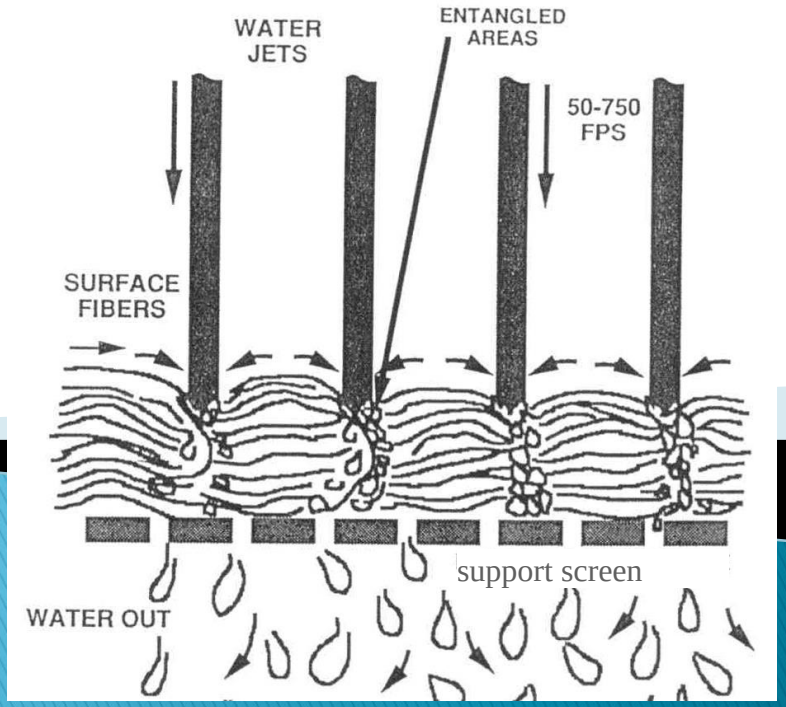
Chapter VIII. – IX.

Spunlace (Hydroentanglement)

Principle of spunlace bonding

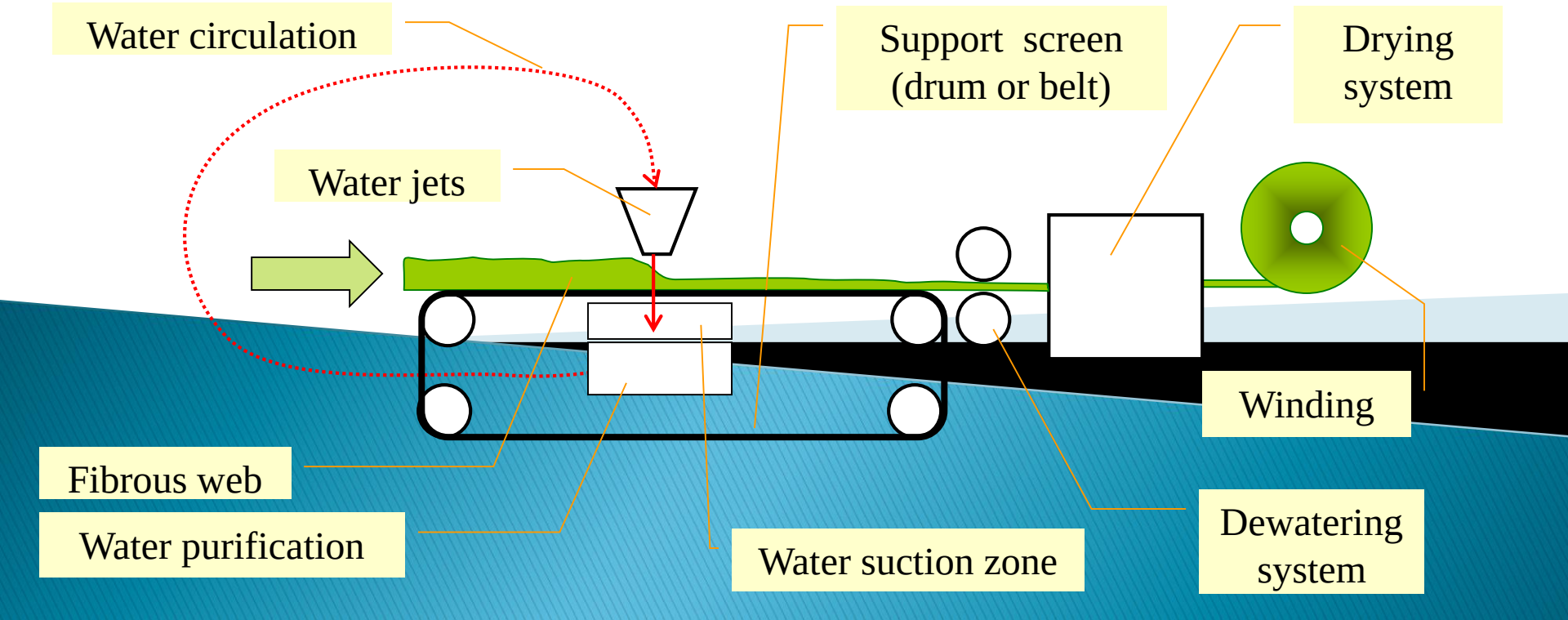
Spunlace or hydroentanglement is web bonding technology, which uses fine, high pressure jets of water to cause the fibres to interlace. Water jet due to high kinetic energy reorientates fibers according to the shape of the support screen (sieve belt or perforated drum). As a bonded web is possible to use whole range of nonwovens: carded webs, spunbond and meltblown webs, wetlaid, airlaid and composites.

Binding point is a set of fibers with various orientation, which are bonded by friction forces (similar as for needlepunch process).



Description of spunlace process

At first is fibrous web preweted to eliminate air pockets. The thin water bundle goes from the jets through the fibrous web and support screen (one hydroentanglement unit). To obtain better bonding efficiency is water sucted from the oposite side of the support screen. Then is water purified and returned to the jet manifold. The structure of the bonded textile depends on the adjustment of water jets and structure of the support screen. It is possible (and often used) to repeate several hydroentanglement units. The pressure of water jets gradually increases. The bonded textile is then dewatered, dryed and winded.



Main features of spunlace textiles

- very good textile drape (low stiffness) and very soft handle
- no chemical or melt binders; it is possible to prepare 100 % natural fibers, suitable for sanitary products, suitable to recycling
- wide range of textile area surface: from 10 to 1000 g/m^2 and higher density (g/m^3) than for needlepunch textiles
- strenght is much higher than after mechanical needling (for the some area weight); similar to woven textiles
- wide range of textile structure (depending especially on the perforated belt structure) – wide range of textile properties
- uniform surface due to more fine interlacing of fibers (compared with needling)
- very high textile production: up to 300 m/min for carded and [illegible] up to 500 m/min for wetlaid and spunbond (meltblown); textile width up to 6000 mm.

Parameters of spunlace process

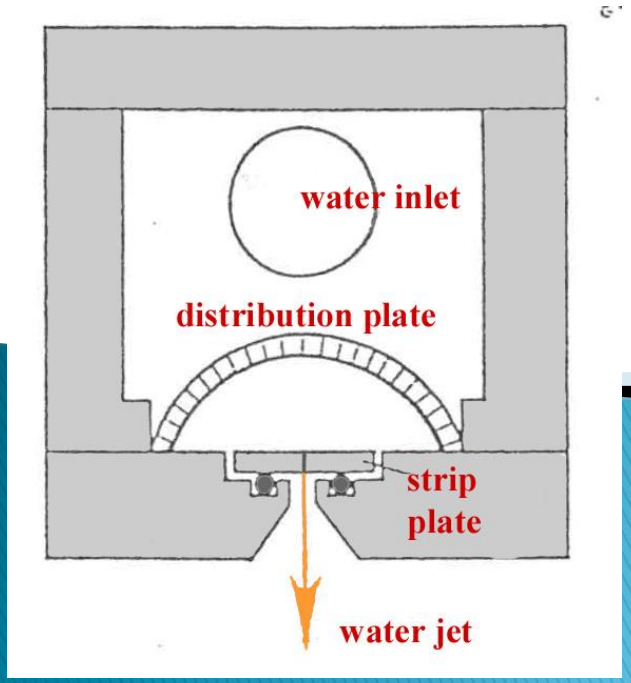
- **Parameters of fiber** - similar as for needlepunch process: fiber diameter, length, cross-section, roughness, finishing, strength, elongation
- **Parameters of web** – similar as for needlepunch process: fiber orientation, web density and web homogenity
- **Parameters of spunlace process:**
  - parameters of water jets (water pressure, density of jets, diameter, distribution, water suction zone...)
  - velocity of web:
  - shape of sieve belt or perforated drum
  - parameters of water (temp[illegible]
  - parameters of dewatering and drying (pressure, temperature, time...)

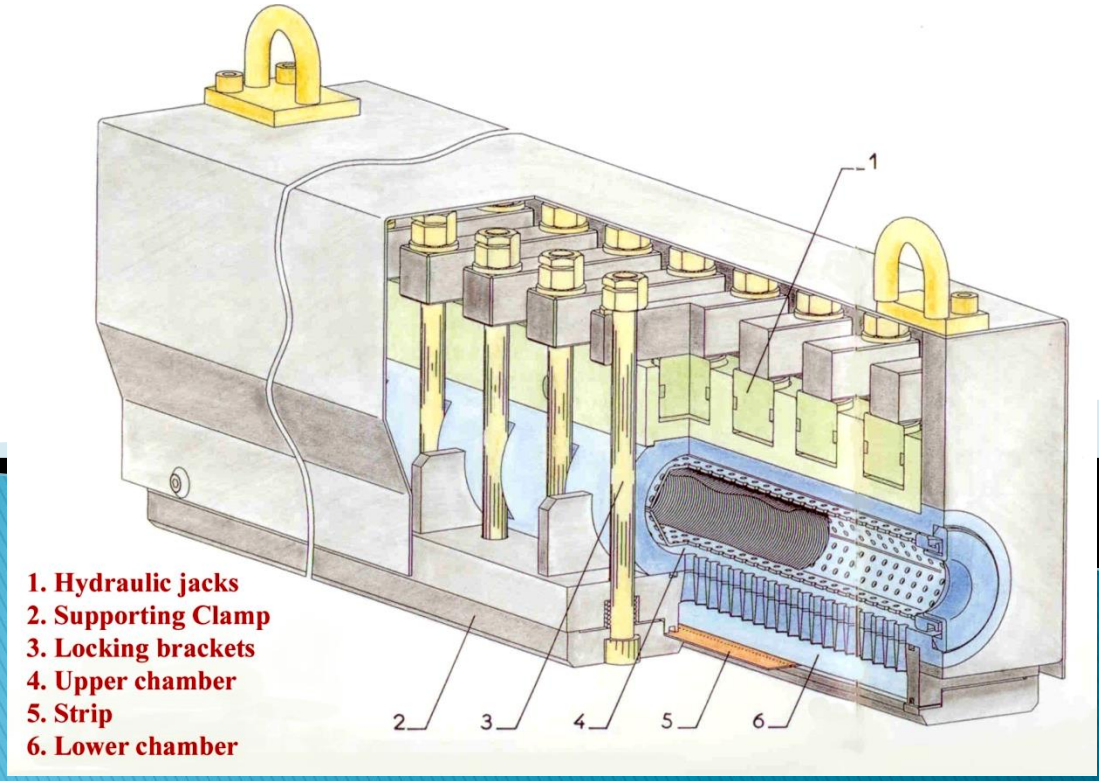
Parts of spunlace machine

Here are described four main parts of spunlace machine:water jets, perforated drum (sieve belt), water purification systemand drying system.

1. Water jets:

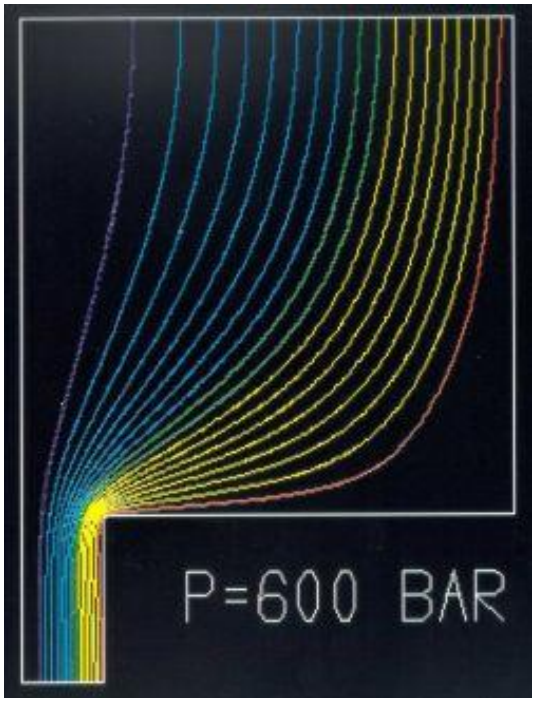
Water jets are ordered to a jet manifold, which is made from stainless steel plate with holes.





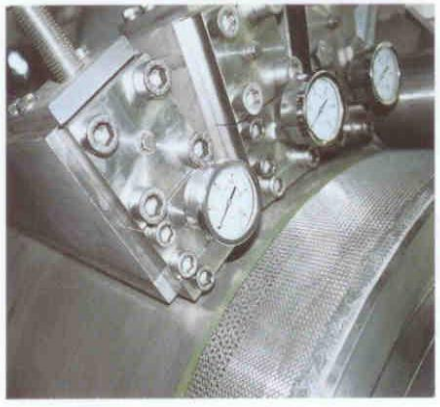
Parameters of water jets:

- Density of jets: 10 – 30 jets/cm
- Jet diameter: 80 – 800 μm
- Pressure inside the jet manifold:
  - up to 60 MPa for web bonding (Fleissner)
  - up to 25 MPa for web patterning (Perfojet)
- Velocity of water jet: 10 – 350 m/sec



Water jet velocity profile

Overviev and placing of jet unit



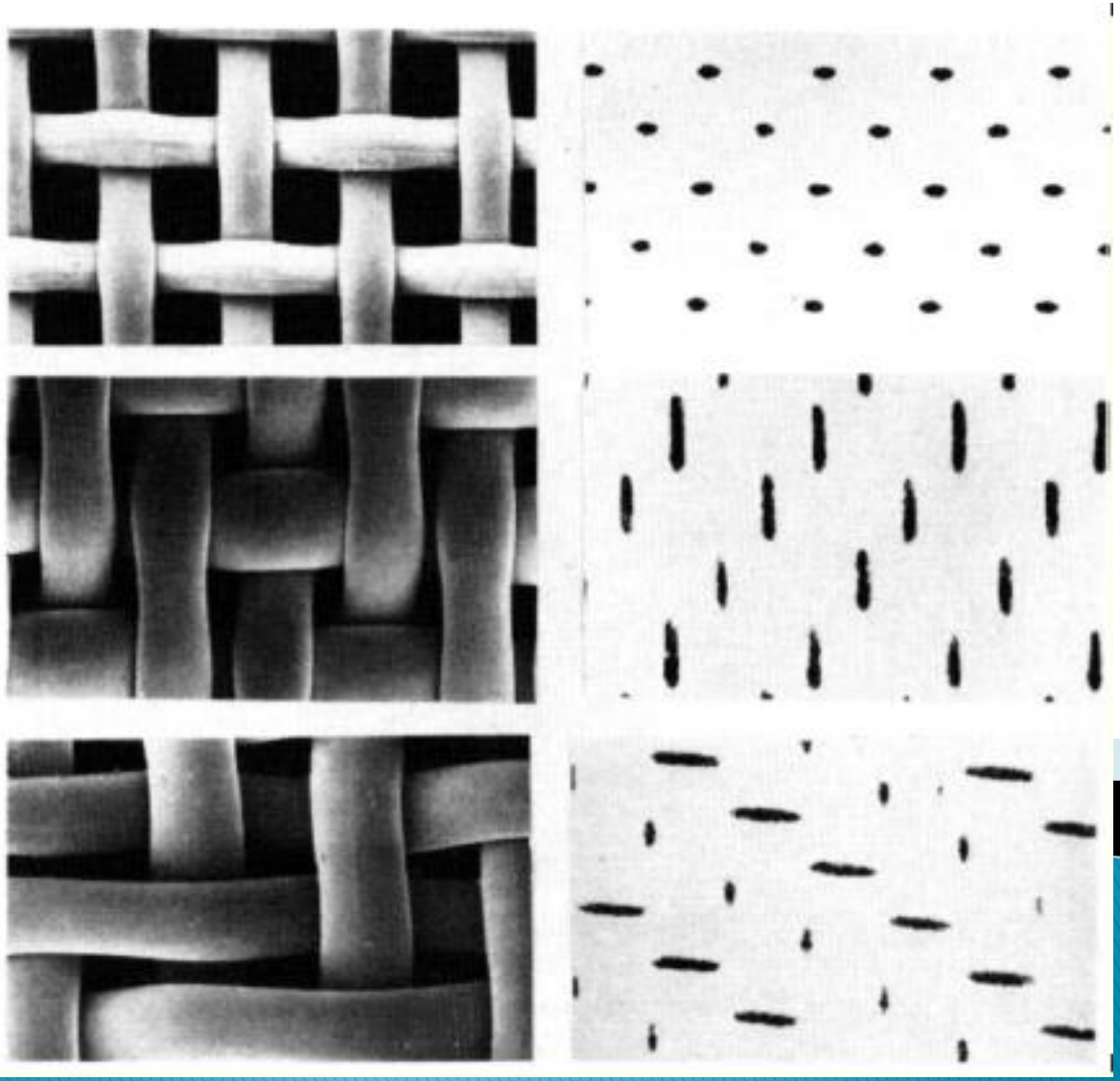
2. Support screen (drum or sieve belt)

Support screen has two main purposes: at first to hold fibrous material to obtain reorientation and interlacing of the fibers and at second to determine the final structure of the bonded textile. The structure of the bonded textile pattern the structure of the support screen.

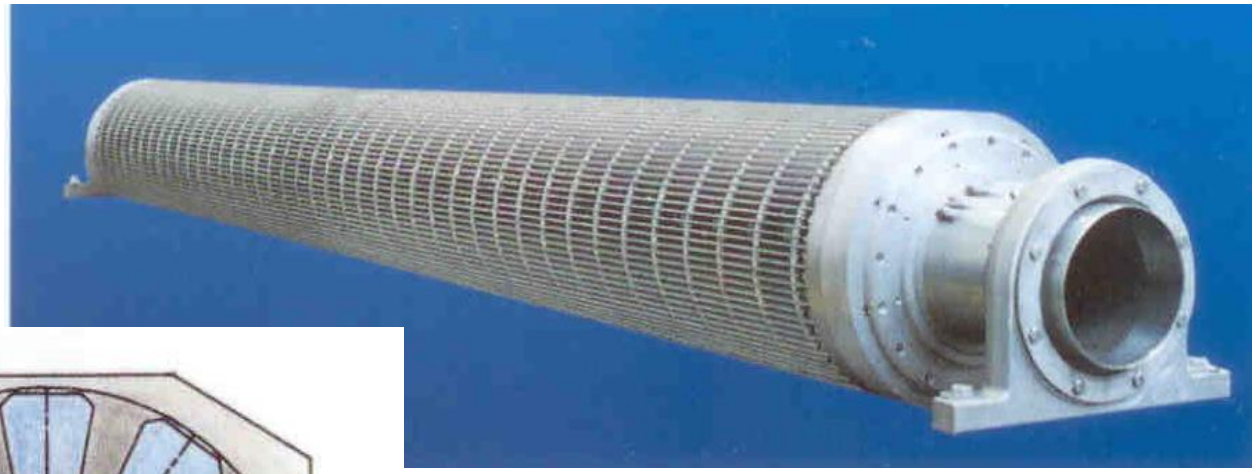
Support screen used for web bonding is made from the bronze or synthetic sieve. The typical range of the sieve wire diameter is 10 – 130 μm. The size of sieve mesh must be precisely defined. When the sieve is too open, the fibers are pushed through and loosed. When the sieve is too compact the kinetic energy of the water jet is dissipated and bonding process is not efficient. The sieve mesh is possible define as an area closed by wires, which depends on the wires diameters and distances. The typical closed area is from 0,012 to 0,5. To obtain more efficient bonding process the water is sucked from the opposite side of the support screen.

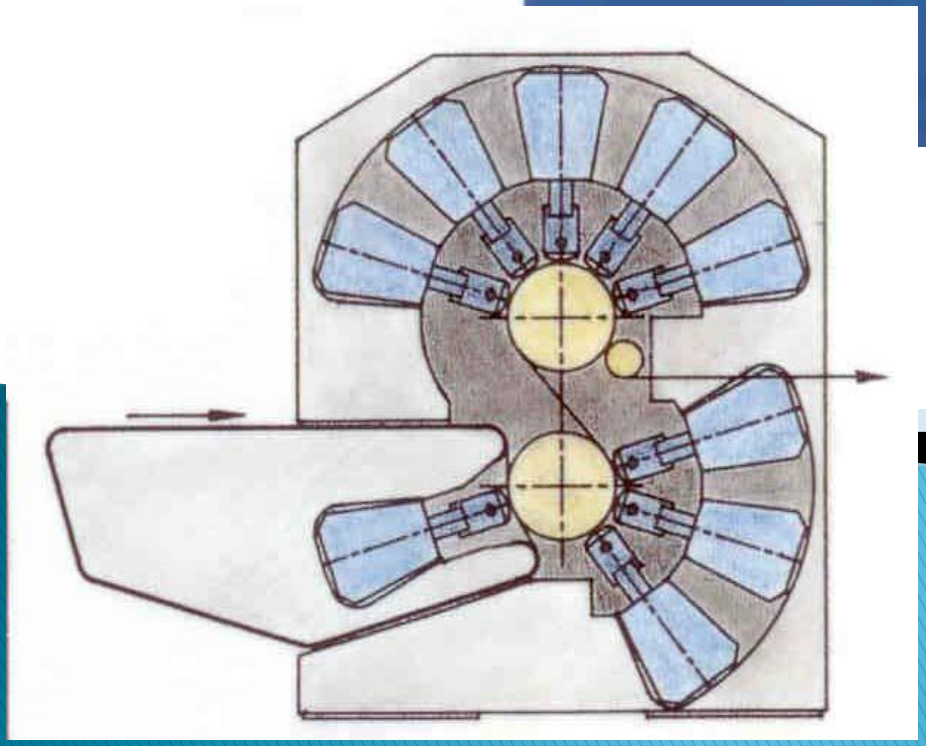
Support screen used for web patterning is made from more fine sieve. Mostly it is perforated drum, where the pattern is made by photographic transfer technique.

Relation between the support screen shape and final product:

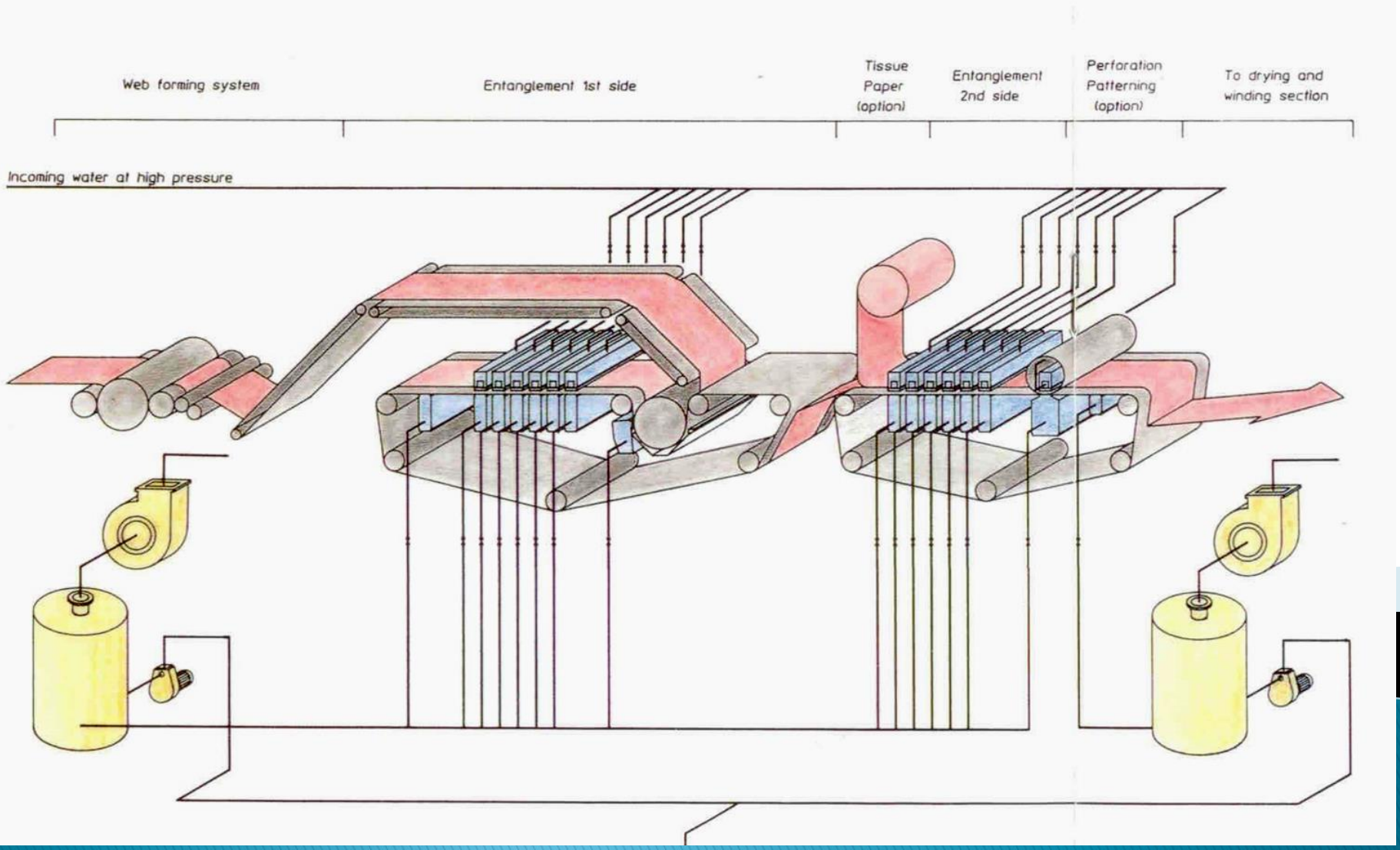


Examples of support screens: peforated drum for web bonding

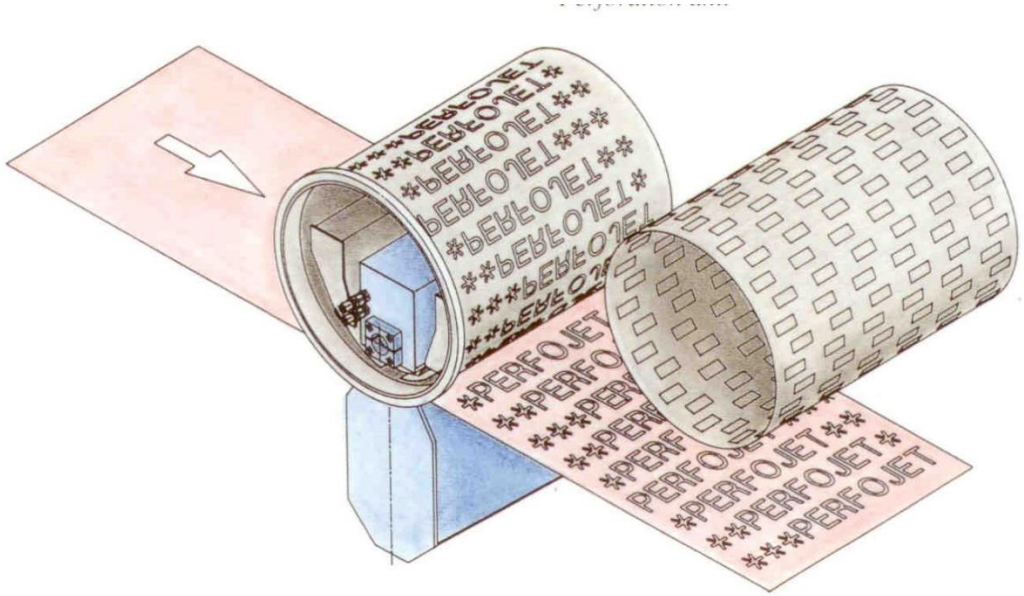


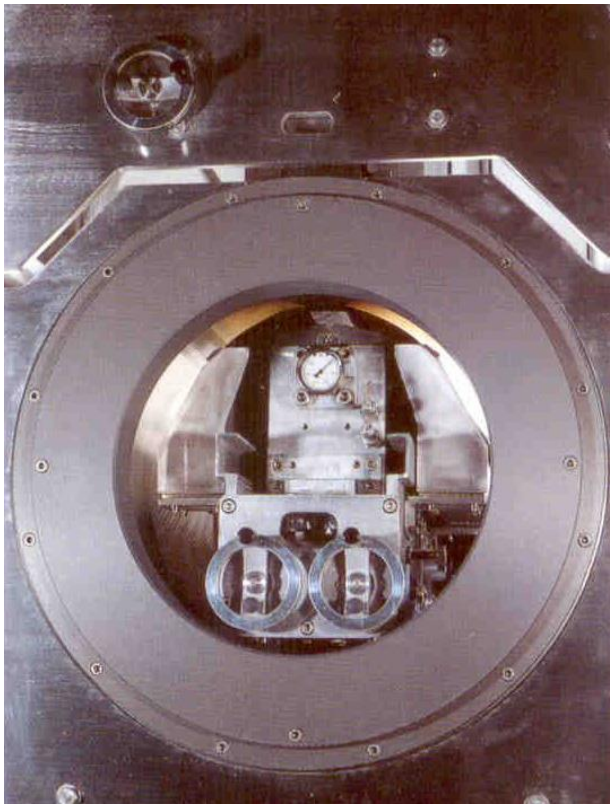


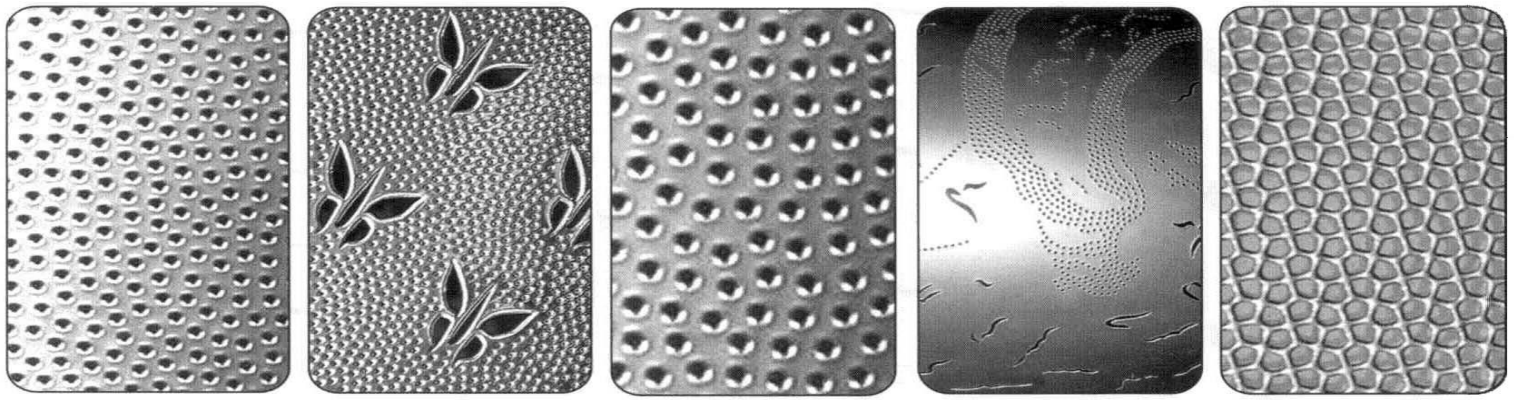
Examples of support screens: sieve belt for web bonding



Examples of perforated drums used for patterning

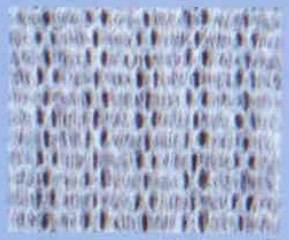


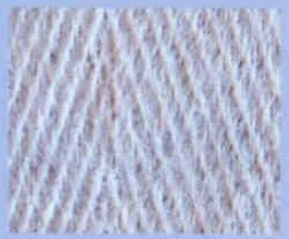


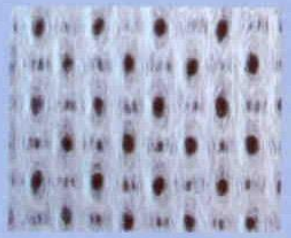


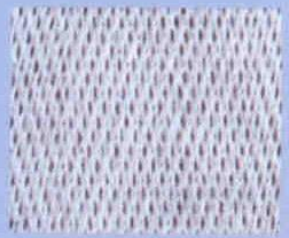
Examples of spunlace patterns:

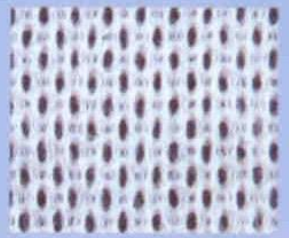
Mesh patterns

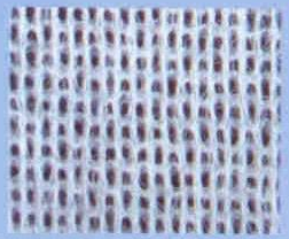

01-S mesh

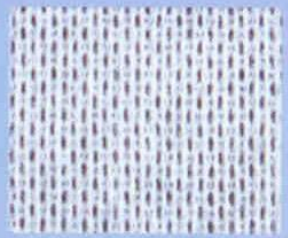

04 - V mesh

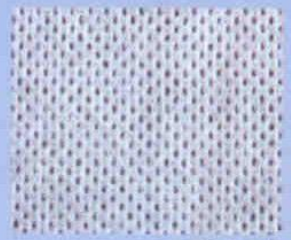

06 mesh

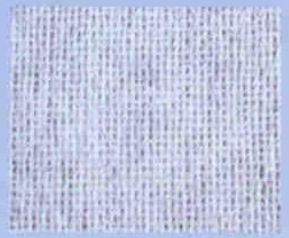

07-V mesh


10 mesh


12 mesh


18 mesh

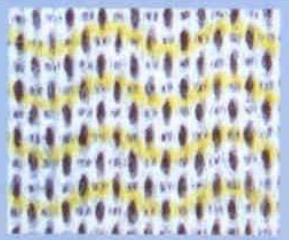

22 mesh

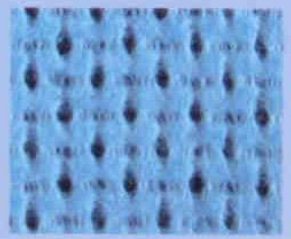

25 mesh

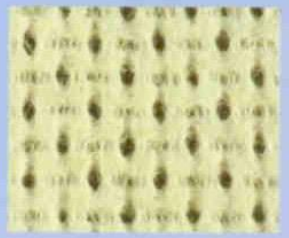

76 mesh

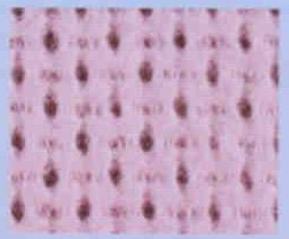
Print, color, emboss, etc.

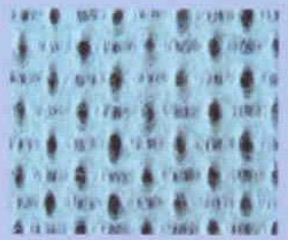
Various printing patterns and colors are available.
様々な印刷、着色が可能です。

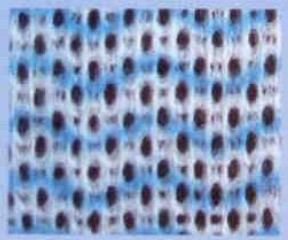








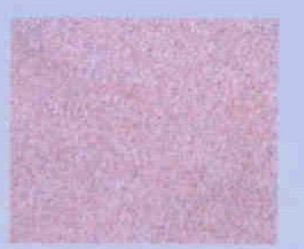





Print
プリント

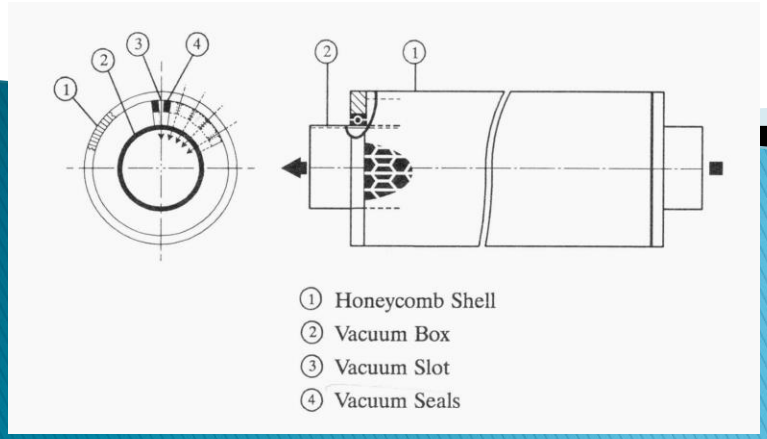

Emboss
エンボス

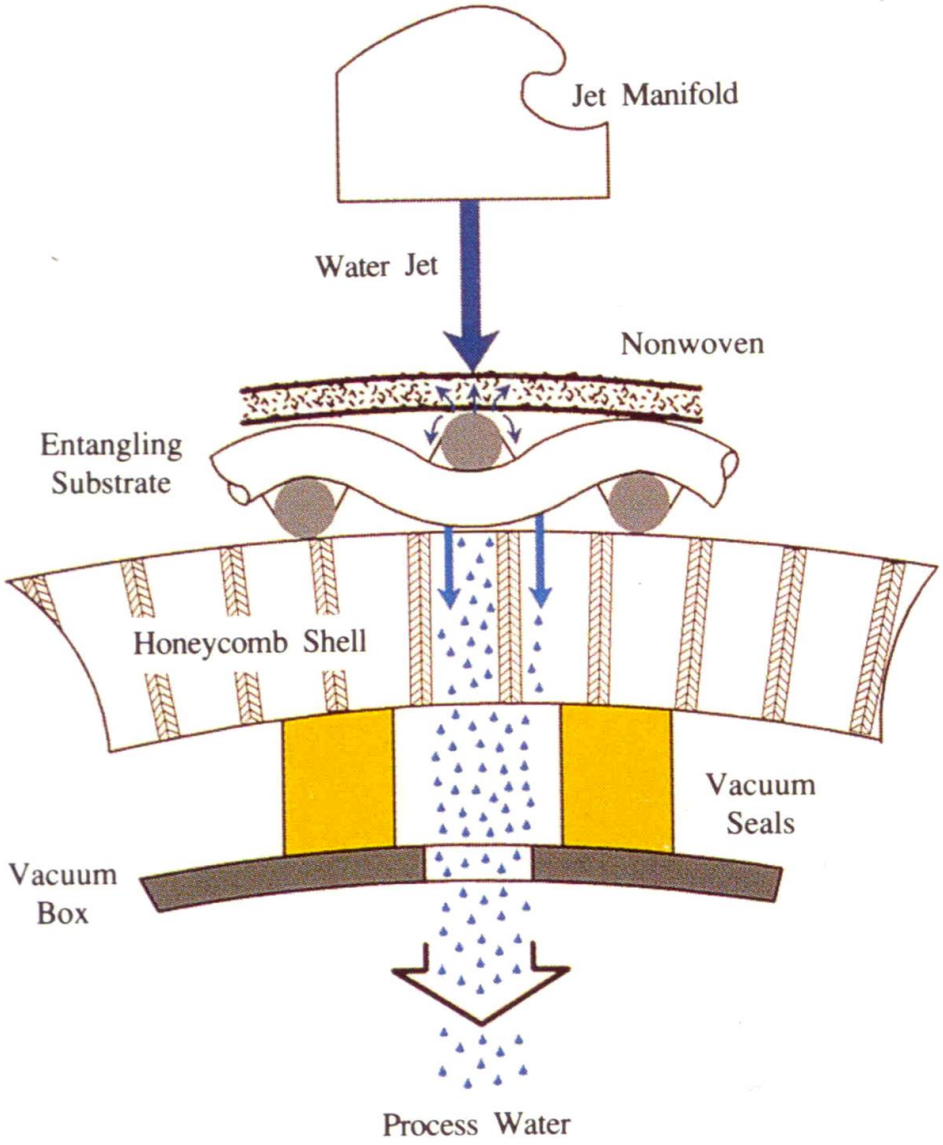

Carbon mixture
炭素繊維混合生地


Velour
ベロア地

3. Water suction system:

The kinetic energy of the water jet is dissipated on the support screen surface. Thus is used water suction system. A vacuum within the support screen removes used water from the product, preventing flooding of the product and reduction in the effectiveness of the jets to move the fibers and cause entanglement. Moreover special shape of water suction named „honeycomb“ help to rectify the water direction.





4. Water purification system

Used water is completely recycled, so it is necessary to monitor folowing parameters:

- Water purity: Water must be free of the air bubles, calcium salts, bacteria, short fibers and linters and other particles. It is very important, because thin water jet would be clogged up (jet diameter is 80-800 μm) or damaged by any particles dispersed in water.
- pH: Neutral to prevent damage of water jet surface.
- Temperature: Warm water decreased bending moment of the fibers and so the bonding efficiency is better.

Typical water purification system has folowing stages:

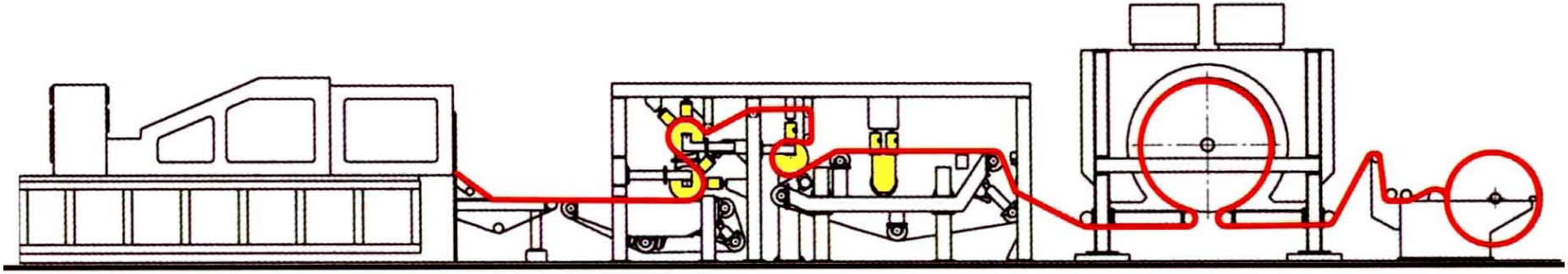
air separator,
coarse filter,
fine filter,
de-ionization unit,
heat exchanger,
bacteria filter

5. Dewatering, drying

Usually are used through-air drums

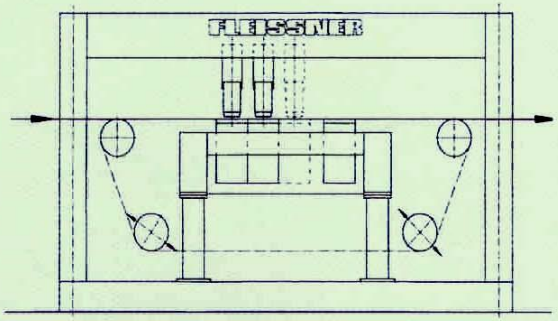
Examples of spunlace lines:

Most known spunlace machines producers: Rieter Perfojet, Fleissner GmbH.

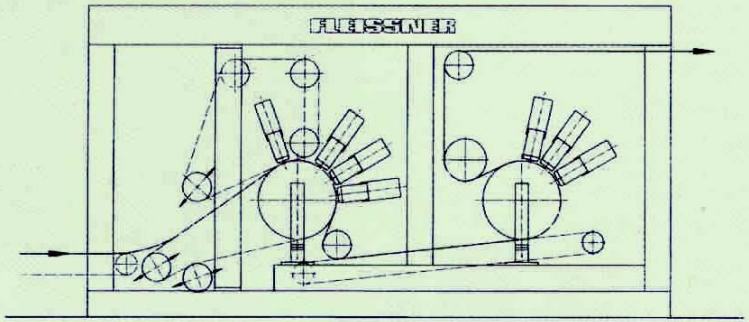


Example of Rieter line

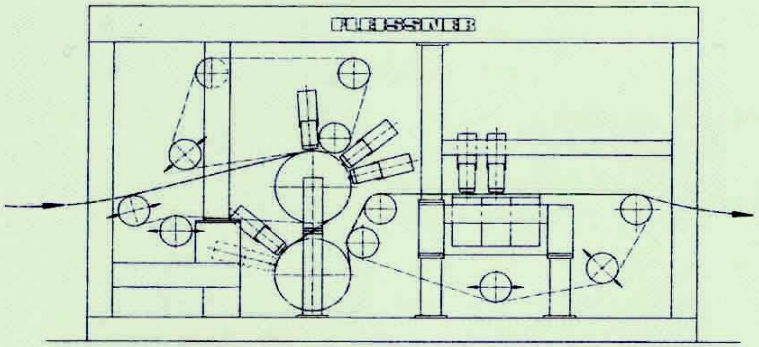
Examples of Fleissner units



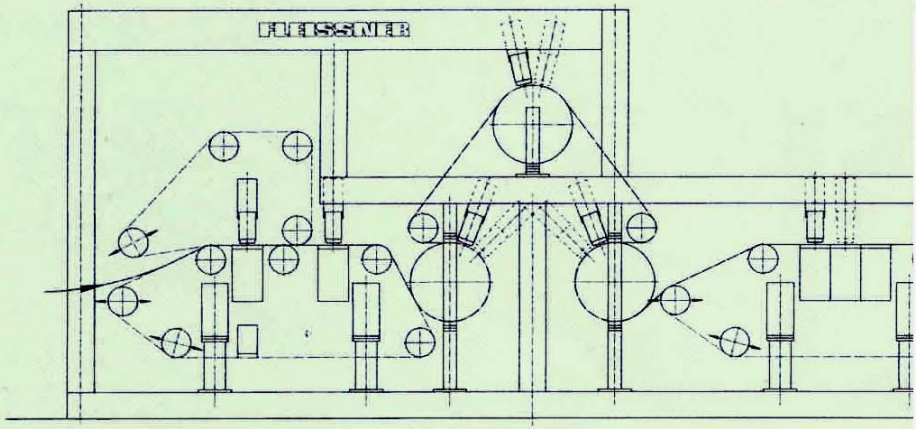
Fleissner-Aquajet Onestep hydroentanglement unit



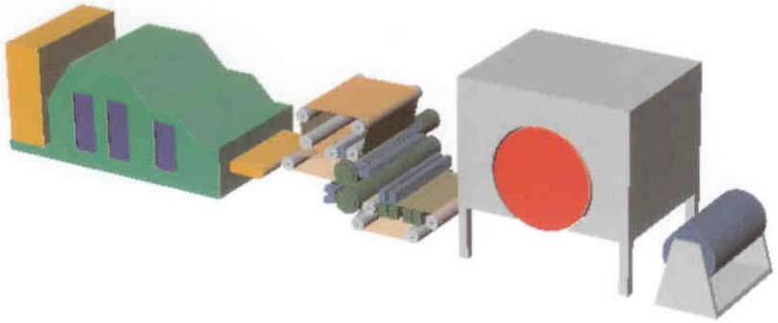
Fleissner-Aquajet Twostep hydroentanglement unit



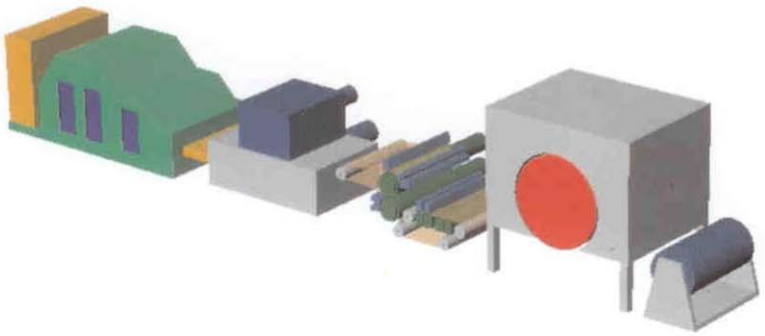
Fleissner-Aquajet Threestep hydroentanglement unit



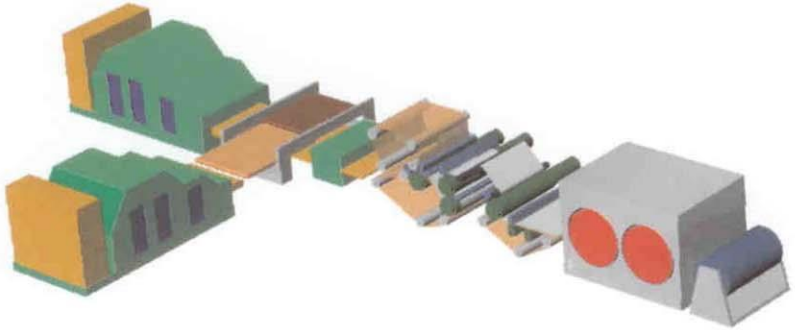
Fleissner-Aquajet Multistep hydroentanglement unit



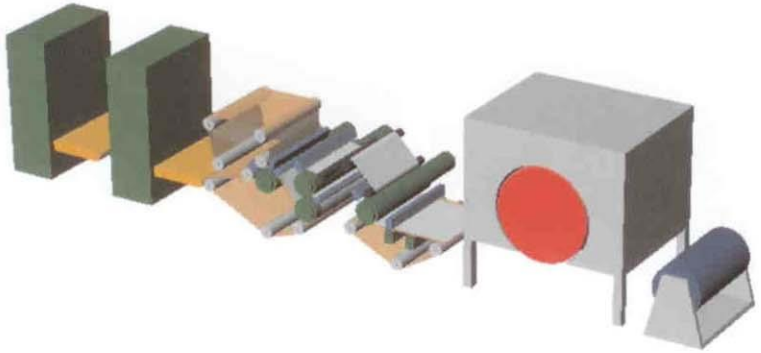
Line for carded nonwovens-low / medium weight, high speed



Line for composite of carded / airlaid nonwovens



Line for carded nonwovens – low / medium / high weight



Line for spunbond nonwovens – high speed 600 m/min; web width up to 5400 mm

Spunlace applications:

1. Hospital use:

   surgical gowns and drapes (fig.1), operational cover sheets, bed sheets, towels...

Fig. 1

2. Medical use:

   wound dressings (fig.2), gauze, wet tissue, cotton products, pads (fig.3)

Fig. 2

Fig. 3

3. Sanitary products:

   baby wipes (fig.4), facial clean wipe, face masks, disposable pants...

Fig. 4

Spunlace applications:

4. Household products:

   cleaning wipes (fig.5), protection fabric for electronics, home furnishing fabrics: table cloths and napkins (fig.6), curtains (fig.7)

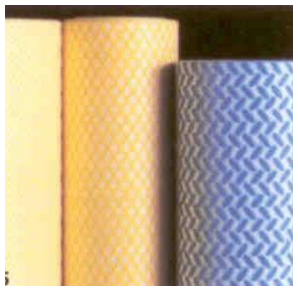


Fig. 5

Fig. 6

Fig. 7

5. Industrial textiles:

   industrial wipes (fig.8), filtration (fig.9), roofing, water insulation (fig.10), protective apparell (fig.11), liquid absorbents

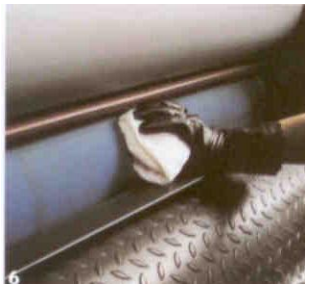


Fig. 8

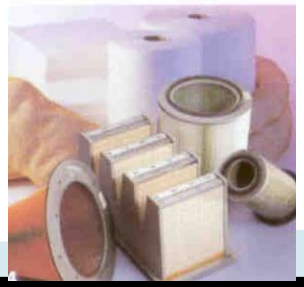


Fig. 10

Fig. 11

Spunlace applications:

6. Automotive products:

   headliners (fig. 12), cleaning wipes,

Fig. 12

7. Interlinings (fig.13):

Fig. 13

8. Coating substrates for synthetic leather (fig.14):

Fig. 14