IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

EFFICIENCY OF NONWOVEN BOARDS MADE OF TAILOR DISCARDS FOR THERMAL AND SOUND INSULATION

MINAKSHI HAZARIKA[1] and DR.G.BAGYALAKSHMI[2]

[1] PG Student, [2] Professor , Department of Textiles and Clothing

Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore

ABSTRACT

Recycling and reusing of waste materials to a new items is increasing and demanding in today's world tremendously. It is an important perspective of earth. In today's times it is an important means of income generation and also to increase environment sustainability. Recently new insulating materials made out of reused and discards are getting more common in today's market. Products that are produced from discard waste materials or components represent an excellent alternative from an environmental point of view, allowing the reduction of the quantity of waste to be treated. Therefore, this study focuses on collecting tailor discards for nonwoven board preparation. The result of the study proves the use of tailor discards for production of needle punched nonwoven thermal and sound insulation boards.

Keywords: - Tailor discards, needle punching, thermal insulation, sound absorption, nonwoven boards.

1. INTRODUCTION

Textile reutilizing is the methodology or strategy of reusing or reprocessing utilized clothing, fibrous material and clothing pieces from the manufacturing process. Textiles in municipal solid waste are discovered especially in discarded apparel, despite the fact that other resources include furniture, carpets, tires, footwear and non-durable items including sheets and towels. Recycling of non-hazardous solid textile waste is a viable alternative. While recycling is not new to the textile industry, it is now a necessity brought on by increased fees at landfills and decreased availability of landfill space. [1].

Recycled textile waste can be utilized as raw material for insulation structures. Theoretically, 97% of textile discards can be reused. Recycling textile waste has an ecological benefit as well as the economical making it progressively famous in the past decades. [2]

Recently new insulating solutions with recycled and discarded materials are becoming more common on the market. The significance of these solutions is also due to their thermal and acoustic properties: specifically materials with high porosity are very interesting because of the fact that they can absorb the sound that enters their matrix and can be dissipated. [3]

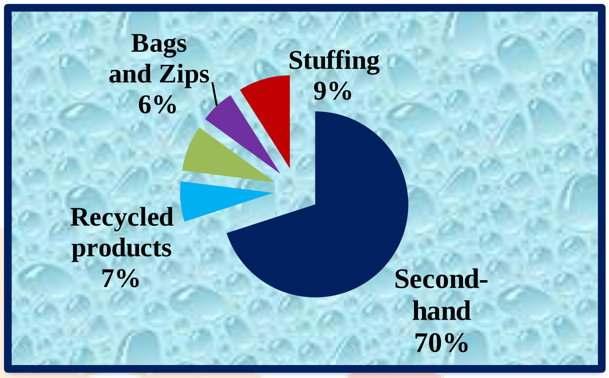


Figure 1.Percentage Usage of Discarded Textiles

Considering the above mentioned facts the study focuses on the reutilization of wool based textile discards to produce nonwoven insulating boards. Therefore, the objectives of the present research are as per the following:-

- To select and collect tailor discards
- To conduct preliminary study for optimizing the parameters for blending
- To prepare suitable thermal and sound insulation boards
- To evaluate the physical and mechanical properties of prepared nonwoven boards.

2. EXPERIMENTAL PROCEDURE:-

2.1 SELECTION OF RAW MATERIALS:-

Based on the literature study, a thorough understanding about the up cycling of waste was understood. More than 5.8 million tones of textile waste were generated every year where only 1.5 million tones of such textiles waste were recycled by industrial and tailoring enterprises.[4]

This has led to the investigator to select one such waste which could be explored for present study. Therefore, tailor discards were considered for the study.

2.2 COLLECTION OF RAW MATERIALS:-

Tailor discards collected from **Free-look Creation, Gandhipuram, Coimbatore** and the discards were composed of wool**.** This unit produces a volume of more than 1 million tons of waste per year and is a specialized men's wear tailoring unit stitches Men's Coat and Suits utilizing wool based material. The firm disposes tailor discards as waste material in corporation bins and in huge volumes would be a cause for landfill.

2.3 BLENDING

In this process, three sources such as Wool waste, Kapok and PET were used for blending to prepare three different types of nonwoven boards such as PET+ Kapok, PET+ Kapok +Wool and Wool+ PET respectively and with blending ratios of **25:50:25,15:60:25,5:70:25% to** form boards.

2.4 CARDING

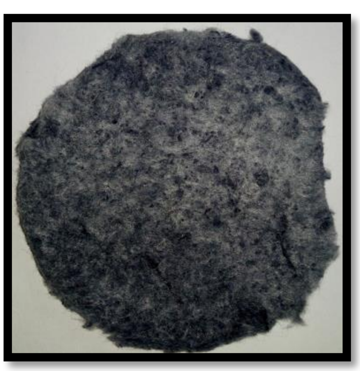
The size of the working/web width is 500mm.By means of easy adjustments it is possible to analyze both short and long fibers. Tailor discards separated into individual fibers was subjected to carding process in **TRYTEX carding machine**. Carding machine helped in fixing and parallelization of the fibers into web or lap. Likewise kapok and polyester fibers were also made into individual laps. These laps were used in layers to make a quality nonwoven boards**.**

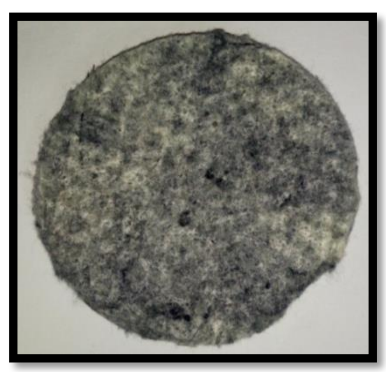
2.5 PRE NEEDLING PUNCHING LOOM

The prepared layers were then fed through a progression of needle punched machine individually. For three different ratios three boards were prepared finally in a pre-needling punching loom.

2.6 NEEDLE PUNCHING

Five layered needle punched nonwoven boards A, B and C were fed into the machine individually and the layers of web were entangled by needle punching using barbed needles in the needle loom .The resultant A, B and C nonwoven boards were found to be thick and solid.





2.7 EVALUATION

The physical properties of all the developed nonwoven boards were tested according to the ASTM standard. This test were carried out to evaluate its properties like fabric weight (GSM g/m2), stiffness test (cm), fabric thickness (mm),FESEM,FTIR, thermal conductivity, sound absorption coefficient measurement test of the prepared nonwoven boards as per their applicability.

2.7.1 WEIGHT (ASTM D3776-96)

Weight is a significant component for comparing the two similar fabrics construction. To calculate the weight of the sample GSM cutter was used to cut and then weighed. In this method the test specimen was placed on the rubber pad without wrinkles and then keeping the GSM cutter on top of the specimen the knob of the cutter was rotated. Blades are there on the cutter which leads the fabric to cut it in a round shape. Then removed the GSM cutter and collected the circular specimen of 100cm^2 and then three needle punched nonwoven boards namely A, B and C respectively were being weighed and readings were recorded.

2.7.2 THICKNESS (JIS B0251-0252)

The screw gauge is an instrument used for measuring accurately the thickness of the nonwoven samples**.** It comprises of a U-shaped frame fitted with a screwed shaft which is joined to a thimble. It is mostly utilized for measuring the diameter of circular objects mostly wires with an accuracy of 0.001 cm. It consists of a screw, a stud and two scales-main scale and circular scale. The linear distance moved by the screw in one complete rotation is called its **pitch (ρ).**

It is equivalent to the distance between two consecutive divisions on the main scale. The circular scale is divided into N equivalent divisions. The linear distance moved by the screw when circular scale is rotated by one division is called **Least Count (LC).**Following the procedure, thickness of the three needle punched nonwoven boards A, B and C were noted and recorded.

2.7.3 STIFFNESS

The stiffness of the samples was determined in **MAG Sim Stiff Tester.** The specimen from original samples of six inch was cut using template provided with the tester.

Each rectangular strip was mounted over a horizontal platform and pushed along with the template to overhang until the edges of the fabric coincide with the index line. The readings were taken from each specimen with each side up, first at one end then the other which was done on both machine and cross directions. As per the procedure, the stiffness of three needle punched nonwoven boards A, B and C were noted and recorded.

2.7.4 FIELD EMISSION SCANNING ELECTRON MICROSCOPY (FESEM)

FESEM gives geographical and basic information at amplification of 10x to 300,000x, with depth of field. It provides significant and more clear, less electro measurably distorted pictures with spatial resolution down to 1½ nanometers-three to multiple times better. FESEM has the ability to examine smaller-area contamination spots at electron accelerating voltages compatible with Energy Dispersive Spectroscopy (EDS). Thus, the entire three needle punched nonwoven boards A, Band C were analyzed for FESEM.

2.7.5 FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

Fourier Transform Infrared Spectroscopy, also known as FTIR Analysis or FTIR Spectroscopy is an analytical technique used to distinguish organic, polymeric and in some cases inorganic materials. The FTIR analysis uses infrared light to scan test samples and observe chemical properties. The samples for FTIR test were prepared and the FTIR instrument send infrared radiations of about 10,000 to 100 cm-1 through a nonwoven samples namely A,B and C individually with some radiation absorbed and some passed through it.

The absorbed radiation is converted into rotational and or vibrational energy by the samples molecules. The subsequent signals at the indicator present as a range, ordinally from 4000 cm^{-1} to 400 cm^{-1}, representing to a nuclear finger print of the sample. Each particles or compound structure will make an exceptional spectral fingerprint, making FTIR analysis an extraordinary tool for chemical identification. Thus, all the needle punched nonwoven boards A, B and C was analyzed for FTIR.

2.7.6 SOUND ABSORPTION COEFFICIENT MEASUREMENTS

Sound absorption properties of the samples were investigated by means of two-microphone impedance tube by using the transfer function method, according to **ISO 10534-2 standard**. The normal incidence sound absorption coefficient indicates the part of the acoustical energy of the incident wave that was absorbed by the tested sample in a specific configuration; the part which is not absorbed is reflected back to the source side. For absorption coefficient measurements by means of impedance tube it is important to consider the environmental setting of air temperature, relative humidity and atmospheric pressure inside the room towards the starting of the procedure and the sample’s addition and fixing by means of plasticine. The sound pressures are measured at the same time in two microphone positions and the transfer function H12 between them was calculated. As per the procedure, the sound absorption coefficient measurements of all the three needle punched nonwoven boards A, B and C were recorded**.**

2.7.7 THERMAL CONDUCTIVITY (ASTM D1518)

Thermal conductivity was measured using **Flat Plate Thermal Conductivity Tester** according to **ASTM D-1518.** To test in Flat Plate Thermal Conductivity tester, the samples A, B & C were cut into 300 x 300mm individually. During the test, the samples were placed on the test plate individually, and the external room temperature was maintained in unit time. From this, the moisture retention rate, heat transfer coefficient and thermal resistance of the nonwoven boards were calculated. Then before inserting the samples into the conductivity chamber it was kept for pre-conditioning about 30 minutes in Humidity and Temperature Control Cabinet. After pre-conditioning the samples, it was inserted inside the chamber at a temperature ranges from

35°C for about 60 minutes to perform three cycles of heating so as to get the average results of thermal resistance and heat transfer coefficient.

Based on the following procedures, three needle punched nonwoven boards A, B and C were evaluated to find the thermal insulation of the boards.

3. RESULT AND DISCUSSION:-

3.1 Analysis of the Physical Properties of Blended Nonwoven Fabrics:

The needle punched sample compositions and their physical properties are shown in **Table I.**

Table I.

Parameters of Needle Punching and Thermal Bonding:-

Samples	Weight Mean (GSM)	Thickness Mean (mm)	Stiffness Mean (cm)
A	**1873.6**	**5.85**	**7.49**
B	**1178**	**5.52**	**5.64**
C	**1190.5**	**4.53**	**4.72**

3.2 FESEM

The longitudinal views of the nonwoven boards A, B and C were determined by **Field Emission Scanning Electron Microscope (FESEM).**SEM images of the sample A, and sample B showed the presence of very tiny scales in case of sample C. These scales were effective in creating additional obstruction to the passage of sound, thereby improving the sound absorption by the sample. Hence, it could be concluded that sample B has absorbed more than 70% of the incident noise in the overall frequency range of 50-5700 Hz with good sound insulating properties.

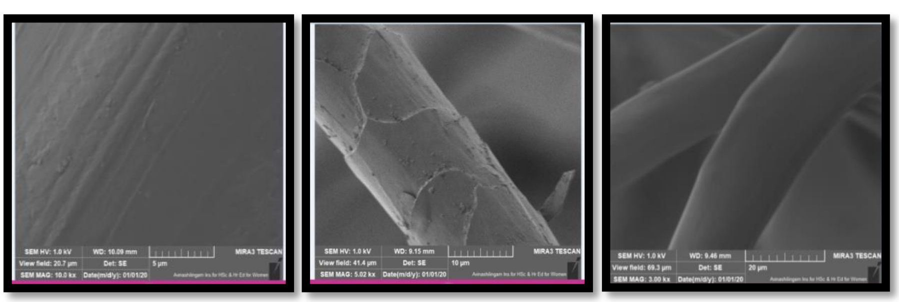


Figure 3.Nonwoven Boards A, B & C

3.3 FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

The results of FTIR spectra of the three nonwoven boards A, B and C was found that the three needle punched nonwoven samples A, B and C comprised of functional groups namely Alkanes, Bromides and Iodides which means that these samples exhibit good chemical bonding.

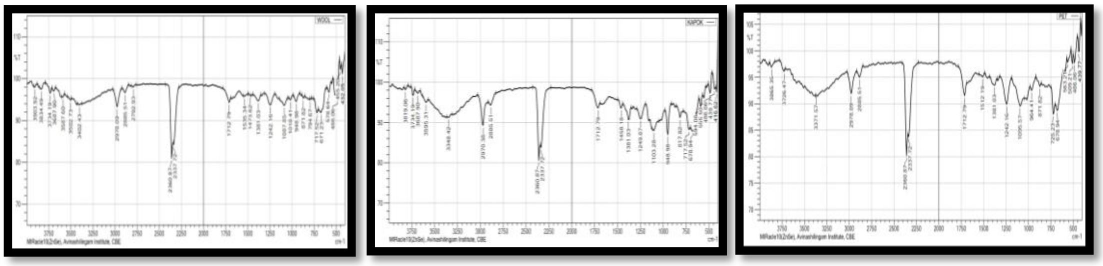


Figure 4.Nonwoven Boards A, B &C

3.4 SOUND ABSORPTION COEFFICIENT MEASUREMENT

The results of Sound Absorption Coefficient measurement of all the three nonwoven boards A, B and C are presented in the **Table II;**

TABLE II

Sound Absorption Coefficient Measurement

Sample	Sound absorption coefficient α_i			Average sound absorption coefficient α_m
	50-1000 Hz	1000-2000Hz	2000-5700Hz	
A	0.342	0.050	0.050	0.147
B	0.737	0.076	0.060	0.291
C	0.596	0.060	0.050	0.235

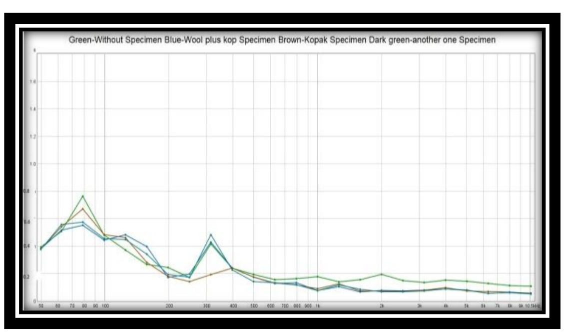


Figure 5.Sound Absorption Coefficient

From the **Table I** ound absorption coefficient in overall frequency range from (50-5700 Hz).Sound absorption coefficient **(α)** of the samples in various frequency ranges are shown in the Table XV respectively. The sound absorption was higher at low frequencies (50-1000Hz) and decreased from medium (1000-2000Hz) to high frequency range (2000-5700 Hz) for all the samples. From the table it is clear that the lowest value of α was 0.14 for sample A and highest was 0.29 for sample B and this difference was significant (50-5700Hz).Therefore, it is concluded that sample B exhibit good sound absorption coefficient with highest α value in addition to the thermal insulation property.

3.5 THERMAL CONDUCTIVITY

The thermal conductivity results of all the three nonwoven boards A, B and C are presented in **Table III**;

TABLE III

Thermal Conductivity

Sample	Thickness (mm)	Thermal Conductivity (W/m°C)	Thermal Resistance (m^2°C/W)	CLO (m^2s°C/Cal)	TIV (%)
A	5.85	2.70	2.16	1.01	99.4
B	5.52	3.77	1.46	0.74	99.5
C	4.53	2.01	2.25	1.07	99.3

From the **Table III**, it is apparent that the thermal insulation properties of the samples were measured in terms of the thermal conductivity. Hence, it could be concluded that sample C has the lower thermal conductivity with better insulation property and were suitable for roof ceiling insulation application in a building as well as also can be used for waterproof applications.

4. CONCLUSION

Upcycling is a huge change of waste products for money saving advantages and waste reduction. In this research work nonwoven boards A,B and C were prepared out of tailor discards exhibit good sound absorption and its characteristics like weight, thickness, stiffness, FESEM, FTIR, sound absorption coefficient measurement, thermal conductivity. Nonwoven boards made of waste materials would be a replacement for commercially available. Thus from the above mentioned experiment it can be concluded that Sample B exhibit good thermal and sound insulation properties and can be used in various applications such as acoustic boards, automobiles, home furnishings, civil engineering, geo-textiles and industrial filters also.

5. RECOMMENDATIONS

- Similar studies can be made by using knitted waste, finished yarn waste, yarn waste etc.
- Development of acoustic products in the field of aspect of Indu tech is worth attempting.

6. REFERENCES

- El Wazna, M,El Fatihi, M,El Bouari A,et al.Thermo Physical characterization of Sustainable Insulation materials made from Textile Waste; Journal of Building Engineering.2017;12:196-201.
- Jordeva S, Tomovska E, Trajković D, Popeski-Dimovski R, Zafirova K.Sound insulation properties of structure designed from apparel cutting waste; 2015;AUTEX2015_Proceedings:256-261.
- Patnaik A, Mvubu M, Muniyasamy S, Botha A, Anandjiwala R.D.Thermal and sound insulation materials from waste wool and recycled polyester fibers and their biodegradation studies. Energy and Buildings.2015; 92:161-169.
- Wang et.al. Properties and product development of tailor waste fiber, Advanced Materials Research.2014; 627:62-66.
- ASTM C1794-19 (2019):Standard Test Methods for Determination of the Water Absorption Coefficient by Partial Immersion, ASTM International, West Conshohocken, PA, www.astm.org.
- Zahra Balador, Morten Gjerde, Nigel Isaacs, Marzieh Imani (2018): Thermal and Acoustic building insulations from Agricultural Wastes; Handbook of Ecomaterials.2018:1-20