Textile technology II

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Lectures

1. Pre-treatment, finishing of blends, wetting, washing.
2. Dyeing.
3. Basic principles of printing, printing technologies.
4. Final finishing.
5. Product engineering of clothing industry.
6. Machinery and equipment in clothing production.
7. Connecting and ironing process in clothing production.
8. CAD systems in apparel production.
9. Technical confection and automotive.
10. Characteristics of non-woven fabrics, methods of their production, application areas of nonwovens.
11. Polymers for the production of nonwoven fabrics and their properties, Binders for nonwovens production.
12. Preparation of fibrous layers.
13. Mechanical, thermal and chemical bonding methods of fibre layers.
14. Repetition and consultation of subject matter.

Annotation

In the course students are informed about technology of textile finishing, nonwovens and clothing. This course provides students with a good basis for understanding textile technologies and enables students to develop further in related subjects.

Selected lectures and teaching materials

Lectures 10. – 13.

Nonwoven technology

Contents of Nonwovens

1. Definition of nonwovens
2. Clasification of nonwovens
3. Fibers for nonwovens, special fibers,binders
4. Nonwovens technologies

Author: Jiří Chaloupek

Nonwoven definition (Europe)

- A sheet, web or batt – directionally or randomly oriented fibers
- Bonded by FRICTION and/or
  COHESION and/or
  ADHESION
- Excluded: paper, knitted, woven,…

Author: Jiří Chaloupek

Nonwoven definition (US)

- A sheet, web or batt – natural or man-made fibers or filaments
- That have not been converted into YARNS
- Bonded to each other by any of several means

Author: Jiří Chaloupek

Nonwovens

- Automotive
- Clothing
- Household
- Medical and Healthcare
- Absorbent hygiene products
- Building
- Civil engineering and geotextiles
- Filtration

Author: Jiří Chaloupek

THE NONWOVENS CAR

1. Covering material for sun-visors
2. Padding for sun-visors
3. A, B, C, column padding
4. Door trim pads
5. Fuel filters
6. Oil filters
7. Moulded bonnet liners
8. Sound-proofing
9. Battery separators
10. Cabin air filters
11. Loudspeaker cover
12. Covering for moulded seats
13. Transmission tunnel
14. Carpet & carpet reinforcement
15. Car mats
16. Vinyl backing for seat covers
17. Backing for tufted carpeting
18. Covering for seat belt anchorage
19. Covering for seat belt
20. Decorative fabric
21. Polyurethane coated backing
22. Seat slip agents
23. Tyre reinforcement
24. Boot floor covering
25. Boot (trunk) liners
26. Silencer (muffler wraps)
27. Moulded fuel tanks
28. Bodywork parts
29. Rear shelf panels
30. Window frames
31. Headliner facings
32. Upholstery backing
33. Loudspeaker housing
34. Sunroof
35. Saloon roof
36. Insulation materials
37. Headliner backings

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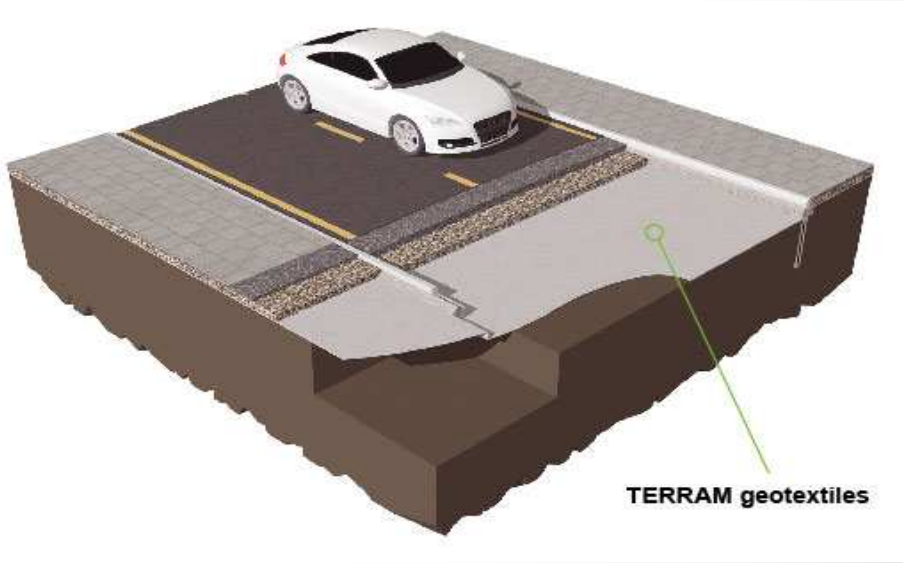
THE VOICE OF NONWOVENS


TERRAM geotextiles

Production principles of nonwovens

- Web forming
- Web bonding
- Fabric finishing

Web forming methods

- Dry Laid (of staple fibers)
- Carded, Air Laid, Combined Carded – Air Laid
- Wet Laid (of staple fibres)
- Spun Laid
- Spunbond, Melt Blown, Electrostatic spun

Web bonding methods

- Mechanical bonding
- Needled, Stitch bonded, Spunlaced, Felts
- Chemical bonding
- Dispersion bonded by saturation, spraying, screen printing, foam
- Polymer solutions bonded
- Thermal bonding by calender, thru-air, ultasound, infrared

Author: Jiří Chaloupek

Raw Materials for Nanowovens

Polymer, fibres and binders are the basic raw materials for nonwovens

Most important terms

1. Processability of raw materials in nonwovens technologies
2. Mechanism of forming nonwovens structures
3. Resulting properties of products as a function of raw material properties

• *Author: Jiří Chaloupek*

Fibres

The producer of nonwovens must consider fiber raw materials from the point view of their

1. Processability in particular technology
2. Impact on the product properties
3. Price

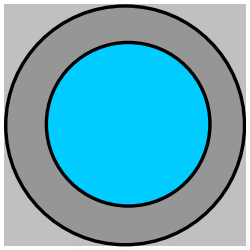
- Fibers for nonwovens
- Polypropylene (PP)- Plastic flow temperature= 155-165 degree of Celsius
- Polyester (poly ethylene terephthalate)- 256-260 degree of Celsius
- Rayon (Viscose)-
- Polyamide 6 (Nylon 6)- 220 degree of Celsius

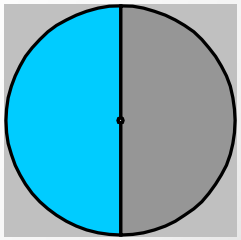
Author: Jiří Chaloupek

Bi-component fibers

- The main advantages that bi-component bonding fibers offer are the following:
- Low shrinkability during thethermal bonding process which also result in high bulk
- Small bonding sites mutually linked by the core and resulting high elasticity and strength of textiles
- Unlimited variety of thermal properties and adhesive capacity of employed polymers.

- The sheat/core and side by side fibers are commonly used as bonding fibers. They are produced using special spinnerets.





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Binders for nonwovens

- Polymer solution
- Polymer dispersion (latexes)
- Foamed polymer dispersions
- Polymer pastes
- Solid polymers: thermoplastic fibers
- thermoplastic powder, foil, meltblowns or spunbond sheet, netting, threads

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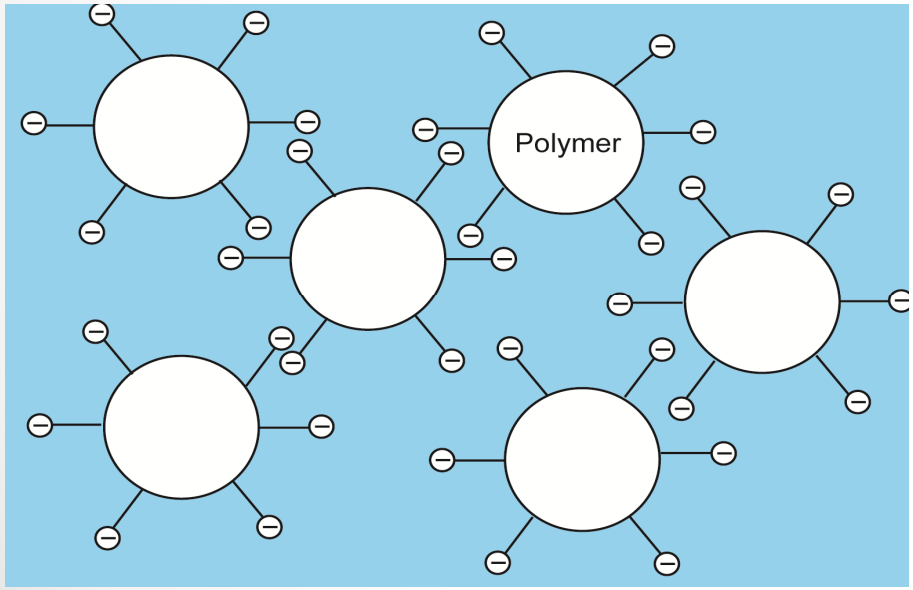
Polymer dispersion (latexes)

- An aqueous polymer dispersion is a two-phases system consisting of homogeneus phase (water) and particles of a polymer



A **surfactant** is an important part of dispersion.
Surfactants are chemicals which reduce surface tension on the surfaces between two immiscible materials.
The **surfactant** prevents the particles from unit

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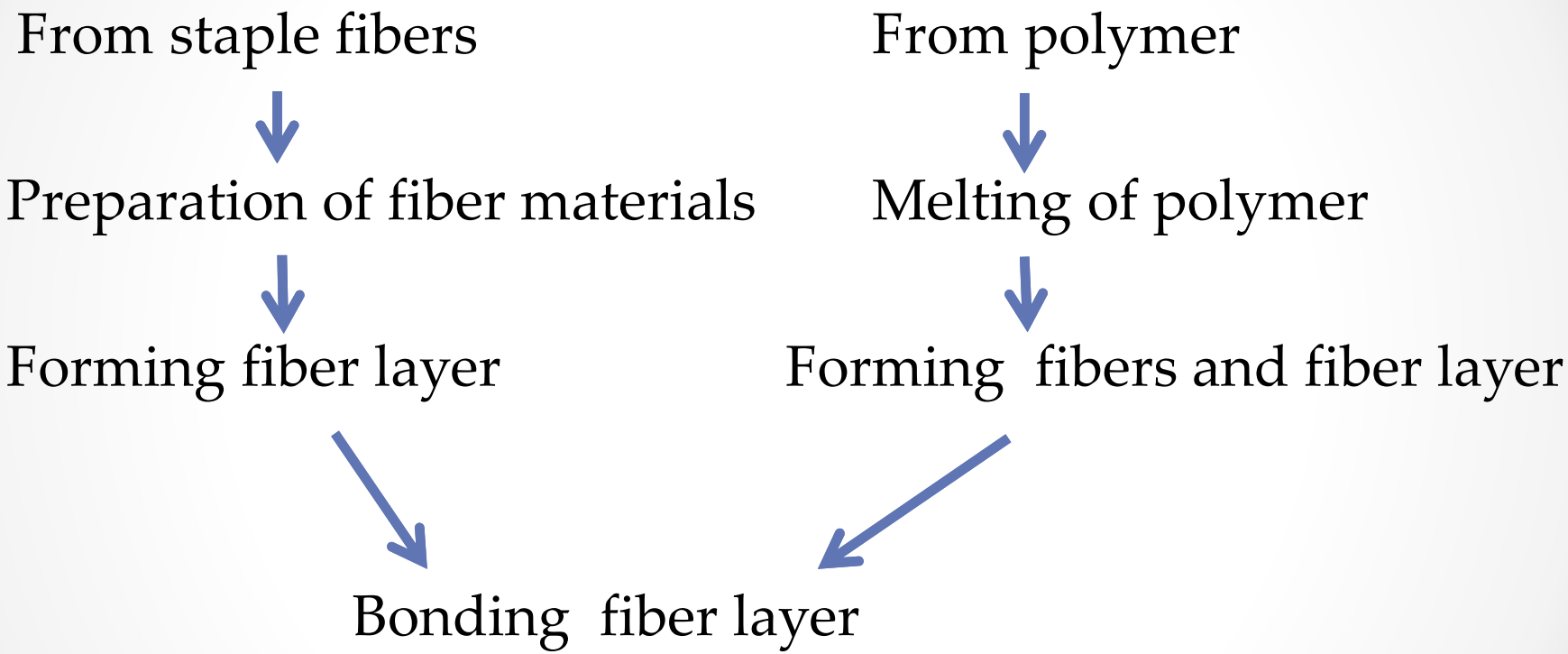
Nonwoven Technologies



Web forming methods

- Dry-laid methods
- Formation and layering carded web (mehanical methods)
- Aerodynamic web formation (air-lay)
- Combined mechanical-aerodynamic methods

Author: Jiří Chaloupek

Mechanical methods

- Carding – In the carding process, individual staple fibers are separated from clumps of fibers and more or less uni-directionally oriented
- Nonwovens- roller card

- Layering of carded web-The prepare fiber layers of desired weight, the carded webs are layered using the following methods:
- Longitudinal layering
- Cross layering
- Perpendicular layering

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Aerodynamic web forming

- In contrast to carding methods, fibers are randomly oriented in the layer. This gives the product more or less uniform properties in various direction.
- In voluminous layer the fibers are oblique to the fabric area.

Advantages are:

- Isotropic stucture of the web
- Voluminous webs can be produced
- Wide variety of fibres processable as natural, synthetic, glass, steel, carbon, etc.

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Aerodynamic web forming

The main disadvantages are as follows:

1) Low level of opening fiber material by lickerin
2) Various stuctures of web in width of layer due to irregular air flow close to walls of duct
3) Possible entangling of fibers in air stream.

The disadvantages 1) and 3) restrict performance of the device. The level of opening of the fibers can be enhanced by reducing the efficiency of the carding process

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Wet-laid methods

- Wet- laid methods were developed as a modification of the papermaking process. 5 percent of nonwoven roll goods are produced using these methods in various countries.

When compared with dry-laid methods, the wet process are distinguished by:

- Large, expensive and high-performance devices, output speeds up to 1000 m/min.
- High demand on energy
- Lightweight, non-voluminous products, usually below 100 /m^2.

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Polymer- laid method

- Spun bond
- Melt blown
- Electrostatic spinning

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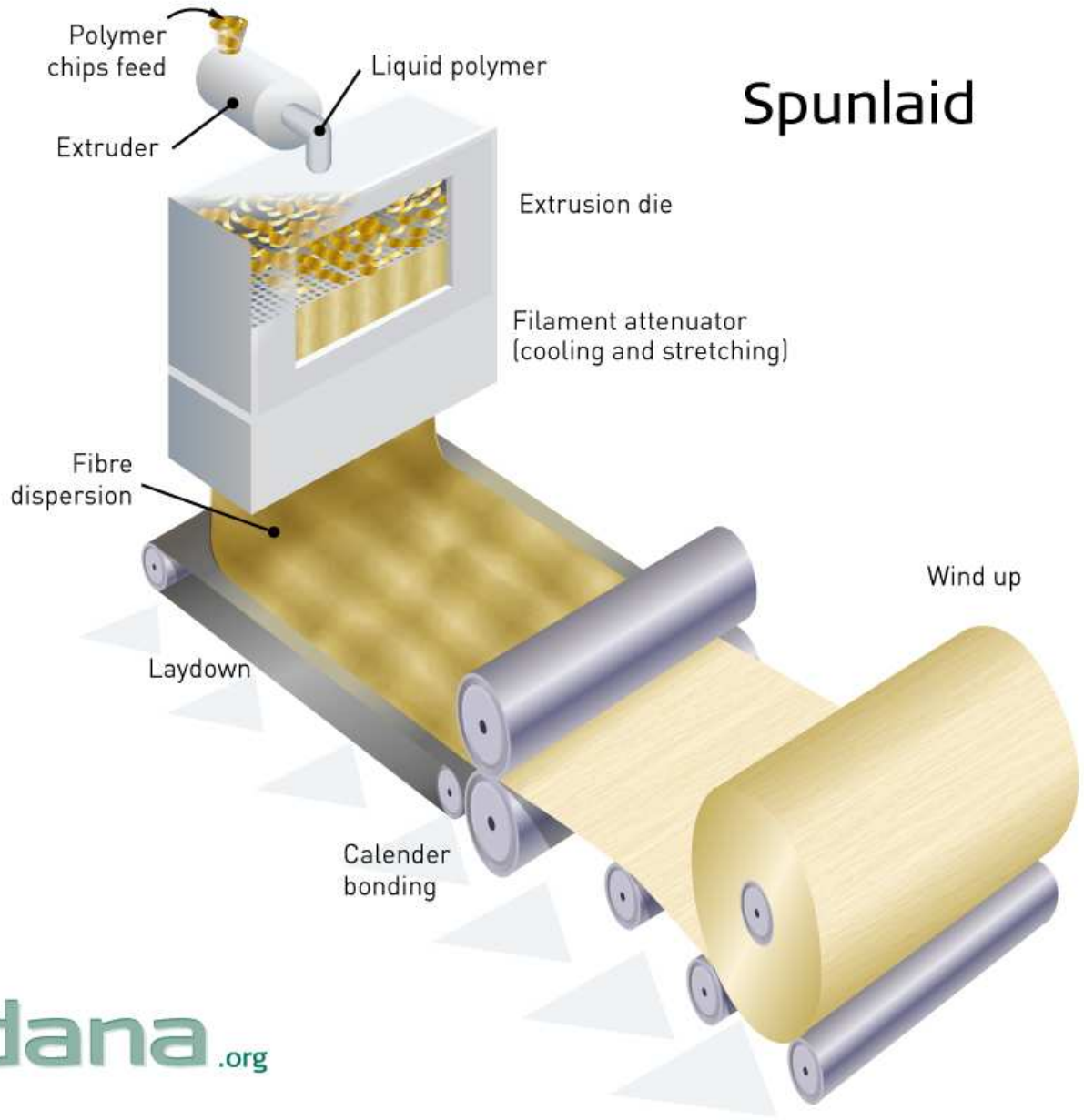
Spunbonding process

The spunbonding process consists of following integrated operation:

- Polymer melting, transport and filtration of polymer melt
- Filament extrusion
- Filament drawing
- Filament deposion
- Bonding

Spunlaid



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Spunbond

Properties of spunbond webs

- Typical area weights of spunbond webs range between 5 - 800 g/m^2, usually 10-200 g/m^2. The layout of filaments is isotropic but can be modified by especially designed deposition systems.
- Filaments are not texturized, are low, medium or high drawn depending on the drawing system.
- Filaments diameters range between 1- 50 micrometers, typically 15 - 35 micrometers. The web are not voluminous with thickness ranging between 0,1-4 mm, typically 0,2-1,5 mm.

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Spunbond

Spunbond nonwovens are utilized in a variety of applications such as:

- top sheet for diapers,
- sanitary napkins,
- protective medical,
- industrial and agricultural apparel and others

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Melt-blowing process

The melt blowing process consists of the following integrated operations

1) Polymer melting
2) Transport and filtration of polymer melt
3) Polymer extrusion and filament forming using hot air
4) Forming web on the surface of wire screen collector belt-bonding

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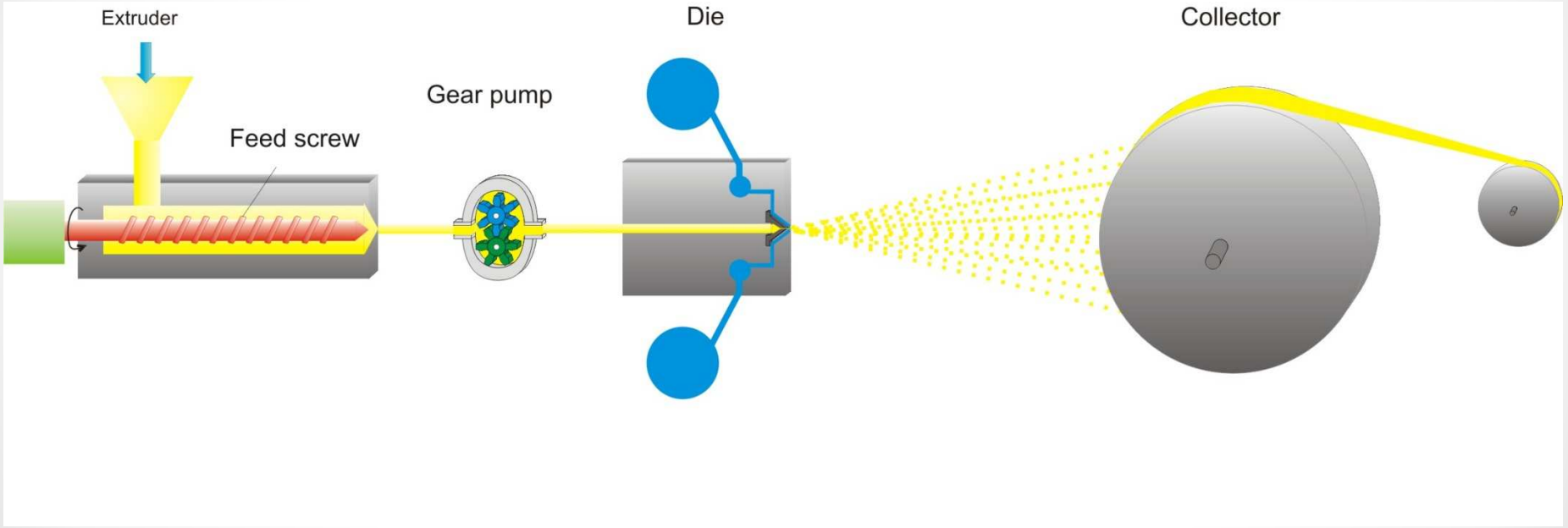
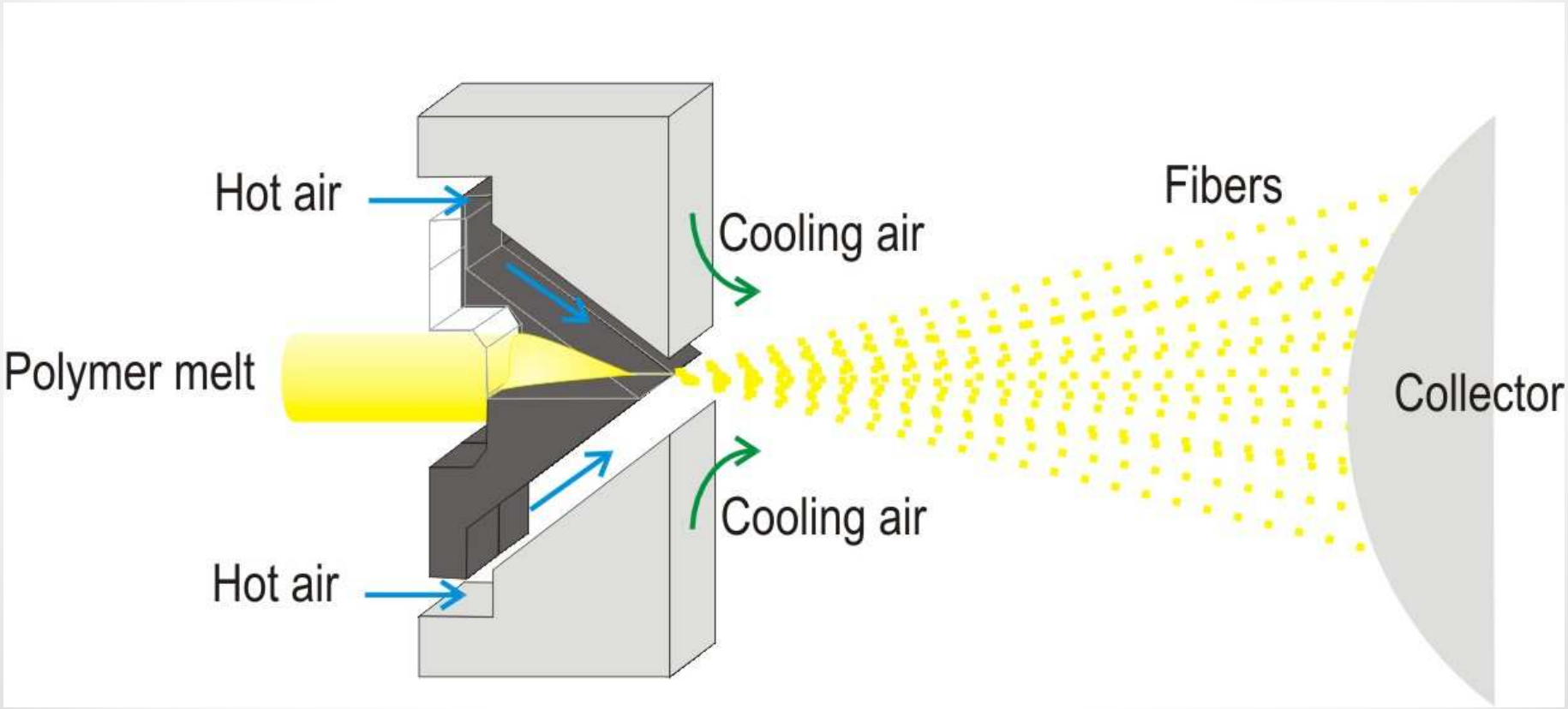
Melt-blowing process



Schematic of melt blown die



Process variables

- The most important on-line variables of the melt-blowing process and examples of their typical values are as follows:
- Temperature of polymer melt: 200-400 degree of Celsius
- Temperature of air: 250-400 degree of Celsius
- Air throughput rate: 100-500 m/s
- Mass ratio air:polymer 100
- Die-to-collector distance: 0,2-0,5 m

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End-uses of melt-blown webs

The main applications of melt-blown webs are

- Filtration
- Oil absorption
- Industrial wipes
- Adhesives
- Batery separtors
- Surgical face masks, and many others
- thermal insulation
- sanitary napkins
- respirators
- protective apparel
- diapers cover stock

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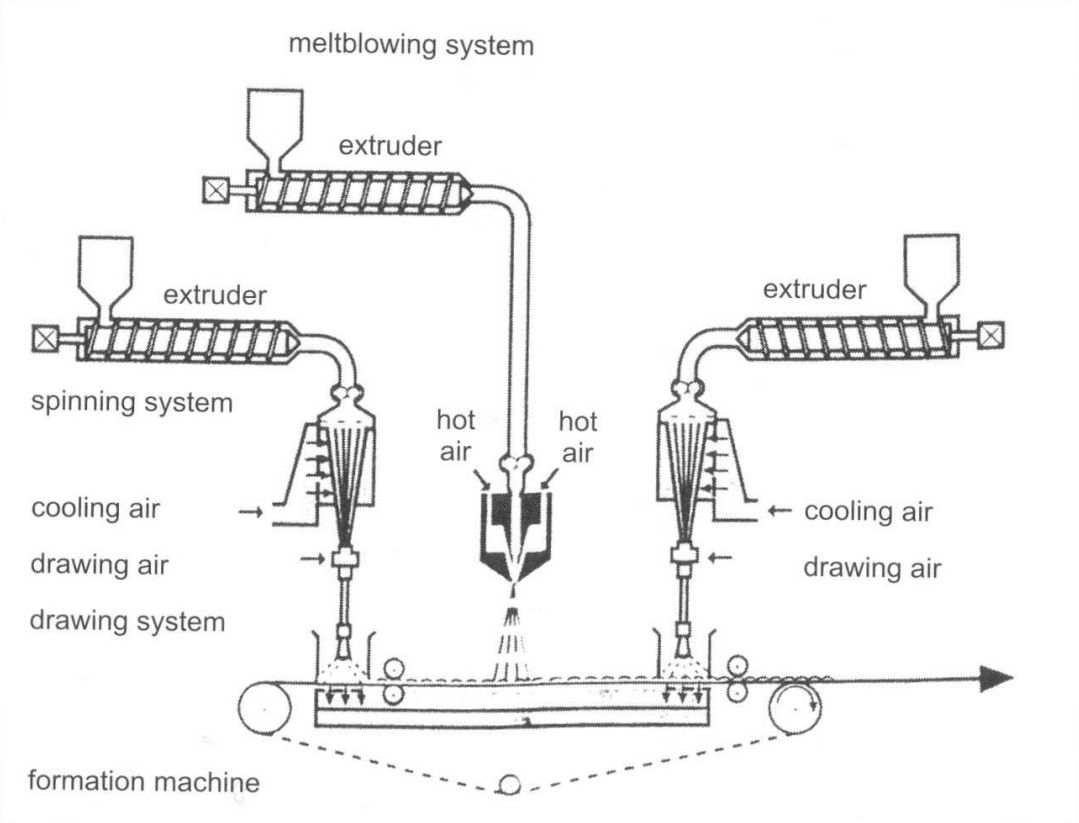
meltblowing system
extruder
extruder
extruder
spinning system
hot air
hot air
cooling air
drawing air
drawing system
cooling air
drawing air
formation machine

Web bonding methods

- Mechanical bonding methods
- Chemical bonding
- Thermal bonding

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Mechanical bonding methods

- Needle-punching
- Spunlaced

Needle- punching

- 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.

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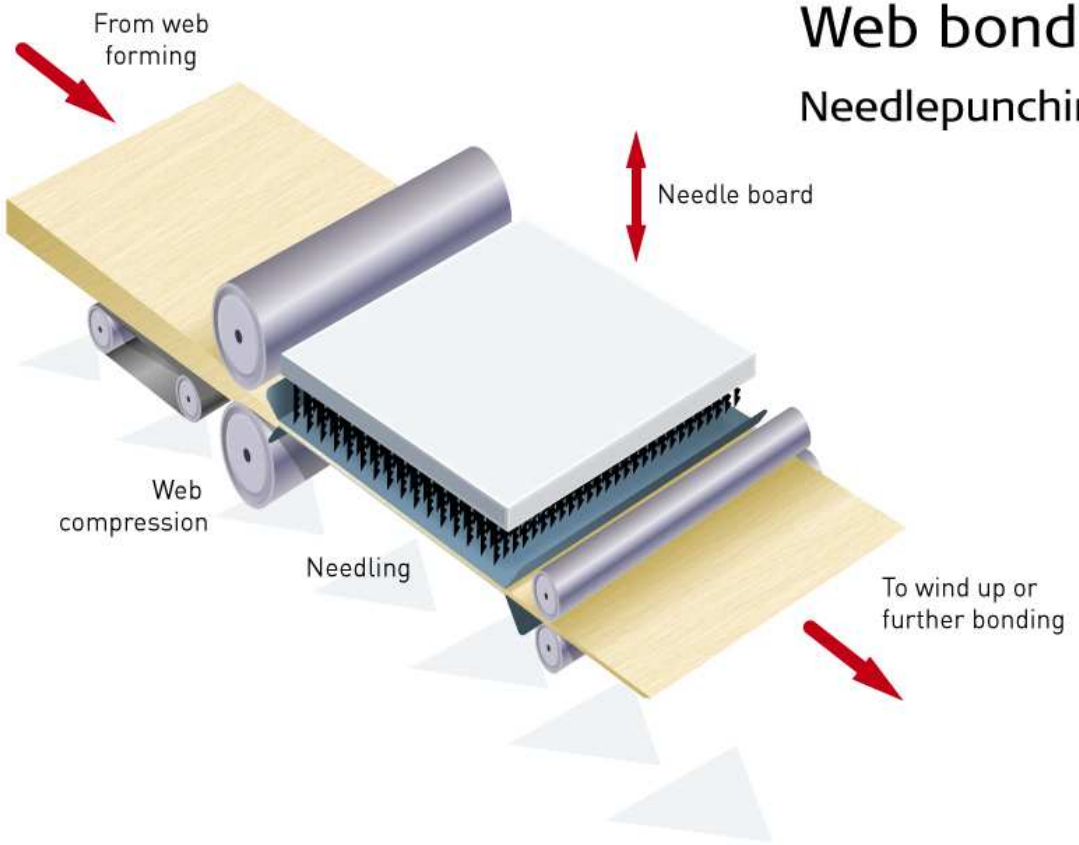
Web bonding

Needlepunching



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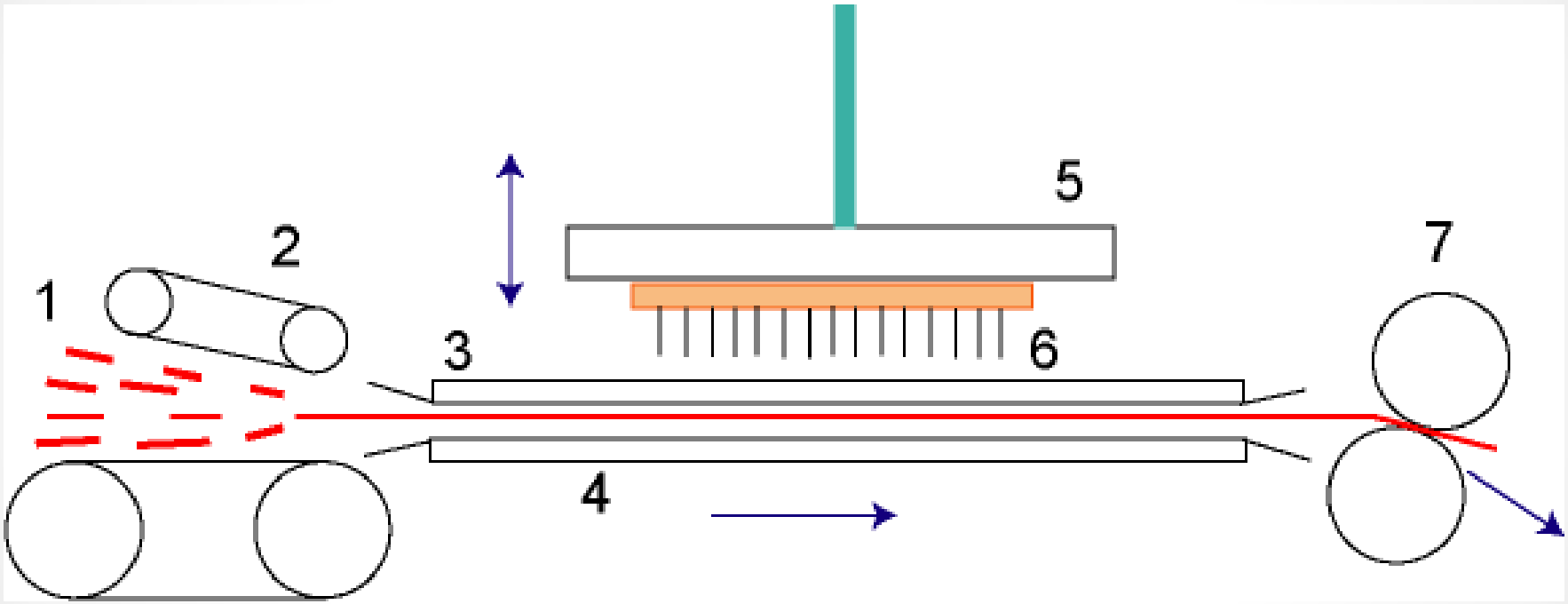
Needle- punching



Needle- punching

- A web is transported by a feeding device between upper and lower holeplate. The barbed needles periodically penetrate through holes in plates and through the web. In every stroke, the barbs of the needles seize fibers and pull the fibers through the web creating a fiber bundle.

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Needle- punching

The needling process has a number of variebles

These are:

a) Material variables- diameter, lenght, tensil properties and friction coefficient of fibers.

b) The off-line variables which can only be changed when the production line is not in operation.

Web forming method, fiber layout, area weight of web,kind of needles in the needle board

c) The on-line parameters which can be changed during production

Number of punched per area, depth of needle penetration and draw ratio of the web inside the needle loom.

- *Author: Jiří Chaloupek*

The number of punches

$$N_v = \frac{a * f * p}{v}$$

a - total number of needles per 1 m of working width (1000 needles per one meter)

f - frequency of needle board (working frequency range between 800-2500 per minute)

p -number of passages through needle loom or number of needle looms in a production line

v – velocity of web (m/s)

- *Author: Jiří Chaloupek*

Spun laced technology

- Spunlace nonwovens fabrics are alternately called water jet-entangled, hydroentangled, or hydraulically needled nonwovens.

- The spunlace process is nonwoven manufacturing system that employs jets of water to entangle fibers and thereby provide fabric integrity.

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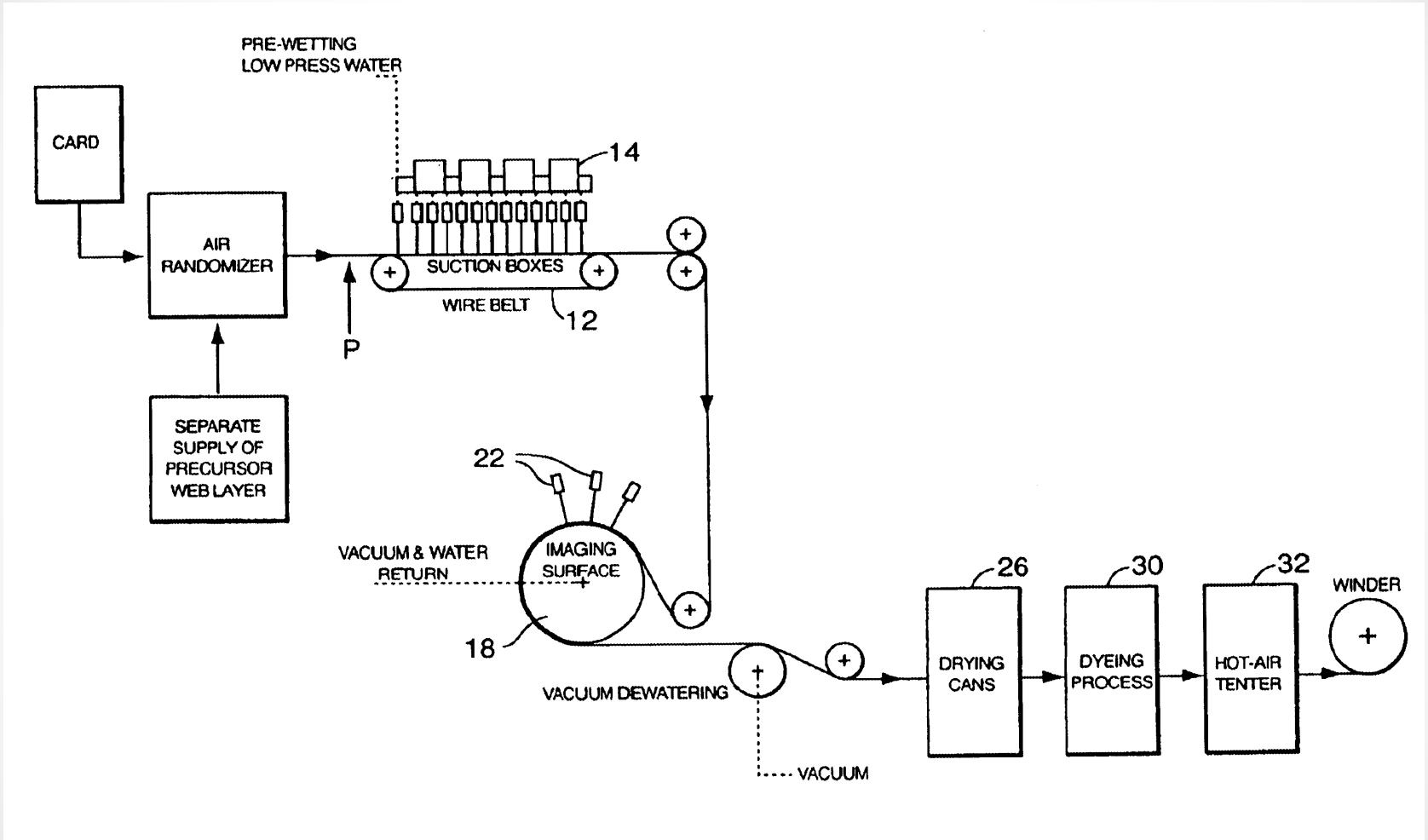
PRE-WETTING
LOW PRESS WATER
CARD
AIR
RANDOMIZER
14
SUCTION BOXES
WIRE BELT
12
P
SEPARATE
SUPPLY OF
PRECURSOR
WEB LAYER
22
VACUUM & WATER
RETURN
IMAGING
SURFACE
18
VACUUM DEWATERING
VACUUM
26
DRYING
CANS
30
DYEING
PROCESS
32
HOT-AIR
TENTER
WINDER

Spun laced technology

Structure and properties

- The sunlaced fabrics are bonded by entangling the fibers. Typically, they are perforated in a pattern which is a mirror image of the forming wire.
- This process gives the fabrics excellent properties when compared with other types of nonwovens, namely softness, drape, hand, conformability, and relatively high strenght.

Author: Jiří Chaloupek

Spun laced technology

End uses

- Medical and disposable apparel, garment interlinings, wipes and home furnishings are the main end-uses of spunlaced nonwovens.

Advantages and disadvantages

- Excellent fabric properties and high productivity are main advantages of the process.
- High investment and energy costs as well as the water filtration requirements are main limiting factors of hydroentanglement.

Author: Jiří Chaloupek

Chemical bonding

- In chemical bonding, bonding adhesives are used in the form of polymer dispersion (latex) or polymer solution

Steps:

- Forming fiber layer
- Apllication of binder,
- Coagulation of binder
- Drying
- Curing

Author: Jiří Chaloupek

Chemical bonding

The following methods of binder application are used:

- Saturation
- Spraying
- Printing
- Froth bonding

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Thermal bonding methods

The process consists of:

- Forming fiber layer
- Aplication of binder by
- Depositing of powder, paste or polymer melt
- Layering up fiber layer and binder netting or foil
- Forming fiber layer of blend of basic and bonding fibers
- Melting binder by increasing temperature
- Forming binder
- Solidification of binder by cooling

Author: Jiří Chaloupek

Advantages of thermal bonding

- The main advantages in comparison with chamical bonding are good hygienic properties of fabrics.
- Environmentally friendly process (no chemicals, no curing agents, no formaldehyde)
  - Simple devices
  - High productivity
  - Low energy consumption

Author: Jiří Chaloupek

Disadvantages

The following disadvantages should be taken into account:

- Demanding blending
- Low fiber –binder interface, possible loe stability in washing and dry cleaning
- Lower productivity of forming fiber layer, the bonding fibers must pass through the device

Author: Jiří Chaloupek

Thermal bonding method

Calender bonding

- In calender bonding, the fiber layer passes through a nip between two rollers. One of the rollers or both of them are heated. The fiber layer is compressed between the rollers and is heated by the rollers

Through-air bonding

- Air permeable fiber layers are effectively heated in a through-air proces.
- This process is useful in both bonding and laminating techniques.
- Mono-component fusible fibers or bi component core sheet fibers with fusible sheet are commonly used as bonding fibers

Author: Jiří Chaloupek

Control questions for students

- ✓ What is definition od nonwoven?
- ✓ Name the industries where there nonwovens.
- ✓ Describe basic production principles of nonwovens.
- ✓ Which type of fibres are use in nowovens?
- ✓ Write basic nonwoven technologies.
- ✓ What operations does spunbondig process consist?
- ✓ What operations does melt-blowing process consist?
- ✓ Describe needle-punching method. Is it mechanical bonding method or thermal bonding method?
- ✓ Name main advanteges and disadvnatages of thermal bonding method.

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Lectures 1. – 4.
Finishing technology

Author: Jakub Wiener

Contorl questions for students

- Describe basic type of finishing.
- What does it mean pretreatment. Can you give an example?
- What is the principle of dyeing? What type of dyeing do you know?
- Define „Dye %“. What does it mean?
- Compare type of dyes for cotton.
- Describe textile printing.
- Define easy-care finish, flame retardant finish and water-repellent finish.
- What does it mean fastness of coloration. Describe „deep of shade“, „grey scale“.
- How does it test fastness of coloration?

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