S.Sakthivel,T.Ramachandran/ International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 3, May-Jun 2012, pp.2983-2987

THERMAL CONDUCTIVITY OF NON-WOVEN MATERIALS USING RECLAIMED FIBRES

Mr.S.Sakthivel*,
Asst. Professor,(Department of Fashion Technology, Angel College of Engineering & Technology, Tirupur, Tamilnadu,India.

Dr.T.Ramachandran**
** Principal Karpagam Institute of Technology, Coimbatore, Tamilnadu, India.

ABSTRACT:

There is good potential for use of Reclaimed fibers such as cotton, Polyester in moldable nonwoven materials for automotive applications. Variety of automotive parts, such as headliner, wall panels, trunk liners, parcel shelves, and hood sound insulators with excellent shape stability can be manufactured by conventional techniques. These fibers are coupled with economic and environmental benefits. The thermal insulation properties of the nonwoven materials were determined, in accordance with ASTM, using the new thermal conductivity tester. The experimental data show that thermal insulation properties of the nonwoven materials vary significantly, depending on the type of Reclaimed fibre.. This research work starts with opening and segregating the reclaimed fibers. Later the fibers get transformed to a non-woven, by passing it through a sequence of operations, which encompass the mechanical web laying technique, the aerodynamic principle and chemical bonding. The focus of this research is to produce compostable used fibre based non-woven. These non-woven disposed off after their intended use in an eco-friendly way. Implementing this innovative method reduces the production cost of automobile interior products.

Keywords: Automotive textiles, chemical bonding, Non-woven, Thermal insulation, web formation.

1.INTRODUCTION

At the current scenario consumers are increasingly inclined to use organic textile products manufactured with ease to protect the environment. The object of the present research work is to use the waste obtained from the industries effectively. The usage of recycled fibers has the advantages of: (a) consuming less resource usage, (b) consuming less energy, (c) recycling textile garments or fabrics which would otherwise become waste, (d) providing economic benefits which is on a downfall in developing countries due to excessive mass production of cotton, and above all the production costs of these types of fibers are lower than when using conventional fibers.

Recycling the solid waste may be defined as the recycling of material and its reuse which could include repair, re-manufacture and conversion of materials, parts and products. Traditionally solid waste management has evolved as mainly the removal of municipal wastes by hauling them out of the city boundaries and dumping them 'there'. This is in conformity with the 'out of sight out of mind' philosophy. However, recycling is currently accepted as a sustainable approach to solid waste management. Recycling of material from solid wastes helps the community economically, environmentally, socially and ecologically, as described.

1.1WASTE AND ITS TYPES

There are two types of wastes polluted generally by the textile industries and the human resources in our environment. The wastage from the textile industries is termed as 'Pre-consumer waste' and from the human resources is termed as 'Post-consumer waste'. In our research work, we took post-consumer waste as raw material for the development of our product. The post-consumer waste is also called as 'Used Textile Clothing'.

The reason behind this choice is that used fabrics for the home textiles is to reduce the manufacturing cost and also to create an awareness on waste management to the society to keep the environment clean. Now-a-days, awareness of the recycling process and their contribution to the environment is increasing. Researchers are focusing on this area to give an alternate solution for the usage of virgin resources and to produce the eco-friendly product.

2. METHODOLOGY

2.1. COLLECTION OF WASTE

The cutting wastes are collected from the various garment industry. The wastes are collected in the form of fresh waste.

2.2. RAW MATERIAL PREPARATION

Before knitted could be manufactured, the raw clothing materials had to be converted into yarn by open end spinning method and it is widely accepted preparatory method. This involves passing cut fabric pieces through two nipped feed rollers that grip the textile while a rapidly rotating cylinder covered in sharp metallic pins mechanically opens the fabric into smaller fractions. The product of mechanical pulling typically consists of a mixture of individual fibers, yarn segments and smaller fabric pieces. Further separation stages are employed to increase the reduction of the segments and pieces into fiber form. The fiber is then collected on a vacuum assisted drum and fed out of the machine. The structure of the textile being re-fiberized influences the dimensions, degree of separation and homogeneity of the fibrous product. Dense woven textiles tend to produce very short fiber lengths, which are unsuitable for use in traditional yarn processing. More loosely formed structures, such as weft knitted textiles, tend to have lower density structures which yield longer fiber lengths when reprocessed.

2.3. FIBER PARTICULARS

2.5% Span Length	50% Span Length	Uniformity Ratio%	Micronaire Value	LINT%	Invisible Loss%	Yarn Waste%
20.65 mm	7.70 mm	37.29	4.06	84.05	0.73	15.22

Table 1. Recycled Fiber Test.

2.4. WEB FORMATION

Once the textile has been reconverted into fibrous form, the fibers must be assembled into a uniform web structure in order that a bonding process can be applied to stabilize the tenuous network. The most common form of dry laid web formation is carding, but heavier weight webs containing waste fibers are also commonly formed into webs using Garnett machines. The mechanically recovered fibers were processed on the NIRI nonwoven carding system and good compatibility was observed in terms of web weight uniformity and the degree of fiber separation. Immediately after carding, the webs were parallel lapped, which involves laying the webs over one another in the machine direction to improve final web uniformity further without changing the predominant fiber orientation. The resulting web is anisotropic in nature, in that fibers are preferentially aligned in the longitudinal direction.

2.5. CHEMICAL BONDING PROCESS

Chemical or resin bonding is a generic term for interlocking fibers by the application of a chemical binder. The chemical binder most frequently used to consolidate fiber webs today is water-borne latex. Most latex binders are made from vinyl materials, such as polyvinyl acetate, polyvinylchloride, styrene/butadiene resin, butadiene, and polyacrylic, or their combinations.

Latexes are extensively used as non-woven binders, because they are economical, versatile, easily applied, and effective adhesives. The versatility of a chemical binder system can be indicated by enumerating a few factors that are considered when such a system is formulated.

The chemical composition of the monomer or backbone material determines stiffness/softness properties, strength, water affinity (hydrophilic/hydrophobic balance), elasticity, durability, and aging. The type and nature of functional side groups determines solvent resistance, adhesive characteristics, and cross-linking nature. The type and quantity of surfactant used influences the polymerization process, polymer stability, and the application method.

Chemical binders are applied to webs in amounts ranging from about 5% to as much as 60% by weight. In some instances, when clays or other weighty additives are included, add-on levels can approach or even exceed the weight of the web. Waterborne binders are applied by spray, saturation, print, and foam methods. A general objective of each method is to apply the binder material in a manner sufficient to interlock the fibers and provide fabric properties required of the intended fabric usage.

2.6. SPRAY BONDING

In spray bonding, binders are sprayed onto moving webs. Spray bonding is used for fabric applications which require the maintenance of high loft or bulk, such as fiberfill and air-laid pulp wipes. The binder is atomized by air pressure, hydraulic pressure, or centrifugal force and is applied to the upper surfaces of the web in fine droplet form through a system of nozzles.

Lower-web-surface binder addition is accomplished by reversing web direction on a second conveyor and passing the web under a second spray station. After each spraying, the web is passed through a heating zone to remove water, and the binder is cured (set/cross-linked) in a third heating zone (Refer illustration). For uniform binder distribution, spray nozzles are carefully engineered.

3. RESULT AND DISCUSSION

After evaluation of various techniques for measurement of thermal insulation properties of poorly conductive materials, such as Chemical bonding and spray bonding nonwoven fabrics, we selected chemical such as PVA and PVC, which is comparable to ASTM C518 Standard Test Method (ASTM 2005). Measurements of specific thermal conductivity of cellulosic-based nonwoven fabrics were performed using a newly developed thermal conductivity meter.

The thickness of the nonwoven samples was measured in accordance with standard ASTM D 5736-95. Before conducting measurements, all samples of non-woven materials were conditioned at standard textile conditions (27±2oC, 65 % ± 2 % RH) for 24 hours. The average of three measurements for each sample was used to calculate mean values of specific thermal conductivity for each nonwoven specimen. The overall accuracy of the measurements of thermal conductivity of nonwoven samples was found to be better then 2%, repeatability – 0.5% and reproducibility – 0.8%.

The experimental data on thermal conductivity (λ) for the chemical or spray bonding nonwovens (**automotive Textiles**) Because all tested samples had slightly different density and/or different cotton/polyester blending ratio, it was important to compare the thermal properties of these samples in a way that eliminates these effects. This was accomplished by normalizing the measured value of specific thermal conductivity of the sample (λ) by density coefficient (**ρ**). Normalized thermal conductivity (λ/**ρ**) provides a better means for comparison of thermal properties of non-woven materials by excluding variations in density caused by manufacturing and/or finishing processes. It also provides a better evaluation tool for these types of materials in light of their possible automotive application as thermal/sound insulators because more lightweight nonwovens would warrant better fuel efficiency.

List of samples of nonwovens

	Sample	**ρ Density (kg/m3)**	**λ (W/mK□)**	**λ /ρ**
Chemical Bonding	1	0.194	0.0416	0.2144
	2	0.247	0.0397	0.1607
	3	0.254	0.0427	0.1681
	4	0.239	0.0436	0.1824
	5	0.233	0.0478	0.2051
	6	0.252	0.0456	0.1809
	7	0.267	0.0435	0.1629
	8	0.231	0.0387	0.1675
Spray bonding	9	0.244	0.0467	0.1913
	Cotton/polyester 75/25	0.211	0.0423	0.2004

Table-2 Non-woven Sample Analysis

Samples of nonwoven

SAMPLE	SAMPLE DESCRIPTION
CB 9-1	Chemical Bonding:2 hours cotton/polyester +PVA
SB 9-1	Spray bonding:1 hour cotton/Polyester +PVA/PVC

Table-3 Sample description

3.1 Nonwoven Material

Nine nonwovens of chemical and spray bonded samples (automotive Textiles;) were produced in our Textile Processing Laboratory. The cotton fiber was cleaned by cotton cleaner and mixed with the polyester fiber in a ratio of

75% cotton and 25% Polyester. The Cotton/Polyester blend was fed into the process of Chemical Bonding to obtain uniform fiber web. The web was further bonded with 10% PVA solution that was prepared from granulated PVA powder and applied to the nonwoven by a padding machine. The padded nonwoven was then dried in an oven

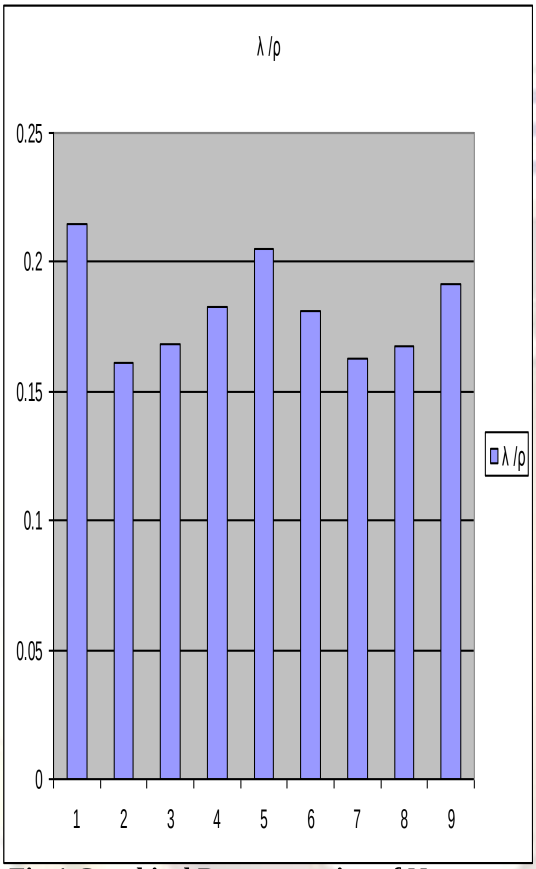

Fig-1 Graphical Representation of Non-woven Material Density (kg/m^3)

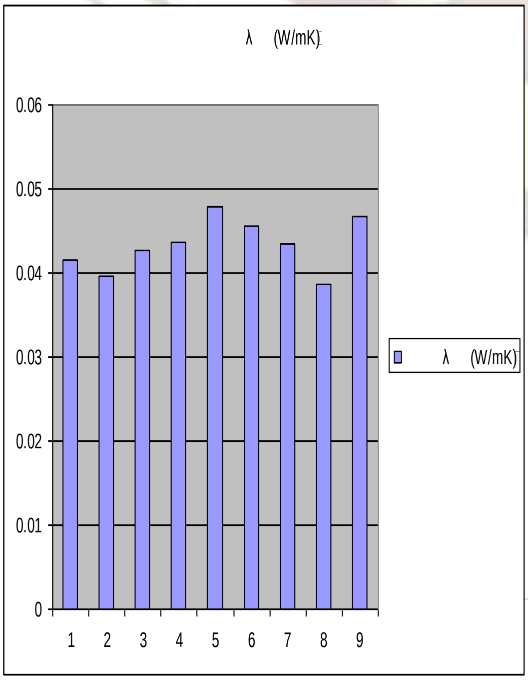

Fig-2 Graphical Representation of Non- woven Material Weight (W/mK).

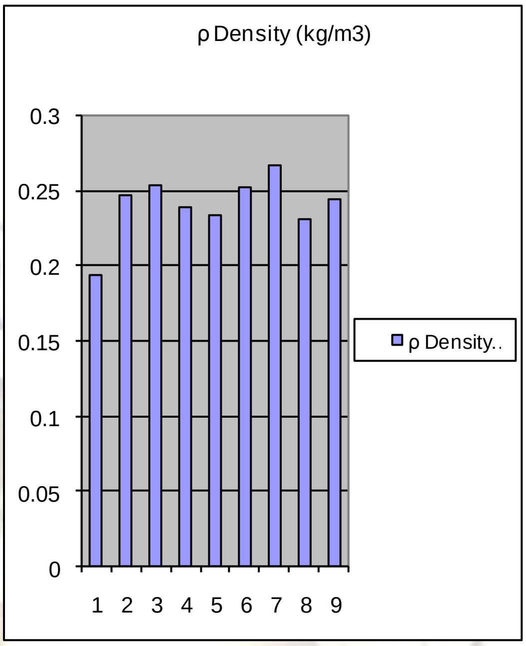

Fig-3 Graphical representation of Average of Density and weight of Non woven Material

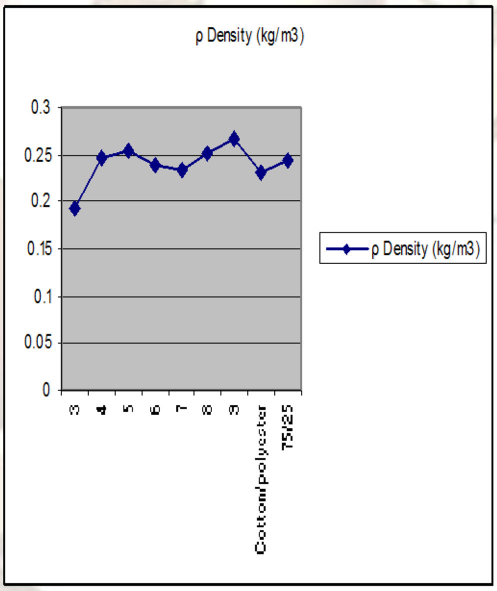

Fig-4 Specific Thermal Conductivities of non-woven Material vs their Density.

4.CONCLUSION

The Reclaimed fibre based non-woven materials, suitable for automotive application, was fabricated from, cotton/Polyester recycled substandard (PVA). The data indicate that Chemical Bonded and Spray Bonded nonwoven Materials would be good thermal insulators than the other nonwovens. Thermal conductivity of Reclaimed fibre-based nonwoven Materials varies significantly, depending on the type of Reclaimed fibers, the ratio of Cotton and Polyester to Reclaimed fibers, and the resulting bulk density of the materials. Data also show that addition of Reclaimed fibers significantly improved thermal insulation properties of Chemical Bonding and Spray Bonding techniques.

5. REFERENCES

1. Gailutė Kazakevičiūtė, Rima Ramanauskienė and Aušra Abraitienė, May 2008, "A Survey of Textile Waste Generated in Lithuanian Textile, Apparel and Soft Furnit Industries", *Indian Journal of Fiber & Textiles, No. 2(44), P.No. 41-48.*

2. Youjiang Wang, February 2010, "Fiber And Textile Waste Utilization", *Indian Journal of Fiber & Textiles, Vol- 1:135–143.*

3. Morley, N.J., Bartlett, C. and McGill I. (2009) "Maximizing Reuse and Recycling of UK Clothing and Textiles": *A report to the Department for Environment, Food and Rural Affairs. OakdeneHollins Ltd.*

4. Brown T. (2001) Infinity Nylon – A Never-ending Cycle of Renewal, *Presentation at 6th Annual Conference on Recycling of Polymer, Textile and Carpet Waste, Dalton, GA, April 30–May 1.*

5. Eisele D. (1996) Reclaimed fibers. Characteristics. Background, *Melliand Textilberichte, 77, 4, 199–202.*

6. Magel, M. and Bieber, B. (1993) "First research results to define a number of selected textile-physical parameters of reclaimed fibres," *Kolloquium Reissfaser* '93, Sachsisches *Textilforschungs institut e.V. Chemnitz.*

7. Fischer, H., Rettig, D. and Harig, H. (1999) "Image processing to measure the length distribution of reclaimed fibres," *Melliand Textilberichte,* 80, 358-360.

8. Bohnhoff, A. and Petershans, J. (2001) "Sorting carpets non-centrally," *28th Aachen Textile Conference,* Aachen, D 28-29 November, DWI Reports, 125 (2002), 242-252.

9. Gulich, B. (2003) Anlagen zum Recycling von Textilabfallen, *IFB - International Fabrics Bulletin,* 4, 53-55.

10. Erth, H. (2003) "Manufacturing and processing of non-wovens on warp-knitting and stitch-bonding machines," *Part 1 VNI - Vliesstoff Non-woven International* Nr. 158, 880- 881, *Part 2 VNI - Vliesstoff Non-woven International* Nr. 160, 928.

11. Erth, H. and Schmidt, G. (2004) "Einsatz von Schmelzklebefasern und Schmelzklebern bei der Herstellung und Kaschierung von Wirkvliesstoffen," *2nd EMS-GRILTECH Technisch Schmelzklebertagung,* 3-5 June, Films/Schweiz.

12. Eisele, D. (1992) "Recyclate aus Reissbaumwolle und Phenoplast - ein bewares System," *Melliand Textilberichte,* 73, 11, 873-878.

Acknowledgement

I would like to thank Dr. N. Gunasekaran, Principal, Angel college of Engineering & Technology, Tirupur and Dr. B.S. Dasaradan, Professor & Dean, Dept. of fashion Technology, Angel college of Engineering & Technology, Tirupur for their advice and help provided during the experimental work.