Technical Textiles

Introduction:

The use of fibres, yarns and fabrics for applications other than clothing and furnishing is not a new thing. Nor is it exclusively linked to the emergence of modern artificial fibres(Synthetic & regenerated) and textiles. Natural fibres such as cotton, flax, jute and sisal have been used for centuries and still find applications in tents, tarpaulins ropes, sailcloth etc. There is historical evidence of woven fabrics and meshes being used to stabilise marshy ground for road building.
The relatively new thing is a growing recognition of the economic and strategic potential of such textiles.

Definition:

The textile materials and products manufactured primarily for their technical and performance properties rather than their aesthetic or decorative characteristics are called technical textiles.
They may be both woven and non-woven and are primarily made out of synthetic and a few natural fibers. Whereas conventional textiles are primarily manufactured for aesthetic or decorative purpose.

Classification of technical textiles.

Technical textiles can be classified in three ways
a. Raw material based: This classification is based on the type of fibers used for making technical textiles.
b. Process based: Technical textiles are classified according to type of process used in making them like woven, knitted, nonwoven.
c. Application based: According to this classification. Technical textiles can be categorized into following 12 parts:

1. Agrotech: Agrotech are those technical textiles which find application in agriculture, aquaculture, horticulture and forestry. Example shade nets, windshield, antibird nets etc.
2. Buildtech: building and construction
3. Clothtech: technical components of footwear and clothing
4. Geotech: geotextiles and civil engineering
5. Hometech: technical components of furniture, household textiles and floorcoverings
6. Indutech: filtration, conveying, cleaning and other industrial uses
7. Medtech: hygiene and medical
8. Mobiltech: automobiles, shipping, railways and aerospace
9. Oekotech: environmental protection
10. Packtech: packaging
11. Protech: personal and property protection.
12. Sporttech: sport and leisure.

2. Geo-Textiles

Introduction

Geo means earth or soil, textiles are used in this sector since time immemorial the classic example of this is the Great Wall of China in its construction branches of a native shrub (tree) is used to reinforce the mixture of clay and gravel. Natural fibers were initially used for these purposes but after the invention of synthetic fibers the fields gain new heights.

> **Definition:** Geo- Textiles are the technical textiles used in soil (including rock) for specific applications to improve bearing capacity, filtration, and drainage, as reinforcement or to prevent intermixing of two adjoining materials.

Fibers used for Geo-textiles and their properties.

When selecting the most suitable fibres for geotextiles, consideration must be given to the general properties of fibres in terms of strength, elongation, flexibility, durability, availability, variability and their production forms, from the civil engineering and textile aspects. Also, factors affecting the economics of fibre cultivation and extraction on a large commercial scale should be taken into account. Allowing for the above factors, six vegetable and three synthetic fibres have been selected as the most promising to form geotextiles: flax, hemp, jute, abaca, sisal, coir, polyester, polyethylene and polypropylene.

General description of flax fibre:

It is used in twines, ropes fishing nets, bags, canvas, tents, cigarette paper and banknotes.
Fibre is extracted by retting process, fibre strength increases when it is wet.
Cross sectional view- Nodes at many points, cell wall thick and polygonal in cross-section.
Cell long and transparent Longitudinal view Cross-marking nodes and fissures fibre cell ends, Ends taper to a point or round. Physical and chemical properties are superior to cotton. Fiber is Yellowish-white, soft and lustrous in appearance. Good degree of rigidity and resists bending. It is a Inextensible fibre, more elongation obtained when dry. One of the highest tensile strength and modulus of elasticity of the natural vegetable fibres. Used as alternative reinforcement to glass, aramid and carbon in composites.

General description of hemp fibre:

Fibre is used to make ropes, marine cordage, ships sails, carpets, rugs, paper, livestock bedding. Hemp is not weakened or quickly rotted by water or salt water. It is stronger, more durable, stiffer and more rigid and coarser than most vegetable fibres.

General description of jute fibre:

It find use in ropes, bags, sacks, cloths, Erosion control applications. Cross- sectional view of fibre is Sharply polygonal, rounded (5–6 sides) corners; wall thickness Varies longitudinal view Fissures and cross marking are unlikely. Lumen varies in size along each fibre. When compared it is not as strong as hemp and flax. Colour of fiber is White, yellow, red or grey; silt like and easy to spin but difficult to bleach and can never be made pure white owing to its lack of strength. If kept dry will last indefinitely, if not will deteriorate in time it holds 5 times its weight of water.

Cheap and used in great quantities, high initial modulus, but very little recoverable/elasticity (woody fibre); exhibiting brittle fracture, having small extension at break. Poor tensile strength, good luster (silky), high lignin content. Individual fibres vary greatly in strength owing to irregularities in the thickness of the cell wall.

General description of abaca fibre:

Its properties when compared are superior to flax, better than hemp for marine ropes. Fbre is creamy and glossy it is stiff and tenacious has even texture and very light colour. It is generally strong and sufficiently flexible can be used for making ropes. There are four groups of fibre yielded from this plant, depending on where the leaves have come from.

General description of sisal fibre:

It is used for making twines, ropes, rugs, sacking, carpets, and cordage and agricultural. Stiff in texture, wide central. It is not as strong as abaca and tends to break suddenly without warning. It can be spun as fine as jute.

General description of coir fibre:

It is obtained from coconut tree and used for making ropes, cordage and sailcloths. Fibre is reddish-brown strong, elastic filaments of different lengths, colour, etc. thicker in middle and tapers gradually towards the ends. It is naturally coarse, suitable for use in sea water, high lignin content makes it resistant to weathering extremely abrasive and rot resistant (high % of lignin) under wet and dry conditions and retains a high percentage in tensile strength.

Natural Fibers	Tenacity (N/tex)	Strain%	Modulus (N/tex)
Abaca	0.7	4	25
Sisal	0.4	4	20
Jute	0.4	2	15
Flax	0.5	4	18
Hemp	0.45	4	20
Coir	0.15	20	3

Synthetic fibres:

Synthetic fibers are the major raw materials for the production of geotextiles. There are four major polymer families used as raw materials for geo-textiles they are polypropylene, polyester, polyamide and polyethylene.

Polypropylene

Polypropylene has been the most widely used polymer for the manufacture of geotextiles because of its low cost, suitable tensile properties and chemical inertness. The demerits of polypropylene are its sensitivity to ultraviolet (UV) radiation and high temperature and poor creep and mineral oil resistance. Hence, geotextiles made form polypropylene should be employed under suitable installation and environmental conditions.

Polyester

Polyester is also an important polymer applied in the production of geotextiles. It displays superior creep resistance and tenacity values and is used in applications where the geotextile is subjected to high stresses and elevated temperatures. The major demerits of polyester is that it de gradation in soils exceeding pH 10.

Polyamide

Polyamides are used where good abrasion resistance is required. The demerit of the fiber is it loses its strength in wet condition.

Essential properties:

There are three main properties which are required for a geotextile

Physical & Mechanical properties: Fibers used in geotextiles should have properties like good flexibility, strength, stiffness etc.

Hydraulic properties: Geotextiles should have properties like good porosity/permeability, so the water can be easily filtered through it and material can be used in applications like drainage and filtration.

Chemical resistance: As the geotextiles are subjected to the environmental conditions they should have good resistance towards light, chemicals and biodegradation.

Characterstics of Geo-textiles:

Woven Geo-Textiles:

Woven fabrics are made on looms by the interlacement of warp and weft. They have a wide range of applications and they are used in lighter weight form as soil separators, filters and erosion control textiles. In heavy weights, they are used for soil reinforcement in steep embankments and vertical soil walls; the heavier weight products also tend to be used for the support of embankments built over soft soils. The beneficial property of the woven structure in
terms of reinforcement, is that stress can be absorbed by the warp and weft yarns and hence by fibres, without much mechanical elongation.

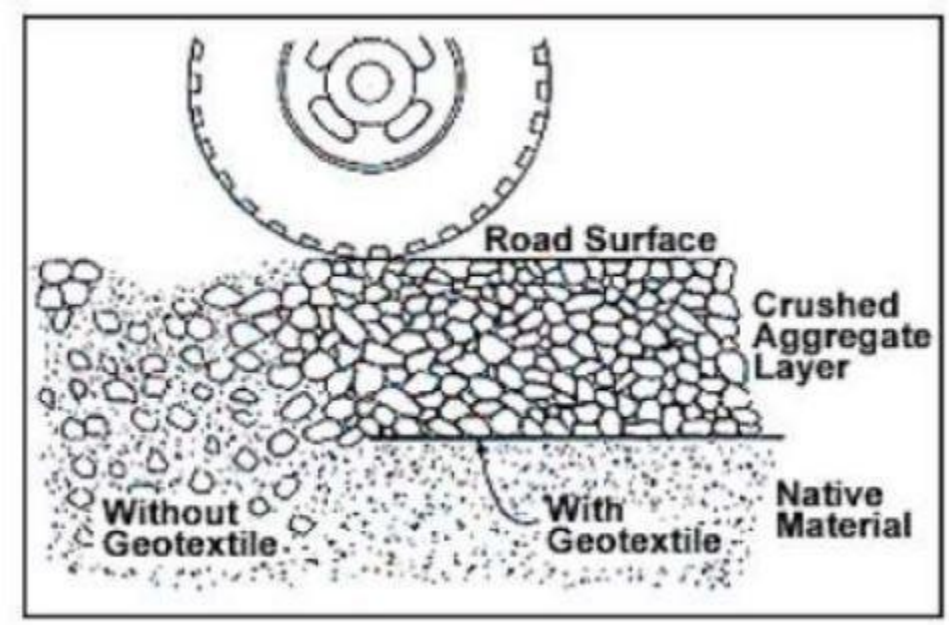
Non-Woven Geo-Textiles:

When directionally or randomly oriented fibres are bonded either by friction and/or cohesion and/or adhesion and constructs a batt, web or sheet is called nonwoven fabrics. Typically, nonwoven fabric can be produced in two steps: formation of web (arranging the fibers in certain orientation characteristics) and bonding the fibres by mechanical, thermal or chemical means. This two-step procedure brings the variation the nonwoven structures, i.e. spun bonded, melt blown, carded, air-laid, adhesive bonded, thermal bonded, stitch bonded, needle punched,
hydro entangled, etc.

Functions of Geotextiles.

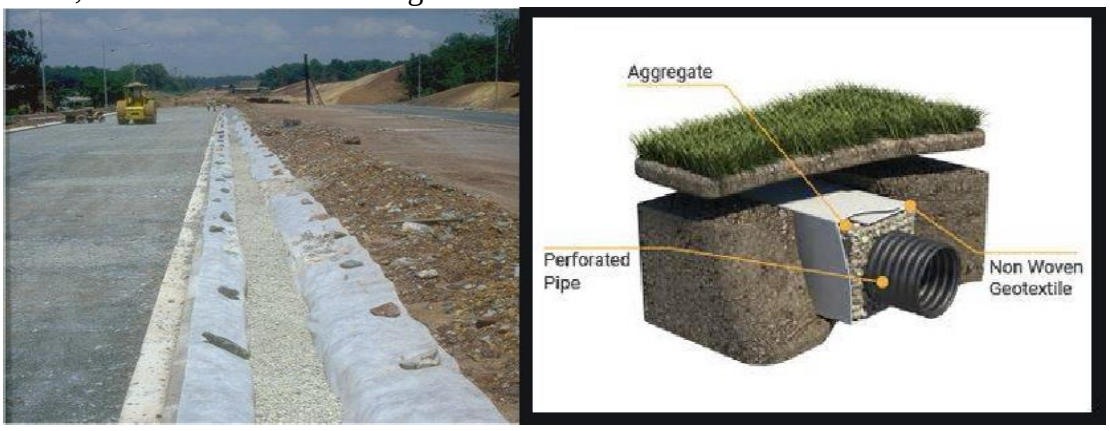
1. Separation:

Gotextiles will prevent two soil layers of different particle sizes from mixing with each other, as is illustrated the image below.



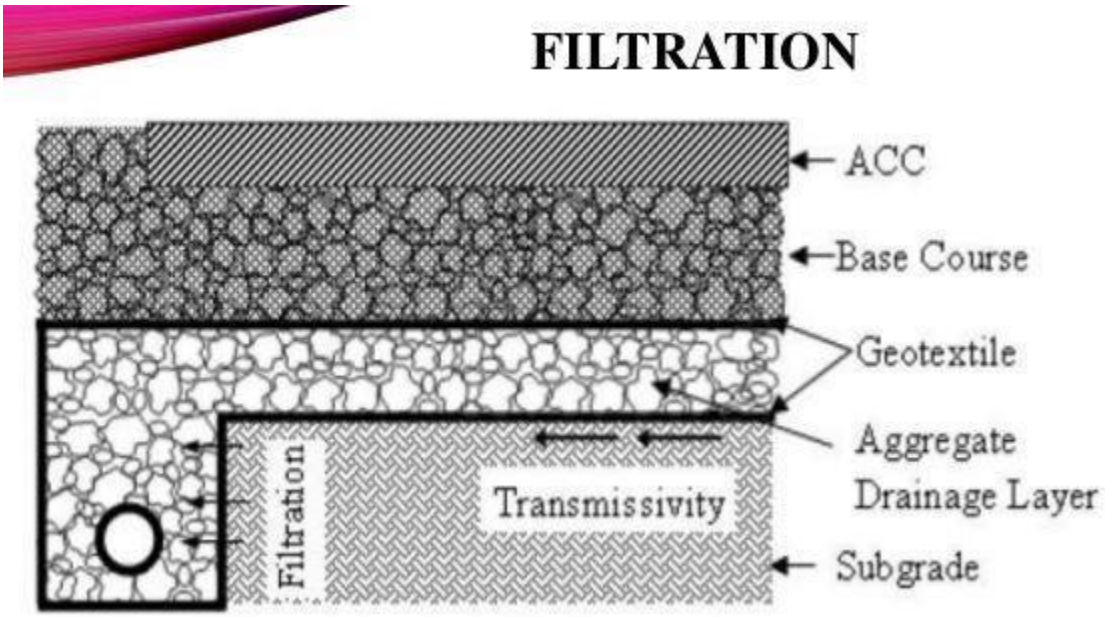
2.Drainage

Geotextiles will efficiently collect superfluous water from structures, such as rainwater or surplus water, from the soil and discharge it.



3.Filtration

Geotextiles are an ideal interface for reverse filtration in the soil adjacent to the geotextile. In all soils water allows fine particles to be moved. Part of these particles will be halted at the filter interface; some will be halted within the filter itself while the rest will pass into the drain. The complex needle-punched structure of the geotextile enables the retention of fine particles without reducing the permeability of the drain.



4.Reinforcement

Heavy geotextiles can be used to reinforce earth structures by means of fill materials. Thanks to their high soil fabric friction coefficient and high tensile strength, they are an ideal reinforcement solution.

5.Protection

Geotextiles are an ideal protection from erosion of earth embankments by wave action, currents or repeated drawdown. A layer of geotextiles can be placed so as to prevent leaching of fine material. They can be used for rock beaching or as mattress structures. They can even easily be placed under water.

Applications of geotextiles/ Geosynthetics:

Geo-Grids:

https://www.youtube.com/watch?v=kdYQnsr1kVs

Geogrids are geosynthetic material made from polymers such as polypropylene, polyethylene or polyester and are used widely in Civil Engineering applications to provide tensile reinforcement of soil. They are in the form of open grids so that soil can strike through the apertures and the two materials interlock together to give composite behaviour. They are used in the construction of retaining walls, steep slopes, roadway bases and foundations.

Geo-Net:

By their structure geonets resemble geogrids. However, contrary to geogrids, they do not feature equivalent strength properties. So, their main function is drainage and combined with geotextile they often form a geocomposite.

Geo-Cell:

Geocell (cellular system) is a system of interconnected surface textured perforated or smooth strips. These strips are connected by an ultrasound weld in order to form a honeycomb pattern. The cellular system is made from a high-density polyethylene HDPE, or polypropylene PP. This

system is mostly applied to reinforce a low-bearing base (railroads, highways, dumping yards, etc.), stabilize surfaces of eroded slopes, and reinforce stream banks and dikes, and erect retaining walls.

Geo-mattres:

Geomats are three-dimensional water permeable polymer or other synthetical materials' structures, thermally jointed with each other. They are used for fixing soil elements, grass and small plants roots, also applied in geotechnics and other construction fields. Geomats are produced in form of regular or random oriented three-dimensional yarn structures or in form of honeycombs or other geotextile or plastic band constructions.

Geomats are applied to create stable vegetation along river, pond banks and slopes to prevent erosion processes of surfaces. Geomats in form of stereoscopic honeycomb constructions are used in combination with geotextiles to reinforce foundations and increase bearing resistance.

Geo-Membrane:

The materials themselves are "impervious" thin sheets of rubber or plastic material used primarily for linings and covers of liquid- or solid-storage or disposal facilities. Thus the primary function is always as a liquid or vapor barrier. The range of applications, however, is very great.

Geocomposites- Hybrid systems/ Combination of any two or all the above geosynthetics types which can function as specifically designed for use in soil, rock, waste and liquid related problems.

Composite: Composite is a material which is made using two or more individual components and the product formed has different characteristics than the individual components.

Medical Textiles:

Introduction:

Combination of textiles and medical sciences has resulted into a new field called medical textiles. New areas of application for medical textiles have been identified with the development of new fibers and manufacturing technologies for yarns and fabrics. Development in the field of textiles, either natural or manmade textiles, normally aimed at how they enhance the comfort to the users. Development of medical textiles can be considered as one such development, which is really meant for converting the painful days of patients into the comfortable days.

Definition:

Technical textiles used in medical applications (Hygiene, Health, Personal Care, Surgical Applications) are called medical textiles. For example baby diapers, surgical sutures, surgical dressings and artificial implants.

Characteristics of fibers used for medical textiles:

The major requirements for biomedical fibers/polymers

- Non toxicity: Fibers used are in contact with human body so they should be non-toxic.
- Nonallergenic: They should not cause any allergy.
- The ability to be sterilized: The physical and chemical properties should not alter during sterilization.
- Biodegradibility/ Durability: Depending upon the application sometimes we need the fibers to be biodegradable like in the case of sutures and sometimes we need the medical textile to last longer as in the case of artificial ligaments.
- Strength
- Elasticity
- Biocompatibility

Fibres used for medical and healthcare application:

Textiles materials that are used in medical applications include fibres, yarns, fabrics and composites. Depending upon the application, the major requirements of medical textiles are absorbency, tenacity, flexibility, softness and at times bio stability or biodegradability.

- Natural & regenerated: Cotton, Silk, Viscose rayon
- Synthetic: Polyester, Poly-amide, Polytetrafluoroethylene (PTFE), Polypropylene Polyethylene, Carbon, Glass
- Specialty fibers: Collagen, Alginate and Chitin

Collagen: Biodegradable protein fiber or hydrogel (gelatin). This is obtained from cow skin. Collagen fibres when used as sutures are equally strong as silk, and they are biodegradable.

Alginate: Biodegradable fibers made from seaweed. Calcium alginate fibres have been proven to be wound healing. Wound dressings made from such fibres are nontoxic, biodegradable.

Chitin: This is a polyacrylamide from crab and shrimp shells. It can be absorbed by the body and promote healing. Artificial skins made from Chitin non-woven fabrics stimulate new skin formation.

Application of Medical Textiles:

Non-Implantable Material:

Materials in this category are generally used for external application on the body and they may or may not make contact with skin. Following are the examples.
Bandages:
These are narrow cotton or linen, plain weave cloth of low texture, either woven or knitted. There are different types depending upon end use.

1. Simple bandage: it hold dressing in place.
2. Elastic bandage: It provide support and comfort.
3. Gauze: It serve as absorbent material.
4. Wadding: It prevent wound adhesion on dressing.

Compression bandage and plasters are some other examples of non-implantable medical textiles.

Implantable medical textiles:

These materials are used inside the body like
1. Sutures: They are used for closing wounds.
2. Vascular grafts: They are used to reconnect blood vessels when the artery is clogged/damaged.
3. Artificial ligaments: To replace damaged natural ligaments.

Extracorporeal Devices:

These are extra corporeally mounted devices used to support the function of vital organs, such as kidney, liver, lung, heart pacer etc. The extracorporeal devices are mechanical organs.

Artificial kidney
Tiny instrument, about the size of a two-cell flashlight. Made with hollow hair sized cellulose fibres or hollow polyester fibres slightly larger than capillary vessels.

Artificial heart
An 8-ource plastic pump lined with decom velour to reduce damage to blood and is a chambered apparatus about the size of human heart

Healthcare/ Hygiene products:

Surgical gowns:
They prevent transfer of bacterias which may be present in the doctor/ staff to the patient. Earlier woven gowns are used now nonwoven gowns are gaining popularity.

Surgical masks:

A good mask should have higher filter capacity, high level of air permeability, lightweight and non-allergic.

Surgical caps:
These are made from nonwoven materials based on cellulose. Prevents human hairs from falling on patient which can be a cause of infection.

Apart from this diapers, wipes, surgical hosiery are some other examples.

Automotive Textiles

Introduction:

Automotive textile is an integral aspect of technical textile. Since it cannot be classified in apparel textile, it is more of a techno mechanical application of textile. Industrial textiles are widely used in transportation vehicles and systems including cars, trains, buses, airplanes and marine vehicles. Approximately 50 square yards of textile material is used in an average car for interior trim (seating areas headliners, side panels, carpets and trunk, lining, tires, filters, belts hoses, airbags etc.)

Definition:

Technical textiles used in automobiles and their components are called automotive textiles. For example nylon tyre cord, seat belt, airbags, carpets etc.

Fibers used for automotive textiles:

Acrylic, Modacrylic, Nylon 6, Nylon 6.6, Polyester, Polypropylene, Wool, Cotton, UHM, Polyethylene, Aramid, Glass, Steel, Aluminium etc.

Automotive textile should have following properties:

- Tear resistant
- Burst/ pressure resistance
- Durability
- Heat resistance
- High strength
- Flexibility/ Rigidity
- Puncture resistance etc

Applications of Automotive Textiles: Upholstery, carpets, tyres, safety devices, filtersand engine compartment items.

Upholstery:

The volume of upholstery varies by region since manufacturers from different regions may prefer different styles of vehicle interiors. Both woven manufacture of automotive upholstery. An average of 5-6 m^2 of fabric is used in cars for upholstery. Modern designers are trying to give sporty or elegant look to the car interiors.

Carpets:

Carpet is a composite material made by combining many layers of textiles. They are act as a barrier for noises and vibration. Carpets must withstand high temperature. Needle-felt carpets, tufted cut-pile carpets are generally used. Carpets usually have a rubberized backing.

Pre-Assembled Interior Components:

Door kick panels, boot linings roof linings, parcel shelves and insulation (heat, sound, vibration etc.) materials are important examples for pre-assembled interior components. Coated laminated needle-punched non-woven and warp knits are the main materials used for the category.

Tyres:

The textile material in a type is used mainly for reinforcement. Textile materials such as viscose, glass and steel cords provide dimensional stability as well as reinforcement. Dimensional stability is an essential requirement for tyres. Strength is provided to tyres mainly by the web of fibres that lies with the body of the tyre called carcass.

Safety Device:

Seat belts and air begs are commonly used for safety in automotives. The seat belts control the forward movement of the wearers in the controlled manner during sudden stoppage of the vehicle. About 1 Kg of textile fiber per car is consumed in seat belts. An airbags is an automatic safety restraint system it is not an alternative to seat belt but a supplement.

Filters and Engine Compartment Items:

Hoses, belts and linen are important components car engine which are reinforced with textile materials. Automotive filters are largely made of textiles. Some example of the filters used in automotive are largely made of textiles. Some examples of the filter are air filter and oil filter. The function of these filters is to filter the fluid before it enters the engine because of delicate machine component may be destroyed if the dust particle enters into the engine.

Protective Textiles:

Introduction:

Textiles, which have most common uses for clothing & that provide a certain outlook or appearances. But for working in adverse environment we need protection rather than appearances. Protective textile is one kind of technical textile which provides some protective functions like heat protection, ballistic protection, hazardous chemical protection, cold protection etc.

Definition:

Technical textiles used for protective fabrics under hazardous conditions are called protective textiles. For example fire proof fabric, bullet proof fabric etc.

Fibers used for protective textiles and their specific properties:

SL No.	Fiber	Uses
01	Meta-aramid fiber	Industrial protective clothing, Racing driver's suit, Filter bags for hot gas, Cargo covers, Boat covers, Fire hose reinforcement.
02	Pera aramid fiber	Tyre cords, Radiator hose and brake shoes of racing cars, Body armor, Reinforced composites for aircraft, High-speed boat components.
03	Carbon fiber	Aircraft and a Space shuttle, Automotive, Medical Implants, and Marine.
04	Glass fiber	Consumer goods, Roofing Tiles, Corrosion resistant products used in highway overlay, Aircraft, and aerospace.
05	Polypropylene fiber	Marine ropes and cables, Sailcloth, Protective clothing, Boat hulls.
06	Spandex fiber	Foundation garments, Support hose, Sports and leisure garments.
07	PBI	Hot gas filtration, Thermal protective clothing, Racing driver's suit.
08	Tencel	Filtration media for the oil industry, Medical Textile, Industrial fabric.
09	Inorganic fiber	Aircraft, Automobile, Sport, Electrical Application and Military Application.
10	Fluorine-containing fiber	Filtration media for corrosive material, Refrigeration, Packing Material.

Application of Protective Textiles: Bullet Proof fabric, fire proof fabric, high visibility fabric, protection from electromagnetic radiations, protection against micro-organisms, chemicals and pesticides.

Fire proof fabric:

People who are working in firefighting, welding or moulding factories that produce enough heat and flame, have to wear this type of apparel. Human body feels burning effects at 45°C and burning

at 72°C. This protection is related to the ability of textile to resist conductive, convective, radiant thermal energy or more.

Bulletproof clothing:
This type of clothing works as a form of body armor that minimizes injuries from projectiles fired from handguns, shotguns, or rifles. Sometimes it is called ballistic vest or bullet-resistant vest. These vests use layers of very strong fibers to catch and deform a bullet by spreading its force over a larger portion of vest fiber. Police, military, bomb disposal officers wear this type of clothing. Aramid fibers are used for this purpose.

Micro-organism protection and chemical protection:
Microorganisms can cause diseases in humans and various chemicals like mustard and sarin are harmful for humans as they attack on skin and respiratory system and can lead to death. For this a multilayer fabric is required the outer clothing is generally made of polyester or some other synthetic fiber like nylon or mod acrylic. Its is many times coated with butyl rubber so that the liquid do not penetrate inside the structure. Middle layers contain activated carbon so if some gas pass inside it will be absorbed by it. The internal layers are made of cotton so the wearer can be comfortable as it absorbs its moisture.

High visibility textiles:
These textiles are used where danger of not being seen is there like a person working in low light condition or in dark and if he/she is not visible to others accidents can happen. The fibers like polyester, nylon, acrylic are used in these textiles. they are dyed with fluorescent agents which absorb UV radiations and reflect them in the form of visible light.

Protection from electromagnetic radiation:
Humans can be exposed to electromagnetic radiations due to nuclear disaster or in medical field (Ultrasound, x-rays, MRI). These radiations can cause cancer and other problems in humans. Conventionally coating of lead is done over fabrics to protect him from radiations. Now p-aramid fibers containing high concentration of tungsten and polyester fabrics coated with (barium sulphate or vinyl chloride resin) are used.

4. Industrial Textiles

Introduction:

Industrial fabrics are used in an extensive range of automotive, printing, belting, filtering and processing applications. Both synthetic and natural materials are used in the manufacture of industrial fabrics, which are woven, or knit, in a variety of patterns or produced in unwoven textures.

Definition:

Technical textiles used for industrial purposes are called industrial textiles. Cord, ropes, belts etc. are examples of industrial textiles.

Fibers used for industrial textiles and their specific properties:

Some of the materials used to create industrial fabrics include fiberglass yarns, aramid fibers, graphite, nylon, Kevlar, polyester and Teflon.

Application of Industrial Textiles: Cords and ropes, belts and filter fabrics.

Conveyor Belts:

Conveyor belts consist of woven fabrics that are coated on one or both sides with a man-made or natural rubber. With the lamination process, many processes, many layers of fabrics and other substrates can be combined.

Conveyor belts are generally made of three main components:

1. Carcass : The reinforcement found inside the conveyor belt is due to this only it also provide strength and absorb strength. Fibers like aramid, nylon, polyesteretc are used to make carcass.

2. Skims: The material between different layers is called skims. Rubber, pvc, urethane isused for this purpose.

3. Covers: The cover protects the carcass and extends the life of belt. Depending upon the end use many type of coating is given to conveyor belt.

Application of belts: Mining, construction, thermal power plants, packaging, food processing units etc.

Ropes and cords:

In olden days ropes made of abaca, sisal, jute were used and now more emphasis is given to nylon, polyester, Kevlar, polyethylene is given because of their superior properties.

There are two more common types of rope making technique

1. Twisted rope: Here many yarns are twisted together to make a strand and these strands are twisted again to make the resultant rope. Here both type of twists are used.

2. Braided rope: In this technique many strands are braided to form the resultant rope.

Applications: Mining, industrial application, rescue operations, commercial fishing etc.

Filters:

In filtration process one kind of substance from another kind. The media used to separate is called filter. Textiles are porous means they have empty space between their structures and can be used in filtration.

There are two type of filtration

Dry filtration: In this solid is separated from the gases. Fibers like polyester and PTFE are used for constructing dry filters. Polyester or other synthetic fibers are more used because the offer better properties.

Wet Filtration: Here solid is separated from liquid. Here polypropylene is mostly used in wet filtration, other fibers like nylon, Teflon, acrylic etc.

Applications:

Air filters, water filters, tea bags, cigarette filters and surgical masks etc.

Sports Textiles:

Introduction:

The use high functional & smart textiles has proven their high level of performance & succeeded in their functional properties. Not only as sportswear, but also the textile materials are used as sports equipments & components manufacturing as well. According to the functional requirements of particular sports, special apparels for specific sports are been manufactured. Many fibres, yarns, fabrics & finishes developed to meet the needs of the sports sector.

Definition:

Technical textiles used in sports sector are called sports textile. For example sports clothing, waterproofing, and sports surfaces.

Fibers used for sports textiles and their specific properties:

Different kinds of fibres are used for sports textile some of them are polyester, polyester-viscose, cotton and nylon and special fibers like (spandex, lycra, dacron)

Application of Sports Textiles: Sports clothing, sports surfaces and equipment's.

Sports clothing:

The textile used in sports clothing should have good functional properties (Durability, abrasion resistance, antimicrobial etc), moisture management (easy drying) and good aesthetic values (luster, handle). The clothing wick off moisture and this cause quick drying.

Artificial turf:

Artificial turf or synthetic grass consists of pile fibre and backing fabric fabricated from polyester tyre yarn. The pile fibre is made of either nylon 6 or nylon 6.6 or polypropylene / polyethylene which are then custom extruded into a monofilament ribbon form.

Parachute canopy fabrics and accessories:

Parachutes are used for aerial delivery of men, materials/cargo, heavy equipment, vehicles etc. Besides, they are widely used as air decelerators for arresting the high speed of fighter aircrafts during landing to reduce wear and tear of the braking mechanism of the aircrafts. Parachutes are also used for accurate bomb dropping, controlled decent of flares etc.

Sleeping Bags:

A sleeping bag may be used in high altitudes with -50OC temperature or in warmer places having temperature in the range of 10OC. Sleeping bags are lightweight and are capable of providing warmth, comfort and protection from wind and water. According to international standards, the maximum permissible total weight of a sleeping bag is around 1.5 kg.

Sleeping bags are constructed with tough yet soft touch nylon taffeta Shells filled either with holofil fibre, down feathers, cotton, or polyfill sheet in mummy shape. These fabrics having characteristics of water-repellency, breathability and in the range of 37-120 GSM are extremely light weight, windproof and have very high tear resistance. Sleeping bags produced using synthetic fibre filling constitutes 80 percent while remaining 20 percent use cotton filling.

Sports Composites:

The Indian sports goods industry manufactures a wide range of sports goods encompassing as much as 318 different items. Textiles are used as raw materials in certain sports items (eg. inflatable balls, cricket protective equipment and boxing equipment etc.) though in extremely small quantities.

Inflatable balls (football, basket ball, volley ball, beach ball, rugby ball etc.) are made of polyester-viscose / polyester / cotton fabric as inner layer and nylon thread which is usually of 9 ply while cotton thread of 5-6 ply are used for stitching.

Protective equipments for cricket comprise leg-guards, batting gloves, wicket keeping gloves, thigh pads, helmets, caps & hats, cricket kit bags etc. Leg-guards are made of PU laminated / PVC coated fabric in front and cotton fabric on the inner side. Batting gloves are made of PU laminated fabric while wicket keeping gloves are made of PVC coated fabric. However, leather is preferred for manufacture of the best quality cricket gloves due to strength and durability required in these gloves. Thigh pads are entirely made of cotton fabrics on outer and inner side whereas cricket kit bags are made entirely of polyester fabrics.

Boxing equipment (boxing gloves, punch bags etc.) is made of PU laminated / PVC coated fabrics, woven polyester fabric, nylon coated with PVC on both sides and canvas.

Textiles for Packaging:

Introduction:

Packaging textiles include all textile packing material for industrial, agricultural and other goods. The demand for packing material is directly proportional to economic growth, industrial production and trade as goods are produced and then distributed both locally and internationally. The growing (environmental) need for reusable packages and containers is opening new opportunities for textile products in this market.

Definition:

The technical textiles, used in packaging and subsequent transportation are called "PACKTECH".

Fibers used in packaging

High density polyethylene
Low density polyethylene
Linear density polyethylene
Polypropylene
Nylon polyester
Poly vinyl chloride
Jute, Flax

Application of Packaging Textiles: Fabrics for bags and luggage, food packaging.

Jute Sacks:

A range of heavy jute fabrics either in plain or twill weaves manufactured by using coarse jute fibre in larger percentage than used for manufacturing tarpaulin, hessian or such light fabrics. Sacking refers to the coarser and heavier cloth, used primarily for sacks for packing materials, which do not need special protection, but has higher weight. Jute bagging material is in demand because of the openness of the weave, which allows air to circulate while protecting the contents. Sacking bags, specifically used for the purpose of storing agro-based products, are known as Hydro carbon free bags that have been treated with vegetable oils to destroy the harmful effect of hydrocarbons. Thus sacking bags have great demand not just in the cement industry but also in the agro-based industries.

Tea Bags:

Tea bags are sold by organised tea producers to the high-end consumers. Tea bags consist of a filter paper pouch with a thread, which holds the tea powder and a tag. The tea bag is dipped in hot water / milk to produce the beverage.

Tea bag filter paper is made with a blend of wood and vegetable fibers. The vegetable fiber is bleached pulp abaca hemp, a small plantation tree grown for the fiber, mostly in the Philippines and Colombia.

Heat-sealed tea bag paper usually has a heat-sealable thermoplastic such as PVC or polypropylene, as a component fiber (100% non-woven technical textile) on inner side of the teabag surface. The filter paper used for making tea-bags is a 12-17 GSM non-woven material. The heat-sealing type tea-bag paper is of 16.5 to 17 GSM approx while the non-heat sealed tea-bag paper is around 12 – 13 GSM.

Soft Luggage:

The luggage industry is classified into hard and soft luggage. Hard luggage are mainly the large travel bags made from moudled plastic. Soft luggage is made out of woven fabrics like nylon and polyester. It comprises of uprights, totes, duffle and sky bags which can be with or without wheels and handles. The soft luggage today is becoming very popular due to the ease of carry as it is light and flexible. It includes handbags, military backpacks, athletic backpacks, wallets, briefcases and other soft sided luggage items.

Leno Bags:

Leno bags are excellent for packing & preserving material for vegetables like potato, onion, ginger, garlic, cabbage etc. and fruits like pineapple, citrus fruits, raw mango, coconut etc.
The Leno bags available in various widths and different warp colours
Leno bags has the advantages like Superior aesthetics, excellent mechanical properties, Chemically Inert, Ease in handling & storage, Reuse & recyclable and cost effective.

Polyolefin Woven Sacks:

Woven sacks are manufactured out of PP/HDPE materials.
These are laminated or unlamented, ultra violet stabilized TiO2, CaCO2 or anti-slip coated or as specified.
Higher Strength, Light Weight, Minimal Seepage, Moisture Proof, Long Lasting (Durable), cheaper (as it can be reused).
Used in the packing of cement, fertilizers, thermo plastic raw materials, food grains, sugar, Fertilizers, Chemicals, Food Grains, Cattle Feed, Salt.

Flexible Intermediate Bulk Containers:

FIBC's are one of the most cost effective and ideal types of packaging for shipping and storing dry bulk products. They are available for powdered and granular materials like chemicals, foodstuffs, minerals, grain, building materials and etc. Big bags are produced from either tubular or flat polypropylene (PP) woven fabrics. These fabrics can be both coated or uncoated and vary in different weights. FIBCs can vary from 900 gms to 3 kgs in weight depending upon the bag properties and weight to be carried. There are three types of FIBC bags: Panel type, circular woven type, baffle type (Square bag). These bags have capacities ranging from 500-4000 kgs.

5. Coating and Laminating Textiles

Introduction and Definition.

Coated fabrics are engineered composite materials, produced by a combination of a textile fabric and a polymer coating applied to the fabric surface. The polymer coating confers new properties on the fabric, such as impermeability to dust particles, liquids and gases, and it can also improve existing physical properties, such as fabric abrasion. The fabric component generally determines the tear and tensile strength, elongation and dimensional stability, while the polymer mainly controls the chemical properties, abrasion resistance and resistance to penetration by liquids and gases. Many properties, however, are determined by a combination of both these components, and both base fabric and polymer must be carefully selected by a thorough consideration of the properties required in the finished product.

Coated textiles is defined as a material composed of two or more layers, at least one of which is a textile fabric and at least one of which is a substantially continuous polymeric layer. The layers are bonded closely together by means of an added adhesive or by the adhesive properties of one or more of the component layers. In other word it is described as a textile fabric on which there has been formed in situ, on one or both surfaces, a layer or layers of adherent coating material.

Applications of coating and laminating textiles.

Coated fabrics can be used as

- Coverings or as a barrier for protection, separation containment.
- For appearance modification for decorative or functional purpose.
- Improving dimensional stability, controlling stretch, preventing edges from frying or curling.
- For control of porosity, e.g. for filtration.
- As a matrix for holding some functional material, chemical, pigment or other agent.
- As a processing aid, for example in ‘in situ’ moldings, vacuum technique or thermo-moldings.
- Combining the specialist properties of polymers with the flexibility, strength, drapability and covering power of a fabric.

Polymeric materials for coating.

PVC
PVDC (Polyvinylidene chloride)
PTFE (Polytetrafluroethylene)
Natural Rubber
Nitrile Rubber
Butyl Rubber
Silicon Rubber
Polyurethane

Coating techniques: Following techniques are used for applying coating on textile material.
Kiss roll
Direct coating (Knife)
Foam coating
Spray coating
Transfer coating
Rotary screen coating

Fabric lamination:

Lamination consists of bonding pre-prepared polymer film or membrane with one or more textile substrates using adhesives, heat, or pressure.
Combined fabric or laminated fabric is defined as a material composed of multiple layers, at least one of which is a textile fabric, bonded closely together by means of an added adhesive, or by the adhesive properties of one or more of the component layers.

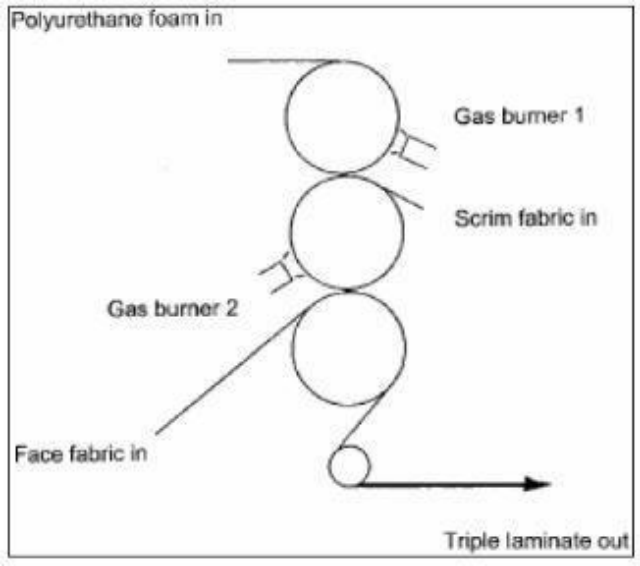
Polymeric materials for lamination:

- PVC
- PTFE (Polytetrafluoroethylene)
- Polyurethanes
- Polyolefins etc.
-

There are two type of lamination process

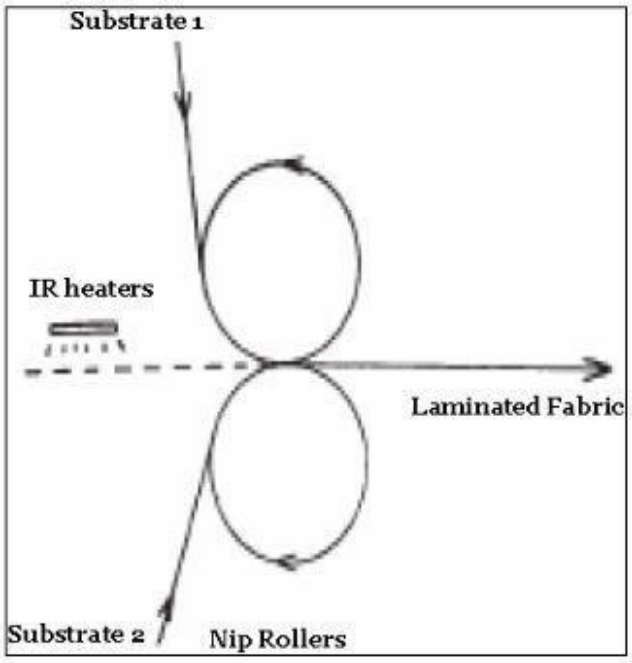
1. Flame lamination:

Here three components are used scrim fabric, face fabric, and polymer
film/foam. The moving foam is melted by flame which then act as a adhesive to the fabric which is laid over it.



Hot Melt Lamination:

Flame lamination is not environment friendly. Calenders are used.
Two materials being joined are made into a sandwich with hot melt adhesive powder film or web in centre.
The calender calender melts the adhesive due to heat and pressure and produce a laminate. Sometimes IR heaters are used to pre-heat maerials
and adhesive before nipping.



Applications:

- There are numerous application like Gloves, Cut/slash resistant materials, Aprons, Footwear, Space suits, Waterproof materials, Tents, Exercise Mats, Carpeting, Airbags, Conveyor belts

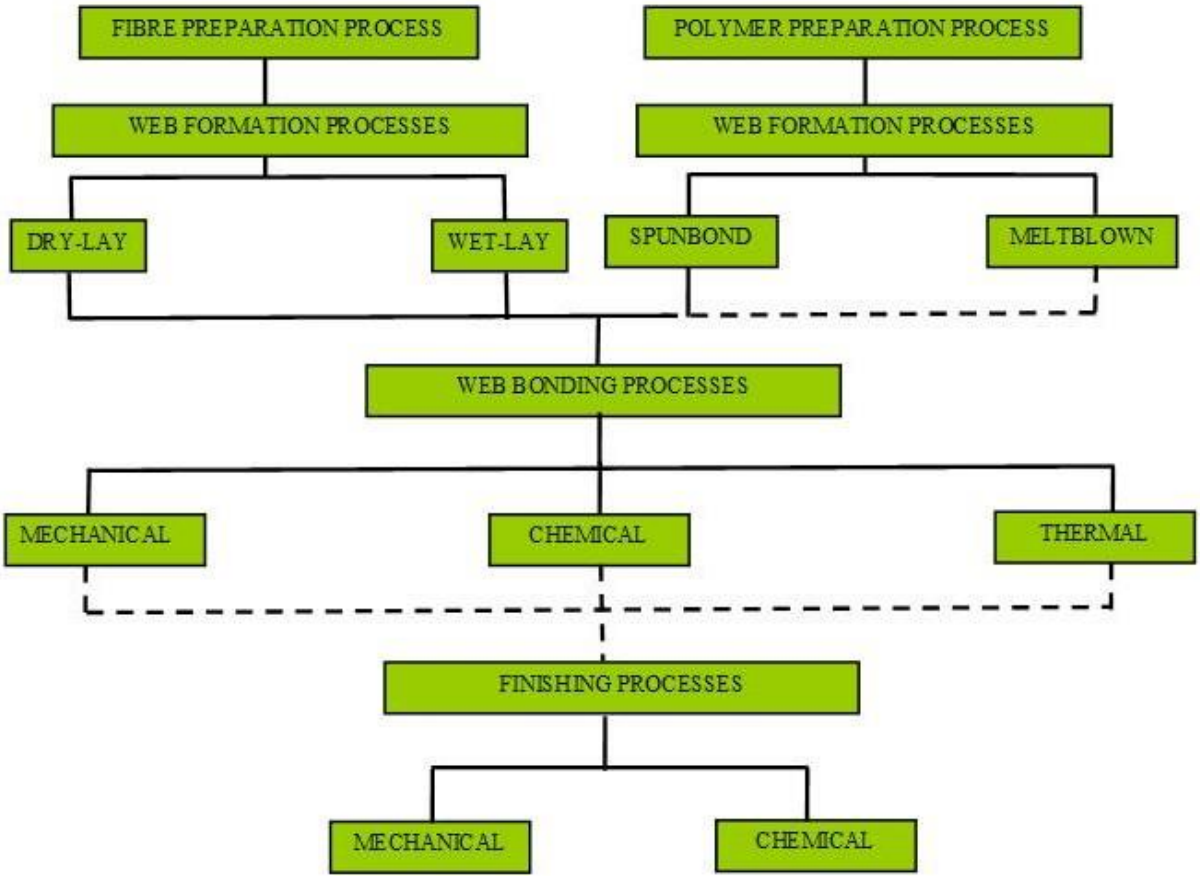
6. Non-Woven Textiles

Introduction and Definition.

One of the most rapid growing sectors of the textile market is of nonwovens. The use of nonwovens in technical textile is not a new trend. Today, nonwovens are being widely used in many industrial sectors and they play a vital role in their application in technical textiles worldwide.

A nonwoven is a textile structure produced by the bonding or interlocking of fibres, or both, accomplished by mechanical, chemical, thermal or solvent means and combinations thereof. The term does not include paper or fabrics that are woven, knitted or tufted.'

Flow chart of production cycle of non- woven textiles.



Web formation methods:

The laying down of the fibers to create a loosely held fibrous web structure is called web formation. The web is at this point is weak and will be bonded later.
There are four web formation methods:

- Dry Laid
- Wet Laid

- Polymer Laid
- Composite

Dry laid system:

Principles and machines used for formation of web in dry laid are similar to spinning industry.
Steps of web formation in dry laid
Fiber selection: Majority of dry laid non-woven uses staple fibers Factors like absorbency, strength, permeability, softness, tear-strength are considered before selecting a fiber. Bonding technique and finishing also affect the selection of fibe because they may cause a change in the fiber properties.

Fiber Preparation:

Bale opening: Bale are big bundles of fibers. Fibers are packed compactly in a bale which need to be open. Opening is done by two opening rolls.

Blending: Different fibers are intimately mixed.

Opening: Some opening is already done in bale opening and blending the fiber are further opened by openers which contains rolls. These rolls are covered with metallic clothing.(Wires)

Web former feeding: It make a uniform mat of well opened fibers which will be feed into web forming machine

Web formation:
Here mat of fibers is feed into a carding m/c which have a rotating cylinder and a series of rollers covered with fine wire or teeth's.
It separate small tufts into individual fibers(Individualization of fibers).
It arrange the fibers in parallel way from entangled mat.
The web now formed can be laid in three ways parallel laid, cross laid or random laid.

Air Laid (Random laid):

In air laid fibers are feed into an air stream and from there to a moving belt or perforated drum. It has lower density and more softness than carded webs.

Wet laid system:

The wet-lay nonwoven process is known to be derived from the wet-laid paper making process. H. Fourdrinier developed a papermaking machine that has been the basis for the most modern papermaking machines employing very short fibers.

The fibres are mixed with water and it forms fibre-water suspension. This suspension is then pumped through the headbox to the perforated wire. The water is drained through the perforations and the fibres are laid on the moving wire to form a web. The wet-laid web is then dried and bonded by using binder. It is again dried and finally wound on a roll.

Spun bond system:
They are produced using principles and machines related with fiber extrusion. In this process polymer is extruded from spinneret to form filaments. They are laid down on a conveyor belt to form a continuous web. This web is bonded mechanically/ chemically/ thermally to make spun bond nonwovens.

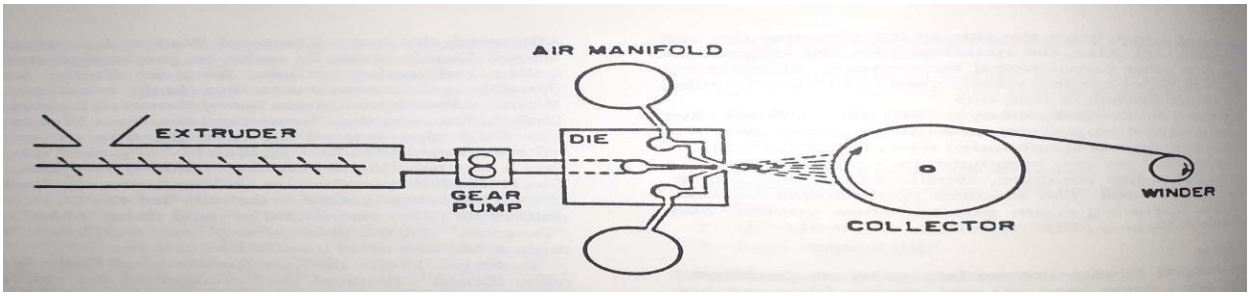
Sequence of operations carried out in spun bond process:

Extruder: Here polymer granules/pallets/chips are fed and due to application of friction and heat they are converted into a molten mass.

Metering Pump: It ensure constant flow of molten polymer to the next section.

Die block assembly: It contains two components feed distribution system and spinneret. Spinneret is circular or rectangular piece which has several hundred or thousand holes/orifice in it.
Drawing: Drawing is done using a specially designed aerodynamic device.
Deposition: This is also done using a specially designed aerodynamic device here filaments are deposited as a random web on a moving belt.
Bonding: Once we get web, it can be bonded using techniques like chemical/ thermal/ mechanical bonding.
Winding: Finally the material is wounded on a cardboard core and processed according to end use.

Melt blown system:
In this process mainly thermoplastic fiber forming polymer is extruded through a die containing several hundred small holes. Convergent stream of hot air rapidly attenuate the extruded polymer stream to form extremely fine diameter fibers.



Sequence of operations carried out in Melt Blow system:
Extruder, Gear Pump, Die assembly (Die nosepiece & spinneret) are similar like in spun bond system.
Air Manifold: It supply high velocity hot air through the slots to the top and bottom sides. Temperature of air ranges from 230- 360 degree Celsius and velocity of air is 0.5 to 0.8 the speed of sound.
Web formation: Here the hot air and microfibers progresses towards and collector screen and solidified fibers make a self-bonding nonwoven web. A vacuum is provided in the collector screen to suck the hot air and enhance the process.

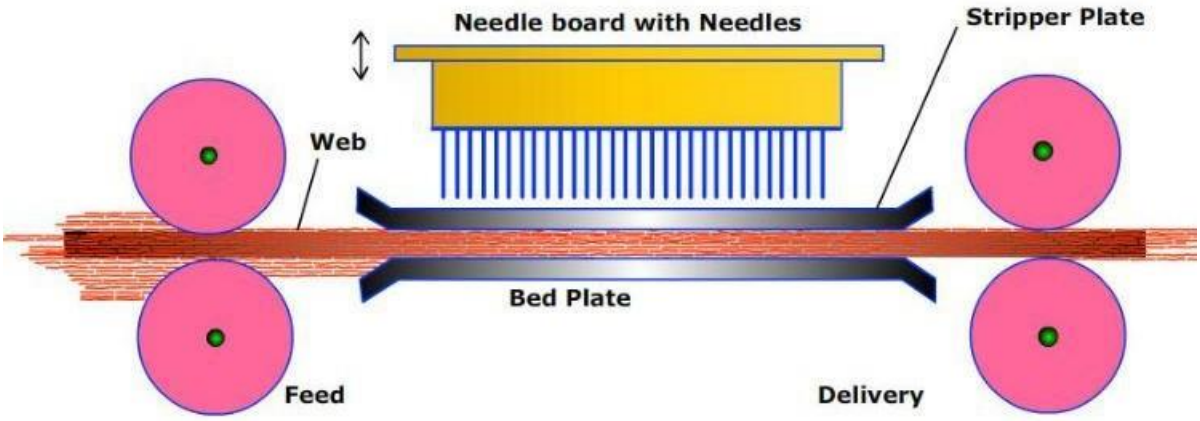
Bonding: In this system fibers sticks and entangles with each other and there is no need of bonding arise in some cases thermal bonding may be done.
Winding: Web is generally wounded on a nonwoven core.

Web Bonding Methods:

Fibrous webs or batt have little mechanical strength and a further manufacturing process is necessary to form a fabric with useful properties. There are number of processes which are used to accomplish this task.
There are three methods for bonding nonwovens:

- Mechanical Bonding: Needle Punch and Stitch Bonding Hydroentanglement process
- Thermal Bonding
- Chemical Bonding

Needle punching:
In needle punching fibres are mechanically entangled to produce a nonwoven fabric by repeated penetration of barbed needles through a preformed dry fibrous web.
The machine which does this work is called as needle loom.
The fibrous web, which is unbonded and therefore thick and voluminous, is fed to the machine by a pair of feed rollers.
It then passes in-between a pair of perforated bed plates. The needles are arranged in a needle board.
The needle board is mounted on a beam which moves up and down.
When the board move downwards, needles passes through the holes of the top bed plate, through the web, and through the holes of the bottom bed plate.
When the board moves upwards, the barbed needles withdraw upwards and the bed plate strips the web off the needles. As a result, the fibres are mechanically interlocked, thereby providing the mechanical strength. The needle bonded nonwoven is delivered by a pair of delivery rollers.



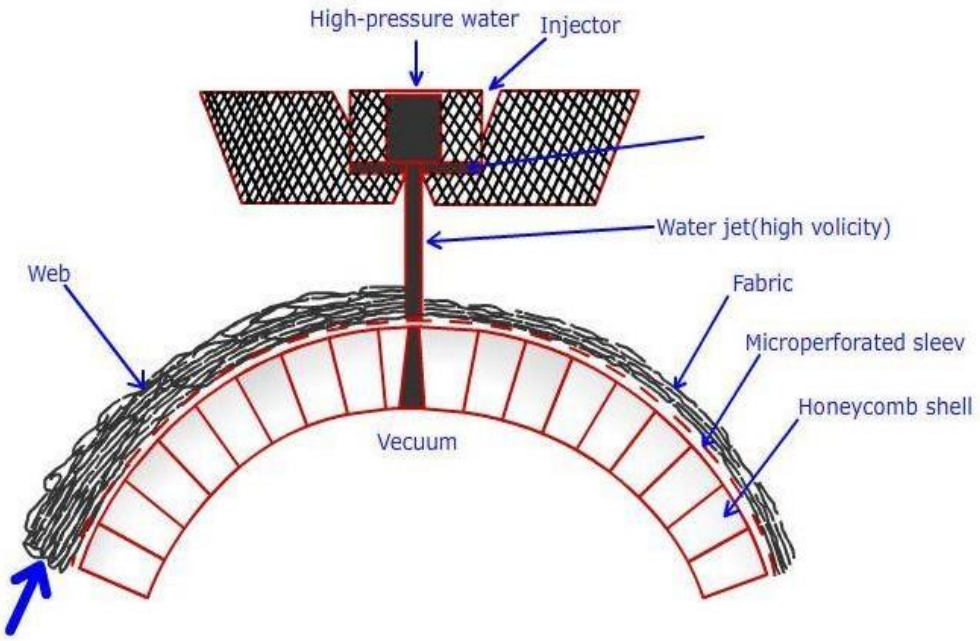
Stitch Bonding:

Stitch bonding is a method of consolidating fiber webs with knitting elements with or without yarn to interlock the fibers. There are a number of different yarns that can be used. Home furnishings are a market for these fabrics. Other uses are vacuum bags, geo-textiles, filtration and interlinings.

In many applications stitch-bonded fabrics are taking the place of woven goods because they are faster to produce and, hence, the cost of production is considerably less.

Hydroentanglement/ spunlacing/ hydraulic entanglement/ water jet needling:

In this technique bonding of the fibres in a web is done by means of high energy water jets.
In this high pressure water is pumped through a series of fine nozzles.
Web is pre-wetted with water to make it compact.
The high velocity water jets are directed to the unbonded web, which is supported on a moving perforated conveyor.
The conveyor may have a flat bed surface or cylindrical surface.
The entanglement among the fibres is caused by the high velocity water jets.
The dewatering or suction boxes are located below the conveyor sleeve so that water can be recycled and reused.



The quality of entanglement depends On:

1. Water pressure
2. Dimensions of water needles
3. Number of water needles
4. Type of fibers etc.

Thermal bonding:
Fibers in the webs can be bonded thermally for providing sufficient strength against mechanical deformation.

A web consisting of thermoplastic and non-thermoplastic fibres was made and then heated to the melting or softening temperature of the constituent thermoplastic fibres followed by cooling or solidify the bonding area.
Thermal bonding requires a thermoplastic component to be present in the web. The thermoplastic component becomes viscous under the application of thermal energy. The polymer flows to fibre-to-fibre crossover points where bonding regions are formed. The bonding regions are fixed by subsequent cooling.
The thermal bonding process is environmental-friendly, as no latex binder is required.
The thermal bonding process consumes less energy compared to foam bonding or hydroentanglement bonding.
The thermal bonding processes utilize either thermoplastic fibres alone or blends containing thermoplastic fibres.
The non-binder fibre components may be referred to as the base/ carrier fibres.
Commercially, a variety of base fibres are used. The binder fibre component normally ranges from 5-50 % on weight of the fibre depending on the targeted properties of the final product made.

Fibers Used:
The base fibres can be of natural or synthetic or mineral or metallic origin.
The binder fibres can be **momocomoponent** like polyester (PET), polypropylene (PP), polyamide (PA), and polyethylene (PE)
Bicomponent (sheath-core) like PE/PET, PE/PP, and CoPET/PET.
Looking at the thermal bonding process, it is important to note down the melting temperature of these fibres.

Thermal bonding processes:
Calender bonding (Flat & embossed calender) : Web is passed through nip of heated rollers.
Through-air bonding: Hot air is used to soften/melt binding polymers.
Infrared bonding: The IR emitting bulbs/heaters are used to radiate electromagnetic energy in part of the IR wave length region and this energy cause bonding.
Ultrasonic bonding: A horn is vibrated at a frequency of 20-40 KHz. The friction between horn and surface of web heats the fibers and bonding takes place.

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

Various chemical binders/polymers:

- Vinyl polymers and copolymers,
- Acrylic ester polymers and copolymers,
- Rubber and synthetic rubber

Applied in aqueous dispersions/ emulsions/ solution form. They have sufficiently low viscosity to allow easy penetration into the web

Method of application:

Saturation Bonding: Complete immersion of the nonwoven web in a bath containing binder. Usually a padding mangle is used.
Foam Bonding: air or water is used to dilute the binder and as a mean to carry the binder to the fibres. It dry faster cost is reduced.
Spray bonding: Binder is sprayed onto a moving web in fine droplet form through a system of nozzles, which are mounted on machine.
Print Bonding: The binder is only applied in predetermined areas as per the design in the rotary screen.

Applications of non-woven textiles: There are numerous applications of non-woven textiles some of them are listed below:

- Agricultural coverings
- Agricultural seed strips
- Apparel linings
- Automotive headliners
- Automotive upholstery
- Carpeting
- Civil engineering fabrics
- Civil engineering geotextiles
- Disposable diapers
- Envelopes
- Filters
- House wraps
- Household & personal wipes
- Hygiene products
- Insulation
- Labels
- Laundry aids

- Roofing
- Sterile medical-use products
- Tags
- Upholstery
- Wall coverings

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