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Evaluation and Comparison of Acoustic Performance and Thermal Conductivity of Spacer Fabrics ⋆

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Abstract

The utilization of 3-Dimensional (3D) porous textile materials by the civil and mechanical engineers for improved thermo-acoustic environment has widened the research scope. Unconventional three-dimensional textile material which grabs the attention of the researchers for multi-functional applications is spacer fabrics. Since spacer fabrics have superior thermal and acoustic characteristics compared to conventional woven/knitted structures or nonwovens due to their wonderful 3D porous nature. It has two outer layer connected with the help of monofilament or multifilament spacer yarn which kept the fabric bulkier with low density and highly breathable. Due to porous nature, interconnected pores, bulkier and 3D structure, the spacer fabrics have ability to attenuate more sound energy than the conventional materials. This research paper presents an experimental investigation on the sound absorption behaviour and thermal properties of warp knitted spacer fabrics. The Sound absorption coefficient (SAC) and thermal conductivity (K) were measured using two microphone impedance tube and Alambeta. This study deeply discusses the influence of material parameters and characteristics on acoustic properties of 3D spacer knitted fabrics. The results show that the fabric surface property, porosity, flow resistivity and tortuosity have significant effects on the sound absorption as well as thermal conductivity. With the obtained results, this work derives regression equations and correlation between noise absorption and thermal properties of spacer fabrics.

Keywords: Noise Reduction Coefficient (NRC); 3D Spacer Fabrics; Flow Resistivity; Thermal Conductivity

1 Introduction

The materials and structures using noise reduction or sound insulating materials are to reduced ambient noise have received much attention [1]. Noise is an unwanted level of sound and unfor-

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tunately most of the machines that have been developed for industrial purposes for high speed transportation or to make life more comfortable are accompanied by noise. Noise-absorbing materials absorb unwanted sound by dissipating sound wave energy when it passes through and also by converting some of the energy in to heat. Noise can cause different types of negative effects on humans that are exposed to it inside auditoriums, theatres and even can damage buildings. The effects on humans are hearing loss, change of individual behaviour, reduction of sleep, communication interference and effect on domestic animals and wildlife [2]. A healthy young person can hear sound in the frequency range of about 20 Hz to 20000 Hz, but speech is composed of sound mostly in the range of 200 Hz to 6000 Hz. The frequency range where the human ear is most sensitive is 200 Hz to 2000 Hz. There are several methods to decrease noise and one of them is the use of sound absorption materials. Porous material is a typical passive medium widely used for sound absorption. Sound absorbability of this kind of material also depends on the sound wave frequency [3, 4]. The acoustic performance of sound absorbing poro-elastic materials is governed by its five intrinsic physical parameters like flow resistivity, porosity, tortuosity, viscous and thermal characteristic lengths [5]. The most important parameter which determines sound-absorptive and sound-transmitting properties of acoustic materials is the flow resistivity.

The absorption of sound results from the dissipation of sound energy, owing to the viscous friction and heat exchange when sound waves propagate and reflect through the flexible porous structure [6]. Many authors have explained this dissipation mechanism in the past [2, 6]. Noise-absorbing materials absorb unwanted sound by dissipating sound wave energy when it passes through and also by converting some of the energy in to heat, making them useful for control of noise. Porous material is a typical passive medium widely used for sound absorption. In general a porous material with rigid backing absorbs more at middle and high frequencies than at low frequencies of sounds [7]. Porous material is a typical passive medium widely used for sound absorption. Sound absorbability of this kind of material depends on the sound wave frequency. Currently, successful sound absorption materials commercially available for acoustic treatment consist of rigid porous medium, micro perforated panels, nonwovens and composites. Various studies and research on textile fabrics, nonwoven mats etc. have been conducted in order to analyze their noise absorption performance [8, 9]. These studies suggested some drawbacks in existing materials like poor performances, bad structural stability, difficult to produce with textured surface for aesthetics etc. Hence in order to overcome all these drawbacks, 3-dimensional spacer fabrics grab the attention of researchers in this decade.

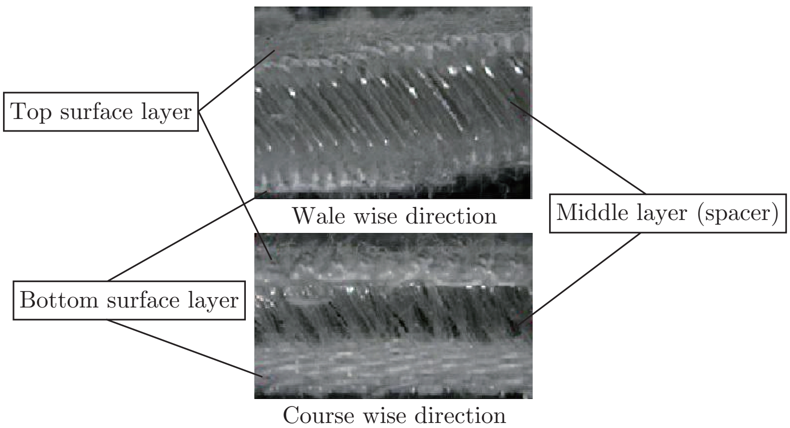

Fig. 1: Structure of spacer fabrics [13]