ENGINEERING OF NON WOVEN PRODUCT FROM HUMAN HAIR

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BONAFIDE CERTIFICATE

Certified that this project report titled ENGINEERING OF NON WOVEN PRODUCT FROM HUMAN HAIR is the bonafide work of Mr. SUBASH.P, who carried out the research under my Supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this for any other candidate.

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ABSTRACT

The need of textile products and its demand is growing every year. Every time new fibers have been found. In this project work human hair is taken for producing non-woven needle punched fabric.

Human hair is thrown in land as a waste. Only long hair is converted into wigs and other materials. So waste human hair is available enormously in all the places. In this project work, needle punched non woven felt is manufactured from human hairs of 2 to 5 inch length and analyzed the physical characteristics such as area density, thickness, water retention, impact strength, fabric stiffness, abrasion resistance, crease recovery angle and compared with wool needle punched non woven felt physical characteristics.

For producing non-woven needle punched fabric, human hair fibers are purified from its impurities. And washed with shampoo solution and dried. The washed human hair is needle punched with backing material.

From the result its found that flexural rigidity of human hair non woven felt fabric is 25.97% lesser than wool non woven felt fabric and abrasion resistances is 4.5% higher than that of wool non woven felt and crease recovery angle is 3.8% lower than that of wool non woven felt and impact strength founds to be equal and water retention value is 64.33% lower than that of wool felt fabric and oil holding capacity varies for different viscosity of oil.

From the study it's suggested that human hair needle punched fabric can be used as a carpet, filter material for drainage; spill oil cleaning material, etc.

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CHAPTER 1

INTRODUCTION

Hair grows at 0.5 mm per day; there are 100000 hair follicles on a head. So daily production is 50 meters per day. Human hair can be used for a variety of purposes if it processed properly. It could be, braided into fine twine or thick rope, woven into sheets or felt mats, the matrix which bound together stones, pebbles, and pieces of wood.

The natural fibers like cotton, jute, etc are needed to be cultivated and the man made fibers like polyester, nylon, etc are to be derived from chemicals. All these involve a lot of investments, care and technology. Whereas the human hair is readily available in huge quantities as a waste.

Human hair fiber has been chosen for this work because of its abundant availability in the country and its cheap production cost. It is also biodegradable after few years and hence it does not pollute the environment. Moreover this fiber does not require any special cultivation means. The next requirement is production of non-woven fabric from waste human hair. For this, the needle punching technique has been chosen, because we cannot convert the human hair into yarn and needle punching is a single step process of converting the fibers directly into a fabric form. Hence it helps in reducing the production cost and also this technique is the most eco friendly because it does not employ any chemicals or involve usage of heat energy. Human hair being a natural cannot be bonded by any other method.

Non-woven finds numerous applications ranging from baby diapers to industrial high performance textiles. Some of the important areas where non woven are treated as primary alternative for traditional textiles as geo textiles, materials for building, thermal and sound insulation material, hygienic and health care textiles and automotive industries. Non-woven are also used in cover stocks, agriculture, aerospace, home furnishings, etc.

Needle punched material is used in loom state packaging, sound proofing, floor covering, blankets, the industrial belt products, civil engineering drainage and road building applications.

At some stage in all classification of production techniques for non-woven fabrics there arises a division between two main categories, namely chemically and mechanically bonded fabric. The major process for producing mechanically bonded fabric from fibrous webs is needle punching and figures extracted by Burnip and Newton show needle punching to be either 30% of total non woven fabric production or 25% according to Nutter. In addition, has shown that in 1970 at least 8% of all West German textile production was in the form of needle-punched fabric.

CHAPTER 2

LITERATURE REVIEW

2.1 HAIR STRUCTURE

A hair is a specialized outgrowth of part of the skin called the epidermis. Hair two distinct parts, the hair follicle and the hair shaft.

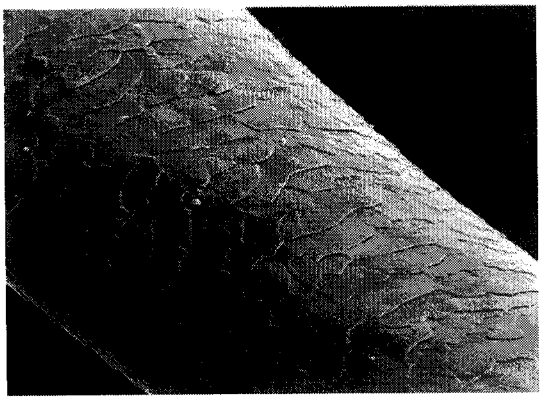


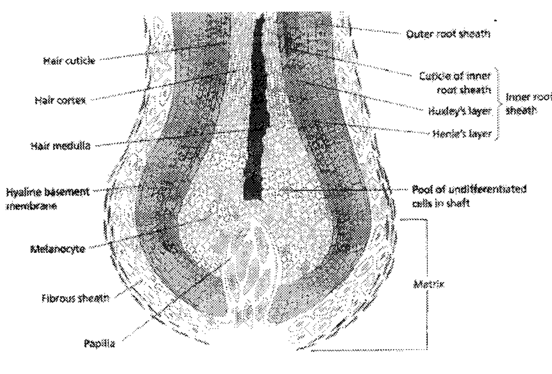
Fig 2.1 A perfect hair seen under the electron microscope

2.1.1 The Structure Of The Hair Bulb

The mid-follicle region

Actively growing cells die and harden into what we call a hair. As the cells below continue to divide and push upwards, the hair grows upwards too, out of the skin. It now consists of a mixture of different forms of the special hair protein, keratin.

The living cells gradually die, and are compressed to form the hair .



2.1.2 Chemistry Of Hair

The main constituent of hair is the protein keratin. Keratin is a remarkable protein, which is resistant to wear and tear. It is the protein that makes up feathers, claws, nails and hoofs, as well as hair.

Like other proteins, keratin has very large molecules made up of smaller units called amino acids, joined together in chains like beads on a string.[1]

2.2 HAIR STRENGTH

Hair is strong so that a single hair can support a load of about 100 grams without breaking. The keratin protein of the cortex is responsible for this unusual strength. The long keratin molecules in the cortex are compressed to form a regular structure, which is strong & flexible. Proteins are made up of long chains of amino acids. Most protein chains are made up of various mixtures of the same 20 or so amino acids.

Keratin is unique in that its chains contain high concentrations of a particular amino acid called cystine. Every cystine unit contains two crysteine amino acids in different chains, which have come to lie near to each other and are linked together by two sulphur atoms, forming a very strong chemical bond known as a disulphide linkage.

Many disulphide bonds form down the length of the keratin chains, joining them together like the lungs of a ladder. The disulphide bond is one of the strongest bonds known anywhere in nature. This cross-linking by disulphide linkages between the keratin chains accounts for much of the strength of hair.

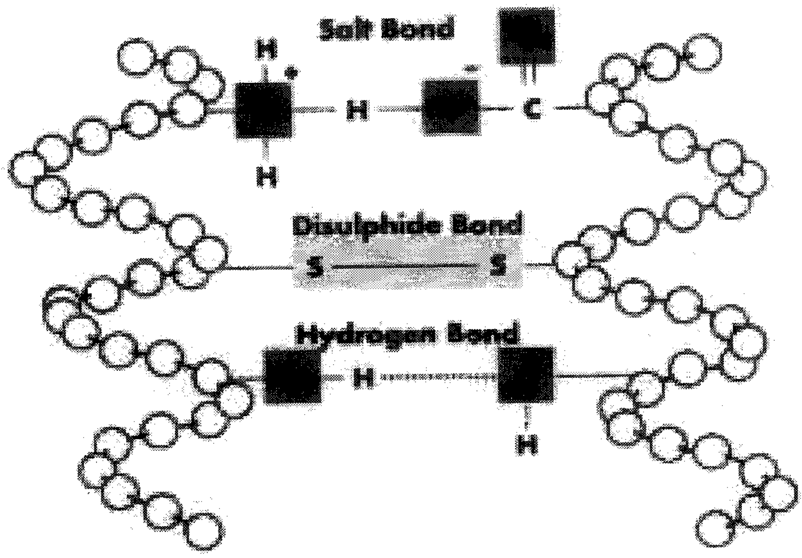


Fig 2.3 Chemical bonds within the hair [1].

2.3. PHYSICAL PROPERTIES OF HAIR

2.3.1 Elasticity

Hair can resist forces that could change its shape, its volume or its length due to elasticity. The elasticity of hair depends on the long keratin fibers in the cortex.

2.3.2 Moisture content

Moisture content of hair is greater when the atmosphere is moist and humid, and less when the air is dry. When hair is wet the cortex swells and the edges of the cuticle scales tend to lift. The hair surface temporarily loses its smoothness. There is therefore more friction when wet hair is rubbed than when it is dry.

2.3.3 Porosity

In a normal, undamaged hair shaft, very little water can get either into or out of the cortex. This is because the cuticle covering the cortex is intact, and is then almost (but not quite) waterproof [1].

2.4 POTENTIAL SUTURING MATERIAL

In ancient Indian medicine, the human hair's efficacy as a simple, widely available and cost-effective suturing material is recorded. A clinical study has been conducted to prove its utility in treating simple wounds. With further research, human hair has a great potential to be used in a wide range of surgical procedures, says Yunus G Solanki & Dr R Govind Reddy [2].

Difference in the constitution of the blood & conditions of life must produce variations in the hair, & this is especially evident in scaly formation. When viewed through the microscope the human hair looks like a smooth tube, but if we view it in vertical section we can see small spaces between the edges of the scales. Taking up a hair of wool, we find that the scales are much more definite, & rougher on the surface, as well as regularly joined, by W.S. Murphy [3].

2.5 WOOL FIBER MORPHOLOGY

The morphology and composition of human hair closely resembles that of wool. While wool contains α-keratins (protein molecules in α –helix conformation, [4] in a complex mixture with proteins of irregular structure), silk and feathers are composed of β-keratins (protein molecules partially in β-pleated sheet conformation[5])

2.5.1 Composition And Structure Of Morphological Components Of Wool

The fiber is surrounded by cuticle cells which overlap in one direction and which consist at least of four layers, the epicuticle, the A-layer and the B-layer of the exocuticle, and the endocuticle. The cuticle surrounds a compacted mass of cortical cells of spindle form aligned with the fiber axis and with their fringed ends inter-digitating with each other.[6]

2.5.2 Moisture Absorption:

In a standard atmosphere of 65% RH and 20deg.C regain values range from 14 to 18%. Preston and Nimkar[1] found that loose wool retained 133% regain when suctioned at -30cm of mercury from the wet state but only 45% when centrifuged at 1000g for 5 minutes.

2.5.3 Electrical Resistance:

Electrical current in wool is carried either by charged ions present as impurities or by the mobility of protons in hydrogen bonds. According to a theory by Hearle[7], only dissociated ions are free to move, and the degree of dissociation depends on the dielectric constant ε through its influence on the dissociation energy of two charged particles. Application of the Law of Mass Action leads to equation:

$$\text{Log } R = (A/\varepsilon) + B$$

Where R is the electrical resistivity and A and B are constants.

Changes in ε cause orders-of-magnitude changes in resistance, because of the logarithmic dependence. Empirically, it was found that at higher values of moisture content *M*, log *R* varied linearly with log *M*. Up to about 6% moisture content, the resistivity of wool is constant with a value over 10^{12} ohm cm or, in mass terms, 10^{12} ohm g/cm^2. The drop in resistance starts at a higher moisture content than in cotton and this reflects the way in which the first absorbed water is firmly bound.

As is readily apparent in the DC Conductivity measurements, there is virtually through dry or pre-soaked hair at any of the voltage settings from 100 DC hair has extremely high electrical resistance and does not appear to conduct voltage potentials. The AC voltage tests yielded similar results.

The conductivity requires a continuous hydro water molecules and it is the sensitivity to the pathways throughout this network that results resistively of wool fibers (alpha-keratin) at 25 ohm-cm at 25% water content to 3 X 10^{12} ohm based on the mass of dry keratin.

2.6 Characteristics Of Wool & Human Hair Fiber

The diameter, length, fineness, elasticity details of human hair, wool fiber is given in table 2.1

2.1 Comparison Of Wool And Human Hair

S.No	Properties	Human hair	Wool
1	Diameter	80 to 120 micro meter	20 to 40 micro meter
2	Length	-----	5 to 50 centimeter
3	Fineness	90 to 100 micron	12 to 21 micron
4	Elasticity Dry stage Wet stage	 18% 40%	 30% 30%

The chemical composition of human hair and wool fiber is given in table 2.2

2.2 Comparison Of Composition Of Human Hair And Wool

	Hair	Wool
Carbon	51%	51%
Oxygen	21%	24%
Nitrogen	17%	16.5%
Hydrogen	6%	7%
Sulfur	5%	3.5%

2.7 DETAILS OF NEEDLE PUNCHING

Goswami, Tamas, and Scardino measured the punching force on polyester fibers by means of an apparatus with fifteen needles mounted on an Instron Tester.

Hearle and Husain[8] made a study of frictional effects with a more drastic experiment in which viscose-rayon fibers were treated either with Bradsyn PEG, a polyethylene solution (from Hickson & Welch Ltd) to reduce fiber friction, or with Syton 2X, a colloidal dispersion of silicon in water (from Monsanto chemical fibers caused a reduction in fabric tenacity from that measured on fabrics made from untreated webs, but that this tenacity was increased if fibers were treated with the polyethylene solution. Treatment with Syton 2X on the web or on loose fiber prior to web formation caused a considerable decrease in the fabric tenacity: with a high percentage of application of Syton 2X, the increase in fiber friction was such that it was found impossible to conduct needling.

A study of fiber blends has been made by Tan[9]. Experiments were done on both intimate blends and mixed multi layers of (a) different fibers, (b) fibers of different length and (c) fibers of different linear density. In general, the properties of blends were better than would be expected; in other words, the tenacity and initial modulus of the blends were greater than the average weighted mean of the respective properties of the constituents. When different lengths of fiber were used in the one web, it was found that, if the longer fibers were in the top layer, the fabrics were stiffer, had a more rigid network, but were not necessarily stronger; if a mixture of fibers of different linear densities was employed, the stiffer and stronger fabric was created if the coarser fibers were in the top layer.

Tan also studied hygral expansion and found that the value for needled fabrics was numerically equal to that for the constituent fibres. He was particularly interested in the dimensional stability of nylon carpets in changing conditions of humidity, and he showed that, even though nylon has low moisture absorption, it has a hygral expansion that is not negligible. He found that, needled fabrics, the lengthways expansion of the fiber is important, which is in contrast to woven fabrics, in which the axial swelling is of more importance. In blended fabrics, the hygral expansion of the fabric was intermediate between those of the constituent fibers.

The mechanical properties of the fabric will depend on inter-fiber friction, which is controlled by the frictional properties of the fibers concerned. Higher inter-fiber friction results in the occurrence of less slippage, although high fiber friction may cause damage to the web during needling[10]. The mechanical properties also depend on the web weight: the higher this is, the more needling will occur, and the denser, stronger and stiffer the fabric is likely to be. Fiber length is very important for cohesion in the web, and fiber breakage thus needs to be reduced to a minimum.

Fiber density is also important, because it controls the fiber surface-area and the nature of fiber pick-up by the needles[11]. In general, long, fine, strong fibers needled by fine-gauge needles to a low penetration with a high needling density will produce the highest quality fabrics : this is, of course, also the most expensive production system, and so the choice of raw materials and method will be compromised by economic factors.

2.8 NEEDLE PUNCHED PRODUCTS

Although considerable effort has been put into the development of carpets and wall-coverings, other areas of the market have received considerable attention. For instance, endless felts, such as paper-makers felts, have been the subjects of a number of patents[12-14] To give the felt stability during needling, it has also been suggested that a scrim be employed, this being destroyed during later needling. The use of heat-shrinkable fibers has been suggested, for example, in filter fabrics to give strong low-elongation materials[15]. These are obtained by means of a heated calendar on the web, which is prevented from shrinking at this stage. The shrinkable fibers are then allowed to straighten, which causes the fabric elongation to be lowered. Needled fabrics can be made as three-dimensional materials, a well-known example being the shaped shoulder pads made on the Dilo SKN Machine[16]. Another Dilo machine which is used for making tubular fabrics, is the Dilo Rontex, in which the web from a card is fed into the form of a helix round a roller and is drawn off sideways after being needled at an angle to the

Several British companies are licensees for what is known as the Fiber-lock Process[18]. This is used for making apparel fabrics. The Fiber lock fabrics have a scrim into which a finer layer of low-linear-density fibers is needled. This fine layer acts as a key for the main needling of the surface fibers. The final part of the Fiber lock Process is a wet finishing treatment, which locks in the surface fibers. This system is said to achieve the abrasion resistance, flexibility, and low weight (240-600 g/m^2) that are necessary for needled fabrics to be employed in the apparel trade.

2.9 WOOL NEEDLE PUNCHED FABRICS

Around 1870, the commercial production of needle punching machines was established for driving barbed needles through fibrous webs to introduce the mechanical entanglement needed to form a fabric that is commonly referred to as a 'needle felt'. After preparation of the wool blend and the formation of a web on either a Garnett or carding machine, the web is normally cross-lapped before needle punching. Many other fibers, as well as a wide range of wool types, can be converted into fabric using this approach. Early machines were capable of about 100 punches /min compared to over 3000 punches / min possible on some modern systems. In basic form, a needle punching machine consists of a perforated bed-plate, which supports the batt during the process, and a perforated stripper plate set immediately above which assists in stripping the reciprocating needles on their return stroke (as the needles withdraw from the batt). The barbed needles are designed to collect and transfer fibers perpendicular (or at preset angles) to the surface of the fabric and then release them when they withdraw from the batt. Different bedplate arrangements, needle designs and needle board layouts are used for making the structured or patterned fabrics needed to produce floor coverings and upholstery. The properties of needle-punched fabrics are greatly influenced by the punch density, needle penetration depth, needle gauge and needle barb configuration, Wool blankets were characterized by excellent flame retardancy but washing presented technical problems because of high wet shrinkage (for example 5-50%) even after the use of a standard oxidative shrink-resist treatement.[19]

Needle punched blankets containing wool were the subject of research undertaken by Smith.[20] Hung[21] investigated the effects of fiber length and blend proportions on the properties of needled blankets containing wool blends and established that a 40% wool 60% man-made fiber composition was the most satisfactory blend, giving pilling performance similar to woven blankets.

In the 1970s research was completed on the production of needle-punched blazer cloths composed of wool (short 64s quality lambs wool and broken tops 60/64s) reinforced with a 45g/m^2 nylon woven scrim.[22] Milled needle punched fabrics were pro0duced with a mean area density of 350 g/m^2.

Wool needle felts and other wool filled products are marketed as oil sorbents for cleaning up spillages[23.24] and find used in horticulture, for example in hanging basket liners.[25] It is also feasible to introduce plant seeds in such products. When laid on the ground, biodegradable fabrics containing wool are used to aid germination of grass seeds by providing an appropriate microclimate under the fabric, and in mulch mats wools is used to inhabit the growth of weeds around young plants. Mulch mat products containing wool are believed to be useful as erosion control materials.[26] Libraries also used wool needle punched fabrics to assist in the preservation of books placed in storage archives.

2.10 NEEDLE PUNCHING

Mechanical bonding refers to the strengthening of the web by inter-fiber friction as a result of the physical entanglement of the fibers. Needle punching is a process of bonding non-woven web structures by mechanically interlocking punch fibers into the web and are then withdrawn, leaving the fibers entangled. The needles are spaced in a non-aligned arrangement, and are designed to release the fiber as the needle board is withdrawn. The needless enter and leave the web while it is trapped between two plates called a bedplate and a stripper plate. The web is pulled through the needle loom by drawing rolls.

Fibrous webs, which are characteristically bulky, are obtained by web forming processes of:

- Carding, cross-lapping or carding-cross-lapping;
- Air laid, except pulp fibrous webs;
- Spun – bonded webs.

2.10.1 Parts of a Needle Loom

1. The needle board:

   This is the base unit into which the needles (ranging in number from 500 per meter to 7,500 per meter of machine width) are inserted and held. The needle board then fits into the needle beam that holds the needle board into place.

2. The bed plate and stripper plate:

   These are two plates between which the web passes, the bedplate is on the bottom and the stripper plate is on the top. Corresponding holes are located in each plate, and it is through these holes that the needles pass in and out. The bedplate is the surface; the fabric passes over when the web passes through the loom. The needles carry bundles of fibers through the bedplate holes. The stripper plate does what the name implies; it strips the fibers from the needle so the material can advance through the needle loom.

3. The web feeding and fabric take up mechanisms:

   These are typically driven rolls, and which facilitate the web's

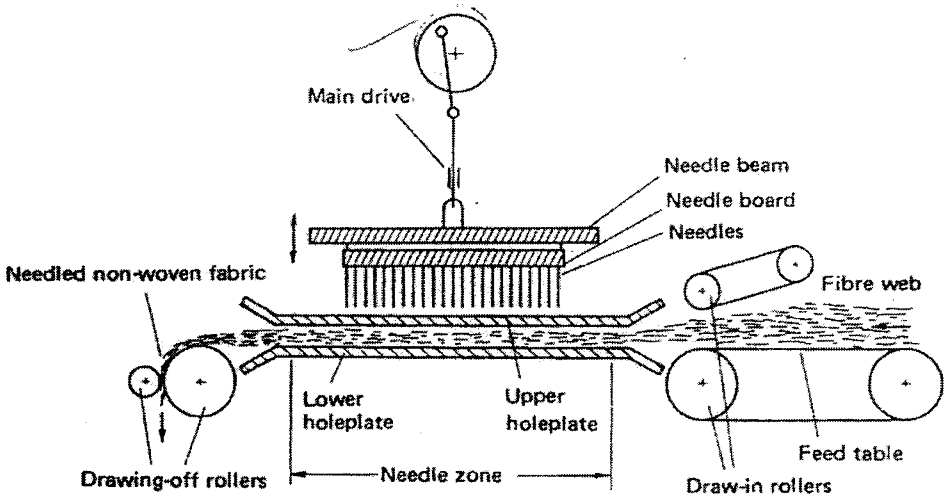
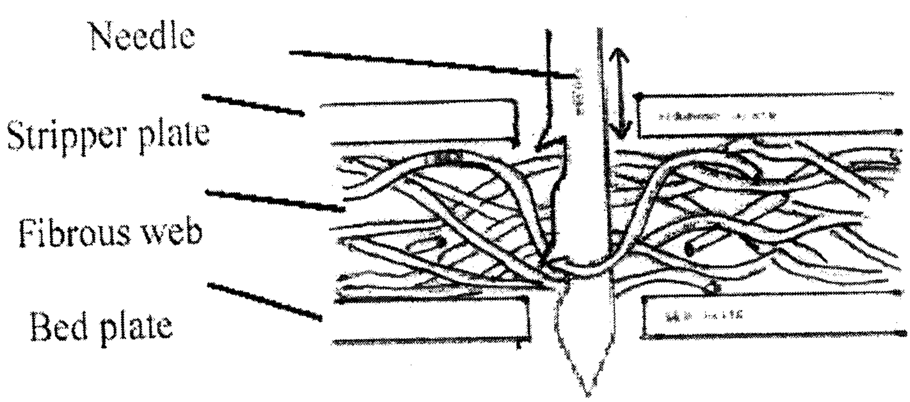


Fig. 2.58 – Diagrammatic illustration of needling.

Fig 2.4 Diagrammatic Illustration Of Needling

2.10.2 Theory of needle Punching:

According to Hearle's model, the vertical structure of a needle-punched fabric consists of fibers pulled through the web by needles and the horizontal structure consists of fibers following curved paths around the vertical tufts. Both these structures are interconnected, so individual fibers can pass through both horizontal and vertical sections.



2.10.3 Studies on influence of parameters on needled fabrics

- Bulky webs need wider setting between stripper plate and bedplate.
- The web derives its strength from the entanglement and interlocking of fibers.
- Increase in the amount of Needling increases fabric modulus, strength, abrasion resistance and stiffness.
- Increase in depth of needle penetration increases fabric modulus, density and strength.
- To secure higher strengths, longer and finer fibers should be used.
- High fiber friction leads to greater consolidation and thus greater resistance to slippage.
- Stretching of web during Needling improves the Dimensional stability, Modulus and Elastic recovery.
- The Mechanical property of the web is affected by fiber length, fineness, friction, and degree of interlocking and fabric thickness.
- A more porous structure offers higher air permeability and good thermal insulation.
- Decrease in web weight decreases the density, and therefore the Air permeability increases and thermal insulation decreases.
- At lower web weights, increase in depth of needle penetration increases the Air permeability.
- Increase in weight, depth of needle penetration or needling density, decreases the breaking elongation.
- Increase in web weight, depth of needle penetration and needling density, increases the initial modulus, compressive and tensile resilience [27-29].

2.11 Summary Of Needles

Purdy has concluded that there is an optimum gauge for maximum fabric strength. In a series of experiments, fabrics were manufactured by means of needle gauge and needles containing 0, 3, 6 and 9 bars successively. the barb spacing was also varied, and the relative effect of all these needle variables was judged from the results of tensile tests on the resultant fabrics .

Smith has measured the amounts of fibers transferred through fabrics by needling.

Hearle and Purdy have demonstrated the occurrence of fiber breakage by obtaining fiber length diagrams before and after needling, and have shown that it is possible to go through a minimum of fiber breakage, as the amount of needling is increased.

Smith's work indicated that there was a relation between which fibers had most contact with the needles and the positions of these fibers in the web, more fibers being transferred from the surface layers than from the lower layers.

Needles have been constructed so as to reduce the friction with fibers and therefore reduce wear.

Needle tracking, that is, the marking of fiber webs by faulty needles or by the faulty positioning of needles, has been discussed in detail by Young169.it was pointed out that the needles at the front of the board caused rapid consolidation of the web and that these needles were the most likely or produce needle tracking. If needles with smaller barbs were used in this position, with regular barbed needles in the remainder of the board, the small final consolidation was accomplished, but with less needle tracking. Tan170 has suggested that the replacement of needles could be made sequentially, so that the most worn needles were at the front of the needle board. This would assist in the reduction of needle tracking [30].

CHAPTER 3

OBJECTIVE

- To engineer the Needle punched Non-woven product from waste Human hair.
- To study the characteristics of human hair Needle punched Non-woven product.
- To compare the characteristics of human hair Non-woven felt with wool Non-woven felt fabric.

CHAPTER 4

METHODOLOGY

The following figure gives the details of methodology adopted to carry out the project work.

Collection of human hair — Collection of wool fiber

↓

Purification of natural and added impurities

↓

Producing the Needle punched non-woven felt fabric

↓

Study the characteristics of non-woven

↓

Compare the characteristics of both non-woven

Fig 4.1Methodology Flow chart

4.1 COLLECTION OF HUMAN HAIR AND WOOL FIBER

Waste human hair is collected from various temples, saloons in Coimbatore district.collected human hair length is maintained between 2 to 5 inch according to the requirement of process. Wool fiber is collected from local sheep near sulfur. Wool fiber length varied between 2 to 5 inches.

4.2 PURIFICATION OF NATURAL AND ADDED IMPURITIES

In wool, natural impurities like oil, wax, and dirt are removed by soap solution and added impurities like vegetable matters are removed manually. In human hair, impurities like oil, wax, and dirt are removed by shampoo solution and added impurities are removed manually.

4.3 PRODUCTION OF NON-WOVEN NEEDLE PUNCHED FELT FABRIC

For producing non-woven needle punched fabric, four picks per inch gauze fabric is used as a backing material. Because human hair lacks crimp in its surface. Due to backing material fiber friction, fabric strength is increased. Human hair is weighted, spread over the gauze fabric. Wooden box, leveling blade are used for maintaining uniform thickness through out the fiber sheet. Three-meter fiber sheet is prepared in this way, after that 1000kgs of weight is placed over the fiber sheet for compression purpose. Compressive load is applied for 5 days. Then the three-meter fiber sheet is needle punched using DILO machine, which is situated in PSG foundry at Neelambur. Wool non-woven needle punched felt fabric, is also produced in the same way.

4.4 CHARACTERISTICS STUDY

For both wool felt, human hair felt the following tests are conducted.

1. GSM testing.
2. Thickness testing.
3. Fabric stiffness testing.
4. Abrasion resistance testing.
5. Fabric crease recovery testing.
6. Impact strength testing.
7. Water retention capacity testing.
8. Oil holding capacity testing.

Finally both non-woven characteristics are compared.

4.5 MACHINE SPECIFICATIONS

- Machine type –OD- 2 /6.
- Make – DILO, Germany.
- Working width – 600 mm.
- Stroke frequency – Max -1200/min and

4.6 ADOPTED SPECIFICATION

- In feed – 0.25m/min.
- Draw off speed - 0.25m/min.
- Stroke frequency – 120 stroke/min.
- Depth of penetration - 10mm.
- Thickness between two plates – 25mm.
- Needle board – 600 needles/board (Size 7.5 x15 inch) (Double board).
- Needle gauge – 5-needles/square inch.

  Down stroking needles.

4.7 TESTING OF SAMPLES

4.7.1GSM Testing

The produced sample is cut into a square specimen of size 10cm x 10cm and placed in a physical balance. The weight of the sample in grams is noted. 100 to get the GSM of the material multiply the obtained weight reading. Similarly five such samples were tested to get the average GSM.

4.7.2 Thickness Testing

The thickness of the samples is measured by using a thickness tester. The sample is placed between the two-presser plates of the thickness tester. The thickness value is directly noted from the dial gauge reading. Similarly the thickness for each sample is tested at ten different places to calculate the average thickness.

4.7.3 Fabric stiffness testing

Stiffness is the resistance offered by a material to a force tending to bend it. Cantilever principle of working is used to determine the stiffness of fabrics. Stiffness is related with handle and drape of the fabric.

5 samples are cut using template .The tester is set on a table so that the horizontal platform and the index lines are at eye level. The specimen is placed

of the template coincides with the datum line. Both the template and fabric are pushed forward slowly. The fabric will tend to drop over the edge on its own weight. Both are moved forward until the fabric cuts the index lines when viewed in the mirror. The bending rigidity, flexural rigidity and bending modulus are calculated.

4.7.4 Abrasion resistance testing

A sample size of 1.5inch is cut using template, weighed and mounted on a mushroom shaped holder. The abradant material may be in the form of emery paper, sand paper, canvas etc., Cut the abradant material to the size of 5x5inches using the template provided. Place the abradant on the abrading table. Now mount the mushroom holder in its position. Set the counter with required number of cycles. Start the machine and after the required number of cycles is completed, the machine will stop. Remove the sample from the holder and weigh it.

4.7.5 Fabric crease recovery

Crease resistance:

The resistance offered by a textile material for creasing during use is called crease resistance.

Crease recovery angle:

A sample size of 2x1inch is cut. The sample is folded exactly into half and is loaded (normally 2kg weight) for 2 minute. One limb of the specimen is holded using a tweezers and is mounted on the clamp of the crease recovery tester. The specimen is allowed to recover for two minute. After two minute the circular dial is rotated in order to coincide the specimen and knife-edge. By observing the angle at which the specimen and knife-edge, it gives crease recovery angle.

4.7.6 Impact Strength

The impact strength value of the samples is tested by cutting a specimen of size 12 inches x 2 inches and then making a slit in the middle for 10 inches length of the specimen. This specimen is then mounted on the jaws of the Ballistic strength tester. The impact strength value is then noted by allowing the load to tear the sample. Similarly five specimens in each sample type are tested to obtain the average impact strength value.

4.7.7 Water Retention Testing

The water retention capacity of the sample is measured by cutting a sample of 10cm x 10 cm and first calculating its dry weight. The sample is then immersed in water and allowed to attain equilibrium by placing in normal atmosphere for 30 min. When the excess water is expelled from the sample. The wet weight of the sample is then noted. The difference between the two weights gives the amount of water held by the sample in grams. When the difference value is divided by the dry weight and multiplied by 100 we get the water retention percentage of the sample. This test is repeated for five specimens of each sample type to get an average value.

4.7.8 Oil Holding Capacity Testing

The Oil holding capacity of the sample is measured by cutting a sample of 10cm x 10 cm and first calculating its dry weight. The sample is then immersed in Oil and allowed to attain equilibrium by placing in normal atmosphere for 30 min. When the excess Oil is expelled from the sample. The wet weight of the sample is then noted. The difference between the two weights gives the amount of Oil held by the sample in grams. When the difference value is divided by the dry weight and multiplied by 100 we get the Oil holding percentage of the sample. This test is repeated for five specimens of each sample type to get an average value.

CHAPTER 5

RESULTS AND DISCUSSION

Human hair non-woven needle punched felt fabric is produced. The characteristics like area density, thickness, water retention, impact strength, fabric stiffness, abrasion resistance, and crease recovery angle are tested. These test results are given in table. The photomicrographs of human hair needle punched fabric and wool non-woven needle punched fabric is given in appendices.

The GSM value of both non-woven fabrics is seems to be similar with the value ranges from 1300 to 1400.

Human hair felt fabric thickness is found as 8mm, where as wool fiber felt fabric thickness is 10mm.

5.1 Test Result Values

PROPERTIES	HUMAN HAIR FELT	WOOL FELT
Flexural rigidity	2911.9 kg/sq.cm	3933.5 kg/sq.cm
Abrasion resistance	90.5%	85%
Crease recovery angle	110.2°	114.6°
Impact strength	40.8lbs	42.8lbs
Water retention value	91.7%owm	257.12%owm
Oil holding capacity For viscosity 12	222.6%owm	307.64%owm
Oil holding capacity For viscosity 22	435.1%owm	457.5%owm
Oil holding capacity For viscosity 32	534.3%owm	494.9%owm

FLEXURAL RIGIDITY

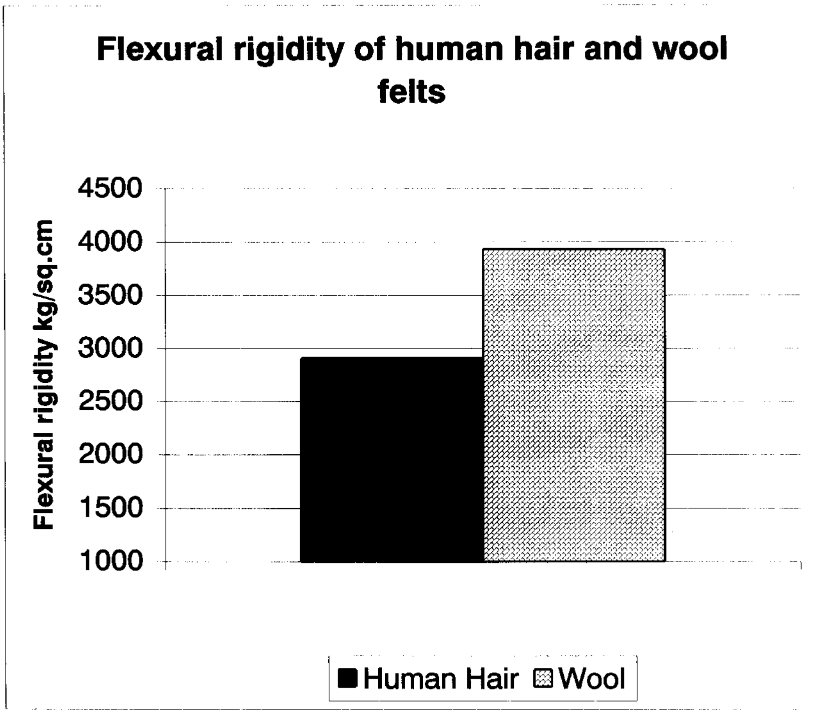


Fig 5.1 FLEXURAL RIGIDITY

Human hair non woven needle punched felt fabric flexural rigidity: 2911.9

Wool non woven needle punched felt fabric flexural rigidity : 3933.5

From Table 5.1, Figure 5.1,Flexural rigidity of human hair non-woven needle punched fabric is 25.97% lesser than that of wool non-woven needle punched fabric. This may be due the fact that human hairs are having uniform thickness with out any crimp with very fine scales. In wool fibers, due to large scale and crimp structured it showed higher flexural rigidity.

ABRASION RESISTANCE

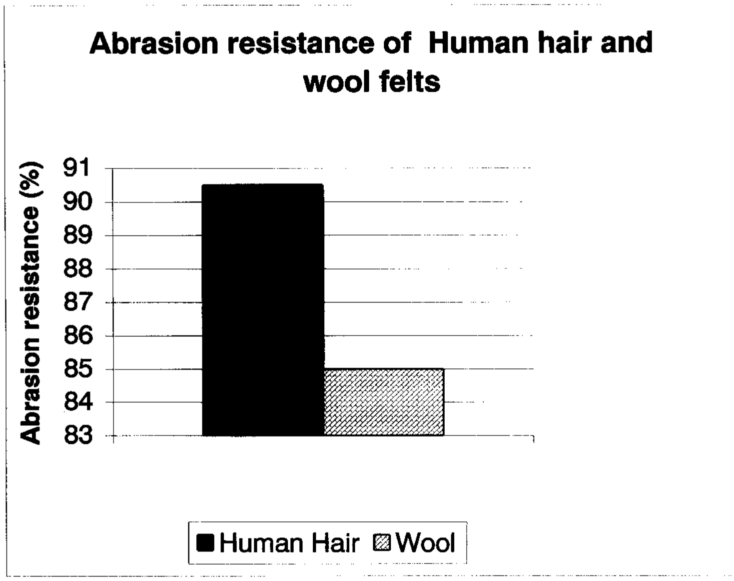


Fig 5.2 ABRASION RESISTANCE

Human hair non woven needle punched felt fabric Abrasion Resistance: 90.5% (300 revolution)

Wool non woven needle punched felt fabric Abrasion Resistance : 85% (300 revolution)

Both non-woven fabrics seem to be high abrasion resistance compared with cotton material. Wool non woven is 4.5% lesser than human hair non woven fabric. Due to large scales and crimps, the wool fiber offered heavy frictional resistances against the emery sheet of abrasion tester, which results in comparatively poor abrasion resistance. So these non-woven materials may be used as carpet.

CREASE RECOVERY

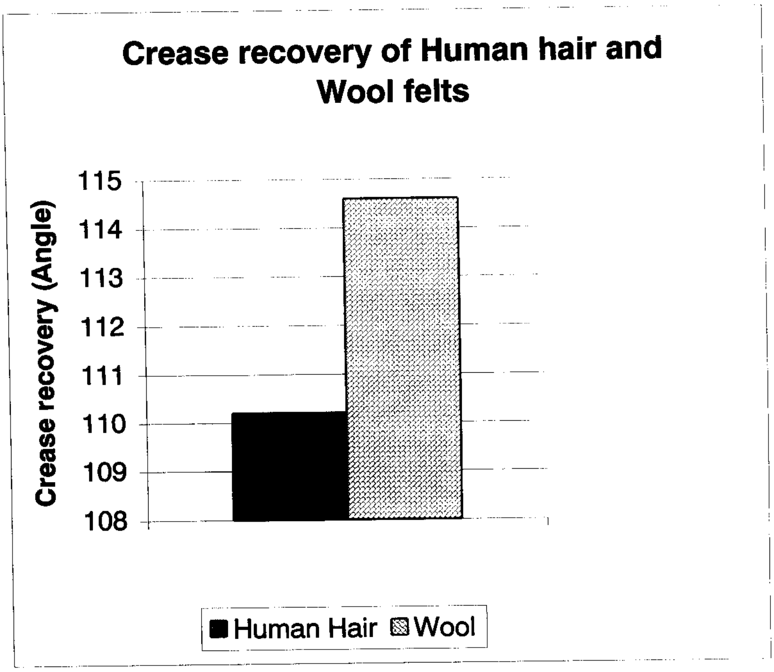


Fig 5.3 CREASE RECOVERY

Human hair non woven needle punched felt fabric crease recovey: 110.2
Wool non woven needle punched felt fabric crease recovery : 114.6

Crease recovery angle of human hair non-woven fabric is 3.8% lower than wool non-wove needle punched fabric. Due to crimp structure wool fiber is having high elastic recovery property, which gave the wool felt with high crease recovery angle.

IMPACT STRENGTH

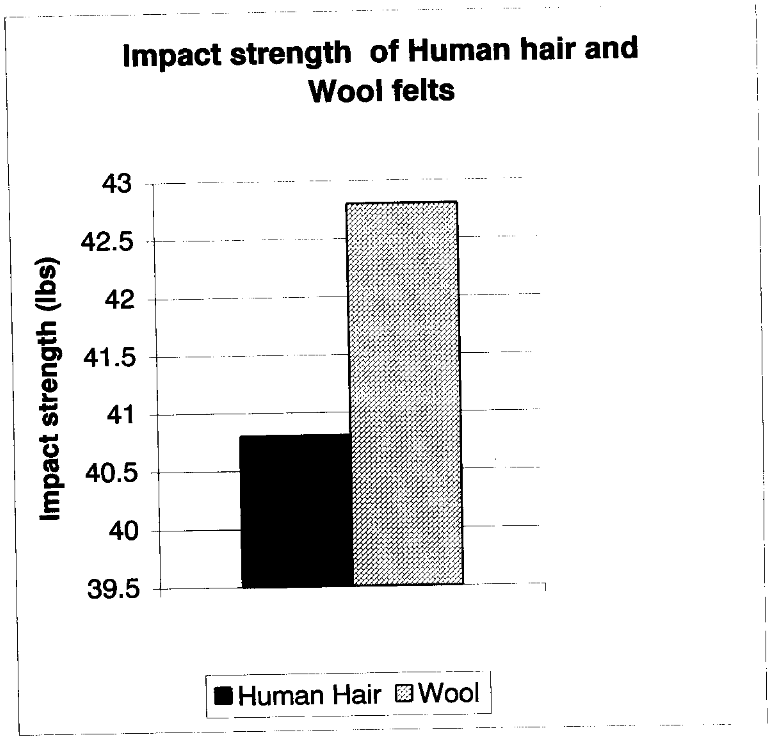


Fig 5.4 IMPACT STRENGTH

Human hair non woven needle punched felt fabric impact strength: 40.8

Wool non woven needle punched felt fabric impact strength : 42.8

Comparatively both non woven tearing strength is same. Due to low tearing strength, these products can be used in packing materials, sound insulation products.

WATER RETENTION

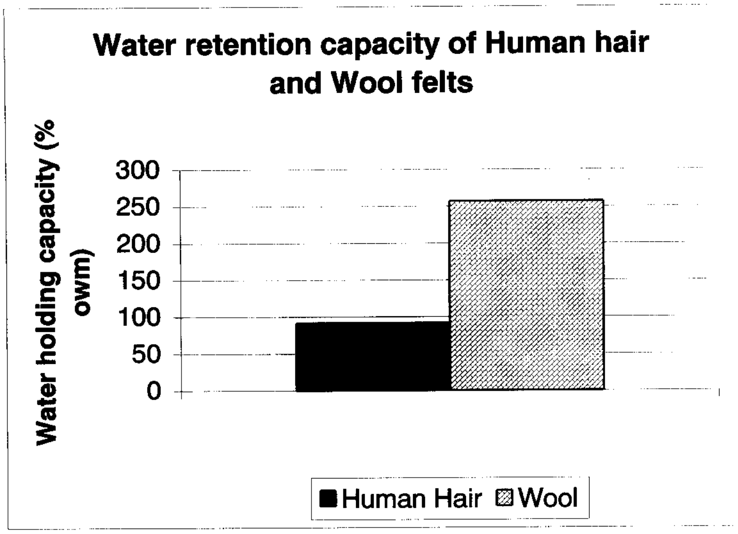


Fig 5.5 Water retention

Human hair non woven needle punched felt fabric Water retention :91.7

Wool non woven needle punched felt fabric water retention :257.12

Human hair non-woven needle punched fabric is 64.33%lower water absorption value than wool felt fabric. This is due to low fabric thickness and lack of fiber crimp, porosity of human hair; so it can be used for drainage purpose.

OIL HOLDING CAPACITY

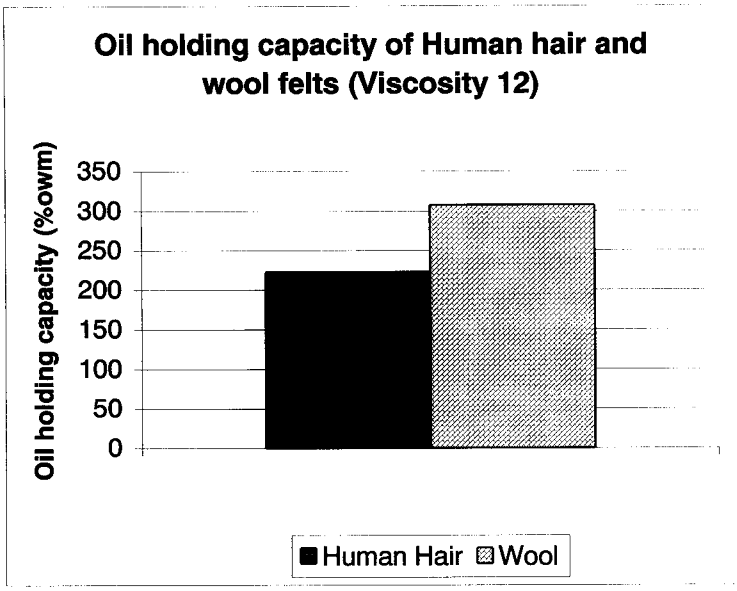


Fig 5.6 OIL HOLDING CAPACITY

Oil holding capacity of human hair felt fabric: 222.6

Oil holding capacity of wool felt fabric : 307.64

For viscosity 12, oil holding capacity of human hair non-woven needle punched fabric is 27.64% lesser than wool non-woven fabric.

OIL HOLDING CAPACITY (VISCOSITY 22)

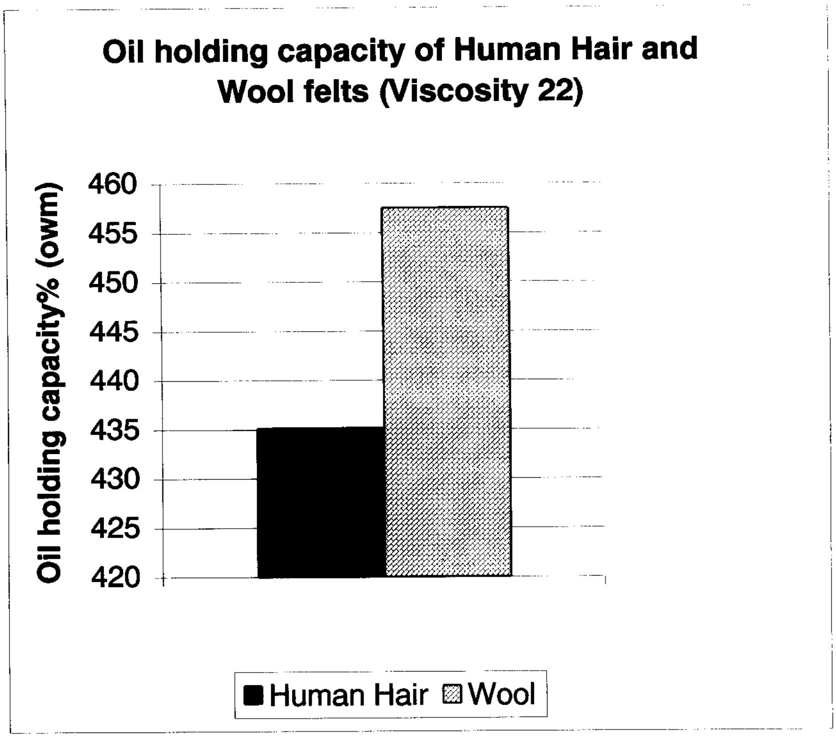


FIG 5.7 OIL HOLDING CAPACITY (VISCOSITY 22)

Oil holding capacity of human hair felt fabric: 435.1

Oil holding capacity of wool felt fabric : 457.5

For viscosity 22, oil-holding capacity of both non-woven needle punched fabric is comparatively equal.

OIL HOLDING CAPACITY (VISCOSITY 32)

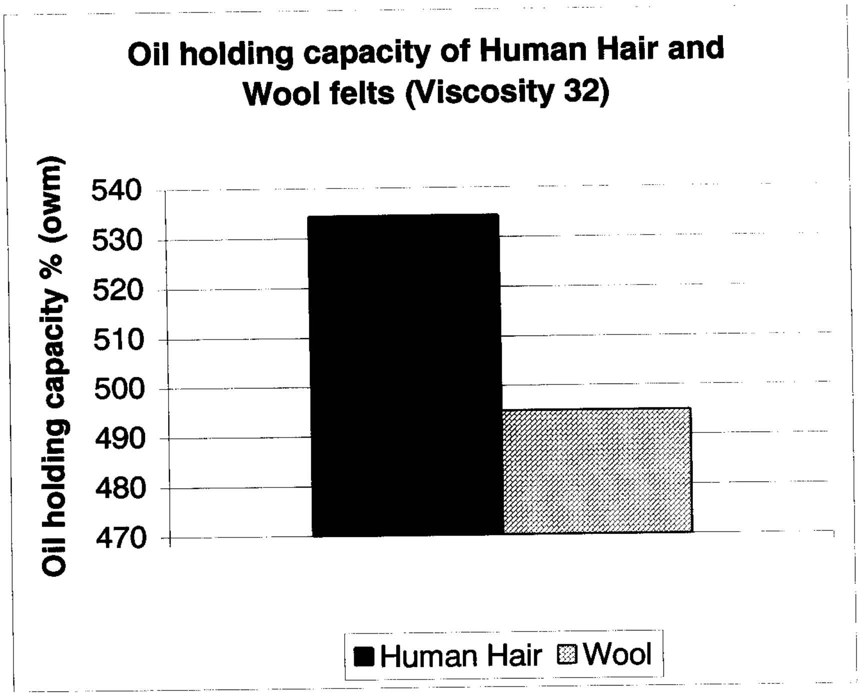


FIG 5.8 OIL HOLDING CAPACITY (VISCOSITY 32)

Oil holding capacity of human hair felt fabric: 534.32

Oil holding capacity of wool felt fabric : 494.95

For viscosity 32, oil-holding capacity of human hair non-woven needle punched fabric is 7.9% higher than wool non-woven fabric. Oil Absorption of human hair non-woven felt fabric is gradually increased when the viscosity increases. So human hair felt fabric is used to absorb the spill oils in fuel derivation, crude oils.

CHAPTER 6

CONCLUSION

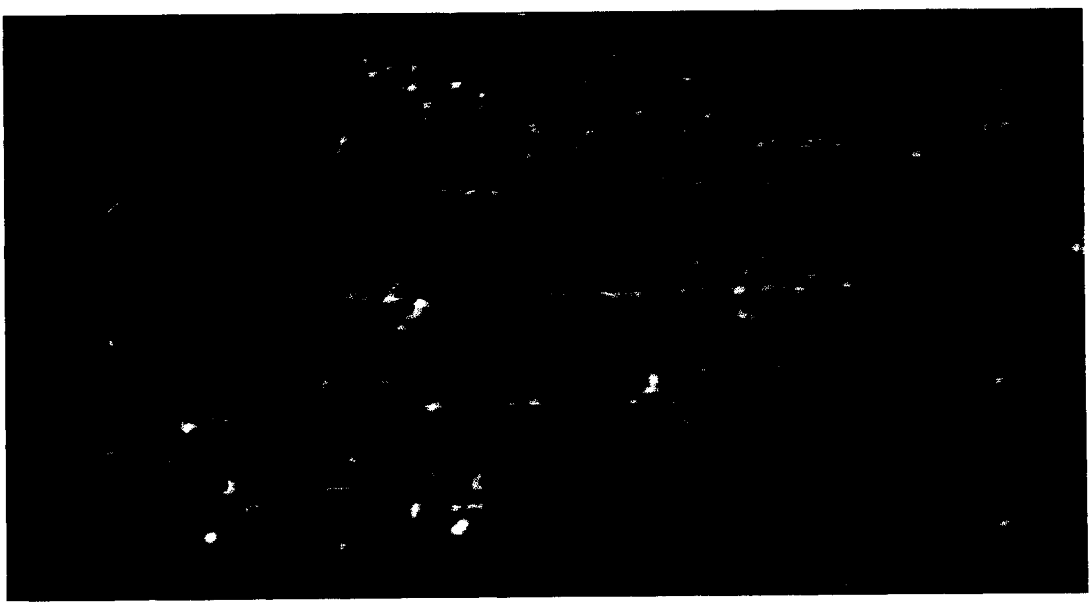
The following are the conclusions

- Human hair non-woven needle punched fabric is successfully produced.
- Flexural rigidity of human hair non-woven fabric is 25.97% lesser due to the fact human hairs are having uniform thickness, without any crimp with very fine scales.
- Both non-woven fabrics seems to be high abrasion resistance compared with cotton fiber material. Abrasion resistance of human hair non-woven fabric is 4.5% higher than wool non-woven fabric.
- Crease recovery angle of human hair non-woven fabric is 3.8% lower than wool non-woven needle punched fabric.
- Wool, human hair non-woven fabric's tearing strength seems to be similar.
- Human hair non-woven needle punched fabric is 64.33% lower water absorption value than wool felt fabric.
- Oil holding capacity of human hair non-woven felt fabric is gradually increased when the oil viscosity increases.
- The human hair felt fabric can be used as a carpet, filter fabric for drainage material, spill oil cleaning material, crude oil cleaning material. And also suggested that, this human hair felt fabric may be used as thermal, electrical insulating material, sound proof material. For that relative testing should be done.

CHAPTER 7

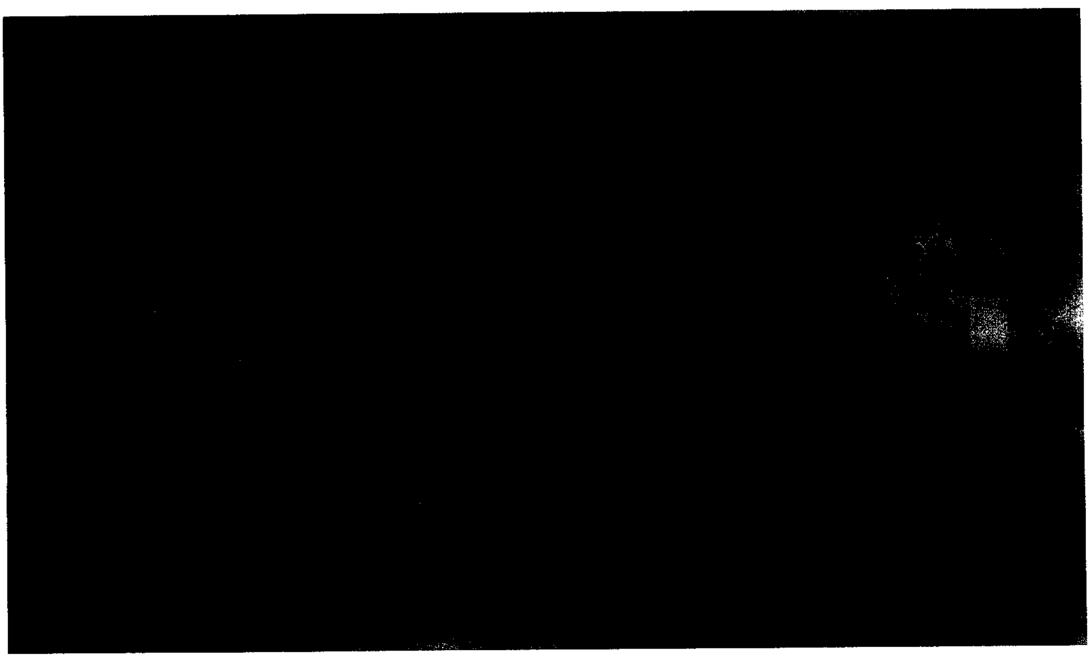
APPENDICES

HUMAN HAIR NON WOVEN FELT FABRIC – FRONT SIDE VIEW



HUMAN HAIR NON WOVEN FELT FABRIC – BACKSIDE VIEW

WOOL NON WOVEN FELT FABRIC – FRONTSIDE VIEW



WOOL NON WOVEN FELT FABRIC – BACKSIDE VIEW

CHAPTER 8

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