

NEEDLE PUNCHING TECHNOLOGY

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Abstract:

Needle punching is the oldest method of producing nonwoven products. The first needle punching loom in U.S. was made by James Hunter machine co. in 1948. Then in 1957, James Hunter produced the first high speed needle loom, the Hunter model 8 which is still used today.

The needle punching system is used to bond dry laid and spun laid webs. The needle punched fabrics are produced when barbed needles are pushed through a fibrous web forcing some fibers through the web, where they remain when the needles are withdrawn. If sufficient fibers are suitably displaced the web is converted into a fabric by the consolidating effect of these fibers plugs or tufts. This action occurs in needle punching occurs around 2000 times a minute.

Needle punched fabrics finds its applications as blankets, shoe linings, paper makers felts, coverings, heat and sound insulation, medical fabrics, filters and geotextiles.

Introduction:

Needle punching is the oldest method of producing nonwoven products. Needle punching technique has been used in industry since 1870s. The needle-punching process is very commonly used to manufacture medium to heavy weight nonwoven fabrics. The first needle punching loom in U.S. was made by James Hunter machine co. in 1948. Then in 1957, James Hunter produced the first high speed needle loom, the Hunter model 8 which is still used today.

The bonding of webs by using needle punching technique is now a day's extensively utilized for the production of numerous products which not only competes with the conventionally used textiles, but exhibit properties hitherto unknown and not attainable by any other method.

Basic Principle:

A needlepunched nonwoven is a fabric made from webs or batts of fibers in which some of the fibers have been driven upward or downward by barbed needles. This needling action interlocks fibers and holds the structure together by friction forces.

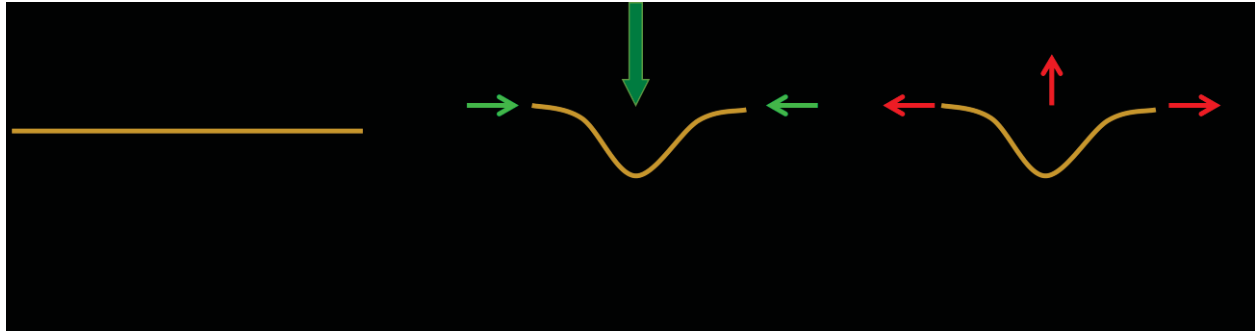


FIGURE 1 PRINCIPLE OF NEEDLE PUNCHING

Binding point is a set of fibers with various orientation, which are bonded by friction forces.

Working principle of Needle punching technology

In needle punching the bonding of the fiber web is the result of intertwining of the fibers and of the inter fiber friction caused by the compression of the web. The phases of needle punching process are shown in figure 2.

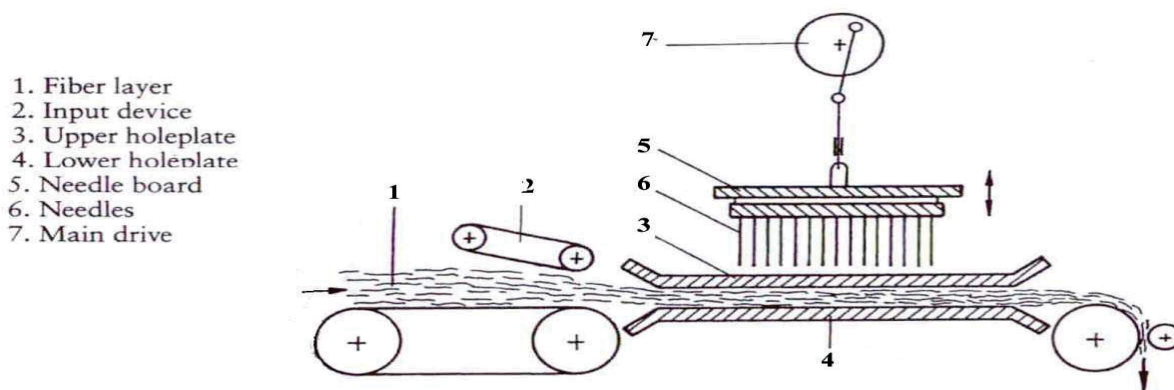


FIGURE 2 PHASES OF NEEDLE PUNCHING MECHANISM

The web is passed over a feed table, through the drawing in rollers and via feed rollers the web is fed to needling area. Here, the web is repeatedly punctured or perforated by a battery of needles and reoriented. This operation is carried out several times minute. In modern machines it is carried out around 2000 strokes per minute. When the needling is done from above, as shown, the web is pressed against the lower boss, also known as the needle to throat plate; flat bed. The upper plate is called stripping plate or holding down plate.

The needle beam supporting the needle board is situated above the needle plate and is powered by a main drive over a cam shaft. Holes are bored into the needle board to take the needles. The three sided shanks of the needles have barbs which grip the fibers as the web is perforated, and pull them through the web. As the needle return, the fibers remain in their new position virtually unchanged since the barbs only face in one direction. The deliver rollers transport the needle web from the needle zone. The material feed can be either intermittent or continuous.

To achieve the desired compression and bonding, it is common practice to have several needling zones in a row, one after the other, with different needle settings and direction of stitching.

Parameters affecting needle punching process

The aim of needle punching is to compress and bind the fibers together. Needle punching process and properties of the needled fabrics have collected and listed as follows:

INFLUENCING FACTORS

TYPE OF FIBER

Fiber	<i>Properties related to individual substances (flexural strength, maximum tensile load and maximum extensibility)</i>
	<i>Geometric properties of fibers (fineness, length, crimp %, cross sectional shape)</i>
	<i>Fiber surface and friction (surface structure, finish and dilustering)</i>

Fiber web	<i>Gsm, thickness, closeness, orientation of fibers, opening of fibers.</i>
Needling machine	<i>Construction(needling technique, stitch angle, material feed, arrangement of needles in needle board</i> <i>Variable machine settings (needle punch depth , numbers of barbs going into the fleece, puncture density for double lift, length of the material feed, effective depth in the needle fabric, punch frequency, dia. of holes in needle plate, distance between two hole plates, position of needle in the board <position of three sided shank in relation to length of material>)</i>
Binding needle	<i>Type of needle ,shape arrangement and number of barbs, thickness of needle, depth of stamp or depth of neck plus “kick-up” of barb, needle wear</i>
Environment	<i>Condition in working and storage area</i>

✨ **Fiber properties**

Virtually all types of fibrous material can be used to make nonwoven bonded fabrics, the choice being dependent on:

- The required profile of the fabric
- The cost/ use ratio (cost effectiveness)
- The demands of further processing.

Since nonwoven bonded fabrics are almost always developed to meet specific requirements, the correct choice of fiber is of supreme importance. It is not only a question of finding the best kind of fibers, but of taking special fiber properties (fineness, length, crimp %, cross sectional shape, finish) into consideration.

It is essential for the development and production of nonwoven bonded fabrics for a comprehensive study to be made of the properties of different fibers. This can be done by comparing the requirements to be met by the particular fabric with results obtained from the various individual fibers.

Mainly the following fiber properties are taken into the consideration:-

1. Crimp

It is almost impossible with most equipment to produce a nonwoven fabric from a completely straight fiber. The natural fibers have varying amount of crimp and, just as the cut filament must be crimped for spinning, a crimp is necessary for formulation of manageable web for nonwoven fabric production. Curly fibers are better than straight and usually curlier the better. Highly crimped fibers tend to form more uniform web which will retain its original structure during the subsequent process.

The amount and type of crimp may be determined by the requirements of the finished product. For example a nonwoven intended for padding or cushioning in automobiles or furniture applications where loft and resiliency are required must be made from fiber having a permanent crimp. For chemical bonding for more binder penetration higher crimp is advantageous.

2. Denier

The choice of denier per filament for fiber to be used in nonwovens is governed primarily by the requirements of the end product. The use of the finer fibers results in great density, strength and softness and at the same time a more opaque sheet (fine fiber has more “covering” power).

Heavy deniers are easier to open for production of a uniform web at higher speeds than fine deniers. The adjustment of the processing equipment of the denier of the fiber used is a very important factor in successful nonwoven fabric production.

3. Length

The staple length of the fibers to be used depends on the type of web forming equipment selected for production line in most cases longer fibers can be used in cards and garnets better than in air lay machines, but there is no advantage in fabric strength derived from longer fiber. In any type of web forming nonwoven fabrics, manufacturers have learned through the experience that low production rates and poor quality fabrics usually result from the use of fibers that are too long. Another result of long fibers may be excessive breakages.

4. Finish

The finish on the fiber surface is usually designated as “bright”, “dull”, or “semi-dull” and the selection is arbitrary depending on the lecture or appearance desired in the end product.

Table 2 shows the various fiber applications according to the end use of fabric.

✱ **Fiber web**

- Fiber orientation. Change of dimension depends on web anisotrop
- Web density. It is necessary to use sufficient number of fibers to make bonding points.
- Web homogeneity
- Web thickness. For good quality of needlepunch textile is necessary to have probably the same web thickness as is the distance between the upper and lower holeplates. Therefore the web thickness must be reduced.

✱ **Technical parameters Needle machine**

1. **Penetration depth**

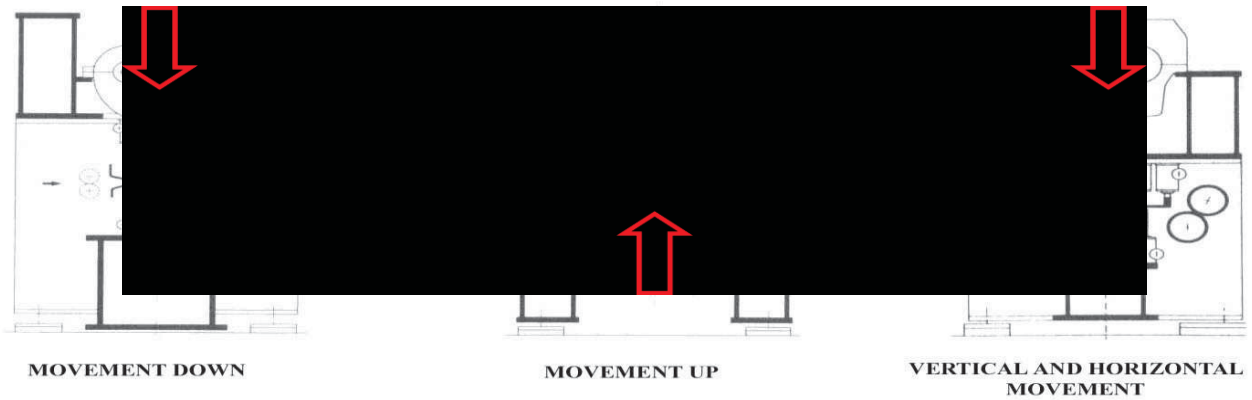
- It changes number of working barbs
- It increases textile strength (until some value) and decreases textile thickness.
- When the penetration depth is too high fibers are pulled through the textile – non uniform textile

2. **Parameters of needles:**

1. Proportions (length, diameter, density of barbs, size of barbs...)
2. Shape of needle parts (shape of working blade, shape of barbs....)
3. Type of needle (felting, structuring)
4. Location on the needle board

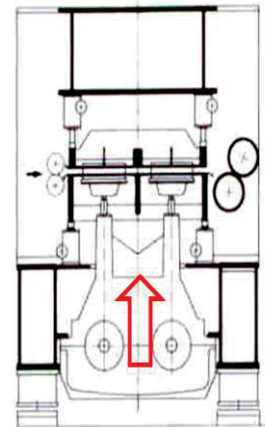
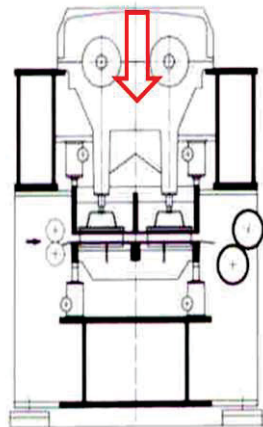
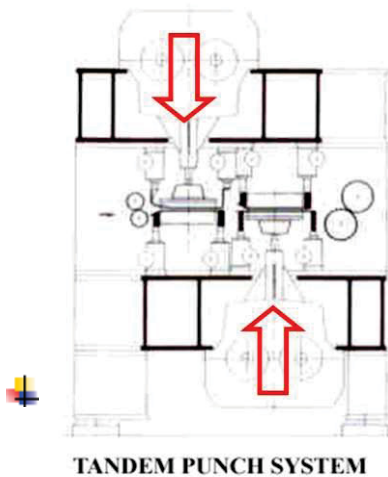
3. **Position of needle boards:**

- Single board system

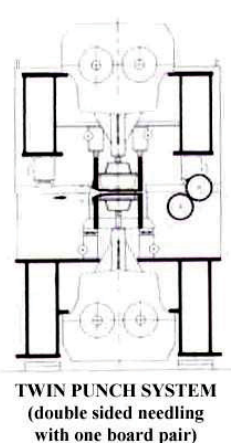
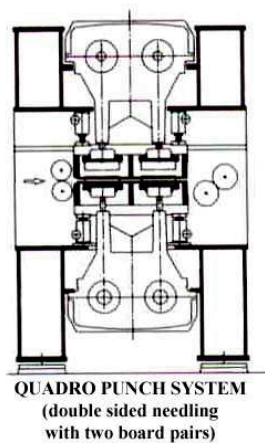


- Tandem board system

Double board system



- Twin and quadro punch system

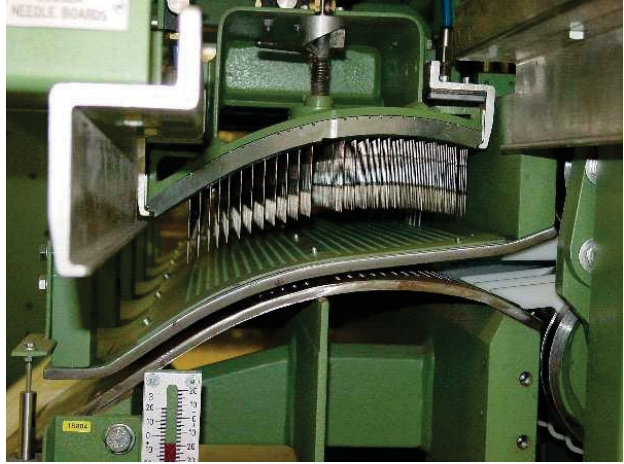


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 Modern development

- **Special shape of needle board angled needle penetration:**

Penetration is achieved by means of an asymetrically curved needling zone and straight needle movement. As advantage is possibility of more random orientation of punched fibers and longer needle path through the web, which creates better fiber reorientation. Thus textile strenght is better.



Application of needle punched material

- **Geotextiles:** Road and railway construction, dams, roofing felts, drain felts, shore protection, reinforcing felts..
- **Automotive fabrics:** Head liners, carpets, door trim, parcel shelves, moulded components, insulation felts
- **Hometex:** Carpets, wall coverings, decor felts, wipes, blankets...
- **Synthetic leather:** Shoe, automotive and upholstery industry, luggage, bags, sport goods
- **Clothing and furniture:** Shoulder pads, waddings, mattresses
- **Filters for gases and liquids,**
- **Other technical felts:** polishing felts, abrasive felts, mineral fiber felts for insulation

Conclusion

- By the simulation of the chemical bonding and the needle punched technology or by use of other alternatives for simulation we can build the textile for the high performance application. And at the considerably good cost.

- Off course its initial investment is higher but the overall performance will compensate the cost.
