A REVIEW ON NONWOVEN FABRICS: MANUFACTURING PROPERTIES AND APPLICATIONS

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ABSTRACT: *This paper reviews various manufacturing techniques of nonwoven fabrics made of natural and synthetic fibers. It has been seen that the needle-punching process is mostly used for manufacturing non woven fabrics for industrial textile applications. Various Physical, mechanical and functional properties of various techniques of nonwoven fabrics have been discussed here. The influence of various factors on various properties of nonwoven such as oil absorbent, Thermal Insulation, Air Permeability, sound reduction, Compressibility, bulk properties Water Absorbency and Acoustic Insulation has been absorbed. Various industrial applications in different fields such as Geotextiles, Dry filtration, Automotive applications, Agriculture and Horticulture Household goods, Acoustic and Thermal insulation have been reported.*

KEYWORDS: Needle punching, Physical properties, Industrial applications, Functional properties.

1. INTRODUCTION:

Bonding of fibrous fleeces mechanically is known as needle punching[1]. The fibers are mechanically entangled to produce a fabric by reciprocating barbed needles (felting needles) through a moving batt of fibers in a needle loom. In principle, a board containing a multiplicity of barbed needles is reciprocated at high speeds as the fibrous fleece passes under the needles. It is usually necessary to needle the fleece from each side and this can be achieved either by passing it through the machine twice, having turned it over between the first and second pass or by using a machine with two needle boards, the first one striking downwards and the second one upward. The needle punching process is well suited to produce medium and heavy weight non-woven from 300 gsm to 3000 gsm. Hence finding needle punching to be the best technique in producing nonwovens, in this paper we are going to review some journals published by various writers.

2. MANUFACTURING METHODS:

2.1 Nonwoven fabric:

Nonwoven fabrics are broadly defined as sheet or web structures bonded together by entangling fiber or filaments (and by perforating films) mechanically, thermally or chemically. They are flat or tufted porous sheets that are made directly from separate fibres, molten plastic or plastic film. They are not made by weaving or knitting and do not require converting the fibres to yarn.Nonwoven fabrics are engineered fabrics that may be single-use, have a limited life, or be very durable. Nonwoven fabrics provide specific functions such as absorbency, liquid repellency, resilience, stretch, softness, strength, flame retardancy, washability, cushioning, thermal insulation, acoustic insulation, filtration, use as a bacterial barrier and sterility. These properties are often combined to create fabrics suited for specific jobs, while achieving a good balance between product use-life and cost. They can mimic the appearance, texture and strength of a woven fabric and can be as bulky as the thickest paddings. In combination with other materials they provide a spectrum of products with diverse properties, and are used alone or as components of apparel, home furnishings, health care, engineering, industrial and consumer goods.

2.2 METHODS:

Non woven fabrics can be made in various methods like

- thermal bonding
- Hydroentanglement
- needle punching/needle felting
- chemical bonding

2.2.1 THERMAL BONDING:

Thermal bonded nonwovens are fabrics produced by using heat to melt thermoplastic powders or fibers (polyester, polypropylene, etc.). ... At the point where two or more fibers intersect, they can be heated to melt to each other. When they cool they will be bonded, which imparts strength to the fabric.

2.2.2 HYDROENTANGLEMENT:

Hydroentanglement is a bonding process for wet or dry fibrous webs made by either carding, airlaying or wet-laying, the resulting bonded fabric being a nonwoven. It uses fine, high pressure jets of water which penetrate the web, hit the conveyor belt and bounce back causing the fibres to entangle.

2.2.3 CHEMICAL BONDING:

In chemical bonding, chemical binders (adhesive materials) are used to hold the fibers together in a nonwoven fabric. Chemical binders are polymers that are formed by emulsion polymerization. The mostly used binders today are water-borne latexes. They are applied in a number of different ways to nonwovens and because their viscosity is close to that of water they can easily penetrate into nonwoven structures by emulsion. After application of binder by, for example, immersion, they are dried and the water evaporates. The binder then forms an adhesive film across or between fibre intersections and fibre bonding takes place.

2.2.4 NEEDLE PUNCHING:

Needle-punched nonwoven fabrics are made from various fibrous webs (usually carded webs) in which fibres are bonded together mechanically through fibre entanglement and frictions after fine needle barbs repeatedly penetrated through the fibrous web. Needle-punched fabrics have characteristic periodicities in their structural architecture that result from the interaction of fibres with the needle barbs. Fibre segments are reorientated and migrated from the surface of the web towards the interior of the fabric, forming pillars of fibre orientated approximately perpendicular to the plane. Hence from the four bonding techniques needle punching is found to be the effective one. Therefore in this article we are going to see about needle punching in detail.

3. MECHANICAL PROPERTIES OF NEEDLE PUNCHED NONWOVENS:

3.1 THERMAL INSULATION:

Polyester has various textile applications due to its easy availability, low cost and mechanical properties.fibre. Thermal insulation property is one of the very important properties of the textile materials for technical textile applications. The methods commonly used to measure the thermal insulation values (TIV) are the disk method, the constant temperature method and the cooling method.. With the increase in fabric weight the number of fibres per unit area of the fabric increases. Due to this reason the fabric thickness increases. As the thickness of the fabric increases the thermal resistance increases. As the thickness increases the thermal conductivity reduces, resulting in higher thermal insulation. This can be corroborated with the fact that in case of jute fabrics, TIV is directly proportional to the thickness of fabric. In case of hollow polyester fibre, the fibre consolidation is higher during needling due to the use of fine linear density fibre. This results in poor thermal insulation of hollow polyester needle-punched nonwoven[6].

3.2 FABRIC DENSITY, PERCENTAGE COMPRESSION AND THICKNESS:

The thickness and also the density of the fabric increases with increase in the weight of the fabric. That is they reported for polypropylene needle punched non woven fabrics. Again with the increase in the number of fibres, consolidated structure can be obtained easily. This is due to the availability of more fibres to be entangled during the needling process to form denser fabric at higher fabric weight. The percentage compression decreases with the increase in fabric weight for all the three cross-sectional shapes of polyester samples.With the increase in fabric weight the amount of fibres per unit area of the fabric increases, as a result more number of fibres share the compressive load. Hence, decrease in percentage compression is observed with the increase in fabric weight[1].

3.3 AIR PERMEABILITY:

Both air permeability and SAP decrease with the increase in fabric weight. While increasing in fabric weight, the fabric becomes thicker as well as denser, resulting in consolidated fabric structure. Though the amount of pores increases with the increase in the number of fibres, the pore size becomes smaller. This, in turn, drops down the air permeability as well as SAP values with the increase in fabric

Weight. The air permeability and SAP decrease with the increase in fabric weight in case of polyester and jute needle-punched nonwoven fabrics respectively. Air permeability also follows a similar trend with fabric weight. It is observed from the figures that the air permeability decreases prominently with the increase in fabric weight at all levels of jute contents.the air permeability is not much influenced by needling density. It shows decrease in trend up to 300 punches/cm2 and thereafter with the increase in needling density, air permeability remains unchanged. Also air flow resistivity increased with decreasing fiber diameter and porosity[1]. Air permeability of the fabrics increases with the increase in blend ratio of the polyester in the blend, except for the 125 g/m2 fabrics. As the density of polyester fiber is lower than that of viscose fiber, the thicknesses of polyester rich fabrics are higher than that of viscose rich fabrics for identical fabric mass per unit area.The air permeability of polyester rich fabrics is lower than that of viscose rich ones. In addition, the air permeability of the fabrics decreases with the increase in mass per unit area and increase in needling density causes an increase in air permeability[11]. The air permeability and the airflow resistance for the multi-layer structure. As expected, with the increasing number of layers the air permeability decreases and, consequently, the airflow resistance increases[14].

3.4 THERMAL RESISTANCE:

It is observed that the thermal resistance increases with the increase in fabric weight. With the increase in fabric weight, thermal resistance increases more prominently at lower needling density (150 punches/cm2), but its effect is negligible at higher needling density (350 punches/cm2),the effect of fabric weight on thermal resistance is almost similar at all needling densities between 150 punches/cm2 and 350 punches/cm2. Both thermal resistance and specific thermal resistance decrease with the increase in needling density. Thermal resistance and thickness increase but air permeability and sectional air permeability decrease significantly with the increase in fabric weight at all levels of jute contents[6].

3.5 SOUND REDUCTION:

In recent years, the subject of noise has increased most of the attention among the whole world. Hence higher noise levels can cause sleep disturbances, stress, hearing loss and decrease in productivity/learn ability it has to be controlled. The Effect of area density, fabric type, source intensity, number of layers, distance of fabric from sound source, distance of fabric from the receiver and fibre type on sound reduction of various needle-punched nonwoven fabrics.effects on fiber type, Different natural and synthetic fibres have different properties that is jute gives the lowest sound reduction among all the samples tested because of less void area due to compact structure which is also reflected in the fabric density but all other synthetic fibres show higher sound reduction also, blends of dissimilar fibres show higher sound reduction compared to their individual performance.Effect of Distance of Fabric from sound source and from Receiver,This study has been carried out with 500, 700 and 900 g/m2 jute needle-punched nonwoven fabric.it is found that the sound reduction increases as the distance of the fabric from sound source increases.also when the sound source is kept stable and the receiver is varied it is found that that sound reduction remains fairly constant with the increase in distance. But the increase in area density of fabric increases the sound reduction.Effect of Area Density of Fabric is decrease in fabric density and a increase in sound reduction with the increase in area Density.

3.6 WATER ABSORBENCY:

Water absorbency of textile materials are very important since the fabric may undergo dyeing and finishing processes. fabrics made out of jute have different uses, e.g. floor covering, wiping, absorbent, agro-textile, where the water absorbency is an important criterion for the performance. Wettability of jute fibre is good among all the long vegetable fibres15. The porous needle-punched nonwoven structure is expected to improve the water holding capacity of the fabric. It is also expected that the density of fabric may play a significant role in water absorbency of such nonwoven fabric.When batching oil is not applied, with the increase in punch density, the bulk density decreases continuously at low depth of needle penetration. But at high depth of needle penetration, bulk density initially increases and then decreases. With the increase in depth of needle penetration, bulk density decreases for low range of punch density, but increases at high punch density[8].

3.7 BULK AND PHYSICAL PROPERTIES:

Bulk and physical properties of fabric determine fabric performance during use and fabric serviceability. Physical properties of fabric are directly or indirectly influenced by the bulk of the material , whereas bulk properties have direct relationship with thermal and compressional behaviour of fabric. In an observation air permeability of random-laid fabrics is found to be higher than that of cross-laid fabric because of the larger number of pores in random-laid fabrics.The effect of fibre fineness on the bulk and physical properties of nonwoven fabric is significant..Bulk and physical properties of needled fabric determine the suitability of fabric for its various applications. The above properties are influenced by the fibre properties, web characteristics, machine design parameters, machine variables and finishing operations. In general, the denser nonwoven fabric made from the same raw material and web weight possesses lower air permeability, and higher strength and elongation. Greater consolidation in nonwoven fabric is usually achieved through higher needling density and needle penetration.Compressibility decreases but compressional recovery improves with the increase in depth of needle penetration[3].

3.8 ACOUSTICAL CHARACTERISTICS AND SOUND ABSORPTION COEFFICIENT:

Controlling acoustical phenomenon in work places and residential areas using a textile material has gained most of the attention among people. Basically nonwoven fabrics are very good acoustical insulators, Due to their high volume-to-mass ratio. study on the effect of various fabric parameters, such as fiber fineness, surface effect, punch density, areal density, and chemical bonding was carried out. The results establish that fiber fineness has a strong influence on sound absorption of nonwoven fabrics. The results also illustrate that a plain surface sample had the highest sound absorption coefficient followed by velour and cord surfaced samples. This was concluded to be due to the different mechanism of fiber transfer by fork and felting needles. It was also found that increase in areal density and punch density positively affected the sound absorption capability of needled fabrics; however, a slight decrease in NRC values of samples with lower areal densities was observed as punch density increased from 90/cm2 to 105/cm2[4].

3.9 OIL SORBENTS:

Oil spillage generally occurs in large ocean water bodies and also in nearby land surfaces. The leakage of oil during production and transport, improper construction of oil storage tanks and explosion of oil storage tanks during wars or natural disasters are known as the major reasons of oil spill. The spilled oil must be either removed or destroyed within a timeframe to prevent major hazard to the environment. The oil spilled over water is removed using different techniques such as skimmer, chemical, bacteria, etc. But these techniques are time consuming and harmful to the environment. With a goal to find out a better one, the fibrous assemblies are being researched for their potential for oil spill cleanup. Therefore by this study they concluded The milkweed and kapok fiber-based nonwovens displayed very high oil sorption capacity as well as oil sorption rate. The cotton fiber based nonwoven was found to sorb 26 g of oil per g of fiber along with a very low water sorption capacity around 1.67 g/g and did not show any chemical degradation or microbial attack even when left in artificial sea water for 10 days. Milkweed and cotton fabrics had good selective sorption of oil over water, as oil could replace around 90% and 85%, respectively, of the previously imbibed water in their structures. The natural fiber nonwovens exhibited poor breaking strength and hence they may fail during usage. These findings indicate that the natural fiber nonwovens with improved strength must be developed as oil sorbents for oil spill removal application[13].

4. CONCLUSION:

We herewith conclude this review article as among the methods, needle punching is considered to be the forward technology very much suited. Lots of research and development are going on nonwovens for various applications and there is also scope for further improvement. Nowadays most nonwovens are used in technical textile sectors such as geotextile, medical textile, agricultural textile, automobile textiles,etc.

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