been passed by governments to restrict noise production in society. Industrial machinery, air/surface transportation and construction activities are assumed to be main contributors in noise production or so called "noise pollution".

4. METHODOLOGY

Air flow resistivity is one of the most important parameters used to describe the acoustic behaviour of sound absorbing materials. These materials are anisotropic, so the air flow resistivity depends on the direction of air flow through the material. Fibre in the material generally lies in planes parallel to its surface, and there is a close relationship between air flow resistivity, density and foam diameter. The air flow resistivity is determined by an experiment whereby steady air flow is passed through a sample of foam material placed in a tube. The mean air velocity, the pressure decreases over the sample, and the thickness of the sample, are measured. One can predict or calculate the air flow resistivity from the foam diameter, density and pressure difference. We are presenting a simple model which allowed the calculation of air flow resistivity values starting from the values of the bulk density of the fibrous material and the foam diameter, and pointed out that the equation was suitable for the foams with uniform diameter. Our model will be used to measure the air flow resistivity to describe the acoustic behavior of fibrous materials.

5. SOUND ABSORBING MATERIAL

Sound-absorbing material is a material that absorbs sound energy that are imposed upon them, making them extremely useful as a tool to control the sound. It is used in a variety of locations, each with different, sometimes where it is close to the sound source itself, no less close to the receiver itself. While most materials absorb sound event itself, the term used for this event is "acoustic material" and was applied to the material in which the main purpose of this is to be a sound-absorbing material with a high absorption rate. The main use of sound-absorbing material is to reduce the reverb sound, where the sound pressure itself and indirectly decrease the reverb sound in a place or in a room (Arenas & Crocker 2010).[3]

Meanwhile, the application by the industry to be generally sound insulation where the noise absorbing material that is often used is glass wool, foam, mineral fibre and other composite materials. Problems that appear now are the dangers of extremely loud noise for hearing and indirectly on human health may be more complex if allowed to persist. Therefore, the need for the better sound environment is needed for a healthy lifestyle. So cheaper, thinner and lightweight material is needed to absorb the sound waves in a greater frequency and very wide is recommended.

5.1 Pourous Material:

Porous material is solids containing cavities, channels, paths, or interstices that allow free movement of sound waves can penetrate them. It is more likely to be classified as porous materials in which a foreign substance such as air and water vapour, depending on their availability (Arenas & Crocker

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2010).[3] Porous materials have been identified as one of the effective ways to serve as a tool to control the sound. This is due to the sound absorption characteristics are affected by the pore geometry factor, and indirectly more extensive study by researchers since lately the pore geometry optimization (Liu et al. 2014).[6] Traditionally porous materials used in vibro-acoustic applications have been treated as isotropic in terms of the elastic as well as the acoustic properties (Ho 2009).

In the case of acoustic, classical model that is often highlighted is the pore size must be equal to the order of magnitude of this belief the material. In the case of multi-scale porosity, a different approach should be used. In the case of two scale porosity, standardization has been done to take into account both the pore size and the number of cases of permeability contrast were distinguished as a function of the ratio between the scales of porosity (Glé et al. 2012).

5.1.1 Closed Pores:

Pores fragmented from their neighbours in any available space that should remain connected, is called a "closed pores". It has an impact on the characteristics and properties of macroscopic materials such as bulk density, mechanical strength and thermal conductivity. However, closed pores are generally less efficient thanopen pores in absorbing the sound energy are imposed upon them (Arenas & Crocker 2010).[3]

5.1.2 Open Pores:

It refers to the ratio of the volume of fluid that occupied continuous fluid phase up to equal the total volume of a porous material itself. For acoustic material itself, the range is approximately [0.70 0.99] (Ová & Lumnitzer 2011).[8] The schematic cross-section diagram of porous material as shown in Figure 5.1

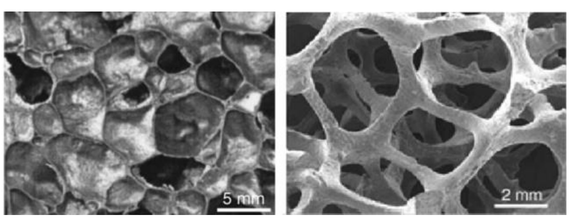

Fig-1: Closed and open porestructure.[13]

6. MEASUREMENT OF AIR FLOW RESISTIVITY

The flow resistivity measured by the method of sending constant air flow velocity as the rate of interest through the survey, and measure air velocity and air pressure drop through the material as a result of the survey.[1]

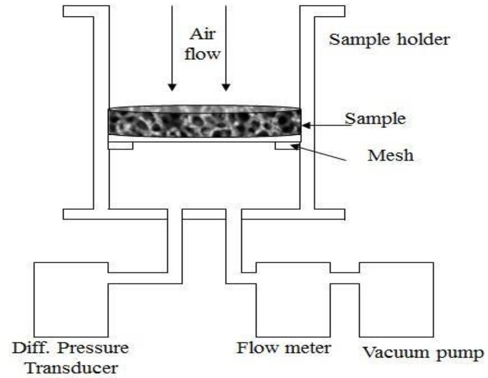

Fig-2: Block diagram for air flow resistivity.[14]

Air flow resistivity is calculated by following calculation method, as per DIN-EN 29053, Standard. [15][16][17]

6.1 Airflow resistance, R:

A quantity defined as

$$R=\frac{\Delta p}{q_v}$$

where Δp is the difference of air pressure, in pascals, across the test specimen with respect to the atmosphere. Whileq_v is the volumetric airflow rate, in cubic metres per second, passing through the test specimen.

6.2 Specific airflow resistance, R_s:

A quantity defined as

$$R_s = RA$$

Where R is the airflow resistance, in Pascal second per cubic meter, of the test specimen. While, A is the cross-sectional area, in square meters, of the test specimen perpendicular to the direction of flow.

6.3 Airflow resistivity, r:

A quantity defined as

$$r = \frac{Rs}{d}$$

whereR_s is the specific airflow resistance, in pascal seconds per metre, of the test specimen. While d is the thickness, in metres, of the test specimen in the direction of flow.

7. TESTING PROCEDURE

Step 1: Check all the connections are correct and power supply to every equipment.
Place the foam sample inside the cylinder by removing upper lid.
Step 2: Start the vacuum pump, wait for some time so that flow get stabilized.
Step 3: Control the by flow control valve and maintain it by 2 liters per min. Note down the pressure drop.

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Step 4: Change the foam sampel and carry out the remaining tests to calculate airflow resistivity.

8. CONCLUSION

From the results of air flow resistivity and sound absorption coefficient gain from the experimental setup, there are some conclusions can be made for this study such as the flow resistivity device has been designed and fabricated according to ISO 9053 standard. This device does not required high technology thus the cost making of device is low. The values obtained from the experimental setup of air flow resistivity can be taken into account with reasonable agreement by comparing with ROXUL results prepared in their own catalogue. Validation of this device been confirmed with the air flow resistivity have been simulated using sound absorption coefficient by Delaney and Bazley theory and impedance tube experimental results with reasonable agreement.

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