Effect of Bicomponent Fibers on Sound Absorption Properties of Multilayer Nonwovens

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ABSTRACT

In this study sound absorption properties of multilayer nonwovens with bicomponent fibers have been derived compared with homocomponent fibers. Multilayer nonwovens obtained by polyester fibers consisted of three layers. The top and bottom layers were spunbonded nonwoven and middle layer was meltblown nonwoven sandwiched between them. Each layer was produced separately to compose unbonded three-layered nonwoven structures. Four different spunbonded nonwoven fabrics having a basis weight of 40 gsm made from four different polyester cross-sectional fibers (homocomponent round and trilobal, bicomponent round and trilobal). Five different meltblown nonwoven fabrics having five different basis weights ranging 100 gsm to 200 gsm were made from polyester round cross-sectional fibers. Spunbonded/ Meltblown/ Spunbonded (SMS) type unbonded multilayer nonwovens had basis weights ranging 180 gsm to 280 gsm. The effect of basis weight on sound absorption performance of multilayer nonwovens has been evaluated in the study. All results have been analyzed statistically. Results show that three-layered nonwoven structures including bicomponent fibers as outer layers had better sound absorption performance than nonwoven structures including homocomponent fibers. This effect becomes more significant as the basis weight increases, resulting insound absorption coefficients.

Keywords: Bicomponent Fiber, Multilayer Nonwovens, Sound Absorption, Impedance tube, Air permeability

INTRODUCTION

Sound is a type of energy that the mechanical vibrations occuring in any source emit as sound waves.. Noise is undesired sound series in variable frequencie which change over time and should be controlled for human comfort and health. One of the noise control methods is sound insulation, a barrier to prevent the passage of sound waves and reduce sound transmission. The major principle of sound insulation is based on sound absorption. Sound absorption means the sorption and transformation of sound energy to another type of energy, mostly heat energy.

Bulky, fibrous, porous textile structures, such as nonwovens, are widely used sound absorbers for many technical applications for instance building and automotive insulations, machine insulations etc. Because of the porosity of the structure and the fibers interlocking in nonwovens are the frictional elements that provide resistance to acoustic wave motion. When sound enters into fibrous materials, its amplitude is decreased by friction as the waves try to move through the tortuous passages. Thus the acoustic energy is converted into heat [1].

Many researchers studied and reported sound absorption characteristics of nonwovens in the literature. Tascan and Vaughn investigated effects of fiber denier, fiber cross-sectional shape and fabric density on acoustical behavior of vertically lapped nonwoven fabrics. The sound absorption coefficients of needle-punched nonwovens with the round, trilobal and 4G cross-sections were measured up to 20 Khz using an instrument they designed. Results showed that as the total surface area increases sound absorption becomes better [2].

Ulcay et al investigated sound absorption properties of spunbonded nonwovens produced from fibrillated islands in the sea bicomponent filaments with the various numbers of islands (1, 7, 19, 37 and 108). The results showed that spunbonded webs with 108 islands were the best acoustic absorbers. Spunbonded nonwovens with island in the sea bicomponent fibers were also compared with some high loft nonwovens; it has been reported that multilayer nonwovens with 108 islands have the best sound absorbing performance [3].

Liu et al studied the acoustic characteristics of dual-layered nonwovens by analysing experimentally and theoretically. In experimental analysis, the sound absorption coefficients at low frequency ranges of 20 dual-layered nonwoven fabrics with four types of meltblown polypropylene nonwovens and five types of hydroentangled e-glass fiber nonwovens were. In theoretical analysis, the effect of thickness and porosity of top and bottom layer on sound absorption coefficient was deterrmined using a numerical simulation method. Experimental results indicated that the measured and calculated data have very similar trends as a function of of thickness, porosity and the sound frequency [4].

Sound absorption properties of some bilayered nonwoven composites at low frequencies were investigated by Kucuk and Korkmaz. Results showed that macrofibrous layer of polyester fibers backed with 70% wool and 30% bicomponent polyester fibers has the best sound absorption properties at all frequency ranges [5].

Factors influencing acoustic performance of sound absorbtive materials have been researched by Seddeq. He reported that the fiber linear density, air permeability, thickness, compression, porosity and the position of the material are the major factors effecting acoustic properties of needle-punched nonwovens [6].

In this study, sound absorption performance of SMS type multilayer nonwovens containing bicomponent fibers have been investigated. Spunmelt nonwovens can be produced economically using short production line. Lighter nonwovens with less thickness will be a good alternative to control the sound absorption compared with commercially available bulky and heavy needle-punched sound absorbers.

Seddeq reported that the most effective factors on sound absorption properties of fibrous materials are fiber diameter, airflow resistance, material thickness, tortuosity, fiber surface area, density of the material and compression [6]. Castagnade et al reported that the sound absorption properties decrease during the compression of a fibrous mat. Yilmaz et al reported a decrease in sound absorption coefficient with increasing compression [7, 8]. It is known that sound waves are transferred by air molecules. Thus, the distance between layers or gaps between them in multi-layer structures can improve sound insulation [9]. Therefore, it is clear that bonding under pressure creates a denser and thinner structure and reduces porosity, and sound absorption is effected negatively. Based on this approach, the layers of the SMS fabrics in this study were not bonded to each other. Fabric design of these multilayer nonwovens is illustrated in *Figure 1*.

MATERIALS

All spunbonded and meltblown nonwoven fabrics were supplied by Mogul Tekstil San Tic. A.S. (Turkey). Homocomponent and bicomponent spunbonded layers having a basis weight of 40 gsm were produced from two different cross-section fibers (round and trilobal) as shown in *Figure 2*. And four different spunbonded layers were obtained with the fiber fibers in the same diameter. Spunbonded structures were flat bonded thermally at same conditions.

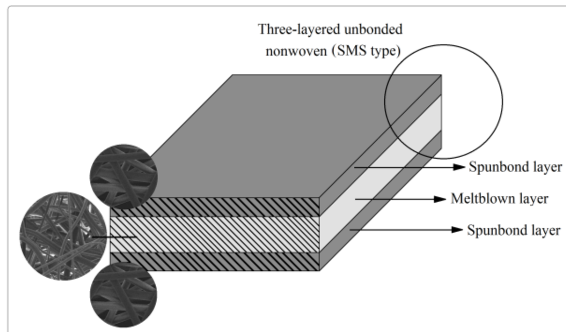

FIGURE 1. Fabric design of multilayer nonwovens.

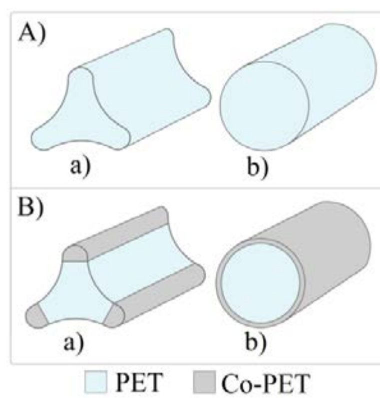

FIGURE 2. Fiber Cross-sections; A)Homocomponent fibers; a)Trilobal, b)Round; B)Bicomponent fibers; a)Bico-trilobal, Tipped trilobal type, b)Bico-round, Core/sheath type.

Bicomponent fibers contain two different polymers extruded together from the same spinneret to compose a single filament and can be classified according to the position of each polymer within cross-sectional area. Typical configurations are side by side, core/sheath, segmented pie, alternating segments, tipped trilobal and island in the sea types. The properties and applications of bicomponent fibers depend on both the properties and distribution of the polymers in the cross-sectional area. Application areas include microfibers, crimping fibers, composites, nonwovens etc. One of the major applications of bicomponent fibers for nonwovens is for self-bonding at lower bonding temperatures than in a typical thermal bonding application. When a bicomponent nonwoven web is heated sufficiently to melt the sheath or tips, polymer melts and flows to the nearest adjacent fiber and binds the structure.

TABLE I. Properties of layers.

Type of Layer	Fiber type	Fiber Content	Fiber Cross-section	Fiber Diameter (µm)	Basis Weight (gsm)	Thickness (mm)
Spunbonded layers	Homocomponent	PET	Round	20-24	40	0.37 ± 0.07
			Trilobal			
	Bikomponent	PET/ Co-PET	Round			0.35 ± 0.05
			Trilobal			
Meltblown layer	Homocomponent	PET	Round	8-May	100	0.62 ± 0.06
					125	0.67± 0.07
					150	0.84± 0.05
					175	0.93± 0.06
					200	1.1± 0.04

TABLE II. Sample description.

Sample ID	Average Basis Weight of Layers (gsm)			Basis Total Weight (gsm)	Average Thickness (mm)	Bulk Density (g/cm^3)	Sample ID	Fiber Cross-section		
	S[1]	M[2]	S[1]					S[1]	M[2]	S[1]
1	40	100	40	180	1.31	0.1374	**R**	Round	Round	Round
2		125		205	1.43	0.1433	**T**	Trilobal	Round	Trilobal
3		150		230	1.54	0.1493	**Bi-R**	Bico-Round	Round	Bico-Round
4		175		255	1.65	0.1545	**Bi-T**	Bico-Trilobal	Round	Bico-Trilobal
5		200		280	1.79	0.1564				

Keys: 1= Spunbonded layer, 2= Meltblown layer

In this study bicomponent spunbonded layers were made from core/sheath type and tipped trilobal type bicomponent fibers. The composition of polymers in core/sheath type is 90% polyester (PET) core with 230-250^{o}C melt point and 10% Co-polyester (Co-PET) sheath with 110-140^{o}C melt point; the tipped trilobal type is 10% Co-polyester (Co-PET) tips with 110-140^{o}C melt point and the remainder is polyester (PET) with 230-250^{o}C melt point.

Five different meltblown layerswith basis weight of 100 gsm to 200 gsm with polyester (PET) round fibers at the same diameter were used. All meltblown nonwovens were bonded thermally at the same conditions to form the middle layers of the multilayer structures. Specifications of the various layers are presented in *Table I*.

SMS compositions of four different spunbonded layers and five different meltblown layers were prepared manually, resulting in twenty multilayer nonwoven structures. Layers were arranged loosely, adjacent to each other. Descriptions of multilayer nonwoven samples are shown in *Table II*. The thickness of the samples ranged from 1.31 to 1.79 mm. Bulk density values were calculated from basis weight and thickness data.

From *Table II,* the samples were coded as R, T, Bi-T and Bi-R according to the change of fiber type and fiber cross-section in the spunbond layers; sample codes of 1, 2, 3, 4 and 5 defined the changes in basis weight of the meltblown layers. For instance 1R designates an SMS type three-layered nonwoven in which the outer spunbonded layers with homocomponent round fibers and a meltblown layer having a basis weight of 100 gsm; 5Bi-T means spunbonded layers with bicomponent trilobal fibers and meltblown layer having a basis weight of 200 gsm.

METHODS

All measurements were carried out at standard temperature (20°C ± 2°C) and relative humidity (65% ± 2%). The thickness of the ten different samples from each material were measured using a standard measuring device according to NWSP 120.6.R0 (15) and average values are listed in *Table II*.

Air Permeability Measurement

Air permeability is a very important property affecting the thermal and acoustic insulation capabilities of nonwoven fabrics Higher air permeability results in higher sound transmission and therefore less sound insulation [10]. Air permeability of multilayer nonwovens was obtained by using an SDL Atlas digital air permeability tester **(**SDL-Atlas Inc., USA). The test were conducted according to NWSP 070.1.R0(15). The measurements were done on five different samples from each material by applying 200 Pa pressure through a 20 cm² test area. The reported results are averages of the five measurements.

Sound Absorption Measurement

There are different measurement techniques to quantify the performance of acoustic insulation materials- acoustic rooms and the impedance tube method. The impedance tube method is the most widely used and significant method owing to short test times with small sample sizes. In this study the sound absorption coefficient was measured using the impedance tube two-microphone method. The principle of the measurement is shown schematically in *Figure 3*. A sound source (loudspeaker) is mounted at one end of the impedance tube, and a sample of the material is placed at the other end. The loudspeaker generates broadband, stationary random sound waves, which propagate as plane waves in the tube, hit the sample and reflect.

Sound absorption coefficients (α) of multilayer nonwovens was measured according to ISO 10534-2. Nonwoven samples were cut into 100 mm and 29 mm diameters for the measurement of large and small tubes. Sound absorption coefficients of 3 samples (2 replications from each material) were obtained by using a Brüel & Kjær impedance tube kit.

The propagation, contact and reflection result in a standing-wave interference pattern due to the superposition of forward and backward travelling waves inside the tube. By measuring the sound pressure at two fixed microphone locations, the the transfer function can be calculated using a digital frequency analyzer. It is possible to determine the sound absorption, complex reflection coefficients and the normal acoustic impedance of the material. The usable frequency range depends on the diameter of the tube and the spacing between the microphone positions [11].

The frequency range in which the large diameter tube was used (0.5 kHz to 6.4 kHz) overlaps the frequency range in which the small diameter tube was used (0.5 kHz to 1.6 kHz). The results of low frequency and high frequency measurements are combined to a continuous curve and the change of the sound absorption coefficients were observed at a frequency range between 0.50- 6.4 kHz.

The sound absorption coefficient (α) is generally used to explain the performance of sound absorbing materials. It is defined as the ratio of acoustic energy that is trapped in the material by the material and ranges from 0 to 1. An ‘α= 0’ value means 0% sound absorption or reflection of all the sound waves and ‘α= 1’ means 100% absorption of sound waves.

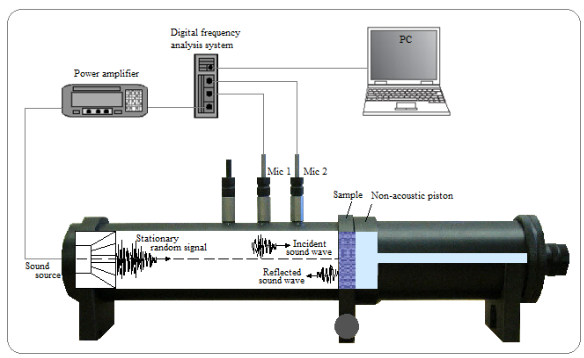

FIGURE 3. Schematic diagram of impedance tube and meauserement devices (Adapted from Brüel & Kjær Sound & Vibration Measurement A/S) [16].

RESULTS AND DISCUSSION

Air Permeability

Air permeability of R and Bi-R samples and T and Bi-T samples are seen in *Figure 4* and *Figure 5* respectively, for increasing basis weights of multilayer nonwovens. For each group of samples air permeability becomes lower as the fabric weight increaes. At higher basis weights of the fabrics, the increase in the number of fibers creates more spaces and a longer tortuous path through which the air must flow. Thus fabric structure becomes more resistant to air flow, resulting in lower air permeabilities. For each range of basis weights, the Bi-R and Bi-T samples are more resistant to air flow than the R and T samples. This indicates that the bicomponent structures restricted the size of air passages and air permeability decreased.

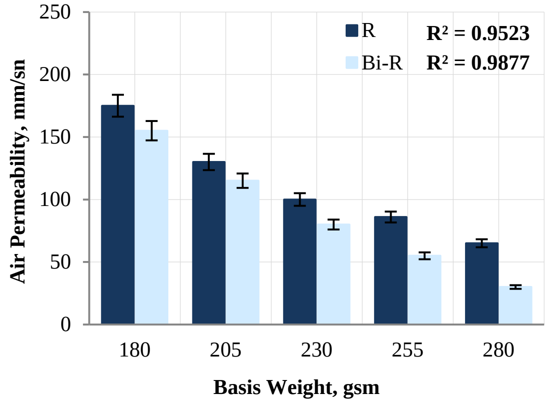

FIGURE 4. Air permeability of R and Bi-R samples.

Design Expert Analysis of Variance (ANOVA) software (Stat-Ease, Inc., USA) was used for statistical data analysis. The effect of independent parameters basis weight (A) and fiber type (B) on the dependent parameter air permeability was examined for Bi-R and R samples with analysis of variance at a significance level of p value less than 0.05.

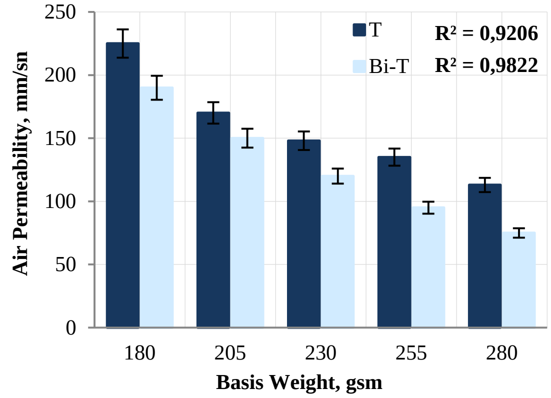

FIGURE 5. Air permeability of T and Bi-T samples.

The model summary statistics and ANOVA results for the data obtained in the study are shown in *Table III*. As presented in *Table III* R-Squared (R^2) equals 0.9955 and the model predicted predicted R-Squared (R_{pre}^2) equals 0.9750. This means that the dependent parameters were affected by the independent parameters ata a confidence level of 99.55% and the model predicts the air permeability succesfully at a level of 97.50%.

In the ANOVA results of R and Bi-R samples, both bassis weight A and fiber type B are significant model terms. According to the F values, A- Basis weight is a more significant influence on air permeability than B- Fiber type. Further, the statistical analysis indicates that fiber type (bicomponent, homocomponent), has less effect than basis weight than basis weight on the air permeability of multilayer nonwovens.

TABLE III. ANOVA for air permeability of R and Bi-R samples.

Source	Sum of Squares	Degree of Freedom (df)	Mean Square	F	Significance
Model	18429.99	4	4607.50	277.85	< 0.0001
A-Basis weight	16473.80	1	16473.80	993.42	< 0.0001
B- Fiber type	1464.10	1	1464.10	88.29	0.0002
Factors within group	492.09	2	492.09		
Residual	82.91	5	16.58		
Cor Total	18512.90	9			
Model	Std. Deviation	4.07	R-Squared		0.9955
	C.V. %	4.11	Adjusted R-Squared		0.9919
	PRESS	463.5	Predicted R-Squared		0.9750

TABLE IV. ANOVA for air permeability of T and Bi-T samples.

Source	Sum of Squares	Degree of Freedom (df)	Mean Square	F	Significance
Model	18148.03	7	2592.58	5950.17	0.0002
A-Basis weight	934.80	1	934.80	2145.45	0.0005
B- Fiber type	802.13	1	802.13	1840.94	0.0005
Factors within group	820.13	5	820.13		
Residual	0.87	2	0.44		
Cor Total	18148.90	9			
Model	Std. Deviation	0.66	R-Squared	1.0000	
	C.V. %	0.46	Adjusted R-Squared	0.9998	
	PRESS	13132	Predicted R-Squared	0.9928	

The statistical analysis of air permeability of T and Bi-T samples exhibited in *Table IV* higher F values for basis weight and thus a lerger effect on air permeability. Air permeability was affected by basis weight and fiber type 100% and the model predicts the values of air permeability at a 99.28% confidence level.

The regression equation for air permeability of R and Bi-R samples obtained from the model is presented below in Eq. (1), and for T and Bi-T samples in Eq. (2). The high levels of the factors are coded as +1 and the low levels of the factors are coded as -1.

$$\text{AIR PERMEABILITY} = +91.67 - 57.40 * A - 12.10 * B - 4.60 * AB + 14.86 * A^2 \quad (1)$$

$$\text{AIR PERMEABILITY} = +129.74 - 42.31 * A - 14.81 * B - 14.43 * AB + 20.87 * A^2 - 3.40 * A^2B - 14.41 * A^3 + 13.67 * A^3B \quad (2)$$

<u>Sound Absorption Coefficient</u>

The sound absorption results of R and Bi-R samples and T and Bi-T samples presentedd in *Figure 6* and *Figure 7* respectively. As many researchers have reported, the increase in basis weight influences the sound absorption positively. In this study higher sound absorption coefficients were obtaineded for the higher weight fabrics for each sample group. It should be noted that Bi-R and Bi-T samples with bicomponent fibers have better sound insulation for each range of fabric weight tested.

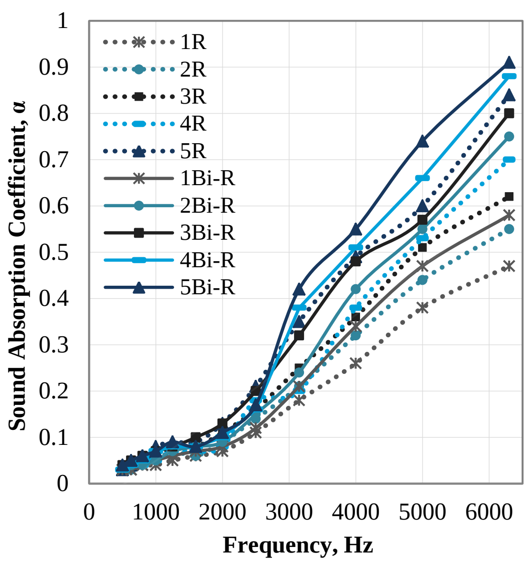

FIGURE 6.Sound absorption of T and Bi-T samples.

For each range of basis weight, there is no correlation between the effect of bicomponent and homocomponent fiobers on sound absorption. For example as the sound absorption coefficient of Sample 4R equals 0.7, that of Sample 2 Bi-R equals 0.75; that of Sample 4T equals 0.62, and that of Sample 2Bi-T equals 0.61 for the frequency of 6300 Hz. This indicates that the lighter three-layered nonwoven fabrics in which the outer layers are spunbonded nonwoven with bicomponent fibers have better sound absorption than the heavier ones in which the outer layers are spunbonded nonwoven with homocomponent fibers.

As shown in *Figure 6,* Bi-R samples had better sound insulation results than R samples. Similarly in *Figure 6* higher sound absorption results have obtained for Bi-T samples compared with T samples. More effective sound absorption with bicomponent fibers is obvious. In addition *Figure 6* and *Figure 7* exhibits that T and Bi-T samples had the poorer sound absorption than R and Bi- R samples.

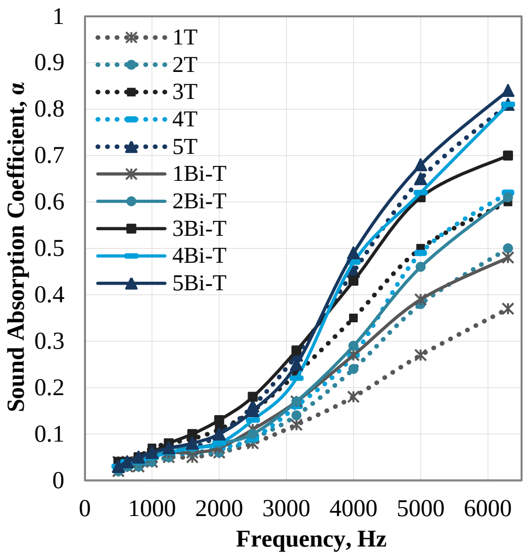

FIGURE 7.Sound absorption of T and Bi-T samples.

The reason for these results may be because the different porosity, tortuosity and roughness of bicomponent and homocomponent structures. Tortuosity is defined as the ratio of actual flow path length to thethickness of the porous medium in the direction of macroscopic flow. A higher value of tortuosity would therefore indicate a longer, more complicated and sinuous path, resulting in greater resistance to fluid/sound wave flow. Tortuosity also directly influences propagation of acoustic waves and absorbance efficiency in fibrous porous media. It has also been shown that the value of tortuosity determines the high frequency behavior of sound absorbing porous materials. [12,13].

In bicomponent fibers with core/sheath and tipped trilobal cross-sections, the Co-PET melted earlier and adhered to adjacent fibers, binding the nonwoven structure. This resulted in a rough fiber surface. And affected flow of sound waves. As the path and flow of sound waves changes, the increase in frictional losses and vibration results in a decrease in acoustic energy. As the result of restricted flow of sound waves, the sound absorption coefficients increased.

A porous absorbing material contains cavities or channels which act as paths for sound waves. The pores that are totally isolated from their neighbors are called “closed” pores. They have an effect on some macroscopic properties of the material such as bulk density and thermal conductivity. However, closed pores are substantially less efficient than open pores in absorbing sound energy. On the other hand, open pores have a continuous channel of communication with the external surface of the body, and they have great influence on sound absorption. [14, 15]. As a consequence it can be concluded that melting part of bicomponent fibers affects the cross-sectional area and fiber surface roughness, resulting in more tortuos passages, lower air permeabilities and higher sound absorption.

From *Figure 6* and *Figure 7*, the sound absorption coefficients of all samples ranged between 0.0-0.3 up to a frequency of 3000 Hz. It should be noted that in SMS type multilayer nonwovens the variation of fiber type, fiber cross-section and basis weight do not result in a significant improvement in the sound absorption properties between the frequencies of 500-3000 Hz. This indicates poor sound insulation for low frequencies, which may be explained by thickness effects [2]. At low frequencies there is little to no difference in sound absorption regardless of fabric thickness. The reason is because sound absorption is a function of the wavelength and thickness of the material. Theoretically, 100% absorption was performed by a material that is half the thickness of the wavelength. Research shows that 100% absorption by a material occurs when thickness was closer to 1/10th of the wavelength [1]. At high frequencies, as the wavelenghts become smaller thinner fabrics control the sound absorption efficiently. Therefore thinner spunmelt nonwovens are good sound absorbers at high frequencies.

The statistical analysis of sound absorption of B and Bi-R samples exhibited in *Table V* demonstrates that fiber types with higher F values are a more significant factor than basis weight. Sound absorption has been affected by basis weight and fiber type at a 99.20% coinfidence level and the model predicts the actual values of sound absorption ata level of 98.88 percent Fiber type (bicomponent or homocomponent fiber) is thus more effective parameter than basis weight on sound absorption performance.

TABLE V. ANOVA for sound absorption of R and Bi-R samples.

Source	Sum of Squares	Degree of Freedom (df)	Mean Square	F	Significance
Model	6.09	16	0.38	797.66	< 0.0001
A-Basis weight	0.024	1	0.024	49.82	< 0.0001
B-Frequency	0.98	1	0.98	2052.60	< 0.0001
C-Fiber type	0.036	1	0.036	74.48	< 0.0001
Factors within group	5.05	13			
Residual	0.049	103	4.769E-004		
Cor Total	6.14	119			
Model	Std. Deviation	0.022	R-Squared	0.9920	
	C.V. %	10.34	Adjusted R-Squared	0.9908	
	PRESS	0.069	Predicted R-Squared	0.9888	

Table VI presents a statistical analysis of sound absorption of T and Bi-T samples. This data indicates demonstrated that the fibers with higher F values have higher effects on sound absorption than basis weight. Sound absorption was affected by basis weight and fiber type at a confidence level of 99.39% and the model predicts the values of sound absorption at a 99.39% level. Thus, the statistics predict that fiber type has a larger effect on sound absorption than basis weight.

The regression equation for sound absorption of R and Bi-R samples obtained from the model is presented in Eq. (3), and for T and Bi-T samples in Eq. (4). The high levels of the factors are coded as +1 and the low levels of the factors are coded as -1. The variables of frequency and basis weight were normalized between -1 and +1; for the variable fiber type the high value represents the bicomponent fibers and the low value is for homocomponent fibers.

TABLE VI. ANOVA for sound absorption of T and Bi-T sample.

Source	Sum of Squares	Degree of Freedom (df)	Mean Square	F	Significance
Model	5.05	22	0.23	718.52	< 0.0001
A-Basis weight	0.014	1	0.014	43.07	< 0.0001
B-Frequency	0.81	1	0.81	2541.69	< 0.0001
C-Fiber type	0.027	1	0.027	85.23	< 0.0001
Factors within group	4.199	19			
Residual	0.031	95	3.25E-04		
Cor Total	5.08	119			
Model	Std. Deviation	0.018	R-Squared	0.9939	
	C.V. %	9.78	Adjusted R-Squared	0.9925	
	PRESS	0.052	Predicted R-Squared	0.9898	

$$\text{SOUND ABSORPTION} = +0.31 + 0.061 * A + 0.45 * B - 0.039 * C + 0.084 * AB - 2.726E\text{-}004 * AC - 0.069 * BC - 3.854E\text{-}003 * A^2 + 0.072 * B^2 - 7.859E\text{-}004 * ABC - 1.502E\text{-}003 * A^2B + 0.017 * A^2C - 7.583E\text{-}003 * B^2C + 0.021 * A^3 - 0.12 * B^3 + 0.016 * A^2BC + 0.027 * B^3C \quad (3)$$

$$\text{SOUND ABSORPTION} = +0.26 + 0.056 * A + 0.43 * B - 0.034 * C + 0.13 * AB - 0.019 * AC - 0.058 * BC - 0.18 * A^2 + 0.23 * B^2 + 3.280E\text{-}003 * ABC - 0.010 * A^2B + 0.013 * A^2C + 0.023 * AB^2 - 1.428E\text{-}003 * B^2C + 0.026 * A^3 - 0.13 * B^3 + 0.018 * A^2BC + 0.028 * A^3B + 0.028 * A^3C - 0.059 * AB^3 + 0.024 * B^3C + 0.15 * A^4 - 0.14 * B^4 \quad (4)$$

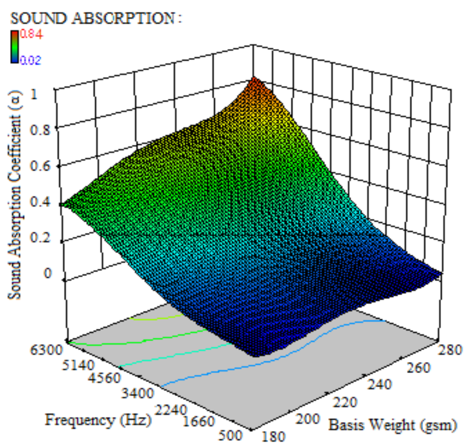

FIGURE 8. Interactive effects of basis weight and frequency on sound absorption coefficient for R and T samples.

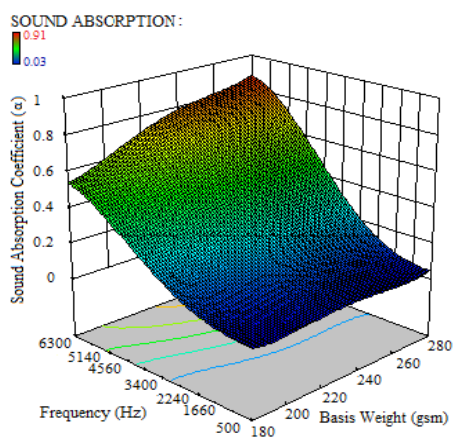

FIGURE 9. Interactive effects of fabric weight and frequency on sound absorption coefficient for Bi-R and Bi-T samples.

Figure 8 and *Figure 9* summarize the interaction effect of basis weight and frequency on sound absorption coefficient for multilayer nonwovens with homocomponent and bicomponent fibers respectively. Higher sound absorption coefficients are observed with increasing frequency and increasing basis weight. This interaction effect is more significant for bicomponent fibers. This is because in nonwovens bonded by interlocking bicomponent fibers contain more paths for the sound waves to move. Increased vibration of sound waves at higher frequencies resulted in frictional losses and absorbtion of sound energy within the structures. Thus, sound absorption performance was improved.

CONCLUSION

In this study three-layer SMS type multilayer nonwovens in which the outer layers were bicomponent spunbonded nonwovens were examined in order to investigate sound absorption properties. Use of round and trilobal bicomponent and homocomponent cross-setional fiobers as outer layers affected sound absorption properties.

All samples had poor sound absorption performance at frequencies up to 3000 Hz. At high frequencies samples with bicomponent fibers had better sound insulation than the other samples. The reason for this may be due to differences in pore structures, tortuosity, fiber surface and fiber cross- section area between homocomponent and bicomponent fibers. During the calendering process used to bond the spunbonded layers with bicomponent fibers with core/sheath and tipped trilobal cross-sections, the Co-PET melted earlier and adhered to adjacent fibers, bonding the nonwoven structure.

From statistical analysis, it was determined that the sound absorption coefficient is affected by basis weight and fiber type at a 95% confidence level. Statistical models predicted the sound absorption coefficient at nearly 99% conmfidence level. Regression equations have been obtained for sound absorption coefficients according to fiber type and basis weight.

In this research bicomponent fibers provide better sound absorption than the homopolymer analogs because of higher bonding and decreased air permeability. The statistical results showed that fiber type and basis weight have significant factors effects on air permeability and thus sound absorption.

As fabric basis weights ranged from 180 gsm to 280 gsm for each sample group, the highest sound absorption coefficients were obtained at the highest basis weight of 280 gsm.

The results show that sound insulation at high frequencies can be improved by using spunmelt multilayer nonwovens. Spunmelt nonwovens offer opportunities to tailor fabrics to deired applications through variations in fiber type and basis weight.

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