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Effect Of Blend Composition And Contact Time On The Properties Of Recycled Polyester Thermal Bonded Nonwoven

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Abstract: A Headliner Often Is A Composite Material That Is Adhered To The Inside Roof Of Automobiles. It Typically Consists Of A Face Fabric With Nonwoven Or Foam Backing. Headliners Consist Of Multilayered Composite Materials That Bring Together Multiple Functionalities Including The Requested Look, Feel, Stiffness And Heat Reduction Needed In Cars. A Headliner's Primary Purpose Is To Cover The Interior Roofing Of Your Vehicle So That It Matches The Appearance Of The Rest Of The Cabin. The Headliner Is Also Responsible For Shielding The Passengers Inside The Cabin From The Intense Heat Conducted By The Roof Of The Car. In This Work, Thermally Bonded Polyester Nonwoven Include Both Binder And Non-Binder Fibers Was Developed For Headliner Applications. The Nonwoven Layers Are Provided With Different Percentages Of Binder Fibers. One Layer Is Provided With 10% To 25% Of Binder Fibers, With The Remainder Being Non-Binder Fibers. This Layer Is Less Rigid, And Provides Loft And Thermal Insulation To The Headline

R Material. The Other Layer Is Provided With A Greater Percentage Of Binder Fibers, And Preferably 50% Binder Fibers. This Layer Provides Structure And Rigidity To The Headliner Material. The Main Aim Is To Study The Effect Of Binder Fibers And Contact Time On The Properties Of Recycled Polyester Thermal Bonded Nonwoven And To Study The Thermal Insulation Characteristics Of The Innovative Headliners.

Keywords: Binder Fiber, Headliners, Innovative, Non Binder Fiber, Polyester, Thermal Bonding

1. INTRODUCTION

Vehicle Headliners On The Interior Of An Automobile Are A Decorative Panel Which Separates The Passenger Compartment From The Sheet Metal Forming The Roof Of The Vehicle. The Vehicle Headliners Insulate Heat From Outside To Inside On The Passenger Compartment. Typically, A Headliner Is Formed Of Several Layers Of Different Materials. Fiberglass Is Utilized In Most Headliners To Provide Strength And Sound Absorption. However, Fiberglass Is Undesirable And Often Uncomfortable To Handle Glass Fibers And It Cause Handling Problems. These Headliners Are Typically Not Recyclable. It Would Be Desirable To Create A Headliner Material Which May Be Easily Recycled. Typically, Headliners Utilize Many Different Materials Formed Into Layers Which Are Bonded

Together. Scraps Are Cut Away From The Material To Leave The Final Headliner Shape. The Scrap Material Is Difficult To Recycle As It Includes Many Different Materials. It Would Be Desirable To Form A Headliner Generally Of A Single Type Of Material.

The Use Of Recycled Fibers In Garment Is Being Seen As One Of The Major Ways To Achieve Sustainability And Circular Economy In Textile Industry (1). The Main Benefits Of Using Recycled Polyester Is To Minimizing Environmental Impacts By Reducing Use Of Raw Materials And Producing Less Waste (2). Benjamin Piribauer Et Al., Mentioned That The End Of Life Textiles Often Consist Of Multi Material Fiber Compositions, These Make Recycling More Complicated Since The Different Types Of Fibers Would Need To Be Separated, Which Is Often Difficult Or Outright Impossible (3). Youneung Lee And Changwhan Joo Stated That The Use Of Recycled Polyester Nonwovens Has Many Advantages Compared To Conventional Sound Absorbers, Including Reduced Product Cost, Good Handling, And Environmental Protection (4). The Use Of Recycled Textile Materials In Nonwovens Provides Alternatives For The Production Of Ecologically Friendly Acoustic Products For The Automotive Industry And Recently Noise Absorbent Textile Materials, Especially Nonwoven Structures Or Recycled Materials, Have Been Widely Used Because Of The Low Production Costs And Their Being Aesthetically Appealing (5).

Sharma And Goel Mentioned That The Nonwoven Fabrics From Recycled Cotton Fiber And Recycled Polyester Fiber Blend Which Gives A New Approach Of Recycled Fiber Application (6). The Thermal Bonding Between The Fibers In The Recycled Polyester Nonwoven Fabrics Was Generated At A Lower Heat-Setting Temperature Than For Virgin Polyester Nonwoven Fabrics (7). The Automotive And Building Interiors Made Up Of Recycled Fibers Are In Potential Market Growth And The Recycled Fiber Nonwoven As Thermal Insulation And Acoustic Absorption Material Were Developed By Using The Fibers Recycled From The Waste Fabrics Of Cotton, Polyester, And Cotton/Polyester Blend Collected From The Garment Industries (8). Head Liners Requirements Are Light Weight, Thin Profile But Rigid Without Any Tendency To Buckle, Flex Or Vibrate, Dimensional Stability, Aesthetically Pleasing And Preferably With A Soft Touch (9). Headliner Consists Of Two Core Materials: The Substrate, Which Can Be Something As Basic As Cardboard, But It Is Normally Pu Or Another Polymer Impregnated With Glass Fibers For Strength And Stiffness, And The Facing Fabric (10). In This Work, An Attempt Has Been Made To Study The Influence Of Blend Composition And Contact Time In Thermal Bonding On The Physical And Mechanical Properties Of The Recycled Polyester Thermal Bonded Nonwovens For Headliner Applications.

2. MATERIALS AND METHODS

2.1 Materials

Headliner Material Is Formed Of Two Layers Formed From Two Types Of Polyester Fibers. The Polyester Layers Include Both Binder And Non-Binder Fibers. Binder Fibers Used Are Low Melt Polyester Fibers Was Shown In Figure 1 And Non Binder Fibers Used Are Recycled Polyester Fibers Was Shown In Figure 2. Both The Fiber Specification Was Given In Table 1.

Table 1 Raw Material And Their Specifications

Properties	Recycled Polyester Non Binder Fiber(Nbf)	Low Melt Polyester Binder Fiber(Bf)
Fineness (Denier)	15	4
Length (Mm)	64	51
Fiber Density(G/Cc)	1.38	1.37
Melting Point (ºc)	250	110

Figure 1. Low Melt Polyester Fiber

Figure 2. Recycled Polyester Fiber

2.2 Methodology

The Binder And Non Binder Fibers Were Opened And Mixed Together With Three Different Combinations 10:90, 25:75 And 50:50 Respectively. Opening And Mixing Of Fibers Were Carried Out By Hand. After Mixing, Fibers Are Then Subjected To Carding Process For The Formation Of Carded Web In Different Combinations Of Fibers. During The Carding, The Fiber Blend Was Further Opened And Individual Fibers Were Combed To Be Relatively Parallel. Carding Process Haven Been Carried Out By Roller Clearer Carding Machine. The Machine Run At The Feeding Speed Of 1.50 Mpm, The Cylinder Speed Of 485.8 Mpm And The Delivery Speed Of 5.47 Mpm. The Produced Carded Web Is Then Thermal Bonded To Form Nonwoven. Thermal Bonding Is A Process That Melts The Web Together At Fiber Crossover Points. Fiber Web Is Significantly Compacted After Thermal Bonding Process. Thermal Bonding Machine Runs At Three Different Speeds, Low Speed-15mpm, Medium Speed- 20 Mpm And High Speed-25 Mpm. Thermal Bonding Temperature Were Maintained About 120ºc Through The Bonding Process. Nonwoven Sample Have Been Prepared With Three Different Ratios And Three Different Thermal Bonding Machine Speeds Is Given Below In Table 2.

Table 2 Nonwoven Sample Preparation

Speed	Bf:Nbf (10:90)	Bf:Nbf (25:75)	Bf:Nbf (50:50)
Low Speed (Ll) 15 M/Min	B1ls	B2ls	B3ls
Medium Speed (Lm) 20 M/Min	B1ms	B2ms	B3ms
High Speed (Lh) 25 M/Min	B1hs	B2hs	B3hs

2.3 Testing And Analysis

A Specified Weight Of A Unit Area Shows The Gsm (Grams Per Square Meter). A Circular Cross Section Of Diameter 114 Mm Is Cut From Fabric And Then Weighs It In Grams. Pieces Were Cut At The Middle Fold Of Fabric And Pressed Slightly And Rounded. The Specimens Were Weighed And Recorded. Nonwoven Thermal Conductivity Was Measured Using Lee's Disc Method. In This Method Two Brass Discs And Two Thermometers T1 And T_2 Were Used. Sample Is Place In Between Two Discs And Thermometer Is Inserted Into The Holes Of The Disc And Then Steam Is Passed Through The Top Disc. When Steady State Temperature T1 ºc Is Reached, Heat Is Conducted Through The Sample And Imparted To The Lower Disc Which Raises The Temperature Gradually And Finally Attains The Steady State Temperature T_2ºc. Both The Temperature Is Noted And Sample Is Removed. Then Lower Disc Is Brought Into Direct Contact With Steam Chamber And Allowed To Raise The Temperature By 10 ºc And Top Disc Is Removed. Cooling Time For Every One Degree Is Noted And Thermal Conductivity Is Calculated.

Evaluation Of Tensile Strength For The Nonwovens Was Performed In Accordance With The Astm D5035-95 For Fabric Break Strength (Strip Method) And Tested Using An Instron Tester Model 4301. The Force Applied On The Specified Size Of A Fabric. When It Breaks, The Machine Automatically Shows The Force And Elongation. It Shows The Capacity Of Fabric Before Fabric Strip Breaks. Elongation Is Then Recorded In Percentage Change. With The Cutter, Strip From Longitudinal Direction And Strips From Transverse Direction From The Fabric Were Placed And Fixed Between Upper Jaw And Lower Jaw With The Gauge Length Of 150 Mm In Universal Tensile Tester. Evaluation Of Bending Length And Flexural Rigidity For The Nonwovens Was Performed In Accordance With The Astm D5732 Standard Test Method For Stiffness Of Nonwoven Fabrics Using The Cantilever Test. This Test Method Covers Stiffness Properties Of Nonwoven Fabrics By Employing The Principle Of Cantilever Bending Of The Fabric Under Its Own Weight. Bending Length Is Measured And Flexural Rigidity Calculated.

3. RESULT AND DISCUSSION

The Table 3 Shows The Physical, Mechanical And Thermal Properties Of Polyester Thermally Bonded Nonwovens.

3.1areal Density

The Figure 3 Shows The Effect Of Binder Fibers And Contact Time On Areal Density Of The Fabrics, It Is Clear From The Figure That With Increase In Binder Fiber Percentage The Areal Density Is Decreases. The Sample Produced With 15 Mpm Shows Higher Areal Density Compared To That Of Other Samples. It Is Mainly Due To More Contact Time And May Cause More Shrinkage Inside The Thermal Bonded Nonwoven Fabrics.

Table 3 Properties Of Polyester Thermally Bonded Nonwovens

Sample	**Gsm (G/M^2)**	**Thickness (Mm)**	**Tensile Strength (Kg/Sq.M)**		**Bending Length (Cm)**	**Thermal Conducivity (W/Mk)**
			Cross Direction	**Machine Direction**		
B1ls	480	2.12	24.92	2.28	39.85	0.0389
B1ms	457	2.10	20.30	2.30	36.00	0.0264

B1hs	430	2.20	19.00	2.04	29.85	0.0180
B2ls	413	1.51	57.50	7.00	40.65	0.0403
B2ms	410	1.49	27.75	3.92	38.30	0.0296
B2hs	390	1.98	4.35	0.35	32.45	0.0301
B3ls	466	2.04	60.97	16.50	42.35	0.0274
B3ms	451	2.01	85.31	16.80	42.50	0.0226
B3hs	427	2.18	32.20	5.23	40.05	0.0200

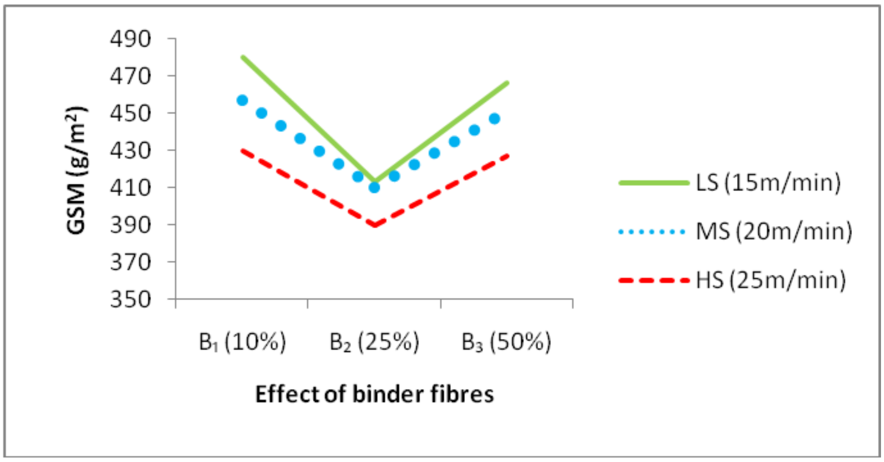

Fig 3 Effect Of Binder Fibers And Contact Time On Areal Density Of The Fabrics

3.2 Tensile Strength (Ts)

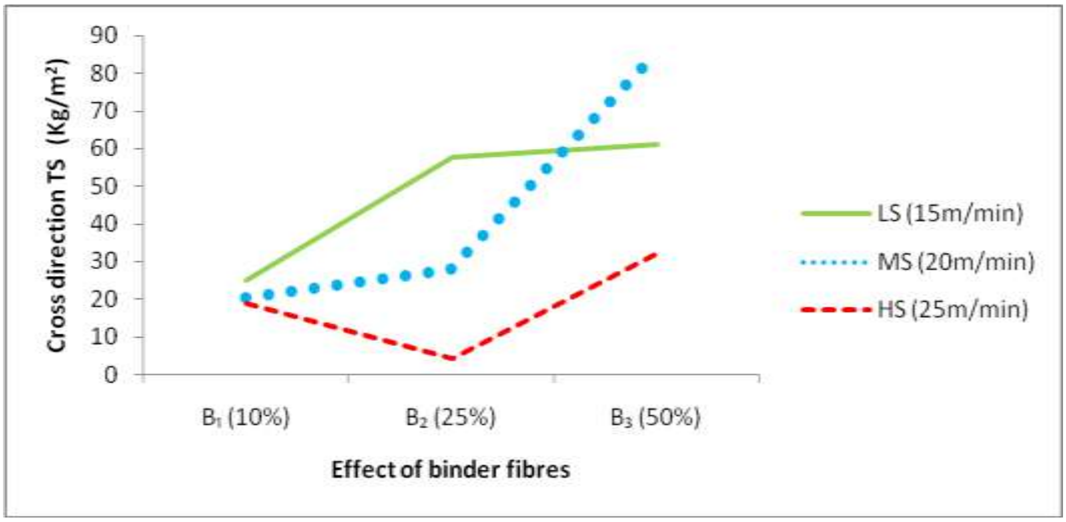

Fig 4 Effect Of Binder Fibers And Contact Time On Cross Direction Tensile Strength Of The Fabrics

The Figure 4 Shows The Cross Direction Tensile Strength Changes On Account Of Change In Binder Fibers Percentage And Contact Time Of The Samples. The Graph Shows That Increase In Binder Fiber Percentage Increase The Tensile Strength For Ls And Ms. Hs Tensile Strength Increase For B_1 And B_3 But Decreases For B_2. On The Other Hand Tensile

Strength Is Increased For B_1 And B_2 When Speed Of The Machine Is Decreased. For B_3 Tensile Strength Is Reduced For Ls Due To Excessive Binding Of Fibers And Fiber Sticking On Rollers During The Time Of Delivery. Tensile Strength Of Ms Is Higher Than That Of Ls And For Hs Tensile Strength Is Lower When Compared To Ls And Ms. High Tensile Strength Is Achieved For The Sample B_3Ms Which Is 85.31 Kg/M² Compared To Other Samples.

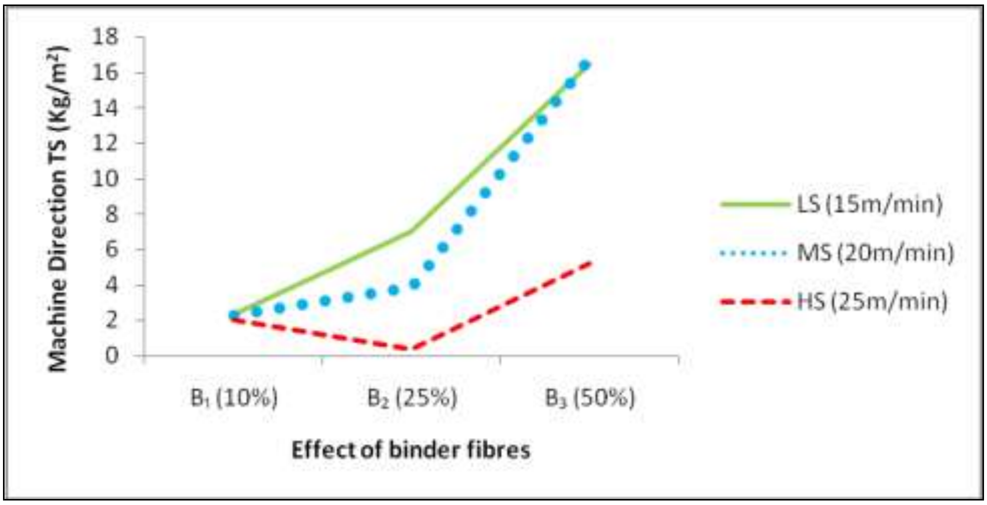

Fig 5 Effect Of Binder Fibers And Contact Time On Machine Direction Tensile Strength Of The Fabrics

The Figure 5 Has Been Plotted To Understand The Machine Direction Tensile Strength Changes On Account Of Change In Binder Fibers Percentage And Contact Time Of The Samples. The Graph Shows That Increase In Binder Fiber Percentage Increase The Tensile Strength For Ls And Ms. Hs Tensile Strength Increase For B_1 And B_3 But Decreases For B_2. On The Other Hand Tensile Strength Is Increased For B_1 And B_2 When Speed Of The Machine Is Decreased. For B_3 Tensile Strength Is Slightly Reduced For Ls Due To Excessive Binding Of Fibers And Fiber Sticking On Rollers During The Time Of Delivery. Tensile Strength Of Ls Is Slightly Lower Than Ms And Greater Than That Of Hs. High Tensile Strength Is Achieved For The Sample B_3Ms Which Is 16.80 Kg/M² Compared To Other Samples.

3.3 Bending Length

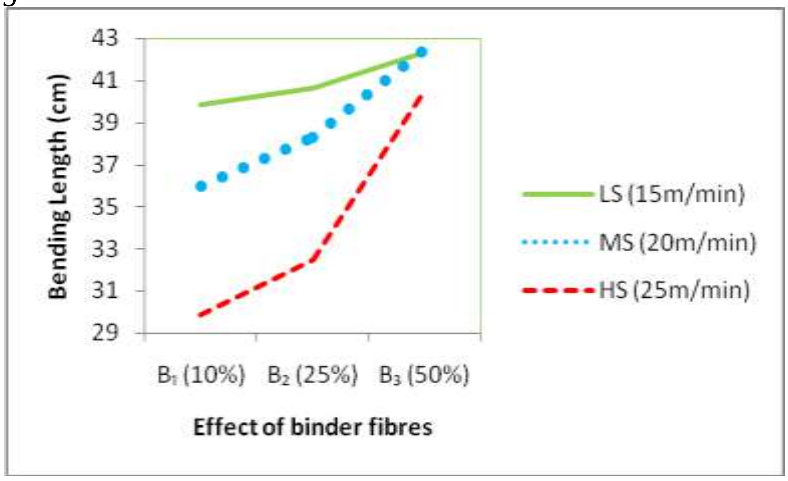

Fig 6 Effect Of Binder Fibers And Contact Time On Bending Length Of The Fabrics

From The Above Graph In Figure 6 Has Been Plotted To Understand The Bending Length Changes On Account Of Change In Binder Fibers Percentage And Contact Time Of The Samples. The Graph Shows That Increase In Binder Fiber Percentage Increase The Bending Length Of The Sample For The Three Different Speed Ls, Ms And Hs. On The Contrary Increase In Contact Time Decrease The Bending Length Of The Sample For B_1 And B_2. For The B_3, Bending Length Is Slightly Lower For Ls Compared To Ms Due The Sticking Of Fiber On Roller Because Of The Excessive Binder Fiber Percentage And For Ms Bending Length Is High Due To The Increase In The Speed Of The Machine And For Hs Bending Length Is Deceased When Compared To Ms. Therefore The Maximum Bending Length Is Achieved At B_3Ms Which Is 42.50 Cm And This Sample Has Higher Stiffness When Compared To Other Samples.

3.4 Thermal Conductivity

Figure 7 Shows The Thermal Conductivity Changes On Account Of Change In Binder Fibers Percentage And Contact Time Of The Samples. For The Three Binder Percentage B_1, B_2 And B_3 The Increase In Speed Of The Machine Ls, Ms And Hs Decreases The Conductivity Value Of The Sample. Therefore Hs Have The Lower Thermal Conductivity Values When Compared To Ls And Ms. Then Increase In The Binder Percentage Increases The Thermal Conductivity Value For B_2 Due To The Lower Thickness Of B_2Ls, B_2Ms And B_2Hs Samples And Thermal Conductivity Decreases For B_3 Because Of The Higher Thickness When Compared To B_2 Samples. For B_1 Samples With Higher Thickness Have Lower Thermal Conductivity Values. Therefore B_1Hs Sample Have Lower Value Which Is 0.0180w/Mk When Compared To Other Samples.

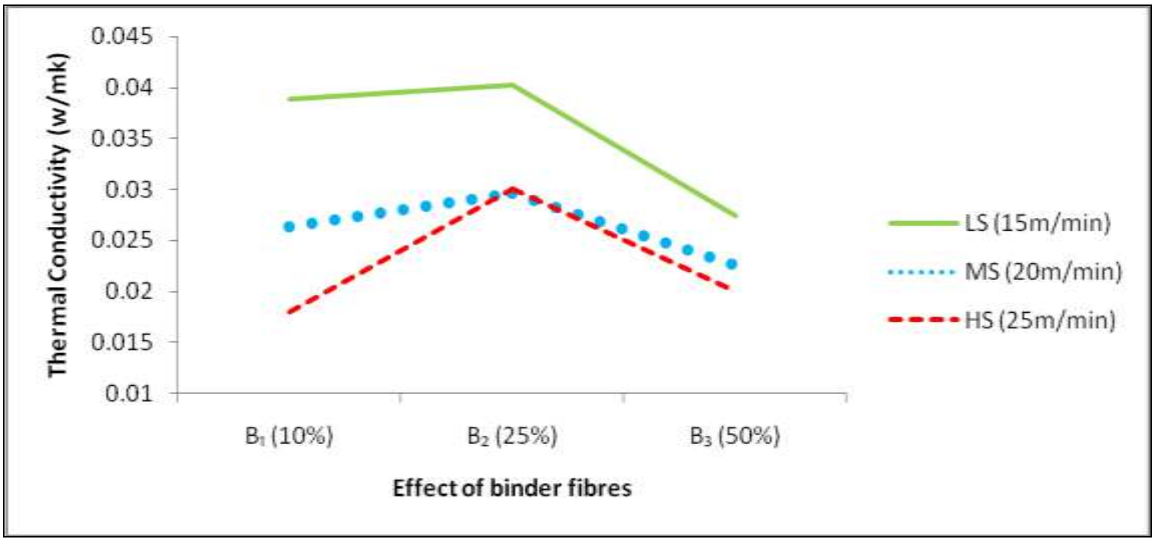

Fig 7 Effect Of Binder Fibers And Contact Time On Thermal Conductivity Of The Fabrics

4. CONCLUSION

Nonwoven Samples Which Is Made Up Of Different Binder Percentage And Different Contact Time Were Fabricated In Thermal Bonding Machine With Recycled Polyester Fiber And Low Melt Polyester Fiber For Headliner Applications And It Is Tested In Terms Of

Physical, Mechanical And Thermal Properties. The Study Revealed That Increase In Binder Fiber Percentage Increase The Both Cross And Machine Direction Tensile Strength For Ls And Ms. Tensile Strength Of Ms Is Higher Than That Of Ls And For Hs Tensile Strength Is Lower When Compared To Ls And Ms. High Cross And Machine Direction Tensile Strength Is Achieved For The Sample B_3Ms Which Is 85.31 Kg/M² And 16.80 Kg/M² Respectively. Then The Maximum Bending Length Is Achieved At B_3Ms Which Is 42.50 Cm And This Sample Has Higher Stiffness.

In Case Of Thermal Conductivity Of The Three Binder Percentage B_1, B_2 And B_3 The Increase In Speed Of The Machine Ls, Ms And Hs Decreases The Conductivity Value Of The Sample. Therefore Hs Have The Lower Thermal Conductivity Values When Compared To Ls And Ms. Then Increase In The Binder Percentage Increases The Thermal Conductivity Value For B_2 Due To The Lower Thickness Of B_2Ls, B_2Ms And B_2Hs Samples And Thermal Conductivity Decreases For B_3 Because Of The Higher Thickness When Compared To B_2 Samples. For B_1 Samples With Higher Thickness Have Lower Thermal Conductivity Values. Therefore B_1Hs Sample Have Lower Value Which Is 0.0180w/Mk When Compared To Other Samples.

The Combination Of Blend Percentage B_3 Which Is 50% Binder And 50% Non Binder Fiber At Medium Speed 20m/Min Have Good Cross And Machine Direction Tensile Strength And Good Stiffness Characteristics. As For Thermal Conductivity B_1Hs Sample Have Lower Thermal Conductivity Due To Good Loft Characteristics And For The Sample B_3Ms Have Moderate Thermal Conductivity Which Is 0.0226w/Mk. Therefore It Can Be Concluded That The B_3Ms Sample Have Overall Good Physical And Thermal Properties When Compared To Other Samples. From This Research Study, B_3Ms Nonwoven And B_1Hs Non-Woven Can Be Combined To Increases The Tensile Strength And Stiffness Characteristics For Headliner Applications And To Have Good Thermal Characteristics.

5. REFERENCES

[1] Abhijit Majumdar, Sandeep Shukla, Anshu Anjali Singh And Sanchi Arora, “Circular Fashion: Properties Of Fabrics Made From Mechanically Recycled Poly-Ethylene Terephthalate (Pet) Bottles”, *Resources, Conservation & Recycling*, 161 (2020).

[2] Tamer Fk And Mohamed Ed, “Recycling Of Textiles”, *J Textile Sci Eng*, 2014.

[3] Benjamin Piribauer And Andreas Bartl, “Textile Recycling Processes, State Of The Art And Current Developments: A Mini Review”,*Waste Management & Research* ,2019.

[4] Youneung Lee And Changwhan Joo, **“**Sound Absorption Properties Of Recycled Polyester Fibrous Assembly Absorbers”, *Autex Research Journal*, Vol. 3, No2, June 2003.

[5] Nazan Avcioğlu Kalebek,“Sound Absorbing Polyester Recycled Nonwovens For The Automotive Industry”, *Fibres & Textiles In Eastern Europe*, Vol. 24, 1(115): 107-113, *2016*.

[6] Sharma R And Goel, “A Development Of Nonwoven Fabric From Recycled Fibers”, *Journal Of Textile Science & Engineering*, Vol 7, Issue 2, Pp.289, 2017.

[7] Yeon Joo Choi, Icksoo Kim And Seong Hun Kim, “Effect Of Heat-Setting On The Physical Properties Of Chemically Recycled Polyester Nonwoven Fabrics”,*Textile Research Journal*, Vol 89 Issue 4, February 2019.

[8] S. Sakthivel, Bahiru Melese, Ashenafi Edae, Fasika Abedom , Seblework Mekonnen And Eshetu Solomon, “Garment Waste Recycled Cotton/Polyester Thermal And

Acoustic Properties Of Air-Laid Nonwovens", Advances In Materials Science And Engineering, 2020.

[9] Walter Fung And Mike Hardcastle ,"Textiles In Automotive Engineering", Woodhead Publishing Limited, 2001.

[10] 10. Senthilkumar R, "Textiles For Industrial Applications", Crc Press, 2014.