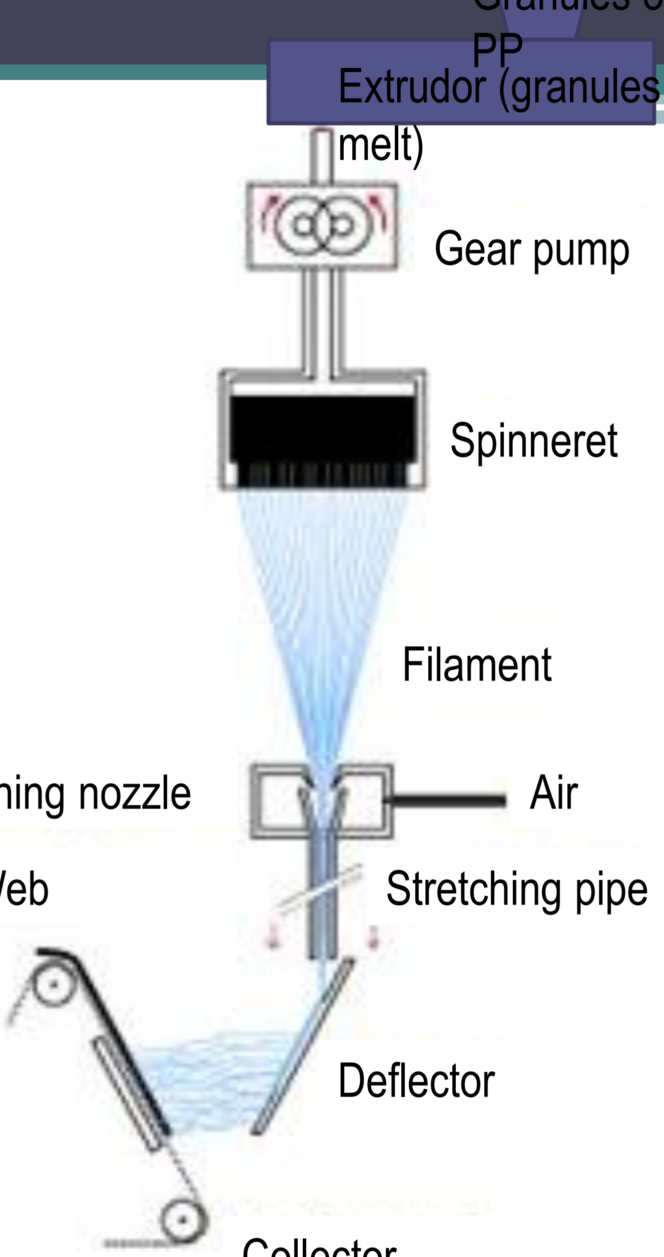
Spunlaid web formation

Spunbond

Meltblown

Spunbond

Spunbond fabrics are produced by depositing extruded, spun filaments onto a collecting belt in a uniform random manner followed by bonding the fibers.



http://www.youtube.com/watch?v=7zBj07wsu0c

- The fibers are separated during the web laying process by air jets or electrostatic charges.
- The collecting surface is usually perforated to prevent the air stream from deflecting and carrying the fibers in an uncontrolled manner. Bonding imparts strength and integrity to the web by applying heated rolls or hot needles to partially melt the polymer and fuse the fibers together.
- Since molecular orientation increases the melting point, fibers that are not highly drawn can be used as thermal binding fibers. Polyethylene or random ethylene-propylene copolymers are used as low melting bonding sites. Before deposition on a moving belt or screen, the output of a spinneret usually consists of a hundred or more individual filaments which must be attenuated to orient molecular chains within the fibers to increase fiber strength and decrease extensibility.
- The web is formed by the pneumatic deposition of the filament bundles onto the moving perforated belt. The web is held by means of a suction current.
  - For some applications, the filaments are laid down randomly with respect to the direction of the lay down belt. In order to achieve a particular characteristic in the final fabric, the directionality of the splayed filament is controlled by traversing the filament bundles mechanically or aerodynamically as they move toward the collecting belt. In the aerodynamic method, alternating pulses of air are supplied on either side of the filaments as they emerge from the pneumatic jet.

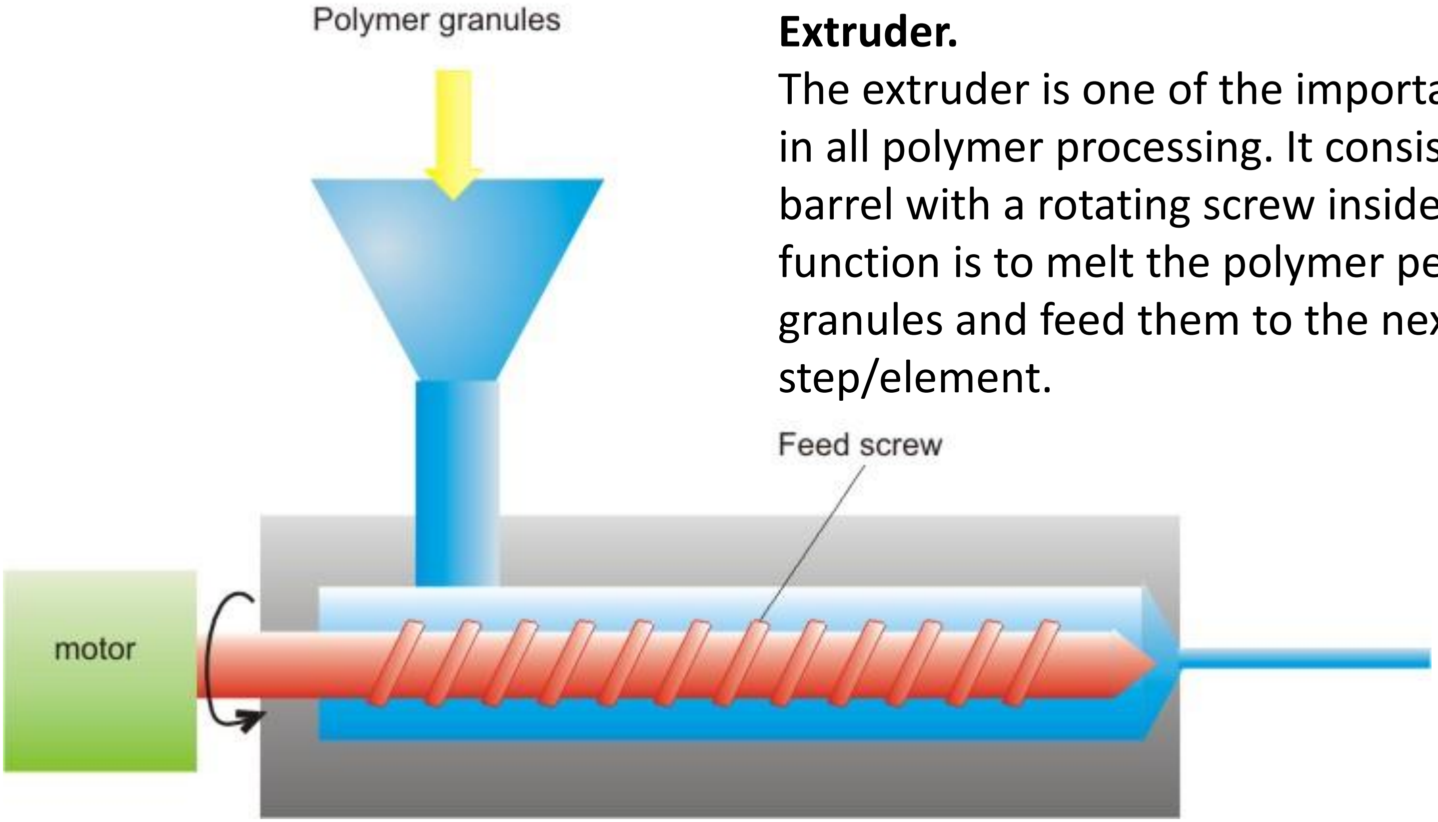
The major elements of the process are:

Polymer Feed.

Polymer feedstock in pellet or powder form is conveyed from storage bins or silos to the feeder section of an extruder.

Extruder.

The extruder is one of the important elements in all polymer processing. It consists of a heated barrel with a rotating screw inside. Its main function is to melt the polymer pellets or granules and feed them to the next step/element.



Extruder

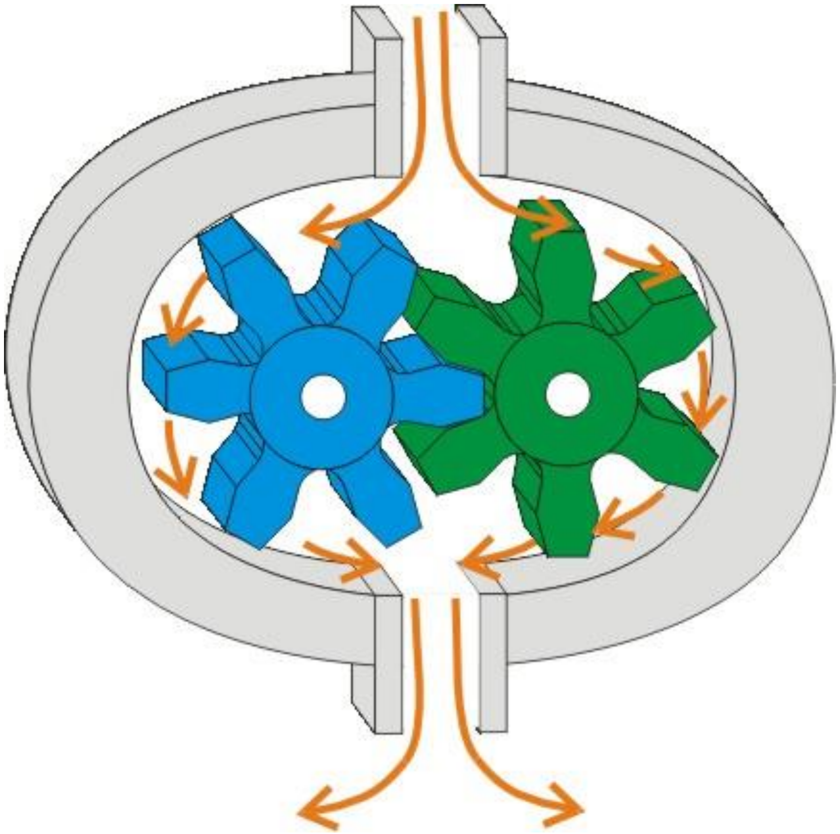
The melting of the pellets in the extruder is due to the heat and friction of the viscous flow and the mechanical action between the screw and the walls of the barrel. There are four different heaters in the extruder, which are set in incremental order. The extruder is divided in to three different zones:

i) Feed Zone: In the feed zone the polymer pellets are preheated and pushed to the next zone.

ii) Transition Zone: The transition zone has a decreasing depth channel in order to compress and homogenize the melted polymer.

iii) Metering Zone: This is the last zone in the extruder whose main purpose is to generate maximum pressure in order to pump the molten polymer in the forward direction. At this point the breaker plate controls the pressure generated with a screen pack placed near to the screw discharge. The breaker plate also filters out any impurities such as dirt, foreign particle metal particles and melted polymer lumps.

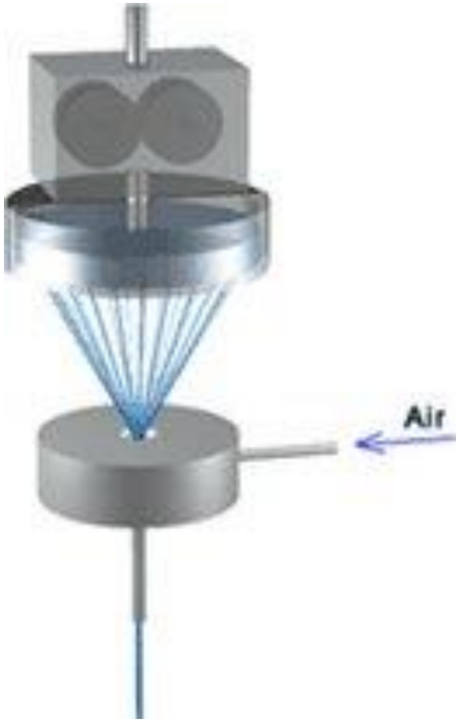
Gear pump

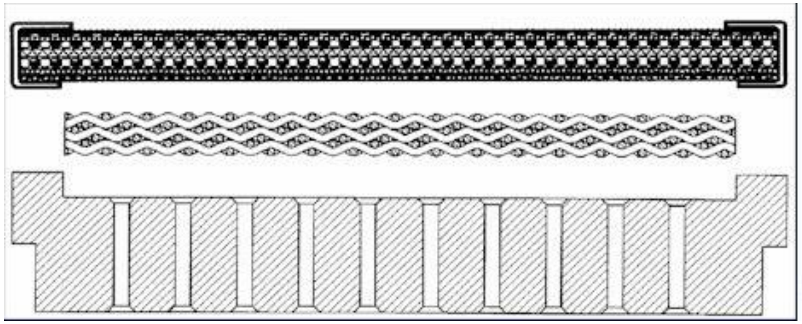


The metering gear pump is a device for uniform melt delivery to the die assembly. It ensures consistent flow of clean polymer mix under process variations in viscosity, pressure, and temperature. The metering pump also provides polymer metering and the required process pressure. The metering pump typically has two intermeshing and counter-rotating toothed gears. The molten polymer from the gear pump goes to the feed distribution system to provide uniform flow to the die nosepiece in the die assembly.

Spinneret

The molten polymer mix is pumped through a heated conduit to a resin filter system and then to a distributor section that leads to the spinnerette units.





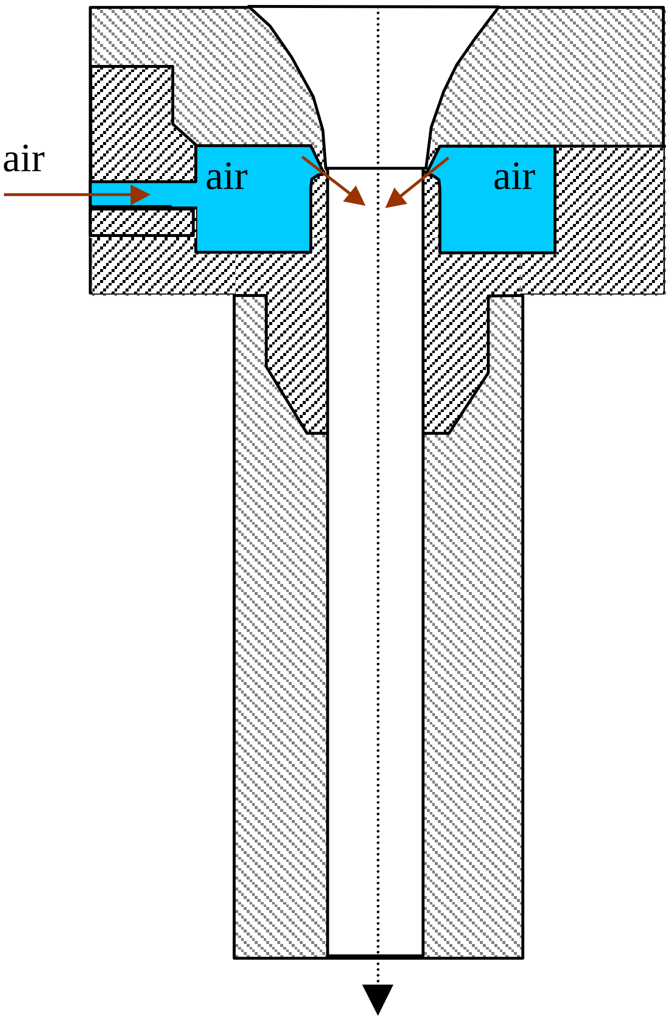
The normal filters are often used for the fabrication of Polyester-Filaments and Micro-Filaments. The XL-Filters have an extremely large pore volume consisting of a large number of woven wire cloth layers with square aperture widths that are arranged over the specific filtration layer. The individual woven wire cloth layers are bonded together as one stable filtration layer via sintering. The edge is formed by a stainless sheet steel ring that, in combination with aluminium flat packings, creates a complete sealing. Depending on the individual usage, the filter layer consists of 15 up to 25 woven wire cloth layers. The pore sizes of the filtration layers range between 20 and 5 micrometers.

The melt passes through the porous filtration layer, arrives at the spinneret nozzle with a high degree of homogeneity and is ideally suited for the spinning process.

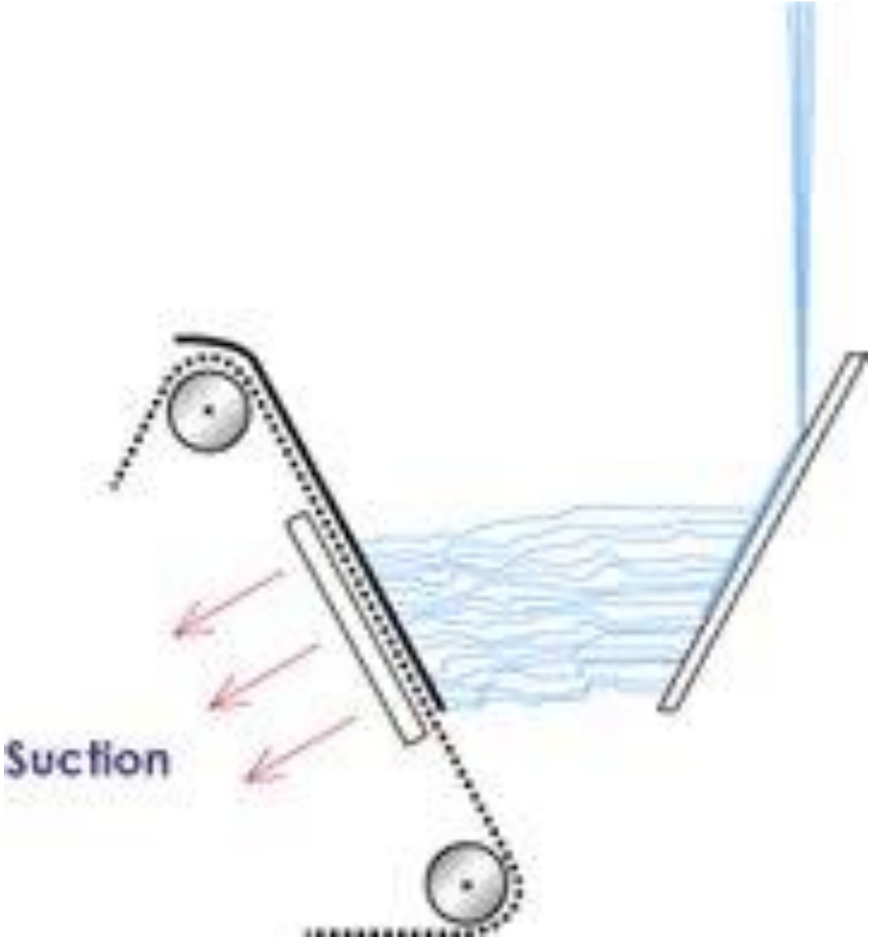
The spinnerette usually consists of a perforated plate arranged across the width of the line. The resin is forced through the many small holes in the spinnerette plate to form continuous filaments.

Quenching / Attenuation Zone

As the filaments emerge through the spinnerette holes, they are directed downward into quench chambers or chimneys. As the filaments travel through these chambers, cool air is directed across the filament bundle to cool the molten filaments sufficiently to cause solidification. The filaments are then led further downward into a tapered conduit by an airsteam. A second stream of high velocity air is directed parallel to the direction of the filaments, causing an acceleration and accompanying attenuation or stretching of the individual filaments. This mechanical stretching results in increased orientation of the polymer chains making up the continuous filament. Such orientation leads to increased filament strength, along with modification of other filament properties, including the filament denier or thickness.



Pneumatic jet for spunbonding

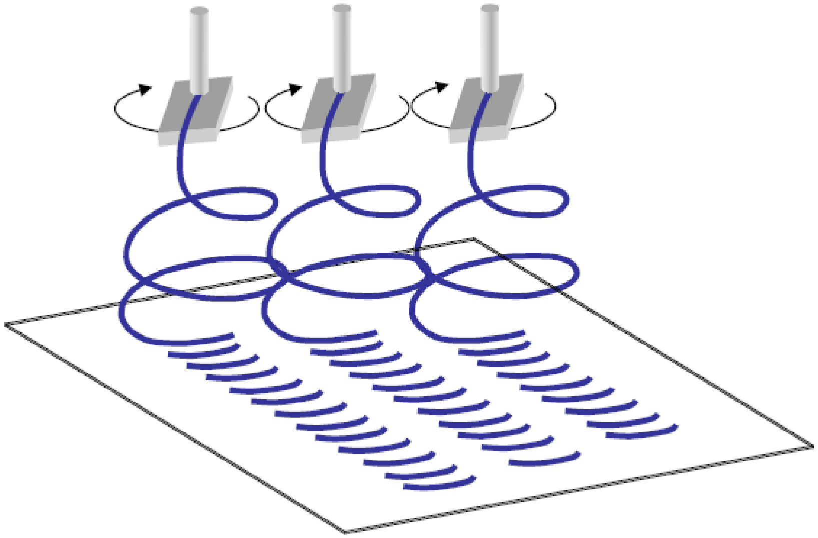


Web Forming

The filaments are deposited in a random manner on a moving, porous forming belt. A vacuum under the belt assists in forming the filament web on the forming belt and in removing the air used in the extrusion / orientation operation. In some processes, an electrostatic charge is placed on the filament bundle to ensure spreading and separation of individual filaments. In other processes, deflector plates are used to lay down the filament sheet in a random manner on the forming belt.

In order for the web to achieve maximum uniformity and cover, individual filaments must be separated before reaching the belt. This is accomplished by inducing an electrostatic charge onto the bundle while under tension and before deposition. The charge may be induced triboelectrically or by applying a high voltage charge. The former is a result of rubbing the filaments against a grounded, conductive surface.

Filaments are also separated by mechanical or aerodynamic forces. The method utilizes a rotating deflector plane to separate the filaments by depositing them in overlapping loops; suction holds the fiber mass in place.



Bonding

The continuous filament web is delivered to a bonding section, where one of several bonding methods can be used to bond the loose filaments into a strong, integrated fabric.

Process components

Preparation of raw material
Dosing unit for primary polymer, pigments and additives
Extruder for melting and conveying the raw materials
Melt filter
Spin pump to ensure a constant throughput to the spin unit
Sheet distributor with spinneret
Filament cooling
Filament extension
Discharge unit (diffuser)
Web forming machine for discharge and conveyance of the filaments
Nonwoven bonding, preferable calendering
Winding

Process description:

Out of the silo the polymer is vacuumfed to dosing station on top of the extruder. Inside the extruder it becomes melted and homogenised. Passing a filter system and a spin pump, the melt is distributed by a coathanger die, feeding the spinneret which forms a curtain of filaments. The filaments are cooled by means of a stream of air in a blowing area, drawn by aerodynamic forces and then transported to the downstream discharge channel. Here the filaments are swirled around and then deposited on the wire mesh belt as a random nonwoven material. This is transferred to the heat bonding calender which by heat and pressure sets the physical properties as tensiles and elongation of the final product. After calendering the material is cooled by a water-cooled pair of rolls and then wound up.

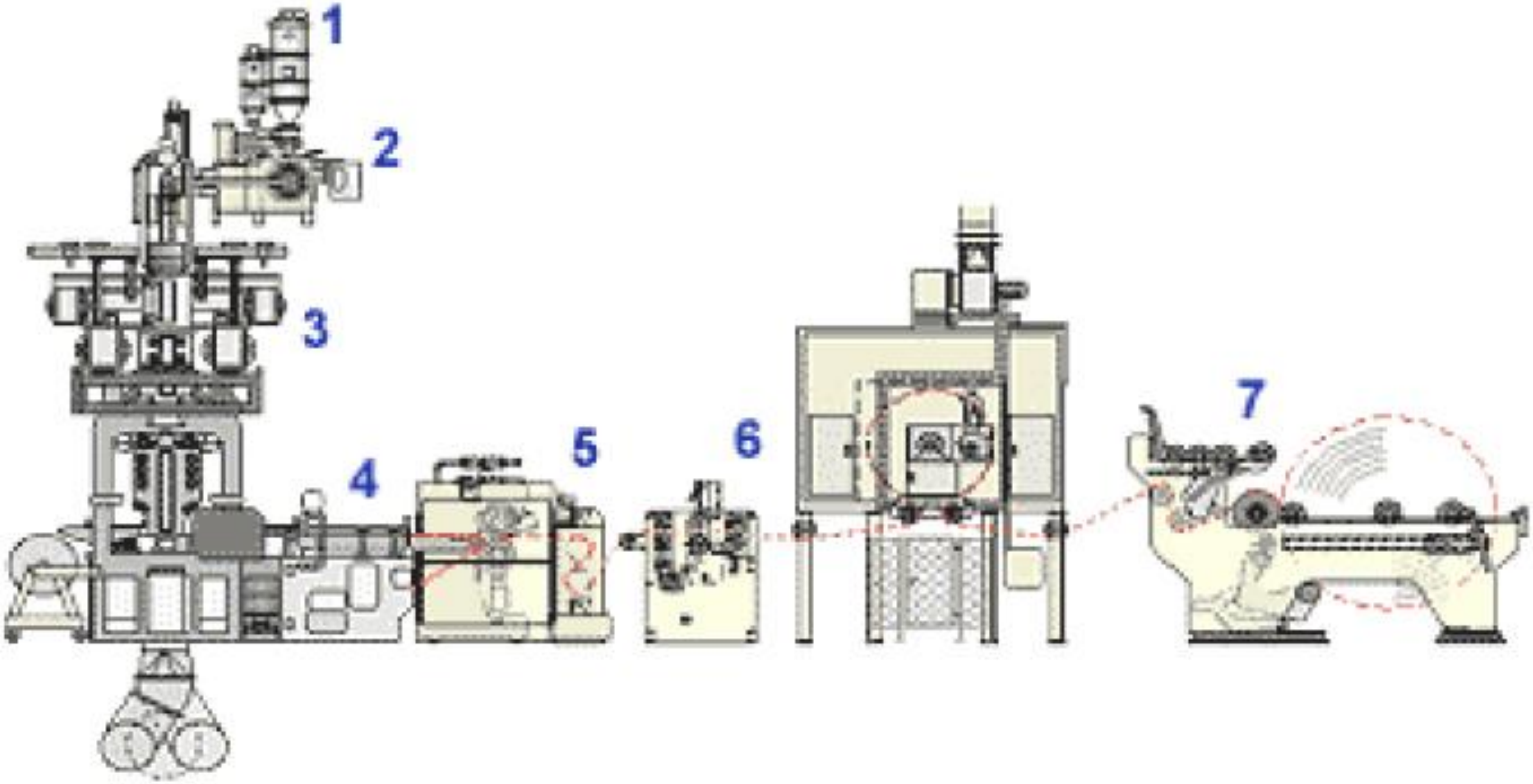
Applications

Hygiene
Industrial applications
Dust collectors
Filtration

Physical properties

High air permeability
Thermo-bonded - no chemicals
Excellent bi-directional and wear properties
Soft and comfortable
Grammage between 10 - 100 g/m² (150 g/m²) if possible

Possible additional nonwoven features:
- Printing - Laminating - Electrostatic charging - improved hydrophilic properties through application of tensides
By using additives or pigment pastes
- Dying in every imaginable shade - fire-retardant properties - antistatic properties - increased UV and gamma ray protection

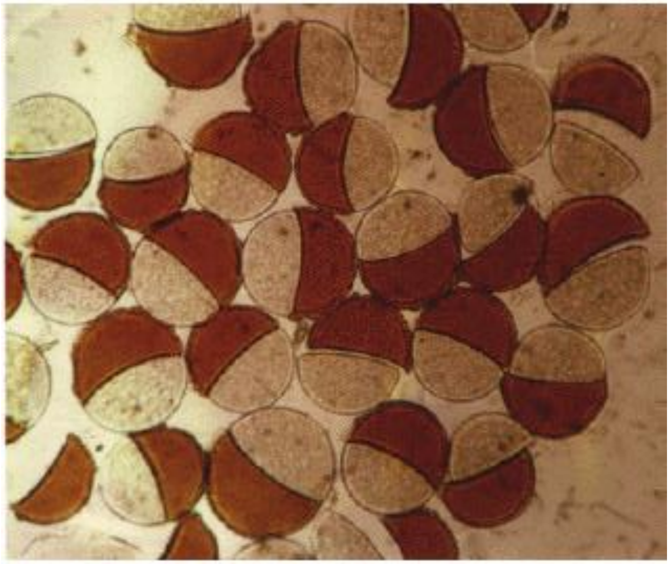


Spunbond line: 1 Dosing unit 2 Melt preparation 3 Filament production 4 Collection and conveyor unit 5 Nonwoven bonding 6 Nonwoven equipment 7 Winder

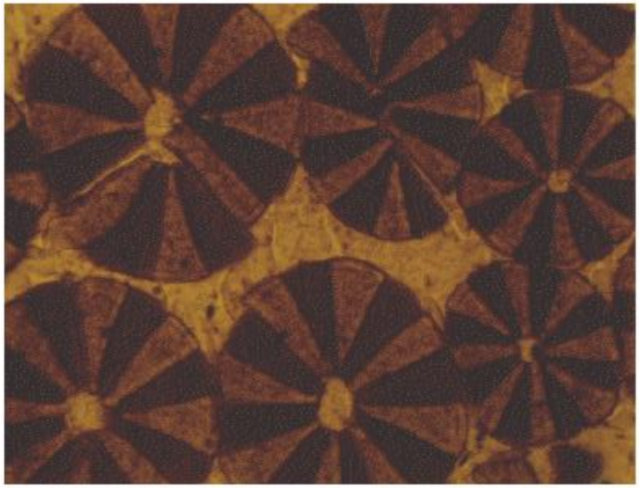
Production amount (thousand of tons)						
Year	1989	1991	1993	1995	1997	1998
Total nonwovens production	414	480	554	646	759	836
Spun bond	143	197	227	268	318	356

under 25 g.m^{-2}	117 000 tons
25 - 70 g.m^{-2}	75 400 tons
70 - 150 g.m^{-2}	87 800 tons
over 150 g.m^{-2}	76 000 tons

Protective Outer Layers - A **bi-component spunbond,** using sheath-core technology. The inner core is polypropylene for strength, with a polyethylene wrap for softness. A silver-gray color was selected because of its heat-resistant properties. The fabric is also treated with UV inhibitors for extended outdoor use. Micro-Porous Middle Layer - The barrier layer is breathable film, a proprietary stretch-film technology developed exclusively for Kimberly-Clark. The film is stretched and subjected to a chemical process that creates microscopic holes smaller than droplets of water or dust, yet large enough to allow moisture vapor to escape. Soft, Paint-Protecting Inner Layer - A bi-component fabric made with polyethylene and nylon. This combination results in an exceptionally high strength-to-weight ratio, with the "soft touch" necessary for today's water-based paint finishes.

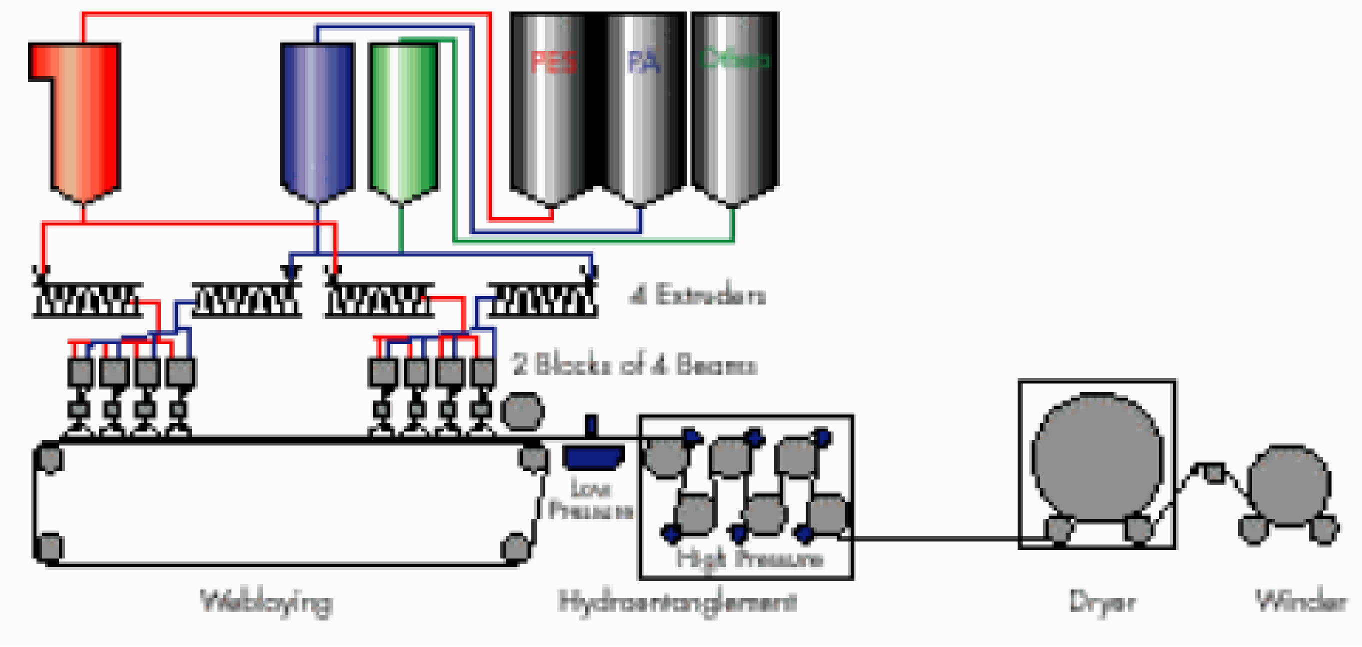


SB side-by-side -60PET_40PA66

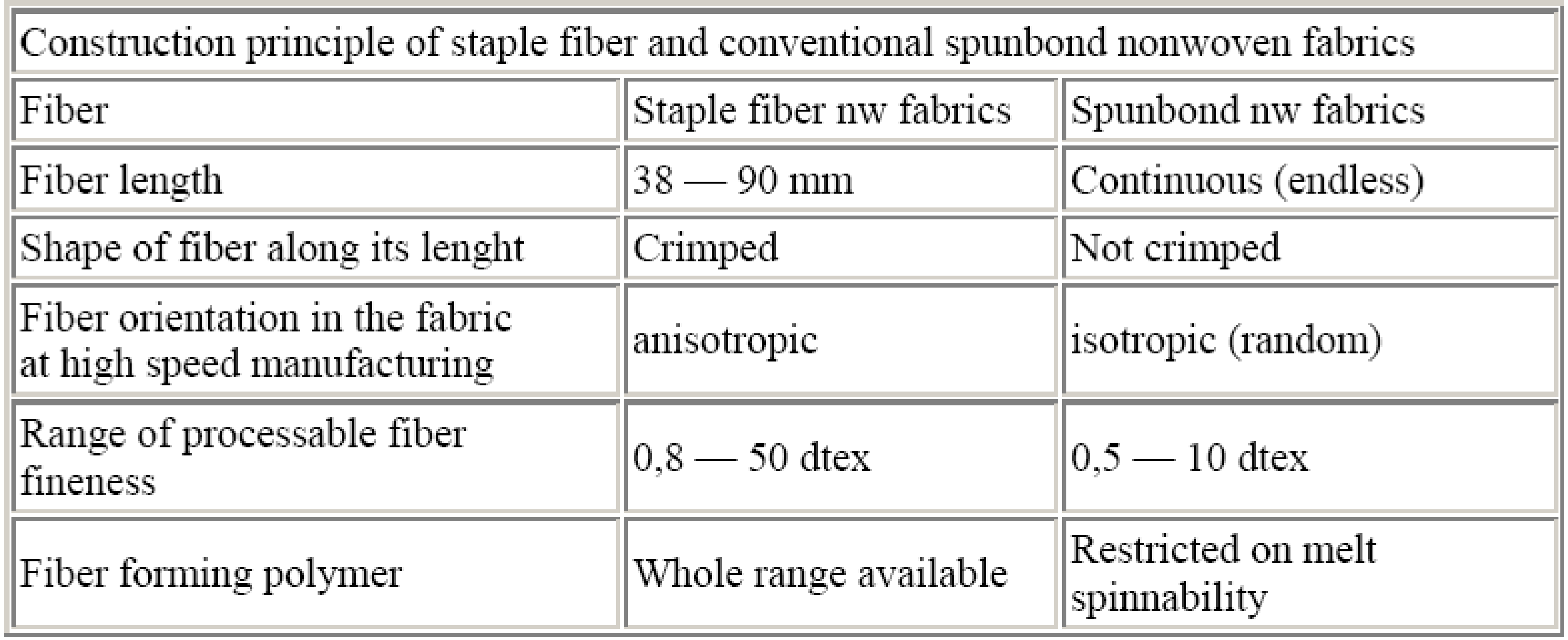


SB 16 segment pie -70PET_30PA66

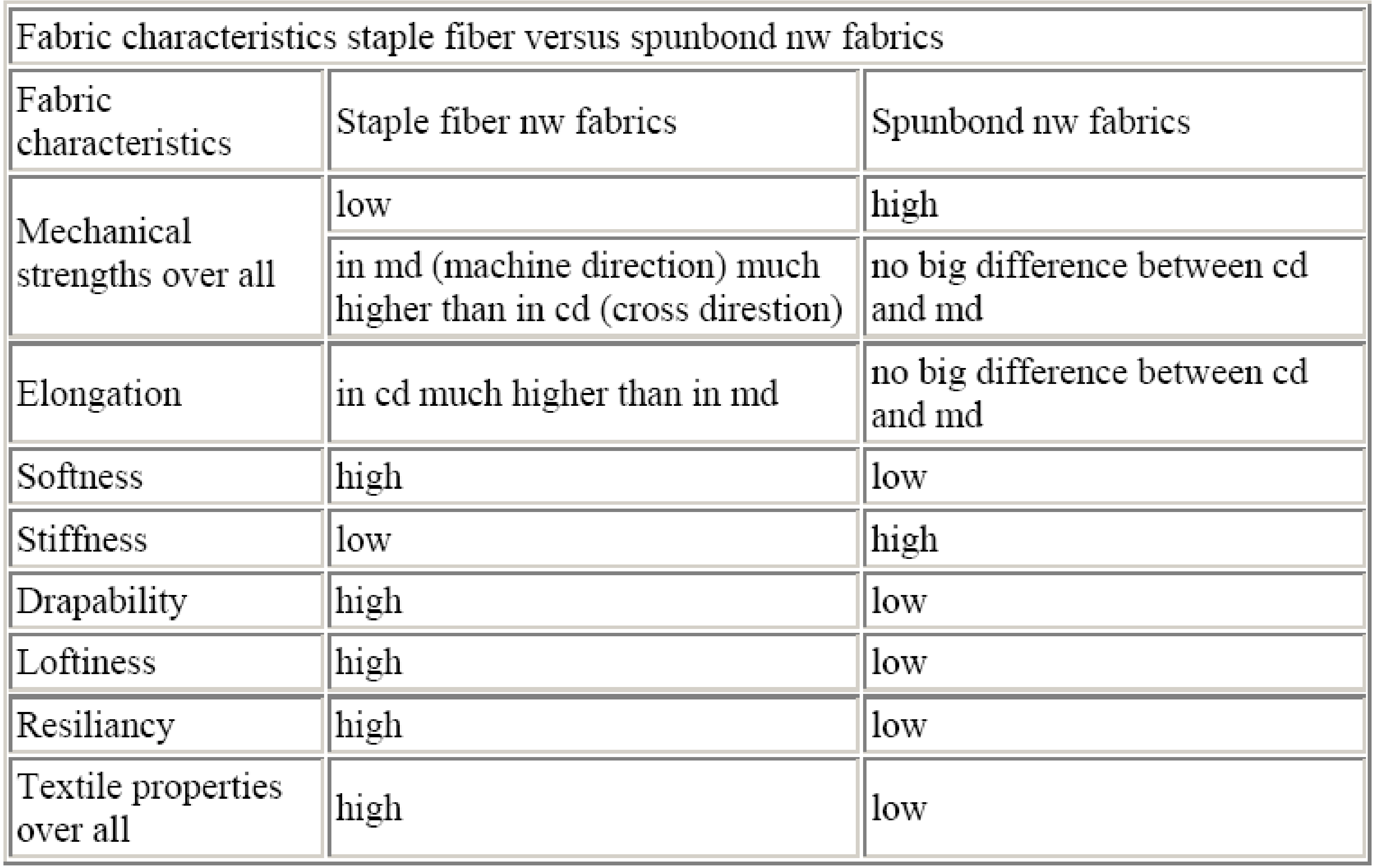
In-line-production is illustrated schematically in figure 4.10, starting from polymer granule and ending with the ultrafine microfiber spunbond fabric. Two different polymers are transported by extruders to the spinneret, leaving it as bicomponental endless filaments, which are quenched and stretched by air streams with a very high speed up to sonic velocity. The stretched filaments are finally laid down onto a moving belt to form a nonwoven fabric of uniform structure. As demonstrated later in more detail the fiber distribution is more or less an isotropical one. Mechanical strengths are practically the same in machine and cross direction which might beneficial for most part of applications.



Summerized over all conventional spunbond nonwoven fabrics provide much higher mechanical strengths in md and cd than carded nonwoven fabrics but because of the non crimped fibers all characteristics derived from such as softness, drapability, loftiness and the like are uncomparably worse than with carded nonwoven fabrics. Expressed somewhat simplified: the non-textile characteristics of conventional spunbonds has been so unfavorable that huge areas of application such as garment industry or upper material for shoes and luggage could not be covered by them.



Construction principle of staple fiber and conventional spunbond nonwoven fabrics		
Fiber	Staple fiber nw fabrics	Spunbond nw fabrics
Fiber length	38 — 90 mm	Continuous (endless)
Shape of fiber along its lenght	Crimped	Not crimped
Fiber orientation in the fabric at high speed manufacturing	anisotropic	isotropic (random)
Range of processable fiber fineness	0,8 — 50 dtex	0,5 — 10 dtex
Fiber forming polymer	Whole range available	Restricted on melt spinnability



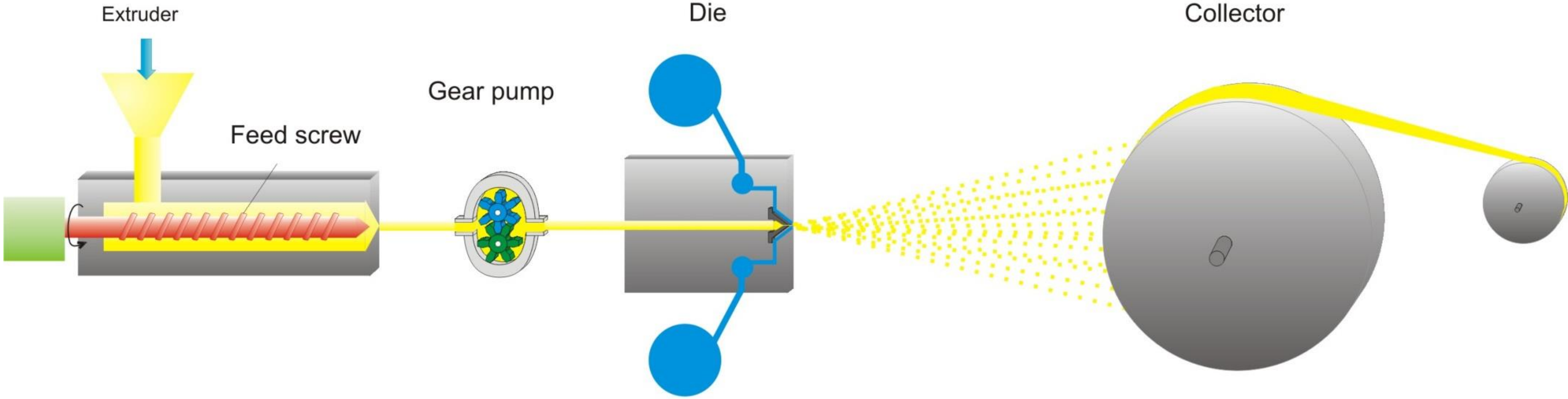
<table>
<tr><th colspan="3">Fabric characteristics staple fiber versus spunbond nw fabrics</th></tr>
<tr><th>Fabric characteristics</th><th>Staple fiber nw fabrics</th><th>Spunbond nw fabrics</th></tr>
<tr><td rowspan="2">Mechanical strengths over all</td><td>low</td><td>high</td></tr>
<tr><td>in md (machine direction) much higher than in cd (cross direstion)</td><td>no big difference between cd and md</td></tr>
<tr><td>Elongation</td><td>in cd much higher than in md</td><td>no big difference between cd and md</td></tr>
<tr><td>Softness</td><td>high</td><td>low</td></tr>
<tr><td>Stiffness</td><td>low</td><td>high</td></tr>
<tr><td>Drapability</td><td>high</td><td>low</td></tr>
<tr><td>Loftiness</td><td>high</td><td>low</td></tr>
<tr><td>Resiliancy</td><td>high</td><td>low</td></tr>
<tr><td>Textile properties over all</td><td>high</td><td>low</td></tr>
</table>

Melt blown

http://www.youtube.com/watch?v=YS5GWWlK6o4&list=PLCog-uy_JB6qasnz2GHW6-8QTs78xDFNQ

Melt blowing is a process for producing fibrous webs directly from polymers using high-velocity air to attenuate the filaments. MB microfibers generally have diameters in the range of 2 to 4 µm, although they may be as small as 0.1 µm and as large as 10 to 15 µm. Differences between MB nonwoven fabrics and other nonwoven fabrics, such as degree of softness, cover or opacity, and porosity can generally be traced to differences in filament size.

The Melt blowing is process in which high-velocity air blows a molten thermoplastic resin from an extruder die tip onto a conveyor or takeup screen to form a fine fiberous and self-bonding web.



The die assembly is the most important element of the melt blown process. It has three distinct components: polymer-feed distribution, die nosepiece, and air manifolds.

Essential features of the process:

Resin storage and resin preparation
Metering unit for main polymer, pigments and additives
Extruder for plastification of the polymeric components
Melt filter
Melt pipe to spin pump
Spin pump to maintain a constant throughput to the spinneret
MeltBlown die head
Hot air supply
Conveyor belt machine, height adjustable
Winding system

Approx. 40% of the MeltBlown material is manufactured in a stand-alone process. The remaining meltblown materials are combined with spunbonded fabrics or laminates to form other materials. Combinations with spunbonded fabrics are primarily used to make nonwoven materials with barrier properties. Another variation is the combination of MeltBlown with cellulose or an absorbent powder, to produce a soft, strong but still absorbent material, which can retain absorbed liquid whilst still keeping its strength.

Polymer The MeltBlown process allows the use of various different polymers: polypropylene MFI 400 - 1500, polyethylene MFI 20 - 200, polyester iV 0,53 - 0,64, polyamide, polyurethane, polyphenylene sulphide. All of the polymers used during MeltBlown production must have a low viscosity. This results in a relatively high melt temperature (compared to other production processes). The melt temperature can be adjusted during production by means of electrical heating systems in the extrusion section.

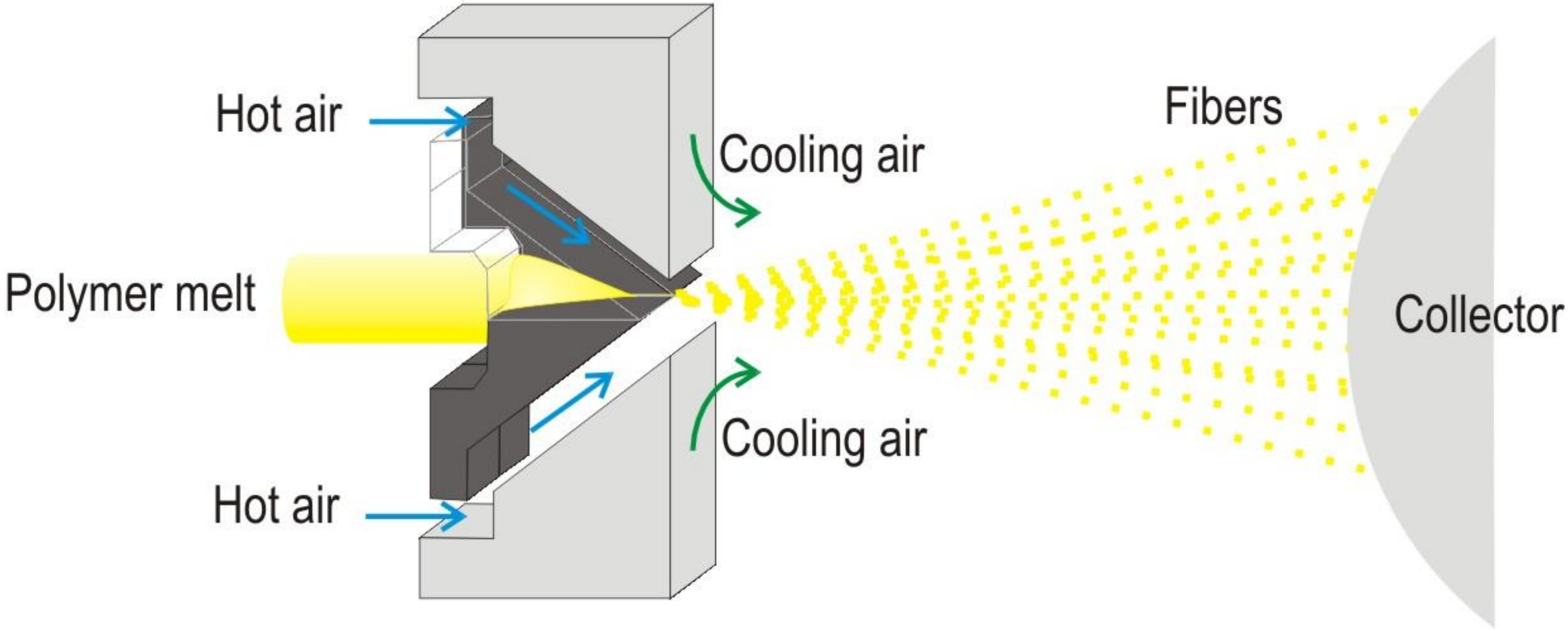
4.3.2. Components

Preparation of raw material
Dosage unit for primary polymer, pigment pastes and additives
Extruder for melting and conveying the raw materials
Melt filter
Spin pump to ensure a constant throughput to the spin unit
Meltblown die to form the filaments
Hot air supply
Web forming machine for depositing the filaments, height adjustable
Winder

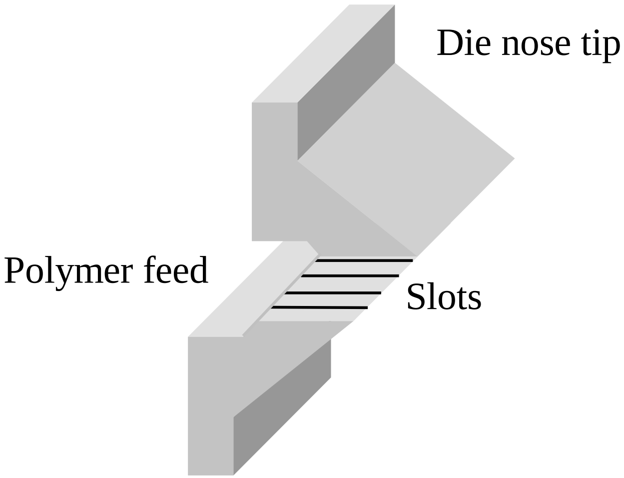
Physical properties

Self-bonding / thermo-bonded
Large area-to-weight ratio
Adjustable pores and capillary structure
PP MeltBlown nonwoven material is hydrophobic / oleophilic
Excellent wick properties / liquid retention
High filtration efficiency
Thermal insulation
Elasticity
Preferred grammage spectrum 5 - 500 g/m²
Preferred filament diameter 1 -2 µm
Porosity
Surface energies
Colours can be used
.. and many others

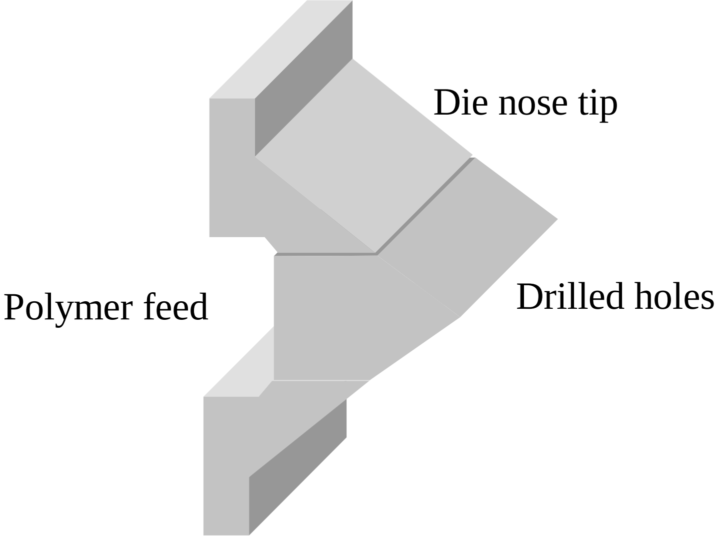
Melt blown die - The feed distribution in a melt-blown die is more critical than in a film or sheeting die for two reasons. First, the melt-blown die usually has no mechanical adjustments to compensate for variations in polymer flow across the die width. Second, the process is often operated in a temperature range where thermal breakdown of polymers proceeds rapidly. The feed distribution is usually designed in such a way that the polymer distribution is less dependent on the shear properties of the polymer. This feature allows the melt blowing of widely different polymeric materials with one distribution system. The feed distribution balances both the flow and the residence time across the width of the die.



Two types of die nosepiece: capillary and drilled hole. From the feed distribution channel the polymer melt goes directly to the die nosepiece. The die nosepiece is a wide, hollow, and tapered piece of metal having several hundred orifices or holes across the width. The polymer melt is extruded from these holes to form filament strands which are subsequently attenuated by hot air to form fine fibers. A typical die nosepiece has approximately 0.4-mm diameter orifices spaced at 1 to 4 per millimeters (25 to 100 per inch). For the capillary type, the individual orifices are actually slots that are milled into a flat surface and then matched with identical slots milled into a mating surface. The two halves are then matched and carefully aligned to form a row of openings or holes. By using the capillary type, the problems associated with precise drilling of very small holes are avoided. In addition, the capillary tubes can be precisely aligned so that the holes follow a straight line accurately. The drilled-hole type has very small holes drilled by mechanical drilling or electric discharge matching (EDM) in a single block of metal.



Capillary type



Drilled hole type

Air manifolds

The air manifolds supply the high velocity hot air through the slots on the top and bottom sides of the die nosepiece. The high velocity air is generated using an air compressor. The compressed air is passed through a heat exchange unit such as an electrical or gas heated furnace, to heat the air to desired processing temperatures. Typical air temperatures range from 230°C to 360°C at velocities of 0.5 to 0.8 the speed of sound.

As soon as the molten polymer is extruded from the die holes, high velocity hot air streams attenuate the polymer streams to form microfibers. As the hot air stream containing the microfibers progresses toward the collector screen, it draws in a large amount of surrounding air that cools and solidifies the fibers.

The solidified fibers subsequently get laid randomly onto the collecting screen, forming a self-bonded nonwoven web. The fibers are generally laid randomly because of the turbulence in the air stream, but there is a small bias in the machine direction due to some directionality imparted by the moving collector. The collector speed and the collector distance from the die nosepiece can be varied to produce a variety of melt-blown webs. Usually, a vacuum is applied to the inside of the collector screen to withdraw the hot air and enhance the fiber laying process.

Machine variables

Machine variables, also called operational variables, are related to the machine and can be changed while the equipment is being operated. These variables include air temperature, polymer/die temperature, die to collector distance, collector speed, polymer throughput and air throughput. All of these affect the final properties of the nonwoven web.

i) Polymer Throughput and Air Flow: both polymer throughput and air flow rate control the final fiber diameter, fiber entanglement, basis weight and the attenuating zone.

ii) Polymer/Die and Air Temperature: These variables combined with air flow rate affect the uniformity, shot formation (large globules of nonfibrous polymer larger in diameter than fibers in webs), rope and fly formation, fabric appearance and feel (soft or stiff).

iii) Die to Collector Distance: This affects the openness of the fabric, thermal bonding among the fibers and basis weight.

Off-line variables

Off-line variables are fixed during a process run and can only be changed when the machine is not in operation. These variables are air gap, air angle, die setback, and die hole size.

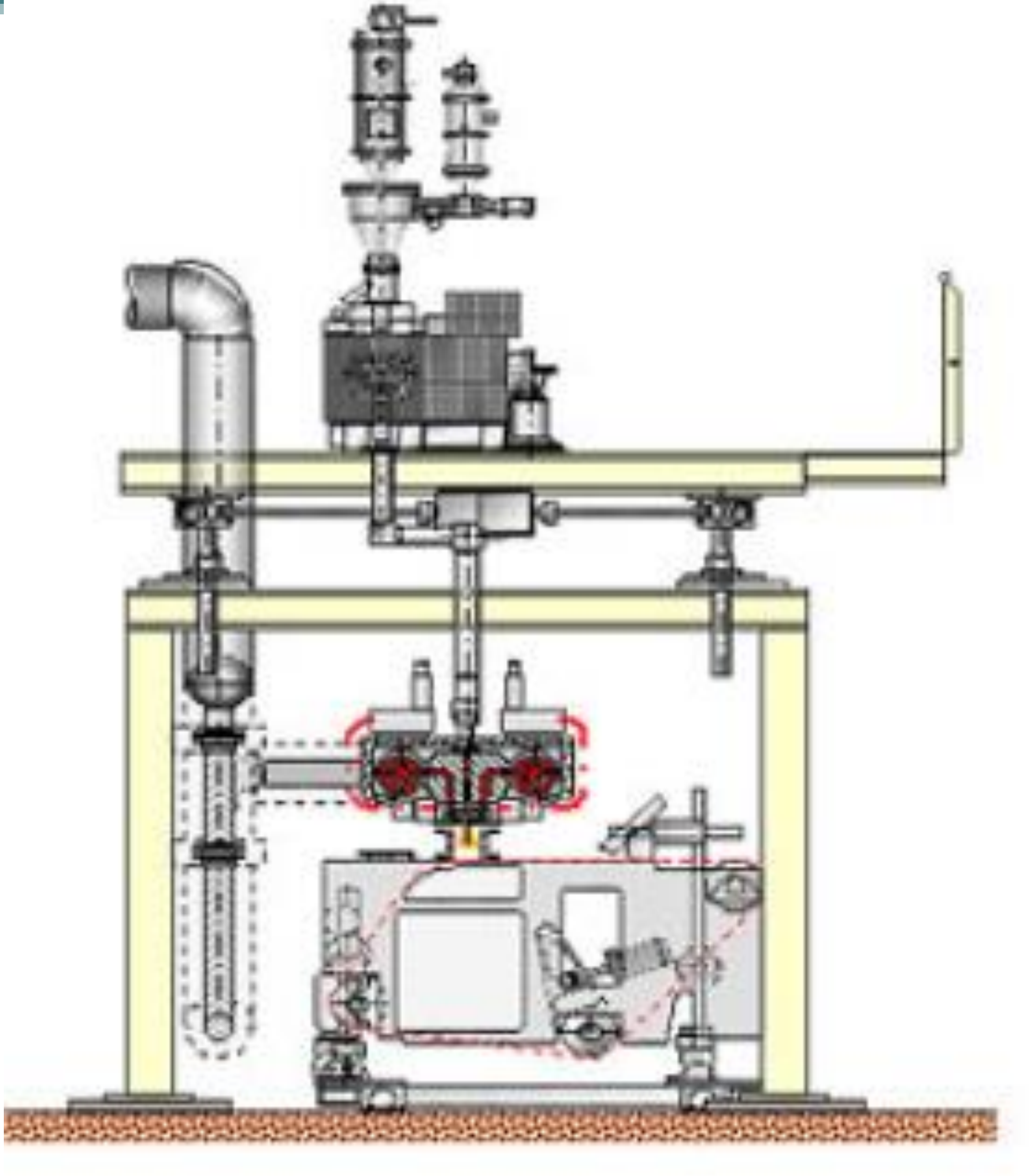
i) Die Hole Size: Die hole size along with die set back affects the fiber size.

ii) Air Gap: It affects the degree of fiber breakage by controlling the air exit pressure.

iii) Air Angle: It controls the nature of air flow, i.e. as the air angle approaches 90° it results in a high degree of fiber separation or turbulence that leads to random fiber distribution. At an angle of 30°, roped or parallel fibers deposited as loosely coiled bundles of fibers are generated. This structure is undesirable. At angles greater than 30°, attenuation as well as breakage of fibers occurs.

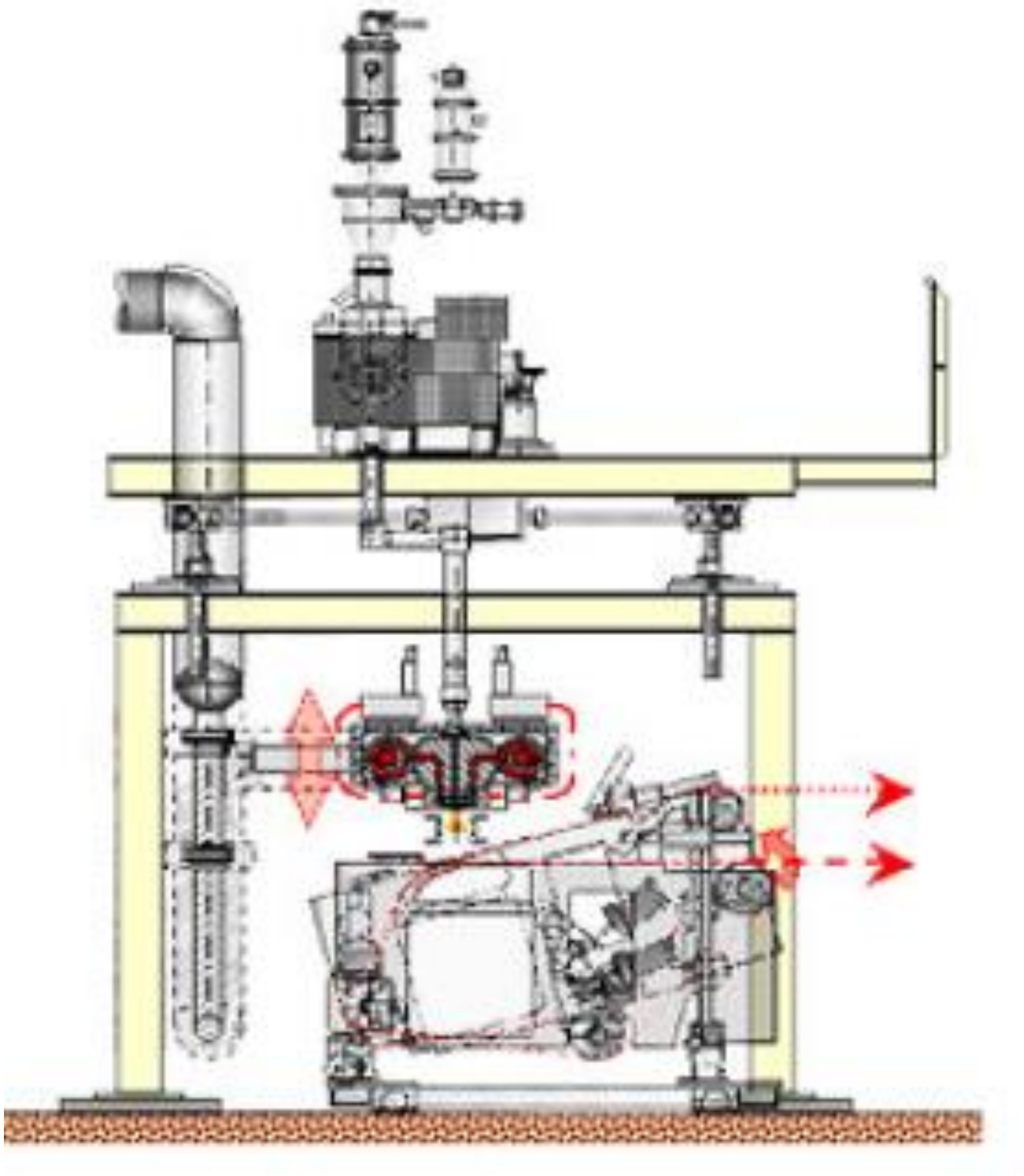
Stand-alone type

The characteristic feature of the stand-alone system is the collector, which can be adjusted in height and angle. This patented design allows precise control of the MeltBlown deposition.



<u>Inline type</u>

Since the common collectors of composite-lines have static height, the adjustment of the die-distance to collector belt (DCD) is done by vertical movement of the entire operating platform.



Properties of melt-blown

Melt-blown webs usually have a wide range of product characteristics. The main characteristics and properties of melt-blown webs are as follows:

- Random fiber orientation.
- Lower to moderate web strength, deriving strength from mechanical entanglement and frictional forces.
- Generally high opacity (having a high cover factor).
- Fiber diameter ranges from 0.5 to 30 μm, but typically from 2-7 μm.
- Basis weight ranges from 8-350 g/m2, but typically 20-200 g/m2.
- Microfibers provide a high surface area for good insulation and filtration characteristics.
- Fibers have a smooth surface texture and are circular in cross-section.
- Most melt-blown webs are layered or shingled in structure, the number of layers increases with basis weight.

The fiber length in a melt-blown web is variable; it can be produced in the range from a few millimeters to several hundred centimeters in length and usually exists over a broad range. The fiber cross-section is also variable, ranging from circular to a flat configuration and other variations.

Type of polymer

The type of polymer or resin used will define the elasticity, softness, wetability, dyeability, chemical resistance and other related properties of formed fibers. One of the advantages of melt-blown technology is to handle many different polymers as well as mixture of polymers. Some polymers, which can be melt-blown, are listed below. However, the list is not complete.

− Polypropylene is easy to process and makes good web.
− Polyethylene is more difficult to melt-blow into fine fibrous webs than is polypropylene. Polyethylene is difficult to draw because of its melt elasticity.
− PBT (poly-butylene terephalate) processes easily and produces very soft, fine-fibered webs.
− Nylon 6 is easy to process and makes good webs.
− Nylon 11 melt-blows well into webs that have very unusual feel like leather.
− Polycarbonate produces very soft-fiber webs.
− Poly (4-methyl pentene-1) blows well and produces very fluffy soft webs.
− Polystyrene produces an extremely soft, fluffy material with essentially no shot defects.

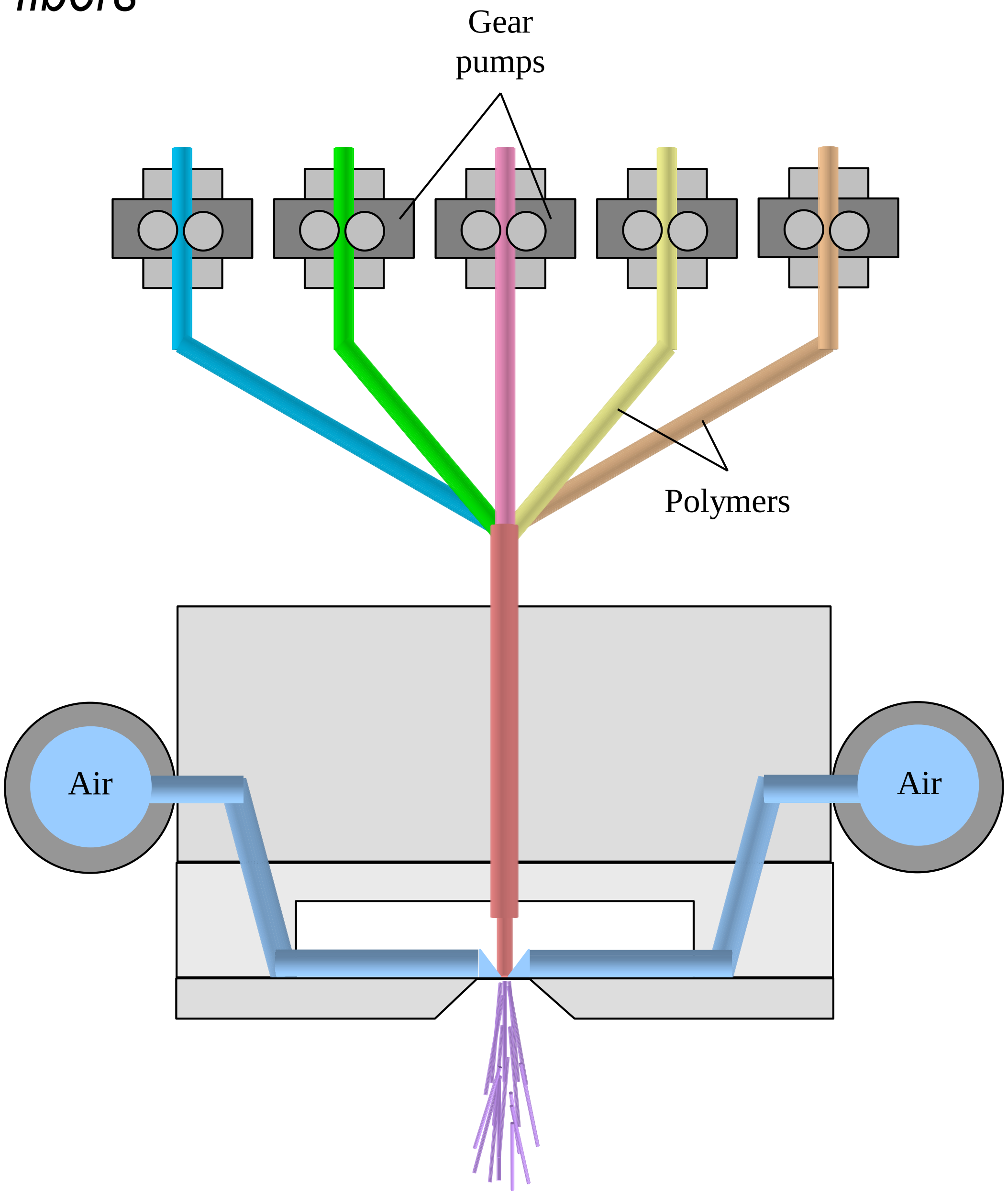
The most widely used polymer that has a high MFR is polypropylene. Polypropylene with its low viscosity has a low melting point and is easy to draw into fibers. It comprises 70-80% of the total North American production.
The feasibility of MB original and recycled PET has also been studied. PET webs have a strong tendency to shrink, depending on the airflow rate used. PET webs produced at high airflow rate shrink more than those produced at low airflow rate because of their higher level of molecular orientation. Heat-setting of melt-blown PET webs or, alternatively, the use of PBT was suggested as a possible means of producing thermally stable melt-blown PET nonwovens.

Melt blown - bicomponent fibers

Bicomponent melt blown systems produce sheath/core, side-by-side, tipped trilobal and tipped cross fibers with approximately 2 micron diameters.

These bicomponent systems operate on conventional meltblown spin hole densities. In addition, Hills has developed melt blown dies with 100 holes per inch that operate with homopolymer at throughputs up to 0.5 grams per hole per minute.

In combination with the patented Hills-meltdistribution Reifenhäuser REICOFIL delivers Bico-Nonwovenlines up to 4.2m working width.



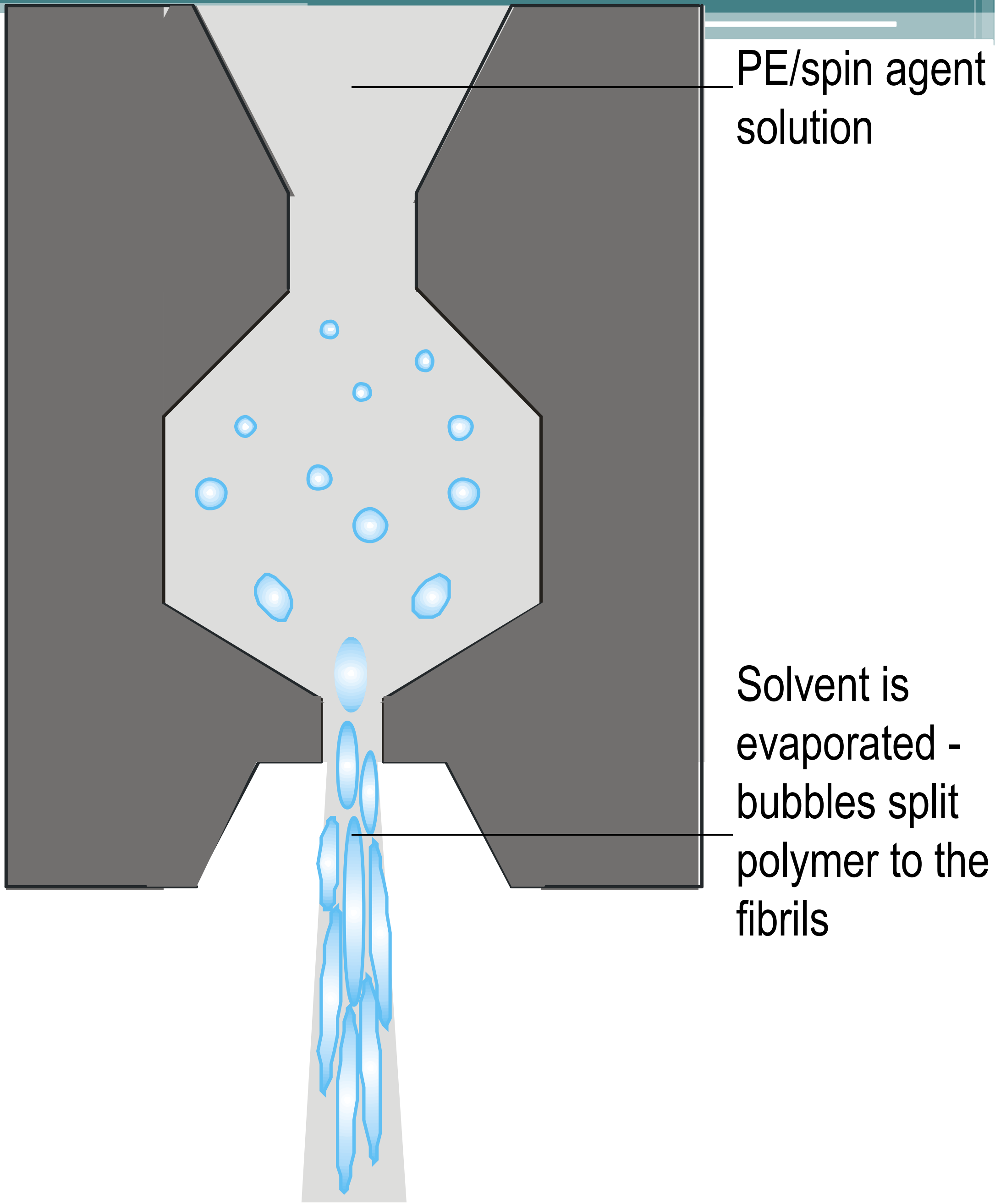
The polymer flow

where ϕ is density of polymer
d_0 is diameter of spinning nozzle
v_0 polymer flow rate into the nozzle
d final diameter of fiber
v_f final (maximal) fiber rate

$$\frac{dm}{dt} = \varphi \frac{\pi d_0^2}{4} v_0 = \varphi \frac{\pi d^2}{4} v_f$$

Flash spinning

Flash-spinning is a deviation from the conventional melt spinning process and is a process created by DuPont company. In flash-spinning, pure solvent droplets and highly saturated polymer/solvent mixtures are decompressed through a spin orifice. As the pressurized solution is allowed to expand rapidly through the orifice, the solvent is instantaneously "flashed off," leaving behind a three-dimensional film-fibril network.



The micro-denier fibers that are produced via this process are interconnected in a continuous network and collected on a moving belt. Then, the sheet is subjected to either full-surface thermal bonding, which creates a stiff, paper-like sheet, or point bonding, followed by in-line softening which creates a drapeable, fabric-like sheet. No binders are used. As a result of this unique process—and its composition of 100% high-density polyethylene—the finished product offers a high surface area and enhanced filtration efficiency, as well as good sheet tensile and high tear strength.

Applications

Construction

One of the most popular and widely known applications of Tyvek® is in the construction industry, where it is used to increase air and water resistance, helping to lower heating and cooling costs in buildings and providing better protection against water and moisture intrusion. The unique qualities of Tyvek® help stop air flow through wall cavities; help hold out bulk water and wind-driven rain; and allow moisture vapor to escape from inside walls. The result is a more comfortable, energy-efficient building with far fewer chances for damage from degradation effects.

Medical Packaging

Tyvek® is used in virtually every form of sterile medical packaging. That's because Tyvek® delivers an optimum balance of bacteria penetration resistance, tear strength, puncture resistance and clean peel, as well as compatibility with existing and emerging sterilization methods.

Protective Apparel

Garments made of Tyvek® are either used for hazardous environments or for general, non-hazardous, industrial use. Examples of uses for hazardous environments include protection against water-based acids, bases, salts and splashes of certain liquids, such as pesticides and herbicides.

Envelopes

The unique composition of Tyvek® results in virtually the strongest envelope available – offering superior protection from punctures, tears and moisture. Remarkably light, Tyvek® envelopes can help to save on mailing costs.

Graphics

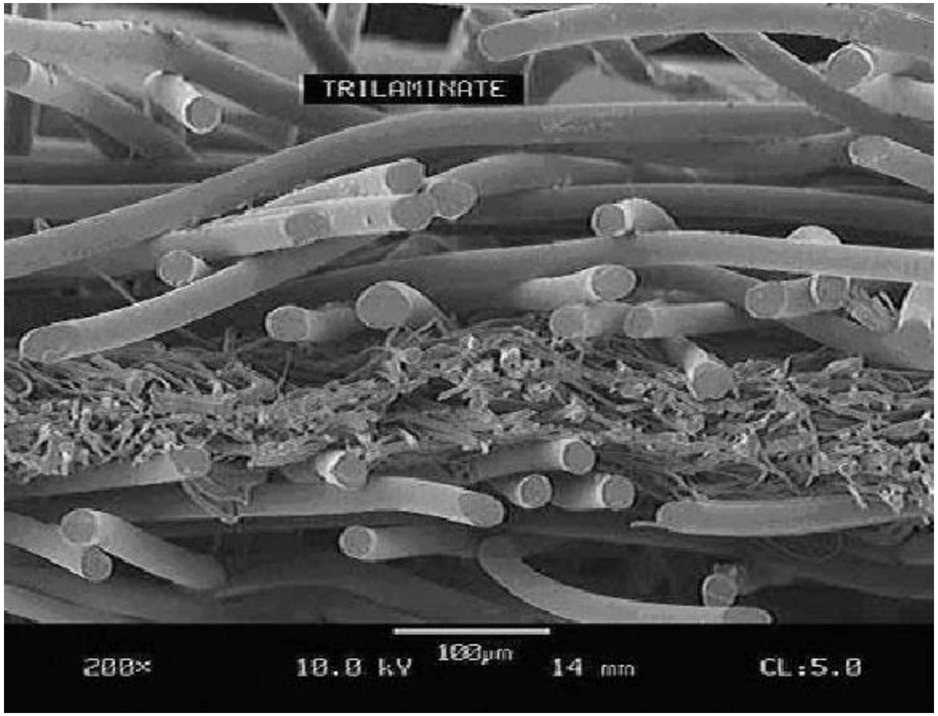
Among the first graphic products manufactured from hard-structure Tyvek® were outdoor advertising posters and banners; labels; tags; and schoolbook covers – applications that benefit from its water, abrasion and tear resistance. Today, many more graphics uses have been found for Tyvek®, such as highly durable maps and guidebooks; chemical container labels; workshop manuals; race numbers for marathon runners; and frozen food labels.

Covers

Because Tyvek® is water resistant, yet breathable, it is ideal for car, boat and camper covers. The unique nonwoven structure of Tyvek® protects against acid rain and salt spray by holding out more water than cotton, polyester or cotton/polyester covers; however, because it is breathable, it also allows trapped moisture to escape, helping to prevent rot and mildew.

Spunbond and melt blown modification

SMS



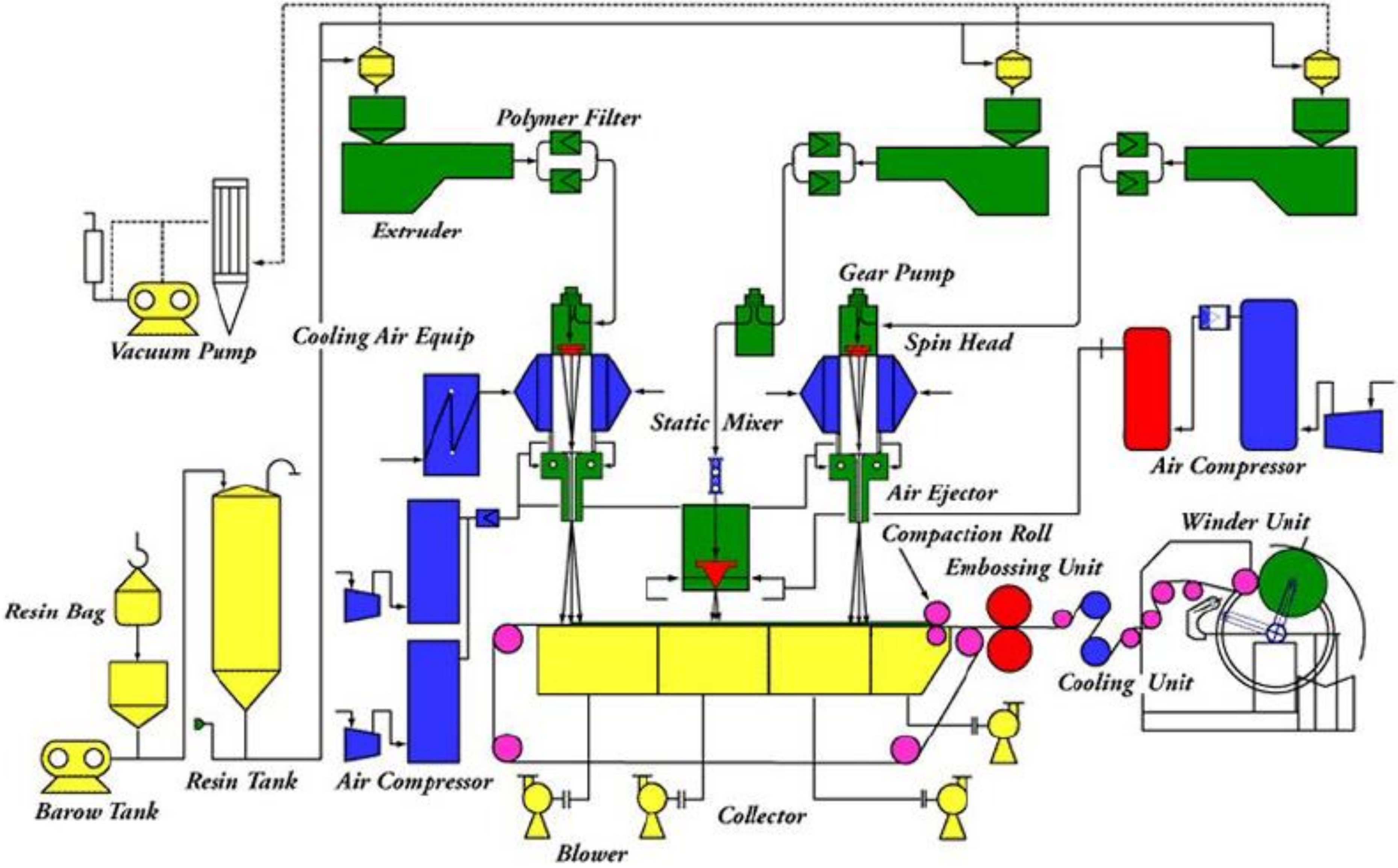
SMS

The operation begins by spinning continuous filaments from the spunbond die of station one. The filaments pass through the quenching zone, which cools and prevents them from sticking together. The quenched filaments pass through a stretching zone where discharged air further draws down and attenuates the filaments. Filaments are randomly deposited on the conveyor. Air passes through the conveyor and is withdrawn by the vacuum system.

The first layer is conveyed under the spinning assembly in station two where micro-sized fibers are blown on top of the first layer, forming a meltblown layer on the spunbond. Average fiber diameter ranges from 0.5 to 15 microns. A fiber diameter of 1 to 10 microns is considered good, while 2 to 6 microns is excellent.

The two-layer laminate is conveyed under station three where a layer of spunbond filaments is deposited on the meltblown layer, completing the SMS structure. The threelayer composite may then pass though a calender or other device to bond the layers together in the conventional manner.

$\Rightarrow$ draw


Polymer Filter
Extruder
Gear Pump
Vacuum Pump
Cooling Air Equip
Spin Head
Static Mixer
Air Compressor
Air Ejector
Compaction Roll
Winder Unit
Embossing Unit
Resin Bag
Cooling Unit
Resin Tank
Air Compressor
Barow Tank
Collector
Blower

Typical products of spunbond and meltblown technologies

Product	**Fabric**
Disposable Diaper, Incontinence	Largest single market segment in nonwovens for cloth-like backsheet, leg cuff and cover stock
Durable Papers	Almost exclusively Tyvek® polyethylene spunbond fabric (Tyvek is a registered trademark of E.I. DuPont de Nemours & Co.)
Disposable, Protective Apparel	Dominated by Tyvek polyethylene spunbond fabric, although growing use of polypropylene spunbond and composite materials
Bedding, Pillows, Furnishings	Competitive market segment using polypropylene and polyester spunbonds
Geotextiles	Heavyweight polypropylene and polyester spunbonds, and needlepunch polypropylene and woven fabrics

Typical products of spunbond and meltblown technologies

Product	Fabric
Furniture	Polypropylene spunbond fabric, polypropylene needlepunch and polyester spunbond fabric
Filtration	Spunbond and meltblown fabric for liquid and air filtration
Automotive, Carpet, Trim	Heavyweight polyester spunbond fabrics
Carpet Underlayment	Carpet backings consisting of PET, polyamide and polypropylene spunbond fabrics
Medical Products	Spunbond and spunbond/meltblown composite fabrics
Roofing	Typically polyester spunbonds

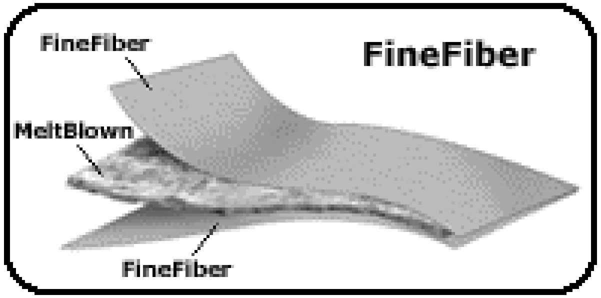
Airlaid sorbents are manufactured from the 100% polypropylene fibers. The polypropylene fibers are ultrasonically bonded between two layers of spunbond fabric.

Sonic bonded low-lint absorbents are manufactured by ultrasonically bonding two layers of melt-blown polypropylene. This construction gives sonic bonded products greater strength than regular melt-blown sorbents, and also provides low-lint properties.

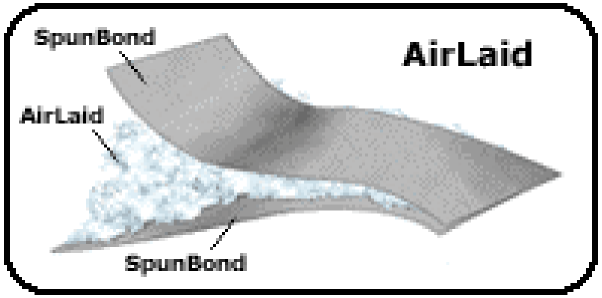
Fine fiber sorbents consist of two layers of fine fiber polypropylene ultrasonically bonded around a high-loft melt-blown core. These low-lint pads and rolls have the highest absorption rates of all our products.

Oil control products

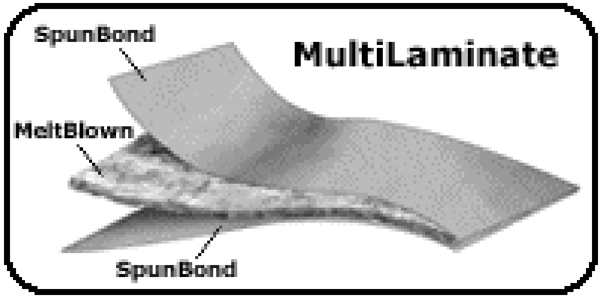
FineFiber technology produces densely-woven, small-diameter strands of fiber to increase surface area for fast absorption and firmer grip. Add 3-ply construction for extra durability and you have a mat that you can walk on safely and is virtually indestructible to foot traffic.



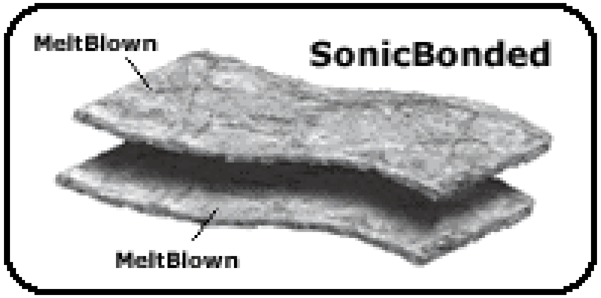
AirLaid technology produces a resilient bounce-back polypropylene fiber that creates uniform pockets of air space that sorb and hold liquids. Insert AirLaid polypropylene between two layers of tough spunbond and bond ultrasonically for added strength. Now you have an ideal mat for wrapping around pipes or fitting into tight spots to help maintain a cleaner, safer workplace.



MultiLaminate technology produces a super-strong, heavy-weight mat for rugged applications. Outer spunbond layers constructed of continuous strands of interwoven polypropylene fibers provide toughness while the MeltBlown inner layer draws and traps ugly grime inside. Resistant to tears and abrasions, this mat is perfect for lining tool cribs and placing under jagged parts and heavy equipment.



SonicBonded technology produces a high-loft mat for faster, greater absorbency. Fuse the layers together with ultrasonic weld points and you've got a mat that sucks up to 57.5
gallons per roll and keeps its shape even when fully saturated. In other words, it won't fall apart! Great for overspray areas and indoor spills where clean, dry floors are important for safety.



Primary process characteristics:

Modular structure of the spunbonding and melt blown components

- Common operating console for all spinning stations
- Common high-speed spinning belt for all spinning stations.
- High-speed winding system with downstream slitter/rewinder

Applications

- Barrier products
- Diaper edges
- Filtration
- Covers for superabsorbents
- Medical applications (for example surgery covers)

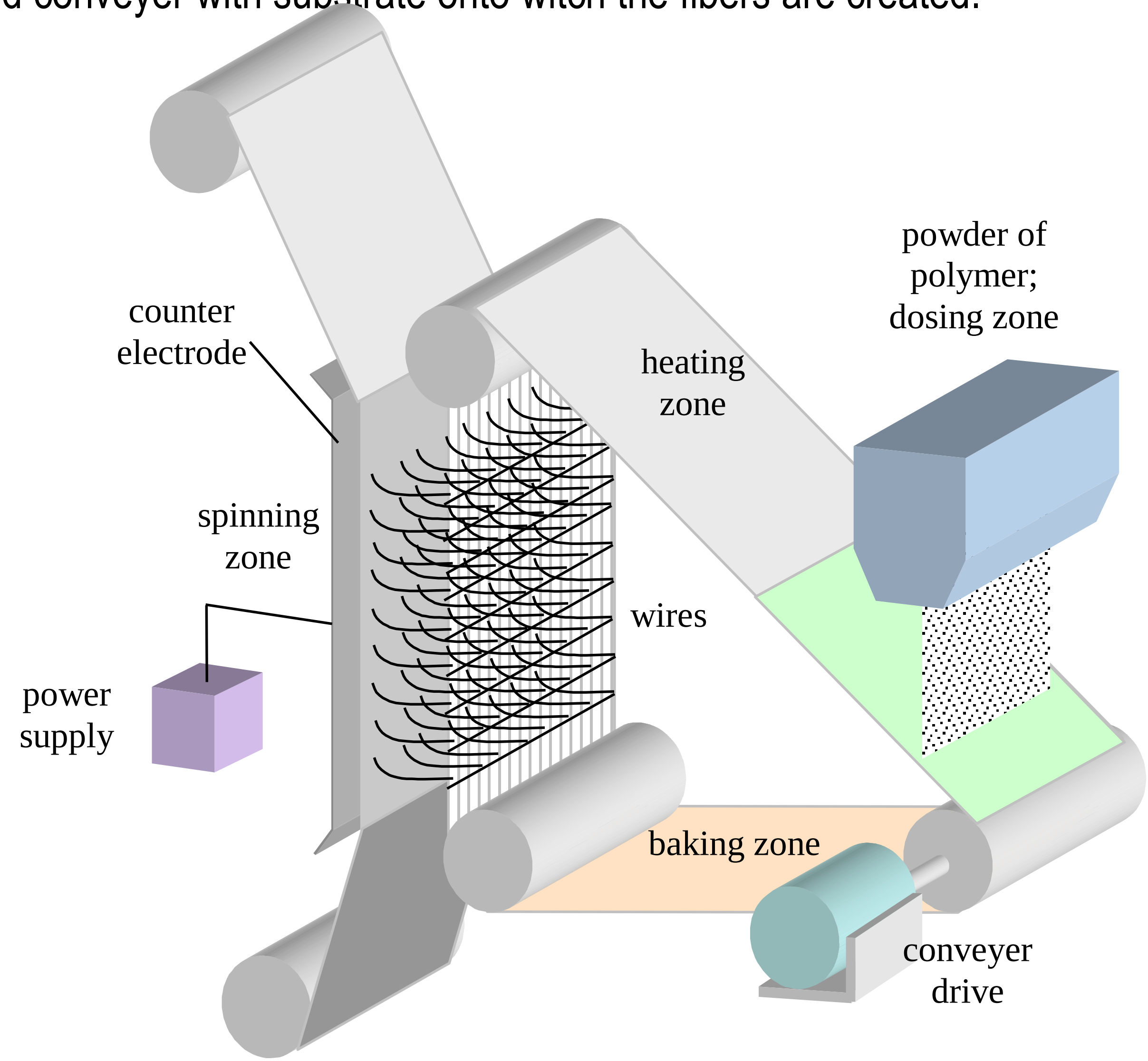
Physical properties

- Thermo-bonded
- High resistance against water column
- Thermal insulator
- Preferred grammage range 10 - 60 g/m²
- Dyable

Electrostatic spinning

In the electrospinning process a high voltage is used to create an electrically charged jet of polymer solution or melt, which dries or solidifies to leave a polymer fiber. One electrode is placed into the spinning solution/melt and the other attached to a collector. Electric field is subjected to the end of a capillary tube that contains the polymer fluid held by its surface tension. This induces a charge on the surface of the liquid. Mutual charge repulsion causes a force directly opposite to the surface tension. As the intensity of the electric field is increased, the hemispherical surface of the fluid at the tip of the capillary tube elongates to form a conical shape known as the Taylor cone. With increasing field, a critical value is attained when the repulsive electrostatic force overcomes the surface tension and a charged jet of fluid is ejected from the tip of the Taylor cone. The discharged polymer solution jet undergoes a whipping process wherein the solvent evaporates, leaving behind a charged polymer fiber, which lays itself randomly on a grounded collecting metal screen. In the case of the melt the discharged jet solidifies when it travels in the air and is collected on the grounded metal screen.

Electrostatic spinning - This technology consists depositing the polymer onto a conveyer of heated wires giving a high voltage potential. The polymer covering the wires, pass over the second conveyer with substrate onto witch the fibers are created.



Parameters:

− Molecular Weight, Molecular-Weight Distribution and Architecture (branched, linear etc.) of the polymer

− Solution properties (viscosity, conductivity & and surface tension

− Electric potential, Flow rate & Concentration

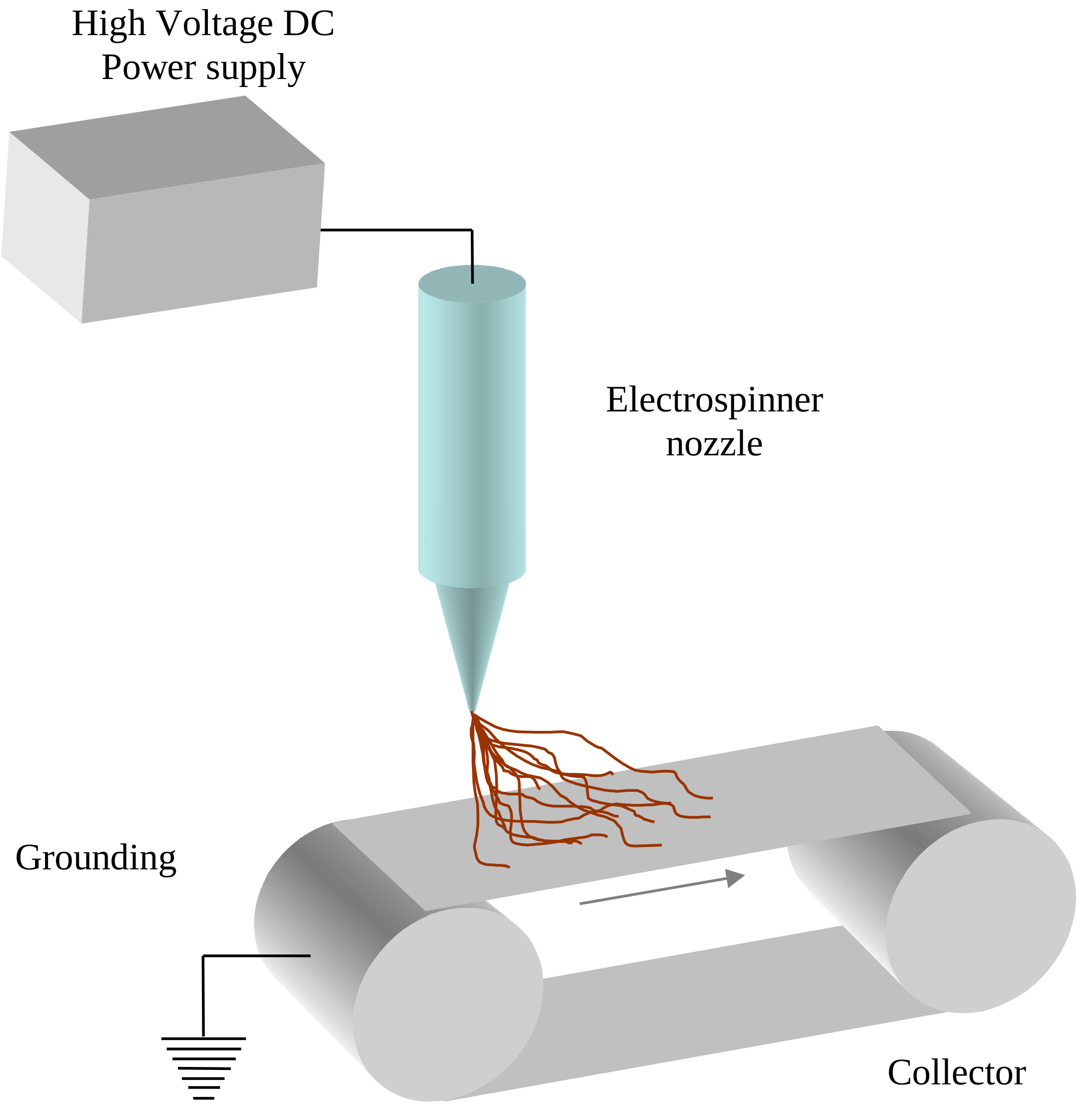
− Distance between the capillary and collection screen

− Ambient parameters (temperature, humidity and air velocity in the chamber)

− Motion of target screen

An important characteristic of electrospinning is the ability to make fibers with diameters in the range of manometers to a few microns. Consequently these fibers have a large surface area per unit mass so that nanowoven fabrics of these nanofibers collected on a screen can be used for example, for filtration of submicron particles in separation industries and biomedical applications, such as wound dressing in medical industry, tissue engineering scaffolds and artificial blood vessels. The use of electrospun fibers at critical places in advanced composites to improve crack resistance is also promising.

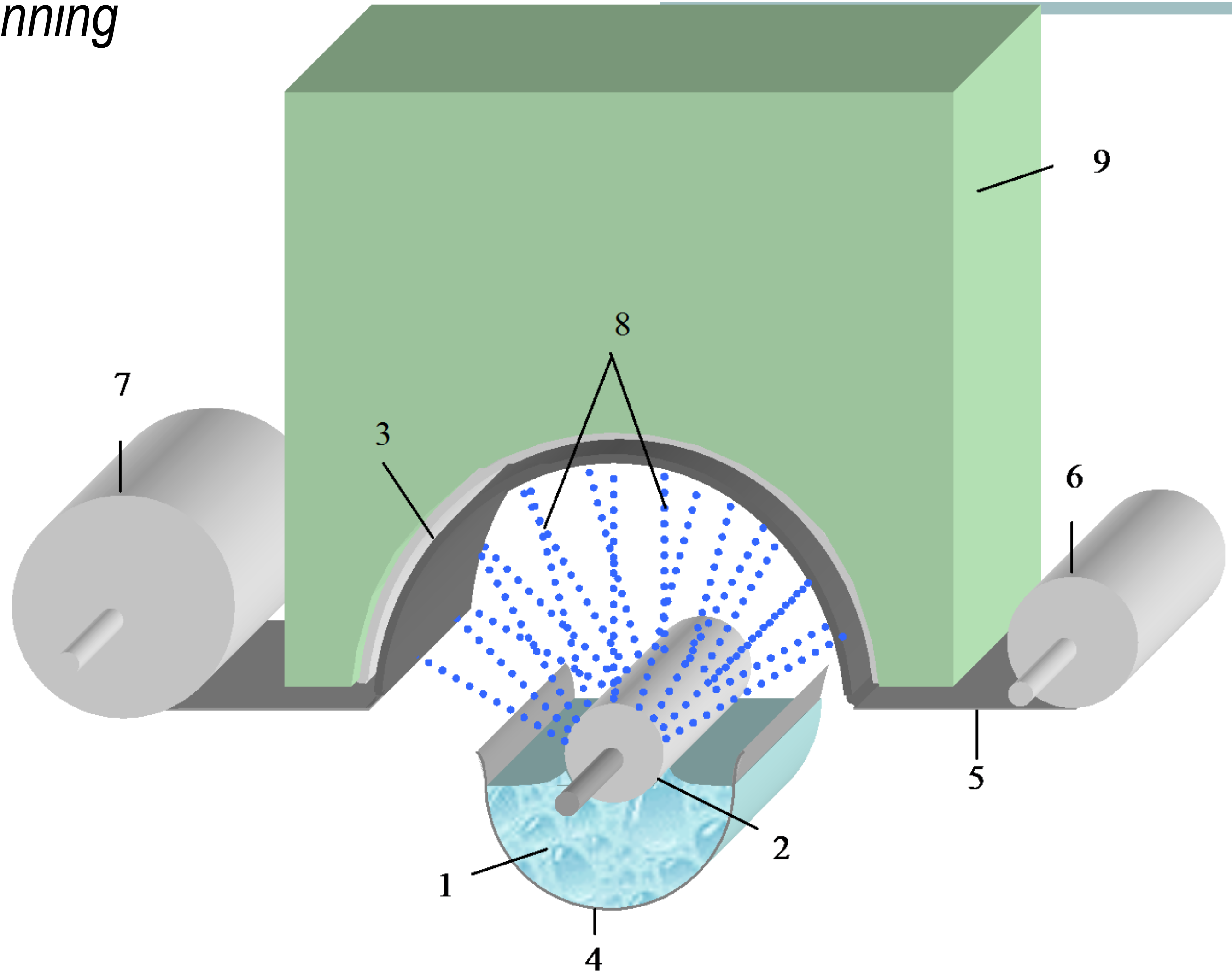
Electrostatic spinning - a schematic diagram of electrospinning



The process makes use of electrostatic and mechanical force to spin fibers from the tip of a fine orifice or spinneret. The spinneret is maintained at positive or negative charge by a DC power supply. When the electrostatic repelling force overcomes the surface tension force of the polymer solution, the liquid spills out of the spinneret and forms an extremely fine continuous filament. It has the misleading appearance of forming multiple filaments from one spinneret nozzle, but current theory is that the filaments do not split.

These filaments are collected onto a rotating or stationary collector with an electrode beneath of the opposite charge to that of the spinneret where they accumulate and bond together to form nanofiber fabric. The distance between the spinneret nozzle and the collector generally varies from 15 –30 cm. The process can be carried out at room temperature unless heat is required to keep the polymer in liquid state. The final fiber properties depend on polymer type and operating conditions. Fiber fineness can be generally regulated from ten to a thousand nanometers in diameter.

Solution spinning



1 – polymer solution, 2 – rotating charged electrode, 3 - counter electrode, 4 – container, 5 - supporting material, 6 - unreeling device, 7 - reeling device, 8 - formation of the nanofibers, 9 - vacuum chamber

A device for nanofibres production from a polymer solution uses electrostatic spinning in an electric field created by a potential difference between a charged electrode and a counter electrode consisting of a container (4) at least partly filled with a polymer solution (1) in which is by a part of its circumference immersed pivoted cylinder (2), which is by a well-known not represented method connected to a source of DC voltage and which forms a charged electrode. Against a free part of the circumference of the charged electrode (2) is a
counter electrode (3) with a different potential situated, which is usually connected to earth (grounded), as described in Fig. 4.21, or it is by a well-known not represented method connected to a source of DC voltage of a different polarity. By rotating the charged electrode, where its part of its circumference is immersed in the polymer solution, is the polymer solution drawn by the circumference of the charged electrode from the container into the space between the charged electrode and the counter electrode, where an electric field is formed. Here on the surface of the charged electrode are from the polymer solution formed Taylor cones of a high stability and they present places of primary formation of the nanofibres (8). The formed nonofibres are by the effects of electric field drift away to the counter electrode and consequently they are deposited on the surface of the backing fabric presenting plane supporting material (5) of the nanofibres into a layer, which thickness is controlled using the velocity of the unreeling device (6) and the reeling device (7). The drift of the nanofibres away of the charged electrode to the counter electrode is promoted by streaming of air sucked from the outer space into the vacuum chamber (9) and passing along the polymer solution container and the charged electrode and passing through the backing fabric presenting plane supporting material of the nanofibres and the counter electrode.
A method and a device according to the invention are applicable for production of layers of nanofibres in diameters from 50 to 200 nanometers.
These layers can be used for filtration, as battery separators, for production of special composites, for construction of sensors with extremely low time constant, for production of protective clothes, in medicine and other fields.

Polymer solvent systems used in electrospinning -

Polymer	**Solvents**
Nylon 6 and nylon 66	Formic Acid
Polyacrylonitrile	Dimethyl formaldehyde
PET	Trifluoroacetic acid/Dimethyl chloride
PVA	Water
Polystyrene	DMF/Toluene
Nylon-6-co-polyamide	Formic acid
Polybenzimidazole	Dimethyl acetamide
Polyramide	Sulfuric acid
Polyimides	Phenol