STUDY MATERIAL FOR B.Sc. FASHION TECHNOLOGY

FIBER TO FABRIC

SEMESTER – I

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FASHION TECHNOLOGY DEPARTMENT

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Fiber to Fabric

Unit: I Fiber Classification, Natural fibers **12 hours**

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Manufacturing process, properties and uses of natural fibers – cotton, linen, Jute, silk, wool. Brief study about Organic Cotton, woolen and worsted yarn, types of silk.

Unit: II Regenerated and synthetic fibers **12 hours**

Manufacturing process, properties and uses of man-made fibres –Viscose rayon, nylon, polyester, and acrylic. Brief study on polymerization, bamboo, spandex, Micro fibres & its properties.

Texturization - Objectives, Types of textured yarns & Methods of Texturization.

Unit: III Yarn manufacturing **12 hours**

Spinning –Definition and classification; Chemical and mechanical spinning; Cotton Yarn Production sequence and objectives- opening, cleaning, doubling, carding, combing, drawing, roving and spinning. Comparison of carded and combed yarn.

Yarn - Definition and classification- simple and fancy yarns. Manufacturing Process of sewing thread – cotton and synthetic. Yarn numbering systems - Significance of yarn twist.

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UNIT 1

FIBER CLASSIFICATION, NATURAL FIBERS

INTRODUCTION

Textiles are classified according to their component and structure or weave. Value or quality in textiles depends on several factors, such as the quality of the raw material used and the character of the yarn spun from the fibers, whether clean, smooth, fine, or coarse and whether hard, soft, or medium twisted Yarn, fabrics, and tools for spinning and weaving have been found among the earliest relics of human habitations. The Textile industry is a term used for industries primarily concerned with the design or manufacture of clothing as well as the distribution and use of textiles.

THE FIELD OF TEXTILE

Food, shelter and clothing are the basic needs of everyone. All clothing is made from textile and shelters are made more comfortable and attractive by the use of textiles. Everyone is surrounded by textiles from birth to death. We walk on and wear textile products; we sit on fabric covered chairs and sofas; we sleep on and under fabrics; textiles dry us or keep us; they keep us warm and product from sun, tire, and infection. Clothing and household textiles are aesthetically pleasing and vary in colour, design and texture. They are available in a variety of Price ranges.

The history of clothing and textiles attempts an objective survey of clothing and textiles throughout human history, identifying materials, tools, techniques, and influences, and the cultural significance of these items to the people who used them. Textiles, defined as felt or spun fibers made into yarn and subsequently netted, looped, knit or woven to make fabrics, appeared in the Middle East during the late stone age.[1] From ancient times to the present day, methods of textile production have continually evolved, and the choices of textiles available have Influenced how people carried their possessions, clothed themselves, and decorated their surroundings

Yarn, fabrics, and tools for spinning and weaving have been found among the earliest relics of human habitations. Linen fabrics dating from 5000 B.C. have been discovered in Egypt. Woollen textiles from the early Bronze Age in Scandinavia and Switzerland have also been found. Cotton has been spun and woven in India since 3000 B.C., and silk has been woven in China since at least 1000 B.C. about the 4th cent. A.D., Constantinople began to weave the raw silk imported from China. India has a diverse and rich textile tradition. The origin of Indian textiles can be traced to the Indus valley civilization. The people of this civilization used homespun cotton for weaving their garments. Excavations at Harappa and Mohan -jo-Daro, have unearthed household items like needles made of bone and spindles made of wood, amply suggesting that homespun cotton was used to make garments

MAJOR GOALS

Textile production played a crucial part in the industrial revolution, the establishment of organized labour, and the technological development of the country. Once, textile production was simple enough that the entire process could and did take place in the home. Now, textiles represent a complex network of interrelated industries that produce fiber, spin yarns, fabricate cloth, and dye, finish, print, and manufacture goods. A material made mainly of natural or Synthetic fibers. They are found in apparel, household and commercial furnishings, vehicles, and industrial products.

Textiles have an assortment of uses, the most common of which are for clothing and containers such as bags and baskets. In the household, they are used in carpeting, upholstered furnishings, window shades, towels, covering for tables, beds, and other flat surfaces, and in art. In the workplace, they are used in industrial and scientific processes such as filtering.

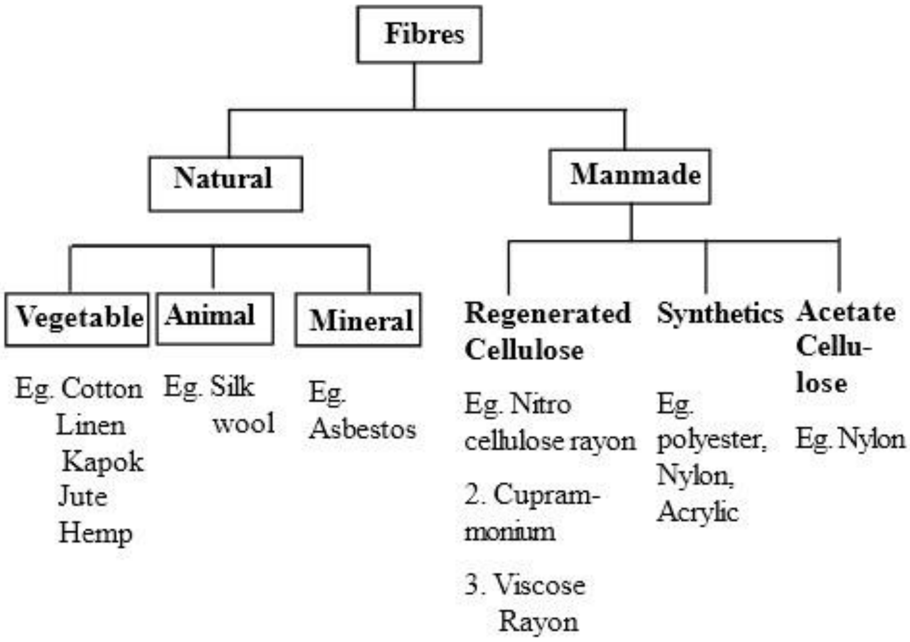
Miscellaneous uses include flags, tents, nets, cleaning devices, such as handkerchiefs; transportation devices such as balloons, kites, sails, and parachutes; strengthening in composite materials such as fibre glass and industrial geotextiles, and smaller cloths are used in washing by "soaping up" the cloth and washing with it rather than using just soap. Textiles used for industrial purposes, and chosen for characteristics other than their appearance, are commonly referred to as technical textiles. Technical textiles include textile structures for automotive applications, medical textiles (e.g. Implants), geotextiles.

CLASSIFICATION OF FIBRES

In order to simplify the study of textile fibres, materials with similar properties must be grouped in some logical order. Each country has developed its own system for naming fibres.

The two major groups, or families, of fibres specified by the act are

- Natural Fibers
- Vegetable fibers



The term <natural fibers= covers a broad range of vegetable, animal, and mineral fibers

Vegetable fibers are generally comprised mainly of cellulose: examples include cotton, linen, jute, flax, ramie, sisal, and hemp. Cellulose fibers serve in the manufacture of paper and cloth.

Seed fiber: Fibers collected from seeds or seed cases. E.g. cotton and kapok.

Leaf fiber: Fibers collected from leaves. E.g. sisal and agaves

Bast fiber or skin fiber: Fibers are collected from the skin or bast Surrounding the stem of their respective plant. These fibers have higher tensile strength than other fibers. Therefore, these fibers are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, kenaf, industrial hemp, ramie, rattan, soybean fiber, and even vine fibers and banana fibers.

Animal fibers

Animal fibers generally comprise proteins and are commonly made from hair or fur.

Wool: refers to the hair of the domestic goat or sheep, which is distinguished from other types of animal hair in that the individual strands are coated with scales and tightly crimped, and the wool as a whole is coated with an oil known as lanolin, which is waterproof and dirt proof. Woolen refers to a bulkier yarn produced from carded, non-parallel fibre, while worsted refers to a finer yarn which is spun from longer fibres which have been combed to be parallel. Wool is commonly used for warm clothing

Silk :

Silk is an animal textile made from the fibers of the cocoon of the Chinese silkworm. This is spun into a smooth, shiny fabric prized for its sleek texture

Mineral fibers:

Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories

Asbestos: asbestos and basalt fiber are used for vinyl tiles, sheeting, and adhesives, "transit" panels and siding, acoustical ceilings, stage curtains, and fire blankets.

Glass Fiber: glass fiber is used in the production of spacesuits, ironing board and mattress covers, ropes and cables, reinforcement fiber for composite materials, insect netting, flame-retardant and protective fabric, soundproof, fireproof, and insulating fibers.

Man Made fibres

Synthetic fibers are the result of extensive research by scientists to improve upon naturally occurring animal and In general, synthetic (manmade) fibers are created by forcing, usually through extrusion, fiber forming materials through holes (called spinnerets) into the air, forming a thread. Before synthetic fibrers were developed, artificial (manufactured) fibers were made from cellulose, which comes from plants.

Polyester: fiber is used in all types of clothing, either alone or blended with fibres such as cotton.

Aramid fiber :(e.g. Twaron) is used for flame-retardant clothing, cutprotection, and armor.

- Acrylic is a fibre used to imitate wools, including cashmere, and is often used in replacement of them.
- Nylon is a fibre used to imitate silk; it is used in the production of pantyhose. Thicker nylon fibers are used in rope and outdoor clothing

FIBRE PROPERTIES

Fibre properties to be spinnable, a fibre must have sufficient length, pliability, strength, and cohesiveness to form a yarn. Fibres must also be inexpensive, available, and constant in supply to be economically suitable for production. To make such a fabric the manufacturer chooses fibres, yarns, weaves, and finishes with a combination of properties which will give the type of Serviceability the consumer wants

Primary Characteristics of Textile Fibre

- Stable length
- Tensile strength
- Fineneness
- Spinnability and
- Uniformity
- Stable length
- Tensile strength,
- Fineness,
- Spinnability, and
- Uniformity

Stable length - Staple fibres are short in length, measured in inches and range from threequartos of an inch to 18 inches in length. All the natural fibres, except silk, are staple fibres. Any filament fibre can be cut into staple of a length determined by the end-use desired

Tensile strength - Strength of a fibre is the ability to resist strains and stresses. It is expressed as tensile strength which is measured in pounds per square inch (p.s.i.) or as tenacity which is measured in grams per denier. Some fibres gain strength when wet, some lose strength, and some are unaffected by water

Spinnability – Spinnability includes several physical properties each having an effect on the ability of the fibres to be spun into yarn. For Example: Staple fibres must have to be capable of taking a twist. They must have a certain degree of friction against one another to stay in place when pull is applied to the yarn. And they must be able to take on hole special finishes for lubrication during spinning or to provide additional surface resistance to abrasion.

Uniformity – This means the evenness of the individual fibres in length and diameter. A fibre possessing this property can produce reasonably even threads. This is also important in connection with the strength of the resulting yarn. The more uniform the yarn the stronger the yarn

Secondary Characteristics of Textile Fibre

- Crimp
- Elasticity
- Cohesion
- Density
- Plasticity
- Colour
- Luster
- Flexibility
- Abrasion resistance

Crimp

Crimp refers to the waves or bends that occur along the length of a fibre. Wool has natural crimp. Manmade fibres may be given a permanent crimp. Fibre crimp increases cohesiveness, resiliency, and resistance to abrasion. It helps fabrics maintain their thickness

Elasticity - Elasticity means the ability of a stretched material to return immediately to its original size

Cohesion - Cohesiveness is the ability of fibres to cling together. This is important in staple fibres, but unimportant in filament fibres

Density - Density and specific gravity are measured of the weight of a fiber. Density is the weight in grams per cubic centimetre. Specific gravity is the ratio of the mass of the fibre to the mass of an equal volume of water at 40°C. The weight of a fabric is determined by the density or specific gravity of the fibres.

Plasticity - Plasticity is that property of a fibre which enables the user to 'shape it semi-permanently or permanently by moisture, heat, and pressure or by heat and pressure alone

Absorbency - Absorbency is the ability of a fibre to take up moisture and is expressed as percentage of moisture regain, which is the percentage of moisture that a bone-dry fibre will absorb from the air under standard conditions of temperature and humidity. The ability of a fibre to absorb moisture is directly related to washability, dyeing, shrinkage, absorption of aqueous finishes, comfort on humid days, and soiling. Staple fibres hold more water than filament fibres since they pack less compactly and create a spongelike condition in the yarn and fabric. For this reason staple fibre fabrics require a longer drying time

Colour – Most natural fibre have some colour. The synthetic fibres too have a slight creamy or yellow colour

For Example:

- ✓ Silk is yellow to tan
- ✓ Wool is brownish tint
- ✓ Cotton is a creamy white or brown

Luster - Lustre is the shine, sheen or brightness of a fibre caused by reflection of light. Smooth fibres reflect more light than rough or serrated fibres; round fibres reflect more light than flat fibres. Filaments which are laid together with little or no twist reflect more light than short fibres which must be twisted together to forth yarns. Manmade fibres can be delustered by adding oil or pigments to the solution from which the fibre is spun.

Flexibility - Pliability or flexibility is the ease of bending or shaping. Pliable fibres are easily twisted to make yarns. They make fabrics that resist splitting when folded or creases many times in the same place.

Rigidity - Stiffness or rigidity is the opposite of flexibility. It is the resistance to bending or creasing. Rigidity and weight together make up the body of the fabric.

Abrasion resistance - Abrasion resistance is the ability of a fibre to withstand the rubbing or abrasion it gets in everyday use. Inherent toughness, natural pliability, and smooth filament surface are fibre characteristics that contribute to abrasion resistance.

Manufacturing process, properties and uses of natural fibres (cotton , linen, jute, silk, wool)

Cotton

The Cotton Plan

The cotton plant belongs to the genus Gossypium of the family Malvaceae (mallow family). It is generally a shrubby plant having broad three-lobed leaves and seeds in capsules, or bolls; each seed is surrounded with downy fiber, white or creamy in color and easily spun. The fibers flatten and twist naturally as they dry. Cotton is of tropical origin but is most successfully cultivated in temperate climates with well-distributed rainfall. The requisites on the basis of which to judge the quality of the cotton are the grade, the colour, and the length of the fibres and the character

The Production Process

In spring

The acreage is cleared for planting. Mechanical cultivators rip out weeds and grass that may compete with the cotton for soil nutrients, sunlight, and water, and may attract pests that harm cotton. The land is plowed under and soil is broken up and formed into rows.

Cottonseed is mechanically planted by machines that plant up to 12 rows at a time. The planter opens a small furrow in each row, drops in seed, covers them, and then packs more dirt on top. Seed may be deposited in either small clumps (referred to as hill-dropped) or singularly (called drilled). The seed is placed 0.75 to 1.25 in (1.9 to 3.2 cm) deep, depending on the climate. The seed must be placed more shallowly in dusty, cool areas of the Cotton Belt, and more deeply in warmer areas.

With good soil moisture and warm temperature at planting, seedlings usually emerge five to seven days after planting, with a full stand of cotton appearing after about 11 days. Occasionally disease sets in, delaying the seedlings' appearance. Also, a soil crust may prevent seedlings from surfacing. Thus, the crust must be carefully broken by machines or irrigation to permit the plants to emerge

Approximately six weeks after seedlings appear, "squares," or flower buds, begin to form. The buds mature for three weeks and then blossom into creamy yellow flowers, which turn pink, then red, and then fall off just three days after blossoming. After the flower falls away, a tiny ovary is left on the cotton plant. This ovary ripens and enlarges into a green pod called a cotton ball.

The boll matures in a period that ranges from 55 to 80 days. During this time, the football-shaped boll grows and moist fibers push the newly formed seeds outward. As the boll ripens, it remains green. Fibers continue to expand under the warm sun, with each fiber growing to its full lengthabout 2.5 in (6.4 cm) during three weeks. For nearly six weeks, the fibers get thicker and layers of cellulose build up the cell walls. Ten weeks after flowers first appeared, fibers split the ball apart, and cream colored cotton pushes forth. The moist fibers dry in the sun and the fibers collapse and twist together, looking like ribbon. Each boll contains three to five "cells," each having about seven seeds embedded in the fiber

At this point the cotton plant is defoliated if it is to be machine harvested. Defoliation (removing the leaves) is often accomplished by spraying the plant with a chemical. It is important that leaves not be harvested with the fiber because they are considered "trash" and must be removed at some point. In addition, removing the leaves minimizes staining the fiber and eliminates a source of excess moisture. Some American crops are naturally defoliated by frost, but at least half of the crops must be defoliated with chemicals. Without defoliation, the cotton must be picked by hand, with laborers clearing out the leaves as they work

Harvesting can be done by machine, with a single machine replacing 50 hand-pickers. Two mechanical systems are used to harvest cotton. The picker system uses wind and guides to pull the cotton from the plant, often leaving behind the leaves and rest of the plant.

The stripper system chops the plant and uses air to separate the trash from the cotton. Most cotton is harvested using pickers. Pickers must be used after the dew dries in the morning and must conclude when dew begins to form again at the end of the day. Moisture detectors are used to ensure that the moisture content is no higher than 12%, or the cotton may not be harvested and stored successfully. Not all cotton reaches maturity at the same time, and harvesting may occur in waves, with a second and third picking.

Next, most cotton is stored in "modules," which hold 13-15 bales in water-resistant containers in the fields until they are ready to be ginned. 9. The cotton module is cleaned, compressed, tagged, and stored at the gin. The cotton is cleaned to separate dirt, seeds, and short lint from the cotton. At the gin, the cotton enters module feeders that fluff up the cotton before cleaning. Some gins use vacuum pipes to send fibers to cleaning equipment where trash is removed. After cleaning, cotton is sent to gin stands where revolving circular saws pull the fiber through wire ribs, thus separating seeds from the fiber. High-capacity gins can process 60, 500-lb (227-kg) bales of cotton per hour. 10. Cleaned and de-seeded cotton is then compressed into bales, which permits economical storage and transportation of cotton. The compressed bales are banded and wrapped

End Uses

Cotton is used in apparel, home furnishing, and industrial fabrics. Its comfort and hand are usually given as reasons for its preference by consumers of apparel and household fabrics. The fact that it is a "natural" product is a factor cited by many who select cotton products. Apparel fabrics of all styles and weights are being used. Knit cotton T-shirts and cotton underwear are preferred for their absorbency and ease of care. Men's shirts and summer suits contain cotton, and the fibre is predominant in women's and children's wear. The domestics market -sheets and towels- is dominated by cotton. Most sheets and pillowcases are blends of cotton and polyester, but 100% cotton sheets are available once again. Polyester is occasionally blended with cotton in towels to provide strength and durability to the base fabric, but the surface pile remains cotton for absorbency

Characteristics:

1) Strong and durable
2) Absorbent
3) Cool to wear
4) Shrinks in hot water
5) Wrinkles easily

b. Proper care:

1) Machine wash
2) Tumble dry at moderate temperatures
3) Press with warm to hot iron (depending on fabric weight)

c. Some common uses:

1) Underwear
2) Socks
3) Shirts, blouses
4) Jeans,
5) Sheets, towels
6) Slip covers

LINEN

Linen yarn is spun from the long fibers found just behind the bark in the multilayer stem of the flax plant (Linum usitatissimum). In order to retrieve the fibers from the plant, the woody stem and the inner pith (called pectin), which holds the fibers together in a clump, must be rotted away. The cellulose fiber from the stem is spinnable and is used in the production of linen thread, cordage, and twine. From linen thread or yarn, fine toweling and dress fabrics may be woven. Linen fabric is a popular choice for warm-weather clothing. It feels cool in the summer but appears crisp and fresh even in hot weather. Household linens truly made of linen become more supple and soft to the touch with use; thus, linen was once the bed sheet of choice.

The Manufacturing Process

1. Cultivating

- It takes about 100 days from seed planting to harvesting of the flax plant. Flax cannot endure very hot weather; thus, in many countries, the planting of seed is figured from the date or time of year in which the flax must be harvested due to heat and the growers count back 100 days to determine a date for planting. In some areas of the world, flax is Sown in winter because of heat in early spring. In commercial production, the land is plowed in the spring then worked into a good seedbed by dicing, harrowing, and rolling. Flax seeds must be shallowly planted. Seeds may be broadcast by hand, but the seed must be covered over with soil. Machines may also plant the seed in rows.
- Flax plants are poor competitors with weeds. Weeds reduce fiber yields and increase the difficulty in harvesting the plant. Tillage of the soil reduces weeds as do herbicides. When the flax plants are just a few inches high, the area must be carefully weeded so as not to disturb the delicate sprouts. In three months, the plants are straight, slender stalks that may be 2-4 ft (61- 122 cm) in height with small blue or white fibers. (Flax plants with blue flowers yield the finest linen fibers

Harvesting

- After about 90 days, the leaves wither, the stem turns yellow and the seeds turn brown, indicating it is time tore harvest the plant. The plant must be pulled as soon as it appears brown as any delay results in linen without the prized luster. It is imperative that the stalk not be cut in the harvesting process but removed from the ground intact; if the stalk is cut the sap is lost, and this affects the quality of the linen. These plants are often pulled out of the ground by hand, grasped just under the seed heads and gently tugged. The tapered ends of the stalk must be preserved so that a smooth yarn may be spun. These stalks are tied in bundles called beets and are ready for extraction of the flax fiber in the stalk. However, fairly efficient machines can pull the plants from the ground as well.

Releasing the Fiber from the stalk

- The plant is passed through coarse combs, which removes the seeds and leaves from the plant. This process, called rippling, is mechanized in many of the flax-producing countries.
- The woody bark surrounding the flax fiber is decomposed by water or chemical retting, which loosens the pectin or gum that attaches the fiber to the stem. If flax is not fully retted, the stalk of the plant cannot be separated from the fiber without injuring the delicate fiber. Thus, retting has to be carefully executed. Too little retting may not permit the fiber to be separated from the stalk with ease. Too much retting or rotting will weaken fibers.
- Retting may be accomplished in a variety of ways. In some parts of the world, linen is still retted by hand, using moisture to rot away the bark. The stalks are spread on dewy slopes, submerged in stagnant pools of water, or placed in running streams. Workers must wait for the water to begin rotting or fermenting the stem sometimes more than a week or two. However, most manufacturers use chemicals for retting. The plants are placed in a solution either of alkali or oxalic acid, then pressurized and boiled. This method is easy to monitor and rather quick, although some believe that chemical retting adversely affects the color and strength of the fiber and hand retting produces the finest linen. Vat or mechanical retting requires that the stalks be

Submerged in vats of warm water, hastening the decomposition of the stem. The flax is then removed from the vats and passed between rollers to crush the bark as clean water flushes away the pectin and other impurities.

- After the retting process, the flax plants are squeezed and allowed to dry out before they undergo the process called breaking. In order to crush the decomposed stalks, they are sent through fluted rollers which break up the stem and separate the exterior fibers from the bast that will be used to make linen. This process breaks the stalk into small pieces of bark called shives. Then, the shives are scutched. The scutching machine removes the broken shives with rotating paddles, finally releasing the flax fiber from stalk.
- The fibers are now combed and straightened in preparation for spinning. This separates the short fibers (called tow and used for making more coarse, sturdy

goods) from the longer and more luxurious linen fibers. The very finest flax fibers are called line or dressed flax, and the fibers may be anywhere from 12-20 in (30.5-51 cm) in length.

Spinning

- Line fibers (long linen fibers) are put through machines called spreaders, which combine fibers of the same length, laying the fibers parallel so that the ends overlap, creating a sliver. The sliver passes through a set of rollers, making a roving which is ready to spin.
- The linen rovings, resembling tresses of blonde hair, are put on a spinning frame and drawn out into thread and ultimately wound on bobbins or spools. Many such spools are filled on a spinning frame at the same time. The fibers are formed into a continuous ribbon by being pressed between rollers and combed over fine pins. This operation constantly pulls and elongates the ribbon-like linen until it is given its final twist for strength and wound on the bobbin. While linen is a strong fiber, it is rather inelastic. Thus, the atmosphere within the spinning factory must be both humid and warm in order to render the fiber easier to work into yarn. In this hot, humid factory the linen is wet spun in which the roving is run through a hot water bath in order to bind the fibers together thus creating a fine yarn. Dry spinning does not use moisture for spinning. This produces rough, uneven yarns that are used for making inexpensive twines or coarse yarns. • These moist yarns are transferred from bobbins on the spinning frame to large take-up reels. These linen reels are taken to dryers, and when the yarn is dry, it is wound onto bobbins for weaving or wound into yarn spools of varying weight. The standard measure of flax yarn is the cut. it is based on the measure of 1 lb (453.59 g) of flax spun to make 300 yd (274.2 m) of yarn being equal to one cut. If 1 lb (453.59 g) of flax is spun into 600 yd (548.4 m), then it is a “no. 2 cut.” The higher the cut, the finer the yarn becomes. The yarn now awaits transport to the loom for weaving into fabrics, toweling, or for use as twine or rope

Physical and Chemical Properties of Flax

1. **Strength:** Flax is one of the strongest fibres. It is especially durable being two to three times as strong as cotton. On the natural fibres, it is second in strength to silk. In linen, weight may be considered a criterion of durability. Flax also increases about 20% in strength when wet.
2. **Elasticity:** Linen has no significant elasticity. It is the least elastic of natural fibres. In order to fit comfortably, linen garments should neither bind nor pull at the seams.

3. **Resilience:** Linen is relatively stiff and has little resilience. Therefore, it wrinkles easily, which use moisture for spinning. This produces rough, uneven yarns that are used for making inexpensive twines or coarse yarns.

4. **Absorbency :**

When absorbency is the main consideration, linen is preferable to cotton. It absorbs moisture and dries more quickly. This fabric takes up water rapidly has very good wicking properties. This makes the fibre comfortable to wear but difficult to dye and finish. It is therefore excellent for handkerchiefs and towels. 5 Density Flax is one of the heavier cellulosic fibres with a density of 1.5 g/cc.

Luster: Flax has a silky luster due to the natural waxes found in the fibre. If this wax is removed by chemicals or solvents, the fibre becomes brittle and harsh.

Effect of Light:

Flax has good resistance to sunlight. Max is more resistant to light than cotton, but it will gradually deteriorate from exposure.

Effect of Heat:

Linen scorches and flames in a manner similar to cotton. Linen may be safely ironed at

204°C (400’). 9 Drapability Linen has more body than cotton and drapes somewhat better

Cleanliness and Washability

Linen launders well and gives up stains readily. Some linen apparel requires dry cleaning because of construction and fabric finish. Care label instructions should be observed.

Shrinkage

Linen does not shrink a great deal; in fact, it shrinks less than cotton. But pre shrinkage finishing is desirable.

Reaction to Alkalis

Linen, like cotton, is highly resistant to alkalis. Linen may also be mercerized.

Reaction to Acids

Linen is damaged by hot dilute acids and cold concentrated acids.

Affinity for Dyes

Linen does not have good affinity for dyes. However, it is possible to obtain dyes linen that hasGood colourfastness. When buying coloured linens, look for the words "Guaranteed Fast Colour On the label or get a guarantee of colourfastness from the store.

Resistance to Perspiration

Acid perspiration will deteriorate linen. Alkali perspiration will not cause deterioration. But in either case discolouration may occur.

Uses

Over the past 30 years the end use for linen has changed dramatically. Approximately 70% of linen production in the 1990s was for apparel textiles whereas in the 1970s only about 5% was used for fashion fabrics. Linen uses range from bed and bath fabrics (table cloths, dish towels. Bed sheets, etc.), home and commercial furnishing items (wallpaper/wall coverings, upholstery, window treatments, etc.), apparel items (suits, dresses, skirts, shirts, etc.), to industrial products (Luggage, canvases, sewing thread, etc.). It was once the preferred yam for hand sewing the uppers of moccasin-style shoes (loafers), but its use has been replaced by synthetics. A linen handkerchief, pressed and folded to display the comers, was a standard decoration of a well-dressed man's suit during most of the first part of the 20 century. Currently researchers are working on a cotton/flax blend to create new yarns which will improve the feel of denim during hot and humid weather.

JUTE

Jute is a long, soft, shiny vegetable fibre that can be spun into course, strong threads. It is produced from plants in the genus Corchorus, family Malvaceae. Jute is one of the cheapest natural fibres and is second only to cotton in amount produced and variety of uses. Jute fibres are composed primarily of the plant materials cellulose (major component of plant fibre) and lignin (major components wood fibre). It is thus a ligno-cellulosic fibre that is partially a textile fibre and partially wood. It falls into the bast fibre category

Cultivation

To grow jute. Farmers scatter the seeds on cultivated soil. When the plants are about 15-20 em tall, they are thinned out, About four months after planting, harvesting begins. The plants are usually harvested after they flower, but before the flowers go to seed. The stalks are cut off close to the ground. The stalks are tied into bundles and soaked in water (retting) for about 20 days. This process softens the tissues and breaks the hard pectin bond between the bast & Jute hurd (inner woody fiber stick) and the process permits the fibres to be separated. The fibres are then stripped from the stalks in long strands and washed in clear, running water. Then they are hung up or spread on thatched roofs to dry. After 2-3 days of drying, the fibres are tied into bundle

Retting

Retting is the process of extracting fiber from the stem or bast of the bast fiber plants. The available retting processes are: mechanical retting (hammering), chemical retting (boiling & applying chemicals), steam/vapor/dew retting, and water or microbial retting. Among them, the water or microbial retting is a century old but the most popular process in extracting fine bast fibers. However, selection of these retting processes depends on the availability of water and the Cost of retting process. To extract fine fibers from jute plant, a small stalk is harvested for pre- retting. Usually, this small stalk is brought before 2 weeks of harvesting time. If the fiber can easily be removed form the Jute hurd or core, then the crop is ready for harvesting.

After harvesting, the jute stalks are tied into bundles and submerged in soft running water. The stalk stays submerged in water for 20 days. However, the retting process may require less time it the quality of the jute is better. In most cases, the fiber extraction process of bast fibers in water retting is done by the farmers while standing under water. When the jute stalk is well retted, the stalk is grabbed in bundles and hit with a long wooden hammer to make the fiber loose from the Jute hurd or core. After loosing the fiber, the fiber is washed with water and squeezed for dehydration. The extracted fibers is further washed with fresh water and allowed to dry on bamboo poles.

Properties of Jute

Good quality jute is coloured yellowish-white and silver-gray and has a lustrous appearance. Jute is usually brownish or greenish and has a unique lustre. The individual cells in jute are shorter than those of any of the other hast fibres, Jute is the weakest of the cellulose fibres when dry and must therefore be spun into coarse yarns.

The average strength of jute is about 3.3 gmødenier. Resiliency is poor, and fabrics do not return to shape after deformation without treatment such as washing and ironing. Jute has low sunlight resistance and poor colour fastness. It is also brittle and subject to splitting and snagging. It is readily damaged by the action of weather, moisture and abrasion. Jute can not be bleached white since disintegrates in strong bleaches, hence it is most often used in its natural colour. Chemical finishes can be used to overcome the natural odor of jute and to make it softer. Jute is similar to other cellulosic fibres in its reactions to heat and chemicals.

Uses

Jute is the second most important vegetable fibre after cotton, not only for cultivation, but also for various uses. Jute is used chiefly to make cloth for wrapping bales of raw cotton, and to make sacks and course cloth. The fibres are also woven into curtains, chair coverings, carpets, area rugs, hessian cloth, and backing for linoleum.

WOOL

Wool is the fiber derived from the fur of animals of the Caprinae family, principally sheep Wool was probably the first animal fiber to be made into cloth. The art of spinning wool into yarn developed about 4000 BC. No one knows when man started using wool is a textile fibre. The dense, soft, often curly hair forming the coat of sheep and certain other mammals, such as the goat and alpaca, consisting of cylindrical fibers of keratin covered by minute overlapping scales and much valued as a textile fabric.

Raw Materials

In scientific terms, wool is considered to be a protein called keratin. Its length usually ranges from 1.5 to 15 inches (3.8 to 38 centimeters) depending on the breed of sheep. Each piece is made up of three essential components; the cuticle, the cortex, and the medulla.

The cuticle is the outer layer. It is a protective layer of scales arranged like shingles or fish scales. When two fibers come in contact with each other, these scales tend to cling and stick to each other. It's this physical clinging and sticking that allows wool fibers to be spun into thread so easily. The cortex is the inner structure made up of millions of cigar-shaped cortical cells. In natural-colored wool, these cells contain melanin. The arrangement of these cells is also responsible for the natural crimp unique to wool fiber. Rarely found in fine wools, the medulla comprises a series of cells (similar to honeycombs) that provide air spaces, giving wool its thermal insulation value. Wool, like residential insulation, is effective in reducing heat transfer.

The Manufacturing Process

The major steps necessary to process wool from the sheep to the fabric are: shearing, cleaning and scouring, grading and sorting, carding, spinning, weaving, and finishing Shearing Sheep are sheared once a year usually in the springtime. A veteran shearer can shear up to two hundred sheep per day. The fleece recovered from a sheep can weigh between 6 and 18 pounds (2.7, and 8.1 kilograms); as much as possible, the fleece is kept in one piece. While most sheep are still sheared by hand, new technologies have been developed that use computers and sensitive, robot controlled arms to do the clipping.

Grading and sorting

Grading is the breaking up of the fleece based on overall quality. In sorting, the wool is broken up into sections of different quality fibers, from different parts of the body. The best quality of wool comes from the shoulders and sides of the sheep and is used for clothing; the lesser quality comes from the lower legs and is used to make rugs. In wool grading, high quality does not always mean high durability. Wool is also separated into grades based on the measurement of the wool's diameter in microns. These grades may vary depending on the breed or purpose of the wool.

Cleaning and scouring

Wool taken directly from the sheep is called “raw” or “grease wool.” It contains sand, dirt, grease, and dried sweat (called suint); the weight of contaminants accounts for about 30 to 70 percent of the fleece’s total weight. To remove these contaminants, the wool is scoured in a series of alkaline baths containing water, soap, and soda ash or a similar alkali. The byproducts from this process (such as lanolin) are saved and used in a variety of household products. Rollers in the scouring machines squeeze excess water from the fleece, but the fleece is not allowed to dry completely. Following this process, the wool is often treated with oil to give it increased manageability

Differences between woolen and worsted

In the spinning operation, the wool roving is drawn out anti twisted into yarn. Woolen V are chiefly spun on the mule spinning machine. Worsted yarns are spun on any kind of spinning machine mule, ring cap or flyer. The differences between woolen and worsted yarns are as follows:

Woolen yarn

Short staple

Carded only

Slack twisted

Weaker

Bulkier

Softe

Worsted yarn

Lang staple

Carded and combed

Tightly twisted

Stronger

Finer, smoother, even fibres

Harder

Physical and Chemical Properties of Wool

1. Strength

Wool fibres are weak but wool fabrics are very durable. The durability of wool is the result of the excellent elongation and elastic recovery of the fibres. Fibre strength is not always an indication of durability since flexibility of the fibre and its resistance to abrasion is also important. The tear strength of wool is poor, Wool is fair abrasion resistance. Flexibility of wool is excellent. They can be bent back on themselves 20,000 times without breaking

2. Resilience

Wool is a very resilient fibre. Its resiliency is greatest when it is dry and lowest when it is wet. It a wool fabric is crushed in the hand, it tends to spring back to its original position when the hand is opened. Because wool fibre has a high degree of resilience, wool fabric wrinkles less than some others, wrinkles disappear when the garment or fabric is steamed. Good wool is very soft and resilient, poor wool is harsh. When buying a wool fabric, grasp a handful to determine its quality

3. Heat Conductivity

As wool fibres are poor conductor of heat, they permit the body to retain its normal temperature. Wool garments are excellent for winter clothing and are protective on damp days throughout the year. The scales on the surface of a fibre and the crimp in the fibre create little pockets or air that serve as insulative barriers and give the garment greater warmth.

4. Absorbency

Initially, wool tends to be water-repellent. One can observe that droplets of water on the surface of wool fabrics are readily brushed off. Wool can absorb about 20% of its weight in water without feeling damp; consequently, wool fabrics tend to feel comfortable rather than clammy or chilly, Wool also dries slowly.

End Uses

Overcoats, suits, dresses and underwear are commonly made from wool. In addition to clothing.

Wool has been used for carpeting, felt, wool insulation and upholstery. Wool felt covers piano Hammers and it is used to absorb odours and noise in heavy machinery and stereo speakers.

SILK

Silk is a "natural" protein fiber, some forms of which can be woven into textiles. A fine lustrous fiber composed mainly of fibroin and produced by certain insect larvae to form cocoons, especially the strong, elastic, fibrous secretion of silkworms used to make thread and fabric.

Silk is often referred to as "the queen of the fibres. The shimmering appearance for which silk is prized comes from the fibres triangular prism-like structure which allows silk cloth to refract incoming light at different angles, Silk is also the strongest natural fiber known to man **Life cycle of silkworms.**

The life cycle of the silk worm begins with eggs laid by the adult moth. The larvae emerge from the eggs and feed on mulberry leaves. In the larval stage, the worm is the caterpillar known as the silkworm. The silkworm spins a protective cocoon around itself so it can safely transform into a chrysalis. In nature, the chrysalis breaks through the cocoon and emerges as a moth. The Moths mate and the female lays 300 to 400 eggs. A few days after emerging from the cocoon. The moths die and the life cycle continues. The cultivation of silkworms for the purpose of producing silk is called sericulture.

Sericulture

Breeding silkworms

Only the healthiest moths are used for breeding Their eggs are categorized, graded, and meticulously tested for infection. Unhealthy eggs are burned. The healthiest eggs may be placed in cold storage until they are ready to be hatched. Once the eggs are incubated, they usually hatch within seven days. They emerge at a mere one-eighth of an inch (3.2 mm) long and must be maintained in a carefully controlled environment. Under normal conditions, the eggs would hatch once a year in the spring when mulberry trees begin to leaf. But with the intervention of Seri culturists, breeding can occur as many as three times per year

Feeding the larva

The silkworms feed only on the leaves of the mulberry tree. The mulberry leaves are finely chopped and fed to the voracious silkworms every few hours for 20 to 35 days. During this period the worms increase in size to about 3.5 inches (8.9 cm). They also shed their skin, or molt, four times and change color from gray to a translucent pinkish color.

Spinning the cocoon

When the silkworm starts to fidget and toss its head back and forth, it is preparing to spin its Cocoon. The caterpillar attaches itself to either a twig or rack for support. As the worm twists its Head, it spins a double strand of fiber in a figure-eight pattern and constructs a symmetrical wall around itself. The filament is secreted from each of two glands called the spinneret located under the jaws of the silkworm, the insoluble protein-like fiber is called fibroin.

The fibroin is held together by sericin, a soluble gum secreted by the worm, which hardens as soon as it is exposed to air. The result is the raw silk fiber, called the have. The caterpillar spins a cocoon encasing itself completely. It can then safely transform into the chrysalis, which is the pupa stage.

Stoving the chrysalis

The natural course would be for the chrysalis to break through the protective cocoon and Emerge as a moth. However, serculturists must destroy the chrysalis so that it does not break the silk filament. This is done by stoving, or stifling, the chrysalis with heat.

The Filature

Sorting and softening the cocoons

• The filature is the factory in which the cocoons are processed into silk thread. In the filature the cocoons are sorted by various characteristics, including color and size, so that the finished product can be of uniform quality. The cocoons must then be soaked in hot water to loosen the sericin, Although the silk is about 20% sericin, only 1% is removed at this stage. This way the gum facilitates the following stage in which the filaments are combined to form silk thread, or Yarn.

Reeling the filament

Reeling may be achieved manually or automatically. The cocoon is brushed to locate the end of the fiber. It is threaded through a porcelain eyelet, and the fiber is reeled onto a wheel. Meanwhile, diligent operators check for flaws in the filaments as they are being reeled.

• As each filament is nearly finished being reeled, a new fiber is twisted onto it, thereby forming one long, continuous thread. Sericin contributes to the adhesion of the fibers to each other.

Packaging the skeins

The end product, the raw silk filaments, is reeled into skeins. These skeins are packaged into bundles weighing 5-10 pounds (24 kg), called books. The books are further packaged into bules of 133 pounds (60 kg) and transported to manufacturing centers.

Forming silk yarn

Silk thread, also called yarn, is formed by throwing, or twisting, the reeled silk. First the skeins of raw silk are categorized by color, size, and quantity. Next they are soaked in warm water Mixed with oil or soup to soften the sericin. The silk is then dried.

As the silk filaments are reeled onto bobbins, they are twisted in a particular manner to achieve a certain texture of yarn. For instance, “singles” consist of several filaments which are twisted together in one direction. They are turned tightly for sheer fabrics and loosely for thicker fabrics Combinations of singles and untwisted fibers may be twisted together in certain patterns to achieve desired textures of fabrics such as crepe de chine, voile, or tram. Fibers may also be manufactured in different patterns for use in the nap of fabrics, for the outside, or for the inside of the fabric.The silk yarn is put through rollers to make the width more uniform. The yarn is inspected. Weighed, and packaged. Finally, the yarn is shipped to fabric manufacturers.

Degumming thrown yarn

• To achieve the distinctive softness and shine of silk, the remaining sericin must be removed from the yarn by soaking it in warm soapy water. Degumming decreases the weight of the yarn by as much as 25%

Finishing silk fabrics (weighting)

After degumming, the silk yarn is a creamy white color. It may next be dyed as yarn, or after the yarn has been woven into fabric. The silk industry makes a distinction between pure-dye silk and what is called weighted silk. In the pure dye process, the silk is colored with dye, and may be finished with water-soluble substances such as starch, glue, sugar, or gelatin. To produce weighted silk, metallic substances are added to the fabric during the dying process. This is done to increase the weight lost during degumming and to add body to thefabric. If weighting is not executed properly, it can decrease the longevity of the fabric, so pure-dye silk is considered the superior product. After dyeing, silk fabric may be finished by additional processes, such as bleaching, embossing, steaming, or stiffening.

Kinds of Silk

Silk refers to cultivated silk

1. Wild or Tussah Silk

The silkworms that hatch from a wild species of moth live on oak leaves instead of mulberry leaves that form the food of the cultivated species. This coarser food produces an irregular and coarse filament that is hard to bleach and hard to dye. The tannin in the oak leaves gives wild sill: its tan colour. Wild silk is less lustrous than cultivated sills, as only a low percentage (about 11%) of sericin is removed in the degumming process, wild silk fabrics are durable and have a Course, irregular surface. They are washable and are generally less expensive than pure-dye silk.

2. Doupion Silk

Doupion silk comes from two silkworms that spin their cocoons together. The yam is uneven, irregular, and large in diameter.

3. Raw Silk

Raw silk refers to cultivated silk-in-the-gum. Raw silk varies in colour from graywhite to canary yellow but since the colour is in the sericin, boiled-off silk is white.

4. Reeled Silk

Reeled silk is the long continuous filament, 300 to 1600 yards in length.

5. Spun Silk

Spun silk refers to yarns made from silk from pierced cocoons and waste silk

Waste Silk

Waste silk is comprised of the tangled mass of silk on the outside of the cocoon and the fibre from pierced cocoons.

Major fiber properties

Physical properties

1. Shape

Silk has a triangular shaped cross section whose corners are rounded.

1. Luster

Due to the triangular shape (allowing light to hit it at many different angles), silk is a bright fiber meaning it has a natural shine to it.

2. Covering power

Silk fibers have poor covering power. This is caused by their thin filament form.

End Uses

Silk is used for luxury apparel, household textiles. It is popular in men's neckties for its hand and drape. Silk apparel fabrics are available in a wide range of weights and constructions. The fibre is used alone and in blends with other fibres.

Silk is used in fine drapery and upholstery fabrics. Some of the most expensive handmade oriental rugs are made of silk fibres. Protection from sunlight damage may be provided by careful lining of draperies and the positioning of furniture so that the silk upholstory is not a direct sunlight. Very fine silk filaments are used in eye surgery. Silk sutures still are used by surgeons. The protein fibre is believed by some to be more compatible with human tissue than sutures of other material

Study about organic cotton

Organic cotton is sustainable cotton grown without the use of synthetic pesticides, artificial fertilizer and other toxic chemicals. By law, organic cotton plants can't come from genetically engineered seeds, and strict regulations dictate how cotton must be grown to be certified organic.

The United States, the Federal Trade Commission (FTC) and the U.S. Department of Agriculture (USDA) oversee organic certification. Other third-party certifications cover the process of turning organic fiber into organic textiles. Chief among these are the Oeko-Tex Standard 100 and the Global Organic Textile Standard (GOTS).

Still, the label "organic" might not take things far enough. When products are marketed as organic cotton textiles or fabrics, that usually only refers to the way the cotton was grown.Your products may still be treated with harmful chemicals like bleaches and formaldehyde or dyed with toxic inks that contain heavy metals. That's why checking for Oeko-Tex and GOTS certification is crucial.

There is a general four-step process to turn a cotton seed into cotton apparel

1. Planting and growing
2. Harvesting
3. Cleaning or "ginning" of the cotton ball,
4. Manufacturing

a) Spinning the cotton fibers to create yarn,

b) Weaving or knitting to create bolts of cotton fabric,

c) Fabric dyeing,

d) Finishing process to create the smooth fabric,

e) Cutting and sewing of garment for consumers.

Manufacturing organic cotton

At each manufacturing step, organic clothing manufacturers do not add petroleum scours, formaldehyde, anti-wrinkling agents, chlorine bleaches, or other unauthentic materials. Natural alternatives such as natural spinning oils that biodegrade easily are used to facilitate spinning; potato starch is used for sizing; hydrogen peroxide is used for bleaching; organic color grown cottons and low-impact dyes and earth clays are used for coloration; and natural vegetable and mineral inks and binders are used for printing on organic cotton fabric. These natural alternatives are used to reduce and eliminate the toxic consequences found in conventional cotton fabric manufacturing.

Limitations to Organic Production

There are many reasons why organic cotton production has not extended to other countries. Nineteen countries tried to produce organic cotton during the 1990s. But many of them have already stopped, not for lack of desire or demand for such cotton, but for economic reasons. Insecticides need to be eliminated from the cotton production system because they are dangerous to apply, have long-term consequences on the pest complex, and deleterious effects on the environment.

Woolen and worsted yarn

The Woolen yarn is medium or coarser in diameter than the worsted yarn which is finer in diameter. The woollen yarn is spun from short fibers which are 1-3 inches where as the worsted yarns are spun with longer fibers which are above 3 inches. Woolen yarns are bulky in nature and the worsted yarns are fine and smooth.

During woollen yarn processing, the fibers are washed, scoured and carded and in worsted yarn processing the fibers are washed, scoured, carded and them combed and drawn. Woolen yarns have low to medium slack twist which results in low twist. The worsted yarns have tighter twist giving them high tensile strength.

The fabric produced by woolen yarn is soft in feel and fuzzy and posses heavy weight the fabric produced by worsted yarn is smooth and has crisp with lighter in weight. Woolen yarns are good insulator due to the trapped air, where as the worsted yarns are not good insulator

The woolen yarn fabrics do not hold the crease well and are less durable than worsted yarns. On the other hand, the woolen fabrics hold creases and shape well and are more durable. Woolen spun yarns are in the production of sweaters, carpets, tweeds. Worsted spun yarns are used In preparation of suits, dresses, crepes.

Manufacturing of Woolen Yarn:

In manufacturing of woolen yarn, the fibers are passed through two stages, carding and spinning.

The objective of the carding process is to disentangle the fibers, during this process the wool fibers are passed through rollers which are covered with thousands of wire like teethes. With the help of these wires the fibers are arranged in parallel manner, this makes the woolen yarn smooth.

By the help of oscillating device, one thin film or sliver of wool is placed diagonally and overlapping another sliver to give a criss-cross effect to the fiber. Type of Silk so many different types of silk to discuss, all with their own uses, quirks and qualities, familiarising yourself with the full range of silks is no small task. For most silk-lovers, it is enough to know that the most commonly used commercial silk, mulberry silk, epitomises everything the fabric is known and loved for. However, if you're just as interested in the diversity of silk as the miraculous qualities of mulberry silk, we've filtered down our favourites into a reasonably-sized list to introduce to you to each of them

Mulberry silk

The silk of choice here at Gingerlily, mulberry silk accounts for around 90% of silk produced globally, and for good reason. Beautifully delicate, luxuriously smooth and featuring a subtle natural sheen, mulberry silk has become a favourite for its appearance and feel. Made famous for its health and beauty benefits, including its natural temperature regulating and hypoallergenic qualities, mulberry silk has become the leading choice for designers looking for a versatile, high-quality type of silk which can be coloured and weaved into a vast range of designs.

Spider Silk

A type of silk which has developed an almost mythic quality due to its regular appearance in fantasy novels and films, spider silk is an incredibly strong fabric which has captured the interest of researchers around the world. As the name suggests, spider silk is produced by species of spider which can produce and spin silk. While the insects themselves use their silk to craft webs and capture prey, the impressive properties of spider silk, such as its steel-like tensile strength at a fraction of the weight, means it has potential for human usage too.

Despite the qualities that make spider silk so exciting, however, it is particularly difficult to extract and process substantial amounts of it. As such, it’s highly unlikely that we’ll be seeing spider silk pyjamas or bedding sets any time soon

Tussar Silk

A beautiful type of silk which has traditionally been used to make sarees, tussar silk is produced by several species of silkworm belonging to the moth family. These silkworms often live within trees in wild forests, and their silk is mainly harvested in countries including China, India, Japan and Sri Lanka.

Eri Silk

Not as soft as mulberry silk, or as fine as sea silk, eri silk is most well-known for its thermal properties. Shared to some degree with mulberry silk, which is also naturally temperature regulating, eri silk is capable of keeping wearers warm in the winter and cool in the summer, but it still hasn’t become the silk-of-choice for fabric production. This is largely due to this type of silk’s elasticity and heavier weight, which make it feel almost wool-like to the touch. While this has made it somewhat less luxurious than other silk types, it is particularly well suited for being blended with other materials such as wool and cotton, so is often the first choice for making silk-blend items such as curtains, bed covers and quilts.

Muga Silk

While many different types of silk have interesting histories, muga silk has a royal reputation which is worth remarking on. The preferred blend of silk of Indian royalty, muga silk has been produced in the Indian state of Assam for centuries by a specific species of silk moth which are fed on a strict diet of aromatic som and soalu leaves. Featuring a naturally golden hue which is luxurious and striking, muga silk is commonly used to make products like sarees and other traditional Indian garments.

UNIT 2

REGENERATED AND SYNTHETIC FIBERS

Manufacturing process of man-made fibre

MAN-MADE FIBER

There are two main categories of man-made fibers: those that are made from natural products (cellulosic fibers) and those that are synthesized solely from chemical compounds (noncellulosic polymer fibers). Rayon is a natural-based material that is made from the cellulose of wood pulp or cotton. This natural base gives it many of the characteristics low cost, diversity, and comfort that have led to its popularity and success. Today, rayon is considered to be one of the most versatile and economical man-made fibers available

VISCOSE RAYON

The process of manufacturing viscose rayon consists of the following steps mentioned, in the order that they are carried out: 1. Cellulose, 2. Steeping, 3. Pressing, 4. Shredding,

5. Aging, 6.Xanthation, 7. Dissolving, 8. Ripening, 9. Filtering, 10. Degassing, 11. Spinning,

12. Drawing, 13. Washing, 14. Cutting.

The various steps involved in the process of manufacturing viscose are shown in Purified cellulose for rayon production usually comes from specially processed wood pulp. It is sometimes referred to as dissolving cellulose or dissolving pulp to distinguish it from lower grade pulps used for papermaking and other purposes. Dissolving cellulose is characterized by a high a -cellulose content, i.e., it is composed of long-chain molecules, relatively free from lignin and hemicelluloses, or other short-chain carbohydrates.

Steeping

The cellulose sheets are saturated with a solution of caustic soda (or sodium hydroxide) and allowed to steep for enough time for the caustic solution to penetrate the cellulose and convert some of it into soda cellulose, the sodium salt of cellulose. This is necessary to facilitate controlled oxidation of the cellulose chains and the ensuing reaction to form cellulose xanthate.

Pressing

The soda cellulose is squeezed mechanically to remove excess caustic soda solution.

Shredding

The soda cellulose is mechanically shredded to increase surface area and make the cellulose easier to process. This shredded cellulose is often referred to as white crumb Aging

The white crumb is allowed to stand in contact with the oxygen of the ambient air. Because of the high alkalinity of white crumb, the cellulose is partially oxidized and degraded to lower molecular weights. This degradation must be carefully controlled to produce chain lengths short enough to give manageable viscosities in the spinning solution, but still long enough to impart good physical properties to the fiber product.

Xanthation

The properly aged white crumb is placed into a churn, or other mixing vessel, and treated with gaseous carbon disulphide. The soda cellulose reacts with the CS2 to form xanthate ester groups. The carbon disulphide also reacts with the alkaline medium to form inorganic impurities Give the cellulose mixture a characteristic yellow color and this material is referred to as yellow crumb. Because accessibility to the CS2 is greatly restricted in the crystalline regions of the soda cellulose, the yellow crumb is essentially a block copolymer of cellulose and cellulose xanthate. 7. Dissolving

The yellow crumb is dissolved in aqueous caustic solution. The large xanthate substituents on the cellulose force the chains apart, reducing the interchain hydrogen bonds and allowing water molecules to solvate and separate the chains, leading to solution of the otherwise insoluble cellulose. Because of the blocks of un-xanthated cellulose in the crystalline regions, the yellow crumb is not completely soluble at this stage. Because the cellulose xanthate solution (or more accurately, suspension) has a very high viscosity, it has been termed viscose.

8. Ripening

The viscose is allowed to stand for a period of time to ripen. Two important processes occur during ripening: Redistribution and loss of xanthate groups. The reversible xanthation reaction allows some of the xanthate groups to revert to cellulosic hydroxyls and free CS2. This free CS2 can then escape or react with other hydroxyl on other portions of the cellulose chain. In this way, the ordered, or crystalline, regions are gradually broken down and more complete solution is achieved. The CS2 that is lost reduces the solubility of the cellulose and facilitates regeneration of the cellulose after it is formed into a filament.

9. Filtering

The viscose is filtered to remove undissolved materials that might disrupt the spinning process or cause defects in the rayon filament

10. Degassing

Bubbles of air entrapped in the viscose must be removed prior to extrusion or they would cause voids, or weak spots, in the fine rayon filaments

11. Spinning

The viscose is forced through a spinneret, a device resembling a shower head with many small holes. Each hole produces a fine filament of viscose. As the viscose exits the spinneret, it comes in contact with a solution of sulfuric acid, sodium sulfate and, usually, Zn^{++} ions. Several processes occur at this point which cause the cellulose to be regenerated and precipitate from solution. Water diffuses out from the extruded viscose to increase the concentration in the filament beyond the limit of solubility. The xanthate groups form complexes with the Zn^{++} which draw the cellulose chains together. The acidic spin bath converts the xanthate functions into unstable xantheic acid groups, which spontaneously lose CS_2 and regenerate the free hydroxyls of cellulose. (This is similar to the well-known reaction of carbonate salts with acid to form unstable carbonic acid, which loses CO_2). The result is the formation of fine filaments of cellulose, or rayon. 12

Drawing

The rayon filaments are stretched while the cellulose chains are still relatively mobile. This causes the chains to stretch out and orient along the fiber axis. As the chains become more parallel, interchain hydrogen bonds form, giving the filaments the properties necessary for use as textile fibers. 13.

Washing

The freshly regenerated rayon contains many salts and other water soluble impurities which need to be removed. Several different washing techniques may be used. 14.

Cutting

If the rayon is to be used as staple (i.e., discreet lengths of fiber), the group of filaments (termed tow) is passed through a rotary cutter to provide a fiber which can be processed in much the same way as cotton.

Physical and Chemical Properties of Rayon

1. Strength

The tensile strength of viscose rayon is greater than that of wool, but is only about half as great as that of silk. Viscose rayon is also weaker than cotton and linen and its strength is reduced 40 to 70% when wet. The strength is controlled by stretching, which causes a greater orientation of the molecules. Viscose is easily stretched when wet and swollen. If dried in a stretched condition, it will relax and shrink upon again becoming wet.

2. Elasticity

Viscose rayon has greater elasticity than cotton or linen but less than wool or silk.

3. Drapability

Viscose rayon possesses a marked quality of drapability because it is a relatively heavyweight fabric. The filament can be made as coarse as desired depending on the holes in the spinneret.

4. Resilience

Viscose rayon lacks the resilience natural to wool and silk and creases readily; but it should be remembered that the resistance of a fabric to creasing depends on the kind of yarn, weave, and finishing process.

5. Heat Conductivity

Viscose rayon is a good conductor of heat and is therefore appropriate for summer clothing. Spun rayon fabrics, however, are adaptable to winter apparel because they can be napped.

6. Absorbency

Viscose rayon is a one of the most absorbent of all textiles. It is more absorbent than cotton or linen. The combination of high heat conductivity and high absorbency of rayon makes it very suitable for summer wear.

7. Cleaning and Washability

Because of its smoothness, viscose, rayon fibre helps to produce hygienic fabric that shed dirt. Some viscose rayon fabrics wash easily, and depending on the finish that may be given to them, they will not become yellow when washed or dry cleaned. Regular rayon fabrics have limited washability because of the low strength of the fibre when wet. When laundered, a mild soap or detergent and warm water should be used.

8. Shrinkage

Viscose rayon fabrics tend to shrink more than cotton fabrics of similar construction. Knitted fabric always shrinks more than flat woven fabrics because of the nature of the construction. When spun viscose rayon is blended with wool, the great amount of shrinkage characteristic of the wool is reduced

9. Effect of Heat Since

Viscose rayon is a pure cellulose fibre, it will burn in much the same manner as cotton. Application of heat at 300°F (150°C) causes viscose rayon to lose strength; above 350°F (177°C), it begins to decompose.\

10. Effect of Light

Viscose rayon has generally good resistance to sunlight, though prolonged exposure of intermediate tenacity rayon results in faster deterioration and yellowing.

11. Resistance to Mildew

Like cotton, viscose rayon has a tendency to mildew. Moths are not attracted to cellulose. Consequently, moth-proffering treatments are not necessary for viscose rayon.

Resistance to other insects is also similar to that of cotton.

12. Reaction to Alkalies

Viscose rayon is fairly resistant to alkalies and oxidizing agents but tends to be harmed to a greater extent by alkalies than are cotton or linen. A mild soap and warm water is recommended when laundering such garments.

NYLON

The first truly synthetic fibre was nylon, which originated from research work in the United States and represented a radically different chemical structure and potentially new properties textiles. Nylon is a general name, which covers materials with a range of qualities, including the two most important clothing types, nylon 6 and nylon 66. All nylon is made from products derived from coal tar or oil and possesses some very unusual properties, including high strength and luster. Certain nylons may be textured and bulked to produce particular tactile qualities in cloth. Other fibres discovered more recently (1941) include the class known as polyester. This largely British invention has, in its Terylene form, many similarities to nylon. Acrylic fibre, produced alongside polyester after 1950, represented the first realistic wool substitute. Its warmth has led it to be used widely for knitwear. Other fibres among the true synthetics include modacrylics and elastomers. The latter are currently extremely popular as Lycra, its stretch properties being utilized in sports clothing. Any synthetic plastic material composed of polyamides of high molecular weight and usually, but not always, manufactured as a fibre. Nylons were developed by Du Pont in the 1930s. The successful production of a useful fibre by chemical synthesis from compounds readily available from air, water, and coal or petroleum stimulated expansion of research on polymers, leading to a rapidly growing family of synthetics.

Basic Concepts of Nylon Production

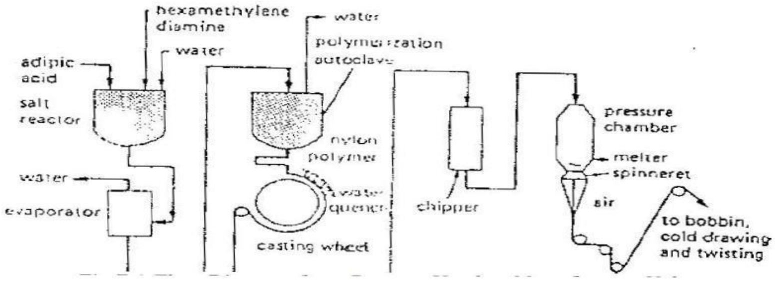
The first approach: combining molecules with an acid (COOH) group on each end are reacted with two chemicals that contain amine (NH2) groups on each end This process creates nylon 6, 6, made of hexamethylene diamine with six carbon atoms and acidipic acid, as well as six carbon atoms.

The second approach: a compound has an acid at one end and an amine at the other and is polymerized to for a chain with repeating units of(-NH- [CH2]n-CO-)x

- In other words, nylon 6 is made from a single six-carbon substance called caprolactam.
- In this equation, if n=5, then nylon 6 is the assigned name. (May also be referred to as polymer)

Manufacturing of Nylon

- Carbon + Nitrogen + Hydrogen + Oxygen (coal) (air) (water) (air) +
- Adipic Acid and Hexamethylene Diamine
- Amide (Nylon Salt
- Heated in Vaccum (Loss of Water)
- Nylon Super Polymer Heated
- Nylon Spinning Solution (Polyamide) Dry Spinning (Cool Air



Manufacture Nylon

Nylon is actually a group of related chemical compounds. It is composed of hydrogen, nitrogen, oxygen and carbon in controlled proportions and structural arrangement. Variations can result in types of nylon plastics, such as combs, brushes, and gears. By a series of chemical steps beginning with such raw materials as coal, petroleum, or such cereal by products as oat hulls or corncobs, two chemicals called hexamethylene diamine and adipic acid are made. These are combined to form nylon salt. Then, since the nylon salt is to be shipped to the spinning mill, it is dissolved in water for easily handling. At the spinning mill, it is heated in large evaporators until a concentrated solution is obtained. The concentrated nylon salt solution is then transferred to an autoclave, which is like a h e pressure cooker. The heat combines the molecules of the two chemicals into giant chainlike ones, called linear super polymers. The linear super polymer is then allowed to flow out of a slot in the autoclave onto a slowly revolving casting wheel. As the ribbons of molten nylon resin are deposited on the wheel, they are sprayed with cold water, which hardens them to milky white opaque ribbons. The ribbons are removed from the casting wheel to a chipper, which transforms them into flakes. Nylon flakes are blended and poured into the hopper of the spinning machine to insure uniformity in the final nylon yarn. Through a value in the bottom of the hopper, the nylon flakes fall onto a hot grid, which melt, them? The molten nylon is pumped through a send filter to the spinneret. The spinneret has one or more holes, depending on the purpose for which the yarn is to be made. As the filaments come out of the spinneret and hit the air, they solidify. This filament can be changed, however, by stretching or cold drawing, the filaments from two to seven times their original length. The amount of stretching is dependent on the diameter, elasticity, and strength desired. As the filaments are stretched, they become more and more transparent. The polyamide molecules straighten out, become parallelized, and are brought very close together. Up to a point, the nylon becomes stronger, more elastic, more flexible and more pliable.

Physical and Chemical Properties of Nylon

1. Strength

Nylon is produced in both regular and high tenacity strengths. Although one of the lightest textile fibre, it is also one of the strongest. The strength of nylon will not deteriorate with age

2. Elasticity

Nylon is one of the most elastic fibre that exists today, though it does not have the exceptional elastic quality of spandex fibre. After being stretched, nylon has a strong natural tendency to return to its original shape, and has its own limit to elasticity. If stretched too much, it will not completely recover its shape. Spun nylon is not as elastic as filament nylon.

3. Resilience

Nylon has excellent resilience. Nylon fabrics retain their smooth appearance, and wrinkles from the usual daily activities fall out readily.

4. Shrinkage

Nylon has good dimensional stability and retains its shape after being wet.

5. Drapability

Fabrics at nylon yarn have excellent draping qualities. Lightweight sheers may have a flowing quality, medium-weight dress fabrics can drape very nicely, and heavier weight jacquards also drape well.

6. Heat Conductivity

Nylon fabrics may or may not conduct heat well. The warmth or coolness of a nylon garment depends on the weave of the fabric and on the type of yarn used. The smoothness, roundness, and fineness of nylon filaments permit the manufacture of very smooth, very fine yarns, which can be packed very closely when weaving the fabric. If nylon fabric is woven compactly, it will not be porous. The tight construction will not permit air to circulate through the fabric, and the heat and moisture of the body will not readily pass through it but will built up between the fabric and the body: so, the wearer will feel very warm.

7. Absorbency

Nylon does not absorb much moisture. Fabrics made of nylon filament yarns will not readily wet through the material-most of the water remains on the surface and runsoff the smooth which therefore dries quickly. Such fabrics are useful for rain coats and shower curtains. Spun nylon fabrics, however, will not dry quickly. Nylon's low absorbency has a disadvantage in that the fabric feels clammy and uncomfortable in warm, humid weather.

8. Cleanliness and Washability

Because of nylon's smooth surface, dirt and stains often come clean merely using a damp cloth. To wash nylon garments by hand or washing machine, use lukewarm water at 100°F (38°C) and a detergent or soap with a water softener. Nylon filament fabrics dry very quickly. They need little or no ironing because the garments are usually heat set to retain their shape, pleats or creases. Spun nylon has a tendency to pill or form balls, on the surface of the fabric. To minimize thus, such fabrics should not be rubbed. They should be washed gently, preferably by hand. Brushing with a soft brush will reduce the pilling.

9. Effect of Heat

Like acetate, nylon will melt if the iron is too hot, therefore, the iron should be set at the proper heat level. It does not burn readily but melts to form glossy beads formation.

10. Effect of Light

Bright nylon is more resistant to the effects of sunlight than most other fibres. Dull nylon will deteriorate a little more quickly than bright nylon; however, even dull nylon has good resistance to light.

11. Resistance to Mildew and Insects

Mildew has absolutely no effect on nylon. Mildew may form on nylon, but it will not weaken the fabric. Moths and other insets will not attack nylon because it has no attraction for them.

12. Reaction to Alkalies

Nylon is substantially inert to alkalies. No reaction with soap, alkalis and alcohols.

13. Reaction to Acids

Nylon is decomposed by cold concentrated solutions of such mineral acids as hydrochloric, sulphuric and nitric acids. A boiling dilute 5% solution of hydrochloric will destroy nylon

Major End Uses

- Apparel - swimwear, active wear, intimate apparel, foundation garments, hosiery, blouses, dresses, sportswear, pants, jackets, skirts, raincoats, ski and snow apparel, windbreakers, children's wear.

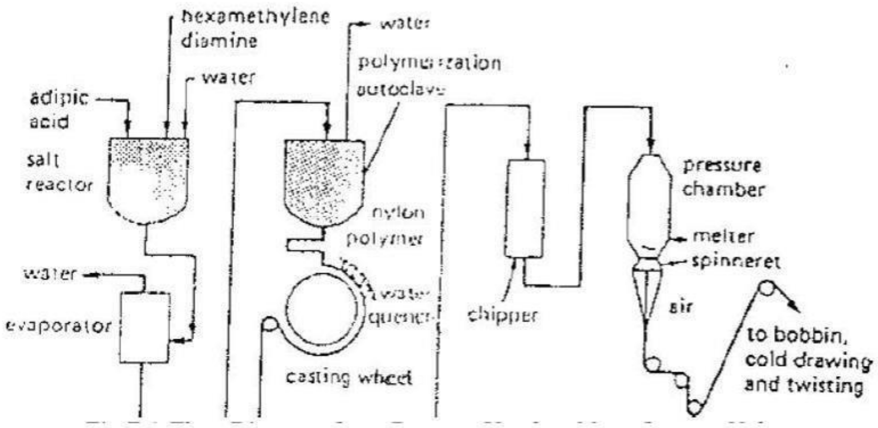
- Home Fashions – carpets, rugs, curtains, upholstery, draperies, bedspreads
- Other – Luggage, back packets, life vests, umbrellas, sleeping bags, tents. Properties
- Lightweight
- Exceptional strength
- Good drapeability
- Abrasion resistant
- Easy to wash
- Resists shrinkage and wrinkling
- resilient, pleat retentive
- Fast drying, low moisture absorbency

POLYESTER

Polyester is a synthetic fiber derived from coal, air, water, and petroleum. Developed in a 20th-century laboratory, polyester fibers are formed from a chemical reaction between an acid and alcohol structure repeats throughout its length. Polyester fibers can form very long molecules that are very stable and strong.

Manufacturing of Polyester

- Terephthalic Acid + Ethylene Glycol o Polymerization
- Polyester + Highly Heated
- Polyester Spinning Solution o Melt or Dry Spinning (Cool Air) Filament o Drawing and
- Stretching
- Polyester Filament



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1. Polymerization

To form polyester, dimethyl terephthalate is first reacted with ethylene glycol in the presence of a catalyst at a temperature of 302-410Â°F (150- 210Â°C).

• The resulting chemical, a monomer (single, non-repeating molecule) alcohol, is combined with terephthalic acid and raised to a temperature of 472Â°F (280Â°C). Newly formed polyester, which is clear and molten, is extruded through a slot to form long ribbons.

2. Drying

After the polyester emerges from polymerization, the long molten ribbons are allowed to cool until they become brittle. The material is cut into tiny chips and completely dried to prevent irregularities in consistency.

3. Melt spinning

Polymer chips are melted at 500-518Â°F (260-270Â°C) to form a syrup-like solution. The solution is put in a metal container called a spinneret and forced through its tiny holes, which are usually round, but may be pentagonal or any other shape to produce special fibers. The number of holes in the spinneret determines the size of the yarn, as the emerging fibers are brought together to form a single strand.

At the spinning stage, other chemicals may be added to the solution to make the resulting material flame retardant, antistatic, or easier to dye.

4. Drawing the fiber

- When polyester emerges from the spinneret, it is soft and easily elongated up to five times its original length. The stretching forces the random polyester molecules to align in a parallel formation. This increases the strength, tenacity, and resilience of the fiber. This time, when the filaments dry, the fibers become solid and strong instead of brittle.

- Drawn fibers may vary greatly in diameter and length, depending on the characteristics desired of the finished material. Also, as the fibers are drawn, they may be textured or twisted to create softer or duller fabrics.

5. Winding

• After the polyester yarn is drawn, it is wound on large bobbins or flatwound packages, ready to be woven into material.

Physical and Chemical Properties of Polyester

1. Strength

Polyester fibres may be characterized as relatively strong fibres. Fabrics of regular tenacity polyester filament yarns are very strong and durable. The hightenacity polyester filament yarns used for tires and industrial purposes are extremely strong; some types are the strongest of all textiles except glass, aramid etc. The staple fibres also vary in strength depending on the type of fibre.

2. Elasticity

Polyester fibres do not have a high degree of elasticity. In general, polyester fibre is having a high degree of stretch resistance. Thus property makes polyester suited for knitted garments; sagging and stretching that would ordinarily occur are reduced. Fabrics of polyester fibre have good dimensional stability.

3. Resilience

Polyester fibre has a high degree of resilience. Not only does a polyester fabric resist wrinkling when dry, it also resists wrinkling when wet. And heat set polyester fibre is suitably resilient for .use in carpets.

4. Drapability

Fabrics of polyester filament yarn have satisfactory draping qualities. Staple polyester can produce spun yarn that is more flexible and softer, thereby imparting the draping quality. Drapability of fabrics of blended polyester staple will depend upon the type and proportion of blend in the yam as well as the fabric construction.

5. Heat Conductivity

Fabrics of polyester fibre are better conductors of heat. The basic polyester filament fibre is round. This results in a smoother yarn woven into fabrics with fewer air spaces and less insulation. Polyester staple fibre is crimped and this does provide greater insulation in the yarns and fabrics.

6. Absorbency

Polyester is one of the least absorbent fibres. This low absorbency has two important advantages. Polyester fabrics will dry very rapidly since almost all the moisture will lie on the surface rather than penetrate the yarns. Fabrics of polyester fibre are therefore well suited for water-repellent purposes, such as rainwear.

Furthermore, this low absorbency means that polyester fabrics will not stain easily.

Many substances lie on the surface and can be wiped or washed off easily.

7. Cleanliness and Washability

Since polyester fibres are smooth and have a very low absorbency, many stains lie on the surface and can easily be washed by hand or machine. Strong soaps are not needed. When ironing polyester fabrics, it is best to use low to medium heat.

8. Effect of Bleaches Polyester fabrics maybe safety bleached because polyester had good resistance to deterioration by household bleaches. If the polyester has an optical brightener, no bleaching is necessary.

9. Shrinkage

Polyester fabrics shrink as much as 20% during wet-finishing operations. Finished polyester woven and knitted fabric will not shrink. They have excellent dimensional stability.

10. Effect of Heat

Depending upon the type, pohester will get sticky at 440 to 468°F (227-242°C). Therefore, if ironing is needed, it should be done at lower temperatures. At temperature in the range of 480 to 554°F (249290°C), polyester will melt and flame.

11. Effect of Light

Polyester has good resistance to sunlight. Fabrics of polyester are therefore well suited for outdoor use. Over a prolonged period of exposure to direct sunlight, however, there will be a gradual deterioration of the polyester fibre. When exposed to sunlight behind glass, polyester shows a considerable increase in resistance to sunlight, it has a marked superiority over most other fibres under these conditions and is very well suited for curtains.

ACRYLIC

Acrylic fibers are synthetic fibers made from a polymer (Polyacrylonitrile) with an average molecular weight of ~100,000. To be called acrylic in the U.S., the polymer must contain at least 85% acrylonitrile monomer. Typical co monomers are vinyl acetate or methyl acrylate.

Manufacturing of Acrylic

The term acrylic comes from the chemical composition of the fibre; the word modacrylic comes from "modified acrylic". Dimethylfromamide or dimethylacetamide is used as a solvent. Some fibres can be spun from acetone. After the polymer is dissolved, it must be filtered to remove impurities and undissolved polymer. The solution is spun by either a wet-spinning or a dry spinning system. Bi component acrylic fibres are formed at the spinneret. After coagulation, the fibre is drawn to produce fibre properties. Fibre crimp is also developed before the fibre is cut into staple.

Properties of Acrylic

The acrylic fibres are stronger than wool and acetate but weaker than most of the other fibres. Elongation and recovery of the fibres are also variable. The acrylic fibres have good resilience. They do not wrinkle easily, and any wrinkles that are formed in garments usually disappear after the fabric relaxes. They are more absorbent than polyester but less absorbent than nylon. The low moisture regain indicates that the fibres generate static electricity. Acrylic fibres burn with a yellow flame. They form a hot gummy residue that drips away from the burning material

L molten drip solidifies to a hard, brittle black bead. The reaction of the original modaerylics to heat was one of the major reasons for their popularity. The fibres were difficult to ignite, and they self-extinguished. The ash was a hard black char. The fibres could be treated so that some were more sensitive to heat than others. Weak alkalies do not affect acrylics. Concentrated alkalies degrade acrylics. Cold, concentrated nitric acid dissolves acrylic fibres, and other concentrated acids weaken them. Dilute acids do not harm the fibres. 'I the acrylic fibres are not affected by household organ,: solvents. Acrylic has excellent resistance to sunlight. Even prolonged exposure does not affect fibre strength. Most acrylic fibres are dyed with disperses dyes.

Uses of Acrylic

The primary markets for acrylic is in apparel and home furnishings. The fibres are usually soft and light in weight. In apparel, the fibre may be used alone or in blends with cotton, wool. Rayon, and polyester. Apparel in which acrylic fibre are likely to lie found include socks, knit sweaters, and sportswear fabrics. Blankets, carpets and upholstery fabrics are made form act lie fibres and acrylic blends. The farbics have wool like hand but are not affected by moths. Household fabrics made from acrylic fibres are especially popular where exposure to sunlight is a problem. Properties

- Strong
- Crisp, soft hand
- Resistant to stretching and shrinkage
- Washable or dry-cleanable
- Quick drying
- Resilient, wrinkle resistant, excellent pleat retention

Polymerization

The chemical reaction of polymerization generally deals with the formation of polymers. The organic monomers react within a solution containing the necessary particles to get the coating. During the procedure, each monomer loses some of the existing chemical groups. Plus, the polymers can notice a different reactivity level and chemical properties than the original monomer.

The process of polymerization is not complex. However, the sequence of monomers combining to form polymers can vary for different solutions. Thus, the description of the procedure can differ.

In the matter of what are polymers and their formation, there are varying reactive mechanisms with different levels of complexity that affect the process. This occurs because of the functional groups that exist within the reacting compounds.

Polymerization- Different Types of Processes

Polymers are forms of macromolecules that occur when multiple smaller molecules called monomers link together. There are two specific types of approaches or synthesis noticeable here. They include:

Addition-based or chain-growth polymerization

Condensation-based or step-growth polymerization

The primary difference between the two synthesis processes is the type and structure of the initial monomer units. Plus, it also depends on the conversion extent and how it relates to the molecular size of the polymer.

Chain growth polymerization

Chain growth or addition type of polymerization is a notable process in which monomers change into polymers. After an additional reaction happens, the additional polymers originate. Based on the monomer type, the adjoined monomers create a branch-like or linear polymer structure while they attach.

The rearrangement of the monomers creates a new type of structure with no molecule or atom loss. There are four specific types under this process.

Cationic polymerization- A cation in the equation creates a chain reaction. Then, the existing monomers join together to form a long chain due to the reaction, which turns into a polymer.

Coordinative polymerization- The process here occurs due to the application of catalysts that control the polymerization of free radicals. Common choices of catalysts are transition metal complexes and salts.

Anionic vinyl polymerization occurs when some of the polymers react with another electronegative group holding a high charge. This causes a chain reaction and results in the polymerization process.

Step growth polymerization

Another name for step-growth polymerization is condensation polymerization. The monomer molecules react and create a bond, which takes the place of other molecules. The polymer molecules occur after the reaction, and one example of it is the water molecule.

The quality and Structure of the created polymer depend on what type of monomer the condensation polymerization process took place with. To note, some monomers hold a single reactive group. They possess a low molecular weight.

If the monomers contain two reactive groups, they form linear polymers with more weight. Additionally, monomers that hold over two reactive end groups create a three-dimensional polymer network.

Notable examples of this process are nylon and polyester (synthetic type) or carbohydrates and proteins (biological type).

Bamboo Fibre Processing

There are two manufacturing methods of bamboo fibres:

Chemical Process

Mechanical Process

Depending upon the type of fabric bamboo fibre can be produce two different chemical methods. Majority of the bamboo fibres are produced by viscose rayon processing method. Which is cheap to produce but it has some environmental downside. Actually this method is regenerated or semi synthetic fibre processing method.

Mechanical Process:

Bamboo fabric of the highest quality is made with production practices that do not extract cellulose. Instead, a natural enzyme is used on crushed bamboo wood fibers, and these fibers are then washed and spun into yarn. This yarn usually has a silky texture, and the fabric made by this process is sometimes called bamboo linen. It is actually true natural bamboo fibre processing.

When bamboo fabric is made with this method, it is not environmentally harmful, and the resulting textile is strong and long-lasting. However, most types of bamboo fabric are not made with this mechanical process; to ensure that you're getting high-quality bamboo fabric, make sure that it is manufactured with a mechanical rather than a chemical process.

Advantages of Bamboo Fibre:

Green and eco-friendly:

Bamboo fibre can be processed through regenerated or natural process. As it is 100% cellulosic it is bio degradable in nature. Bamboo fibre decomposes without causing pollution. "Bamboo fiber comes from nature, and completely returns to nature in the end". As a green textile material bamboo has a great advantage over other natural textile materials. Bamboo can be grown without the use of pesticides, which together with other factors such as fast growing rate and low water consumption makes it a sustainable raw material for textiles.

Soft & Breathable:

Bamboo fibre is finer & softer than cotton. Cross section of bamboo fibres are filled with micro gaps and micro pores. So it has better moisture absorption and ventilation. In summer bamboo fabric can evaporate sweat from human body very fast just like breathing, such types garment gives aesthetically pleasant and cool to the human body. According to authoritative testing figures, apparels made from bamboo fibers are 1-2 lower than normal apparels in hot summer. Apparel made from bamboo fiber is crowned as Air Conditioning Dress.

UV protection property:

Bamboo made fabric has UV absorption property. It protects human skin from UV rays. It can be used as a dress material of pregnant women and children

Uses of bamboo yarn & fabric:

Intimate Apparel uses:

Under garments including socks, bath suit, under wear, towel etc.

Sanitary purpose & medical uses:

Sanitary materials: bandage, mask, surgical cloths, nurses wear and so on. It has incomparably wide foreground on application in sanitary material such as sanitary towel, gauze mask, absorbent pads, and food packing.

UV resistant product:

Due to its' UV resistant property, it is used for making of apparel of pregnant women and children.

Household uses:

Television cover, wall-paper and sofa slipcover

Spandex

Spandex is a synthetic polymer. It is also called Elastane Fiber. Chemically, it is made up of a long-chain polyglycol combined with a short di-isocyanate, and contains at least 85% polyurethane. It is an elastomer, which means it can be stretched to a certain degree and it recoils when released. These fibers are superior to rubber because they are stronger, lighter, and more versatile. In fact, spandex fibers can be stretched to almost 500% of their length.

Properties of Spandex:

Physical Properties of Spandex

Cross section– Spandex filaments are extruded usually from circular orifices, but the evaporation of solvent or the effects of drying may produce non-circular cross-sectional shapes. This may take various forms. In the multi-filament yarns, individual filaments are often fused together in places. The number of filaments in a yarn may be as few as 12 or as many as 50; the linear density of filaments ranges from 0.1 to 3 tex (g/km).

Density: The density of spandex filaments ranges from 1.15 to 1.32 g/cc, the fibers lower density being based on polyesters.

Moisture regain: The moisture of fibers from which the surface finish has been removed lies between 0.8 & 1.2%

Length: It can be of any length. It may be used as filament or staple fiber.

Color: It has white or nearly white color.

Luster: It has usually dull luster.

Strength: Low strength compared to most other synthetic fiber.

Elasticity: Elastic properties are excellent. This is the outstanding characteristic of the fiber.

Heat: The heat resistance varies considerably amongst the different degrades over 300 F.

Flammability: It Burn slowly.

Chemical Properties of Spandex

Acid: Good resistance to most of acids unless exposure is over 24 hours.

Alkalis: Good resistance to most of the alkalis, but some types of alkalis may damage the fiber.

Organic solvents: Offer resistance to dry cleaning solvents.

Bleaches: Can be degraded by sodium hypo-chloride. Chlorine bleach should not be used. Dyeing: A full range of colors is available. Some types are more difficult to dye than others What is Spandex?

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This unique elastic property of the spandex fibers is a direct result of the material's chemical composition. The fibers are made up of numerous polymer strands. These strands are composed of two types of segments: long, amorphous segments and short, rigid segments. In their natural state, the amorphous segments have a random molecular structure. They intermingle and make the fibers soft. Some of the rigid portions of the polymers bond with each other and give the fiber structure. When a force is applied to stretch the fibers, the bonds between the rigid sections are broken, and the amorphous segments straighten out. This makes the amorphous segments longer, thereby increasing the length of the fiber. When the fiber is stretched to its maximum length, the rigid segments again bond with each other. The amorphous segments remain in an elongated state. This makes the fiber stiffer and stronger. After the force is removed, the amorphous segments recoil and the fiber returns to its relaxed state. By using the elastic properties of spandex fibers, scientists can create fabrics that have desirable stretching and strength characteristics.

Spandex Yarn

The primary use for spandex fibers is in fabric. They are useful for a number of reasons. First, they can be stretched repeatedly, and will return almost exactly back to original size and shape. Second, they are lightweight, soft, and smooth. Additionally, they are easily dyed. They are also resilient since they are resistant to abrasion and the deleterious effects of body oils, perspiration, and detergents. They are compatible with other materials, and can be spun with other types of fibers to produce unique fabrics, which have characteristics of both fibers.

Spandex is used in a variety of different clothing types. Since it is lightweight and does not restrict movement, it is most often used in athletic wear. This includes such garments as swimsuits, bicycle pants, and exercise wear. The form-fitting properties of spandex makes it a good for use in under-garments. Hence, it is used in waist bands, support hose, bras, and briefs.

Types of spandex yarn:

Bare yarn.

Covered yarn.

Core spun yarn.

Blend spun yarn.

History of Spandex:

The development of spandex was started during World War II. At this time, chemists took on the challenge of developing synthetic replacements for rubber. Two primary motivating factors prompted their research. First, the war effort required most of the available rubber for building equipment. Second, the price of rubber was unstable and it fluctuated frequently.

Developing an alternative to rubber could solve both of these problems.

At first, their goal was to develop a durable elastic strand based on synthetic polymers. In 1940, the first polyurethane elastomers were produced. These polymers produced millable gums, which were an adequate alternative to rubber. Around the same time, scientists at Du Pont produced the first nylon polymers. These early nylon polymers were stiff and rigid, so efforts were begun to make them more elastic. When scientists found that other polyurethanes could be made into fine threads, they decided that these materials might be useful in making more stretchable nylons or in making lightweight garments.

The first spandex fibers were produced on an experimental level by one of the early pioneers in polymer chemistry, Farben fabriken Bayer. He earned a German patent for his synthesis in 1952. The final developments of the fibers were worked out independently by scientists at Du Pont and the U.S. Rubber Company. Du Pont used the brand name Lycra and began full scale manufacture in 1962. They are currently the world leader in the production of spandex fibers. Molecular Structure:

Spandex is a polymer; its macromolecular structure is made up of repeating units (mars) denoted by the x and n next to the parentheses in the structure. Each Spandex fiber will differ somewhat in length and composition depending on the exact value of x and n.

Characteristics of Spandex:

The most significant characteristic of spandex is its stretch ability. It can be stretched

to a great length and then also recovers it's near to original shape. It can, in fact, be stretched to almost 500% of its length. It is lightweight, soft, smooth, supple and more durable and has higher retractive ability than rubber. As such, when spandex is used for making any clothing, it gives the best fit and comfort and also prevents bagging and sagging of the garment. It is also heat-settable which means that it facilitates transforming puckered fabrics into flat fabrics, or flat fabrics into permanent rounded shapes. Spandex fibers or fabrics can be easily dyed and they also resist damage by body oils, perspiration, lotions or detergents. These fabrics are also abrasion resistant. When spandex is sewn, the needle causes little or no damage from "needle cutting" compared to the older types of elastic materials. The spandex fiber diameters range from 10 denier to 2500 denier and can be found in both, clear and opaque lusters.

Properties of Spandex:

Physical Properties of Spandex Fiber:

Cross section– Spandex filaments are extruded usually from circular orifices, but the evaporation of solvent or the effects of drying may produce non-circular cross-sectional shapes. This may take various forms. In the multi-filament yarns, individual filaments are often fused together in places. The number of filaments in a yarn may be as few as 12 or as many as 50; the linear density of filaments ranges from 0.1 to 3 tex (g/km).

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Strength: Low strength compared to most other synthetic fiber.

Elasticity: Elastic properties are excellent. This is the outstanding characteristic of the fiber.

Heat: The heat resistance varies considerably amongst the different degrades over 300 F.

Flammability: It Burn slowly.

Electrical conductivity: It has Low electrical conductivity.

Breaking tenacity: 0.6 to 0.9grams/denier.

Chemical Properties of Spandex Fiber:

Acid: Good resistance to most of acids unless exposure is over 24 hours.

Alkalis: Good resistance to most of the alkalis, but some types of alkalis may damage the fiber.

Organic solvents: Offer resistance to dry cleaning solvents.

Bleaches: Can be degraded by sodium hypo-chloride. Chlorine bleach should not be used.

Dyeing: A full range of colors is available. Some types are more difficult to dye than others

Raw Materials:

A variety of raw materials are used to produce stretchable spandex fibers. This includes pre polymers which produce the backbone of the fiber, stabilizers which protect the integrity of the polymer, and colorants.

Two types of pre-polymers are reacted to produce the spandex fiber polymer back-bone. One is a flexible macro glycol while the other is a stiff di-isocyanate. The macro-glycol can be polyester, polyester, polycarbonate, polycaprolactone or some combination of these. These are long chain polymers, which have hydroxyl groups (-OH) on both ends. The important feature of these molecules is that they are long and flexible. This part of the spandex fiber is responsible for its stretching characteristic. The other pre-polymer used to produce spandex is a polymeric di-isocyanate. This is a shorter chain polymer, which has an isocyanate (-NCO) group on both ends. The principal characteristic of this molecule is its rigidity. In the fiber, this molecule provides strength.

Polyethylene

This corset-clad torso was produced by Jacob Kindliman of New York City in 1890. Kindliman, a corsetiere, hardly needed to advertise. At that time, women thought it was necessary to wear a corset and considered them indecently dressed without it until early in the twentieth century. Corsets were a combination brassiere-girdle-waist cincher in an all-in-one garment, forming the foundation shape for fashionable dress.

In days before spandex, how did the corset contour the body effectively? In the eighteenth century, thick quilting and stout seams on the corset shaped the body when the garment was tightly laced. In the early nineteenth century, baleen, a bony but bendable substance from the mouth of the baleen whale, was sewn into seams of the corset (hence the term whalebone corsets); however the late 1800s corsets like this were stiffened with small, thin strips of steel covered with fabric. Such steel-clad corsets did not permit movement or comfort. By World War I, American women began separating parts of the corset into two garments—the girdle (waist and hip shaper) and bandeau (softer band used to support and shape the breasts).

Manufacturing Process of Spandex:

Spandex fibers are manufactured in four different ways- melt extrusion, reaction spinning, solution dry spinning, and solution wet spinning. The initial step in all these methods is that of reacting monomers to produce a pre-polymer. Pre-polymer is then reacted further, in a variety of ways, and drawn out to produce a long fiber. The most commonly used method is the solution dry spinning that produces over 90% of the world's spandex fibers.

1. First of all pre-polymer is produced by mixing a macro glycol with a di-isocyanate monomer. They are mixed in a reaction vessel and need the perfect conditions so that they may react to form a pre-polymer. Ratio of the component materials is responsible for giving different characteristics to the fibers. As such the ratio is strictly controlled.

   The ideal ratio of glycol to di-isocyanate may be 1:2.

2. In the chain extension reaction, the pre-polymer is reacted with an equal amount of diamine. It results in a solution which is diluted with a solvent to produce the spinning solution. The solvent makes the solution thinner which can be easily handled. It can then be pumped into the fiber production cell

3. The fiber production cell, the polymer solution is pumped through a metal plate, called a spinneret, which has small holes throughout its structure. The solution gets aligned in strands of liquid polymer. The strands passing through the cell, are heated

in the presence of a nitrogen and solvent gas. The liquid polymer gets chemically reacted and forms into solid strands.

Specific amount of the solid strands are bundled together to produce the desired thickness with the help of a compressed air device that twists the fibers together. As such, it can be said that each fiber of spandex is made up of many smaller individual fibers that join one another due to the natural stickiness of their surface

4. Fibers are finally treated with textile finishing chemicals that can be magnesium stearate or other polymer such as poly(dimethyl-siloxane). These finishes prevent the fibers from sticking together and help in the process of textile manufacturing. Fibers are then transferred through a series of rollers onto a spool. The windup speed of the entire process depends on the thickness of the fibers that can be anywhere from 300500 mi (482.7-804.5 km) per minute
5. The spools with fiber, are put into final packaging and shipped to textile manufacturers or any other customers. The fibers here, may be blended with other fibers such as nylon or cotton fiber to produce the fabric that is used for clothing purposes. These fabrics can also be dyed in order to give a desired color to them

Uses of Spandex Fiber.

Garments where comfort and fit are desired: Hosiery, swimsuits, aerobic/exercise wear, ski pants, golf jackets, disposable diaper, waist bands, bra straps and bra side panels.

Compression garments: Surgical hose, support hose, bicycle pants, foundation garments

Microfiber

Microfiber or micro fiber is a synthetic fiber finer than one or 1.3 denier or decitex/thread. This is 1/100th the diameter of a human hair and 1/20th the diameter of a strand of silk. The most common types of microfibers are made from polyesters, polyamides (e.g., nylon, Kevlar, Nomex, trogamide), or a conjugation of polyester, polyamide, and polypropylene (Prolen). Micro fiber combines two basic fibers, Polyester and Polyamide (a Nylon byproduct). These fibers are usually “split” and formed into a woven fabric of 80% Polyester (the scrubbing and cleaning fiber), and 20% Polyamide (the absorbing and quick drying fiber).

These threads are very small in diameter making them super soft. Rated in denier, the unit for measuring fineness of fabric, a strand of cotton has a rating of 200. A human hair has a denier of 20 and a strand of silk has a denier of 8. Micro fiber has a denier of 0.01 to 0.02! At minimum, 100 times finer than a human hair. Softer than silk, yet bull-dog tough, split Microfiber cloth attracts dust, grime, oily films and salt residues like a magnet.

Micro fiber in front of a human hair

The unique surface structure of split microfiber cloth contains hundreds of thousands of micro fiber “hooks” per square inch! These micro-hooks grab, lift, and hold dust and grime without the need for cleaning solutions. Microfiber cloth can be used damp or dry. Used dry, Micro fiber cloth works like a chamois. The super absorbent weaves holds up to seven times its weight in fluid and will not scratch paint, glass, acrylics or plastic window tint films.

Characteristics of Microfiber

- In spite of very fine quality, micro fibers have exceptional strength.
- They are breathable fabrics.
- Comfort of micro fibers is similar to natural fibers.
- It is soft.
- They are very durable.
- They can be easily maintained and cared for.
- They retain their original shape.
- They are windproof and water resistant.
- They have good moisture wicking ability.
- Micro fiber has excellent drape.
- It is very light weight.

Properties of Microfiber

Microfibers are made solely from man-made fibers. They are the finest of all the fibers. Sportswear from microfibers functions particularly well. It is breathable and at the same time provides reliable protection against wind and rain. Fashionable apparels in microfibers have graceful flow, silk-like feel and are extremely comfortable. Microfiber clothing is not sensitive, retaining its positive qualities after washing or cleaning. General microfiber properties are point out below.

General Properties of Microfiber

- Ultra-fine linear density (less than 0.1 dtex/f), finer than the most delicate silk.
- Extremely drapeable and Durability.
- Very soft, luxurious hand with a silken or suede touch.
- Washable and dry-cleanable.

- Shrink resistance.
- High strength, although the filaments are super fine.
- Insulates well against wind, rain and cold.
- Anti-microbial agents help to protect both family members and work staff from the dangers of the bacteria that cause odor and mildew.
- Microfiber is hypoallergenic, and so does not create problems for those suffering from allergies.
- Microfibre is non-electrostatic.
- Microfibers are super-absorbent, absorbing over 7 times their weight in water.
- Microfiber dries in one-third of the time of ordinary fibers.
- Microfibers are environmentally friendly
- Improved breathability
- Vivid prints with more clarity and sharper contrast
- Appearance retention
- Can be made windproof and water resistant
- The greater fiber surface area also results in higher rates of dyeing at lower temperatures, and decreased fastness to light, crocking (fastness to rubbing), water and ozone

Texturizing

Texturizing processes were originally applied to synthetic fibres to reduce such characteristics as transparency, slipperiness, and the possibility of pilling (formation of small fibre tangles on a fabric surface). Texturizing processes make yarns more opaque, improve appearance and texture, and increase warmth and absorbency. Textured yarns are synthetic continuous filaments, modified to impart special texture and appearance. In the production of abraded yarns, the surfaces are roughened or cut at various intervals and given added twist and producing hairy effect

Types of Yarn Textures

Smooth Yarn

Smooth is the most common and versatile type of yarn texture. The most popular yarn fibers generally fall into this category, including merino wool, linen, cotton, and acrylic. Generally speaking, wool is the smoothest type of yarn.

Fuzzy Yarn

Fuzzy yarns are great for soft, warm projects like blankets, scarves, and big winter sweaters. However, they can be difficult to work with and some people find fuzzy textures irritating to their skin.

Chainette Yarn

Chainette yarn offers excellent stitch definition and stretchiness. The texture Is created by machine knitting lots of narrow plies into one single mesh strand, creating a very thin and lightweight yarn that is often combined with other materials.

Single Ply Yarn

The process of plying yarn locks the individual yarn fibers together, reducing fuzziness by limiting the number of loose hairs floating around.

Texturizing methods:

Texturizing methods includes false twist texturizing, edge crimping, stuffer box, knit-de-knit and air jet texturizing. In this article we will discuss false twisting, stuffer box, Halenca process and edge crimping method of texturing.

False twist texturizing method:

In a false twist texturizing machine, the passage of the multi- filament yarn is as: Feed roller- heating- cooling- twister- take up roller. Modified stretch yarn is obtained with 300% stretch. In this process a POY yarn is allowed to pass between two shafts. The POY yarn is then fed to the shaft one from which it is passed on the shaft two. When the yarn is fed to the machine it has to be drawn and twisted. Once the yarn is out of shaft one, it reaches a heater which heats the yarn at low temperature where it can be thermoset. Soon after that reaches s cooling system which cools the yarn at the low temperature so as to thermoset the twist. The twisting is carried out by friction device like a set of rotating discs there are different types like belts. To obtain a modified stretch yarn there is a need to follow some conditions. Firstly, pass it through a secondary heater with an overfeed and secondly, the temperature should be less than primary heater.

Stuffer box method:

In this process the filaments are stuffed in a confined space of a heater chamber which is called as a stuffer box. In the stuffer box, the filaments are heat set in their crimped from and then they are withdrawn. These yarns are soft, bulky and offer good absorption properties and have less extensibility. The amplitude and frequency of the crimp can be controlled but all the crimps will not be in the same size. The range of the stretch is in the same as that of the modified stretch yarn i.e., 100-150%

Edge crimping texturing method:

This method gives a stretch yarn. In this process a blunt knife edge is taken and the filament is drawn over the knife blunt edge. The knife edge could be heated or the filament could be heated. When we draw the filament over the knife edge the part of filament which is near the knife has to travel less distance than the filament in the outer edges. This result in stretching of outer filament in more amounts compared to that of filament near the edge. This is caused Due to phenomenon of bilateral compression and extension strain which develop crimps. The yarn obtained is helical in structure without twisting.

UNIT 3

YARN MANUFACTURING

Spinning and classification

INTRODUCTION

Spinning is an ancient textile art in which plant, animal or synthetic fibers are twisted together to form yarn (or thread, rope, or cable). For thousands of years, fiber was spun by hand using simple tools, the spindle and distaff. Only in the early Medieval era did the spinning wheel increase the output of individual spinners, and mass-production only arose in the 18th century with the beginnings of the Industrial Revolution. Hand-spinning remains a popular handicraft. The fabrication of yarn (thread) from either discontinuous natural fibers or bulk synthetic polymeric material. In a textile context the term spinning is applied to two different processes leading to the yarns used to make threads, cords, ropes, or woven or knitted textile products. History The earliest spinning probably involved simply twisting the fibers in the hand. Later a stick, called a spindle, was used to add the twist and hold the twisted fiber. Usually a whorl or weight stabilizes the spindle. The spindle is spun and twists the fiber until it becomes yarn. The spindle may be suspended or supported. Later the spinning wheel was developed which allowed continuous and faster yarn production. Spinning wheels may be foot, hand or electrically powered. The hand-turned spinning wheel called a charkha was prevalent in India and was used by Gandhi and his followers. Modern powered spinning, originally done by water or steam power but now done by electricity, is vastly faster than hand-spinning. New techniques including Open End spinning or rotor spinning can produce yarns at rates in excess of 40 meters per second per spinning head.

DEFINITION

Spinning is the art of producing continuous, twisted Strands, of a desire size, from f fibrous materials. In a broad sense, the term is used to include all the operations through which cotton fibers are passed until they become yarn. It is customary to speak of a “spinning mill” to distinguish it from a “weaving mill” or a <finishing plant=. In a narrow sense, spinning applies only to that operation which takes roving, further draws and twists it, and produces yarn.

Objects

1. **Mixing**

- The term mixing refers to the bringing together of two or more varieties of the same basic fibre

- For example, Egyptian cotton fibre combined with American cotton fibre, so that the final yarn remains 100% cotton

2. **Blending**

- Blending refers to the bringing together of fibres from different origins
- For example, wool and silk or cotton and polyester

3. **Cleaning and fibre separation**

- All bales of raw fibres contain a variety of impurities that need to be removed
- The first process is to divide and split the bales into smaller and smaller loose bunches, to remove dust, seeds and unwanted debris
- Some fibre types are then washed or scoured
- Others can be combed or carded to further separate and clean the fibres

4. **Fibre alignment**

- This process follows carding and combing
- Several slivers or groups of carded or combed fibres are combined to form a single sliver of straightened fibres
- The process is called drawing 5. Drafting and twisting
- Drafting is the process of gently drawing out the sliver to reduce it’s linear density or thickness
- Exactly how this is done and what machinery is used depends on the required yarn quality and count
- The final process is to insert the required amount of twist into the single yarn

CLASSIFICATION OF SPINNING

Spinning can be classified in two methods based on its yarn production technique.

1. Mechanical Spinning
2. Chemical Spinning

Mechanical Spinning Methods

- There are a large number of different spinning methods

- Here we will look at some of the most relevant,ring spun, rotor spun, twistless, wrap spun and core spun yarns

1. Ring spun yarns

- The most popular method of staple fibre yarn production
- The fibres are twisted around each other to give strength to the yarn

2. Rotor spun yarns

- Similar to ring spinning
- Generally rotor spun yarns are only made from short staple fibres
- Rotor spinning produces a more regular, smoother yarn than ring spinning
- Rotor spun yarn is weaker than ring spun

3. Twistless yarns

- Rather than being twisted, the fibres are held together by some form of adhesive
- The glued fibres are often laid over a continuous filament core

4. Wrap spun yarns

- The yarns are made from staple fibres bound by another yarn
- The binding yarn is usually a continuous man-made filament yarn
- They can be made from either short or long staple fibres

5. Core spun yarns

- Core spun yarns have a central core wrapped with staple fibres • They are produced in one operation at the time of spinning • For example, a cotton outer for handle and comfort, with a filament (often polyester) core for added strength, (lots of sewing threads) or cotton over an electrometric core (shirring)

Chemical spinning

The term spinning is also used for the production of monofilaments from synthetic polymers for example, polyamides or nylons, polyesters, and acrylics or modified natural polymers, such as cellulose-rayon.

These semi synthetic and fully synthetic fibres can be produced by the suitable following methods.

1. Dry spinning
2. Wet spinning
3. Melt spinning

MATERIALS USED

Yarn can be made from a wide variety of materials:

- Plant fibers: cotton, flax (to produce linen), bamboo, ramie, hemp, nettle, raffia, yucca, coconut husk, banana trees, and soy
- Animal fibers: wool, goat (angora, or cashmere goat), rabbit (angora), llama, alpaca, dog, cat, camel, yak, qiviut (from Musk Ox), and silk
- Synthetic fibers fibers: nylon, rayon (derived from wood pulp), acetate, polyester, tencel (derived from wood pulp), and ingeo (derived from corn)
- Mineral fibers: asbestos

COTTON SPINNING SYSTEM

Spinning is process of manufacturing cotton fibre into yarn. This includes the general operations of opening, picking, carding, drawing, roving and ring spinning in the production of the so called “carded yams”. For “combed yams”, three steps culminating in `combing' are included after the carding operation

1. Ginning

   Ginning is the process of separating the lint cotton from the seed.

2. Blending

A Process or processes concerned primarily with the mixing of various lots of fibres to produce a homogeneous mass. Blending is normally carried out to mix fibres, which may or may not be of similar physical or chemical properties, market values, or colours. Blending is also used to ensure consistency of end product.

3. Opening

Covers the initial treatments given to raw cotton. The separation and opening up of the cotton to remove compression because of baling and shipping. Heavier impurities are also removed from the stock

4. Picking

The final operation in the cotton system preparation line, in which the cotton flocks are opened mechanically, cleaned, and formed into a lap of specified mass per unit area, for feeding to a carding machine.

5. Carding

The process in yarn manufacture in which the fibres are brushed up, made more or less parallel have considerable portions of foreign matter removed, and are put into a manageable form known as sliver.

6. Drawing

Operations by which slivers are blended. Doubled. Or leveled, and by drafting reduced to a sliver or a roving suitable for spinning.

7. Combing

The straightening and parallelizing of fibres and the removal of short fibres and impurities by using a comb or combs assisted by brushes and rollers.

8. Roving

A loose assemblage of fibres drawn into a single strand, with very' little twist. It is an intermediate state between sliver and yarn.

9. Spinning

The final operation in cotton yarn manufacture. It completes the working of the cotton fibres into a commercial, fine, coherent yarn sufficiently twisted so that it is now ready for weaving purposes.

10. Doubling

The number of laps, slivers, slubbings. Or rovings fed simultaneously into a machine for drafting into a single end. Doubling is employed to promote blending and regularity.

11. Twisting

Process of combining two or more parallel single or ply yams by twisting together to produce a ply-yarn or cord. Ply yarns result from twisted single yarns and cords and cables from twisted ply yarns. Twisting is also employed to obtain greater strength and smoothness, increased uniformity in yarn

Comparison of carded and combed yarn

Difference between carded yarn and combed yarn:

No	Carded yarn	Combed yarn
1	The yarn which is obtained without combing is called carded yarn	The yarn which is obtained by combing is called combed yarn.
2	No need to use a lap former machine	Need lap former machine to form sliver into a lap.
3	3.Carded yarn is less uniform than combed yarn.	Combed yarn is more consistent than carded yarn
4	Carded yarn TPI is higher than combed yarn.	Combed yarn TPI is lower than carded yarn
5	Show less strength	Show more strength
6	Carded yarn is more hairy than combed yarn.	Combed yarn is less hairy than carded yarn
7	Less lustrous than combed yarn.	More lustrous than carded yarn.
8	The case of color fastness to rubbing, carded yarn show poor result than combed yarn	Case of color fastness to rubbing, combed yarn show a better result than carded yarn
9	Combing action is not done here	9.Combing action is done here.
10	The quality of the carded yarn is not better than the combed yarn.	The quality of the combed yarn is better than the carded yarn.
11	Carded yarn, the short fiber percentage is high.	Combed yarn, the short fiber percentage is low.
12	The carded yarn has a higher	Combed yarn has fewer
	amount of protruding ends.	amount of protruding ends.

13	Carded yarn is less expensive.	Combed yarn is more expensive
14	Here medium to low twist is used.	Here medium to high twist is used.
15	Less regular in size and appearance.	More regular in size and appearance

Yarn – Definition and classification- simple and fancy yarns.

INTRODUCTION

Yarn is a long continuous length of interlocked fibers, suitable for use in the production of textiles, sewing, crocheting, knitting, weaving, embroidery and rope making. Thread is a type of yarn intended for sewing by hand or machine. The characteristics of spun yarn depend, in part, on the amount of twist given to the fibers during spinning. A fairly high degree of twist produces strong yarn; a low twist produces softer, more lustrous yarn; and a very tight twist produces crepe yarn.

DEFINITION

Yarn consists of several strands of material twisted together. Each strand is, in turn, made of fibers, all shorter than the piece of yarn that they form. These short fibers are spun into longer filaments to make the yarn. Long continuous strands may only require additional twisting to make them into yarns

Types of Yarns

Staple (spun) yarn -made from short, staple fibers that must be held together by some means (usually twisting) in order to be formed into a long, continuous yarn. Natural fibers except silk are staple fibers; manufactured fibers and silk are usually filament but can be cut into staple lengths. Filament - made from long, continuous strands of fiber. (May be monofilament or multifilament). Silk and manufactured fibers come in filament form.

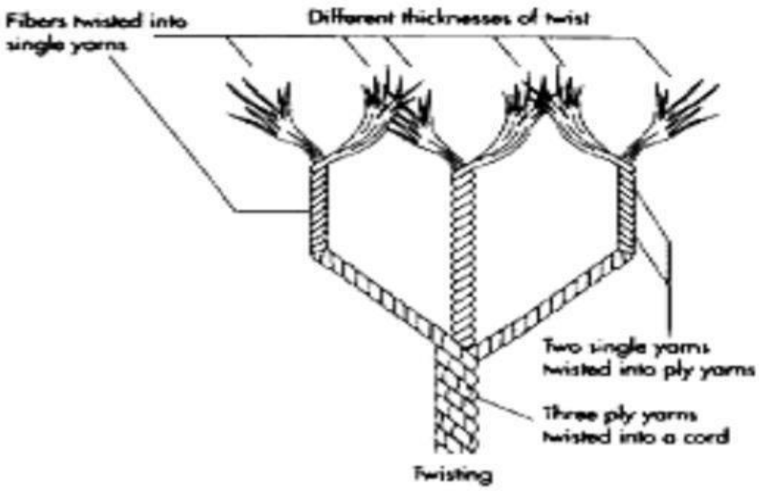
CLASSIFICATION OF YARN

Yarns are also classified by their number of parts.

- Single yarn – made from a group of filaments or staple fibers twisted together; if untwisted, it will separate into the individual fibers

- Ply yarn – (Fig 11.1)two or more single yarns are twisted together to make a single yarn; if untwisted, it will separate into the single yarns which will separate into individual fibers

- Cord yarn –(Fig 11.2) two or more ply yarns are twisted together; if untwisted, it will separate into the plied yarns which will then separate into single yarns which will separate into individual fibers.
- Novelty (fancy, complex) yarns – yarns that have a decorative effect; not uniform in size and appearance.
- Core-spun yarns - yarns that have a central core of one fiber around which is wrapped or twisted an exterior layer of



Yarn Twist Direction of twist (Fig 11.3) When fibers are twisted to make a yarn, they are twisted to the right or left. This twisting is called S or Z twist. Most yarns are made with a Z twist. The direction of twist does not usually affect the characteristics of the yarn or fabric

Fig 11.3 Z- and S-twist yarn Twists per inch The number of twists per inch can, in plied yarns, be determined by counting the number of bumps in one inch, and divide by the number of singles (the strands plied together to make the yarn). In the industry the number of twists per inch is calculated as:

TPI= T.M. *

- Where, T.M. is Twist multiplier or K (twist factor).
- Twist factor has been established by experiments and practice that the maximum strength of a yarn is obtained for a definite value of K.

Amount of twist

Twist is needed in yarn to hold the fibers together, and is added in both the spinning and plying processes. The amount of twist varies on the fiber, thickness of yarn, preparation of fiber, manner of spinning, and the desired result. Fine wool and silk generally use more twist than coarse wool, short staples more than long, thin more than thick, and short drawn more than long drawn. The amount of twist in a yarn helps to define the style of yarn- a yarn with a lot of air such as a woolen yarn will have much less twist than a yarn with little air, like a worsted yarn. It also affects the stretchiness of the yarn, strength, the halo of the yarn, and many other attributes. Filling or weft yarns usually have fewer twists per inch because strength is not as important as with warp yarns, and highly twisted yarns are, in general, stronger. Warp yarns have to be stronger so that they can withstand the tension of the loom.

The amount of twist affects the characteristics and properties of a yarn including appearance, behavior and durability.

- Generally, higher twist creates yarns that are Stronger

  More firms Smaller in diameter Smoother Resistant to snagging and abrasion Resilient Good conductors of heat

- Generally, lower twist creates yarns that are Weaker Softer Larger in diameter Fuzzy

  Prone to snag and abrade Crush easily Resistant to heat transfer Filament yarns often have little or no twist because they are continuous and strong; the fibers will not break or separate from the yarn as easily as spun (staple) yarns

COMPLEX (FANCY, NOVELTY) YARNS

- Complex yarns are made to create decorative effects in the fabrics into which they are woven.
- Usually weaker than simple yarns.
- Usually woven into the filling direction of the fabric.
- Yarns usually exhibit more snagging and wear.

- These are yarns that differ from normal yarns, in appearance, texture and handle
- They constitute a vast range of types, many specifically designed for hand knitters Novelty yarns can be further split into two categories, fancy and metallic yarn. Fancy yarns
- Fancy yarns can be made from staple or filament fibres.
- They are intentional produced to have a distorted or irregular construction.
- Popular effects include knops, snarls, loops and slubs. Metallic yarns
- Usually produced from aluminium sheets laminated with plastic film, cut into thin ribbons.
- Or can be core spun, for example a polyester core with a metallic outer.

Main parts of fancy yarn:

There are three main parts are involved in the fancy yarn.

1. Core (ground) yarn
2. Effect yarn
3. Binder yarn

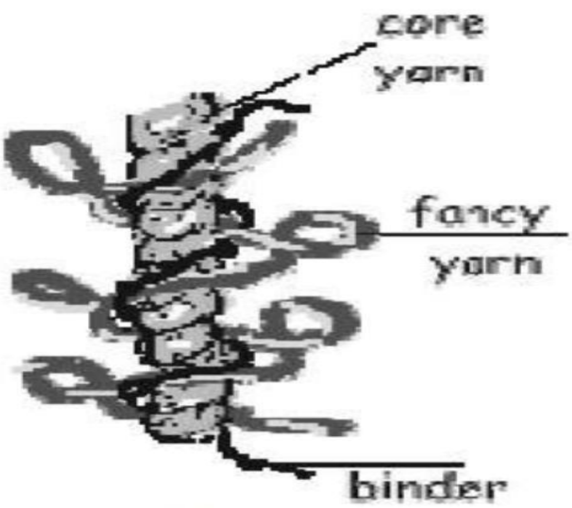


Fig 11.4

- Novelty, fancy and decorative yarns are used in both woven and knitted fabrics.
- Knots, snarls, loops and other irregularities can be introduced to create textured surface effects
- Fancy yarns usually have a base or core yarn which is a conventional plain yarn, this yarn is combined with the effect yarn shown in Fig 11.4
- The effect yarn can be held in place with a binding yarn 11.4.2

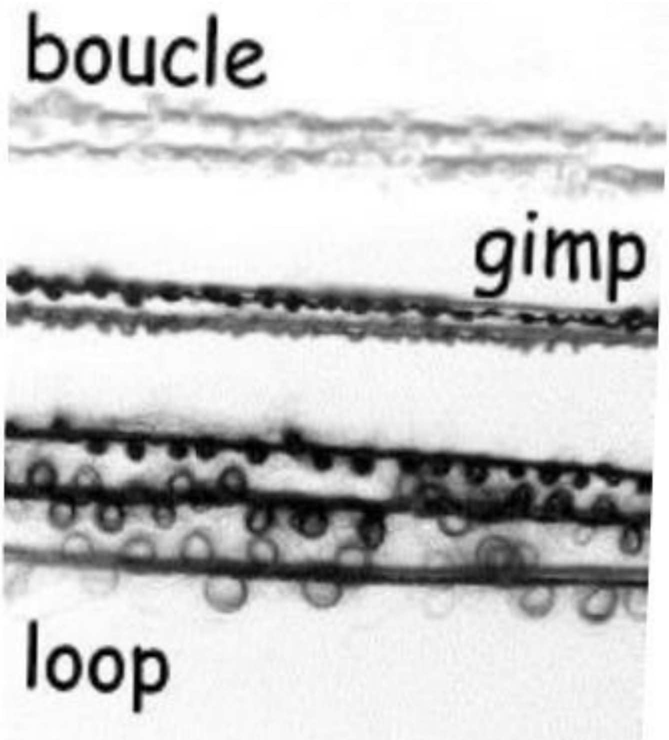
Types of Fancy Yarn

There are many types of fancy, novelty and decorative yarns produced. They can be produced in many ways. • Different coloured fibres can be blended together then spun as one yarn.

- Colour can be applied by printing or dyeing pattern onto roving or yarn.
- Spots of coloured fibre can be twisted in with the base yarn.
- Two or more threads of different, softness, thickness, weight, colour or fibre content can be twisted together
- Raised textures can be introduced by controlling the amount and direction of twist.
- Fancy yarns can be natural or man-made or a combination of both.

1. Boucle, gimp and loop yarns

These yarns are made by feeding one or more effect yarns faster than the core yarn while spinning



Boucle has a hard twisted core yarn, the effect yarn is rapidly twisted round the core so that excess yarn forms an irregular wavy, bumpy surface

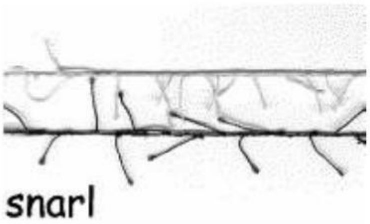
- Gimp is much the same as boucle, but the excess yarn forms a more regular surface
- Loop yarn is the result of the excess soft spun yarn being formed into well shaped circular loops on the hard spun core

2. Snarl yarns

• Snarl yarns are made in a similar way to loop yarns

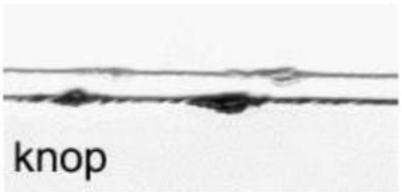
• Except the effect yarn has a high, lively twist, so that the excess bits snarl and double up on themselves and twist together

Just like the lengths of cord we make on a door-knob.



3. Knop or button yarns

- These yarns are also made by feeding the yarns at different rates while spinning
- But this time the excess yarn of one or more of the components forms bunches
- These can be at regular or irregular intervals

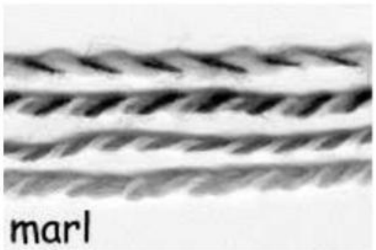


4. Slub yarns

- Slub yarn is characterised by having, alternating short places of thin, firm twist yarn, with places of very thick, loose twist yarn
- The different areas can be at regular or irregular intervals

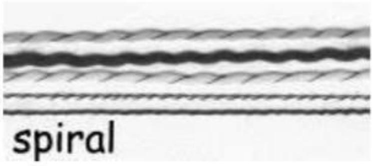
5. Marl yarns

- Marl yarns are made by twistng together two or more ends of different coloured yarns
- The effect pattern is one of regular diagonal stripes of each colour

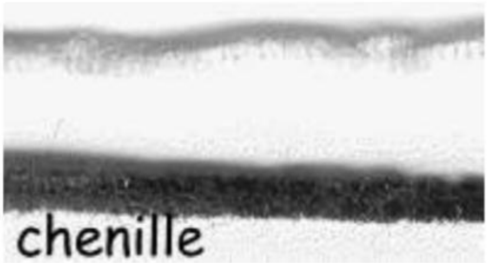


6. Spiral and corkscrew yarns

- These are plied yarns where one yarn wraps around the other, rather than the yarns being twisted together
- A spiral yarn has a higher twist than a corkscrew yarn
- A spiral yarn usually has a thinner yarn wrapped round a thicker core
- A corkscrew yarn has a softer bulkyer yarn wrapped round a thin, firm yarn



6. Chenille yarns



- Chenille yarns have a soft, fuzzy cut pile which is bound to a core
- These yarns can be spun, but the machinery required is much specialized
- For this reason, these yarns are usually woven on a loom
- The effect yarn forms the warp, which is bound by a weft thread
- The weft thread is spaced out at a distance of twice the required length of pile
- The warp is then cut half way between each weft thread.

SEWING THREAD

Sewing thread is found everywhere, in common apparel, home furnishing, sportswear and shoes, in automotive items like air bags and seat belts as well as in various other technical applications. The sewing seam performances of the sewing thread are influenced by material to be sewn, sewing techniques and the end use desired.

Sewing thread functions

Sewing thread covers two main functions; the most important is obviously joining the different fabrics and give the product the necessary strength in the area of its highest stress – the invisible seams. The second function is refining products with decorative stitching. In both cases one thing is often underestimated: Sewing Thread may account only for 0,5% of fiber amount within a garment, however, it shares fairly more than 50% of responsibility for the final quality of a garment.

The requirements can be defined as:

- The ability of sewing thread to meet functional requirements of producing desired seam effectively. • Ability to provide desired aesthetics and serviceability in the seam
- Cost of the sewing thread and that of resultant seam.
  - o Sewing thread availably Sewing thread is available as:
- Spun yarn (Cotton or PES spun)
- Core spun (PES/Cotton; Poly/Poly)
- Flat filament threads (PES, Nylon, etc.)
- Textured filament (Draw-textured or air-textured)
  - o Special threads mainly for technical applications

Functional requirements tensile properties:

1. Sewing thread should have high tenacity with moderate tension. For better loop formation characteristics, the elastic modulus of the sewing thread should be high. Friction: There should be uniformity of friction over long length. Factors are responsible for giving maximum possible tension fluctuation of the yarn components in the cross section and the length. Passage through needle eye: There should be no sudden shocks when thread passes through the eye of the needle. Needle temperature is critical for sewing thread of man made fibres. Free from knots and faults: Sewing thread should be free from knots and faults to give smooth performance.
2. Serviceability during sewing, threads are subjected to abrasion over needles and fabric threads. There is a lose of strength during and after sewing during fabric use. Sewing thread should have high abrasion resistance so that lose strength is minimum. For a good serviceability, seam must be firm. A seam strength test could be performed. Different stitches are applied to different application. Fabric properties affect seam strength along with loop and abrasion strength of sewing thread and the amount damage due to sewing. To avoid puckering of garments around the seams, the thread shrinkage should be generally less then 2% during washing

3. Aesthetic Colour, shade, luster, smoothness, fitness are some of aesthetic related characteristics of sewing threads. Certain amount of hairiness in sewing thread has to positive effect on sewing but this effect has to be sacrificed for appearance. There is a tendency to use dyed sewing thread for appearance.

4. Cost consideration From the raw material aspect, sewing thread of natural silk is expensive. A higher melting sewing thread may be expensive. But, it should have a judicious use in the sense that the fabric for which it is used should also have a high melting points as the hot needles not only attack the sewing thread but the fabric also.

5. Other sewing thread properties In addition to the essential properties, some of the applications may be required for sewing threads to have special properties like, resistance to flexing in seams in shoes, discontinuous surface to provide grip and avoid slippage in the seam for high seam strength applications

Manufacturing Process of Sewing thread – cotton and synthetic

Cotton Yarn Manufacturing Processes

Cotton accounts for almost 50 % of the worldwide consumption of textile fibre. China, the United States, the Russian Federation, India and Japan are the major cotton-consuming countries. Consumption is measured by the amount of raw cotton fibre purchased and used to manufacture textile materials. Worldwide cotton production is annually about 80 to 90 million bales (17.4 to 19.6 billion kg). China, the United States, India, Pakistan and Uzbekistan are the major cotton-producing countries, accounting for over 70% of world cotton production. The rest is produced by about 75 other countries. Raw cotton is exported from about 57 countries and cotton textiles from about 65 countries. Many countries emphasize domestic production to reduce their reliance on imports. Yarn manufacturing is a sequence of processes that convert raw cotton fibres into yarn suitable for use in various end products. A number of processes are required to obtain the clean, strong, uniform yarns required in modern textile markets. Beginning with a dense package of tangled fibres (cotton bale) containing varying amounts of non-lint materials and unusable fibre (foreign matter, plant trash, motes and so on), continuous operations of opening, blending, mixing, cleaning, carding, drawing, roving and spinning are performed to transform the cotton fibres into yarn.

Even though the current manufacturing processes are highly developed, competitive pressure continues to spur industry groups and individuals to seek new, more efficient methods and machines for processing cotton which, one day, may supplant today's systems. However, for the foreseeable future, the current conventional systems of blending, carding, drawing, roving and spinning will continue to be used. Only the cotton picking process seems clearly destined for elimination in the near future. Yarn manufacturing produces yarns for various woven or knitted end-products (e.g., apparel or industrial fabrics) and for sewing thread and cordage. Yarns are produced with different diameters and different weights per unit length. While the basic yarn manufacturing process has remained unchanged for a number of years, processing speeds, control technology and package sizes have increased. Yarn properties and processing efficiency are related to the properties of the cotton fibres processed. End-use properties of the yarn are also a function of processing conditions.

Opening, blending, mixing and cleaning

Typically, mills select bale mixes with the properties needed to produce yarn for a specific end-use. The number of bales used by different mills in each mix ranges from 6 or 12 to over 50. Processing begins when the bales to be mixed are brought to the opening room, where bagging and ties are removed. Layers of cotton are removed from the bales by hand and placed in feeders equipped with conveyors studded with spiked teeth, or entire bales are placed on platforms which move them back and forth under or over a plucking mechanism. The aim is to begin the sequential production process by converting the compacted layers of baled cotton into small, light, fluffy tufts that will facilitate the removal of foreign matter. This initial process is referred to as opening. Since bales arrive at the mill In various degrees of density, it is common for bale ties to be cut approximately 24 hours before the bales are to be processed, in order to allow them to “bloom”. This enhances opening and helps regulate the feeding rate. The cleaning machines in mills perform the functions of opening and first level cleaning.

Carding and combing

The card is the most important machine in the yarn manufacturing process. It performs second- and final-level cleaning functions in an overwhelming majority of cotton textile mills. The card is composed of a system of three wire-covered cylinders and a series of flat, wire-covered bars that successively work small clumps and tufts of fibres into a high degree of separation or openness, remove a very high percentage of trash and other foreign matter, collect the fibres into a rope-like form called a “sliver” and deliver this sliver in a container for use in the subsequent process. Historically, cotton has been fed to the card in the form of a “picker lap”, which is formed on a “picker”, a combination of feed rolls and beaters with a mechanism made up of cylindrical screens on which opened tufts of cotton are collected and rolled into a batt (see figure 89.5). The batt is removed from the screens in an even, flat sheet and then is rolled into a lap. However, labour requirements and the availability of automated handling systems with the potential for improved quality are contributing to the obsolescence of the picker.

Elimination of the picking process has been made possible by the installation of more efficient opening and cleaning equipment and chute-feed systems on the cards. The latter distribute opened and cleaned tufts of fibres to cards pneumatically through ducts. This action contributes to processing consistency and improved quality and reduces the number of workers required. A small number of mills produce combed yarn, the cleanest and most uniform cotton yarn. Combing provides more extensive cleaning than is provided by the card. The purpose of combing is to remove short fibres, neps and trash so that the resulting sliver is very clean and lustrous. The comber is a complicated machine composed of grooved feed rolls and a cylinder that is partially covered with needles to comb out short fibres.

Drawing and roving

Drawing is the first process in yarn manufacturing that employs roller drafting. In drawing, practically all draft results from the action of rollers. Containers of sliver from the carding process are staked in the creel of the drawing frame. Drafting occurs when a sliver is fed into a system of paired rollers moving at different speeds. Drawing straightens the fibres in the sliver by drafting to make more of the fibres parallel to the axis of the sliver. Parallelization is necessary to obtain the properties desired when the fibres are subsequently twisted into yarn. Drawing also produces a sliver that is more uniform in weight per unit of length and helps to achieve greater blending capabilities.

The fibres that are produced by the final drawing process, called finisher drawing, are nearly straight and parallel to the axis of the sliver. Weight per unit length of a finisher-drawing sliver is too high to permit drafting into yarn on conventional ring-spinning systems. The roving process reduces the weight of the sliver to a suitable size for spinning into yarn and inserting twist, which maintains the integrity of the draft strands. Cans of slivers from finisher drawing or combing are placed in the creel, and individual slivers are fed through two sets of rollers, the second of which rotates faster, thus reducing the size of the sliver from about 2.5 cm in diameter to that of the diameter of a standard pencil. Twist is imparted to the fibres by passing the bundle of fibres through a roving flyer. The product is now called roving, which is packaged on a bobbin about 37.5 cm long with a diameter of about 14 cm

Spinning

Spinning is the single most costly step in converting cotton fibres to yarn. Currently, over 85% of the world’s yarn is produced on ring-spinning frames, which are designed to draft the roving into the desired yarn size, or count, and to impart the desired amount of twist. The amount of twist is proportional to the strength of the yarn. The ratio of the length to the length fed can vary on the order of 10 to 50. Bobbins of roving are placed onto holders that allow the roving to feed freely into the drafting roller of the ring-spinning frame. Following the drafting zone, the yarn passes through a traveller onto a spinning bobbin. The spindle holding this bobbin rotates at high speed, causing the yarn to balloon as twist is imparted.

The lengths of yarn on the bobbins are too short for use in subsequent processes and are doffed into spinning boxes and delivered to the next process, which may be spooling or winding. In the modern production of heavier or coarse yarns, open-end spinning is replacing ring spinning. A sliver of fibres is fed into a high-speed rotor. Here the centrifugal force converts the fibres into yarns. There is no need for the bobbin, and the yarn is taken up on the package required by the next step in the process. Considerable research and development efforts are being devoted to radical new methods of yarn production.

Number of new spinning systems currently under development may revolutionize yarn manufacturing and could cause changes in the relative importance of fibre properties as they are now perceived. In general, four of the different approaches used in the new systems appear practical for use on cotton. Core-spun systems are currently in use to produce a variety of specialty yarns and sewing threads. Twist less yarns have been produced commercially on a limited basis by a system that bonds the fibres together with a polyvinyl alcohol or some other bonding agent. The twist less yarn system offers potentially high production rates and very uniform yarns. Knit and other apparel fabrics from twist less yarn have excellent appearance. In air-vortex spinning, currently under study by several machinery manufacturers, drawing sliver is presented to an opening roller, similar to rotor spinning. Air vortex spinning is capable of very high production speeds, but prototype models are particularly sensitive to fibre length variations and foreign matter content such as trash particles.

Winding and spooling

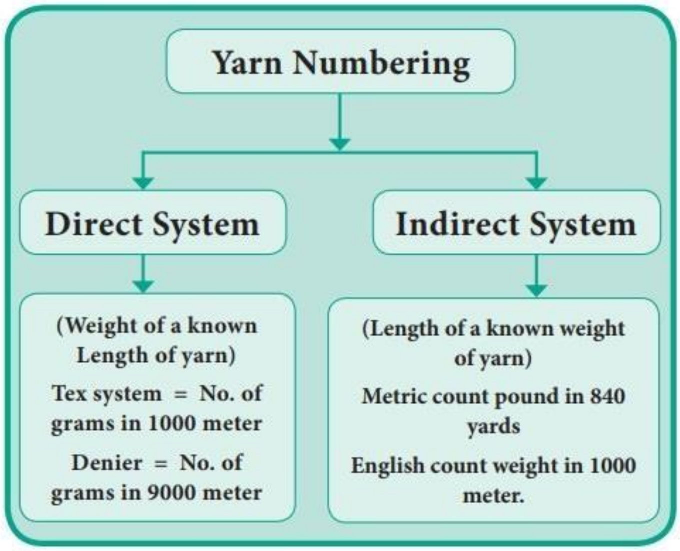
Once the yarn is spun, the manufacturers must prepare a correct package. The type of package depends on whether the yarn will be used for weaving or knitting. Winding, spooling, twisting and quilling are considered preparatory steps for weaving and knitting yarn. In general, the product of spooling will be used as warp yarns (the yarns that run lengthwise in woven fabric) and the product of winding will be used as filling yarns, or weft yarns (the yarns that run across the fabric). The products from open-end spinning by-pass these steps and are packaged for either the filling or warp. Twisting produces ply yarns, where two or more yarns are twisted together before further processing. In the quilling process yarn is wound onto small bobbins, small enough to fit inside the shuttle of a box loom. Sometimes the quilling process takes place at the loom. (See also the article “Weaving and knitting” in this chapter.

Waste handling

In modern textile mills where control of dust is important, the handling of waste is given greater emphasis. In classical textile operations, waste was collected manually and delivered to a “waste house” if it could not be recycled into the system. Here it was accumulated until there was enough of one type to make a bale. In the present state of the art, central vacuum systems automatically return waste from opening, picking, carding, drawing and roving. The central vacuum system is used for cleaning of machinery, automatically collecting waste from under machinery such as fly and motes from carding, and for returning unusable floor sweeps and wastes from filter condensers. The classical baler is a vertical upstroke press which still forms a typical 227-kg bale. In modern waste house technology, wastes are accumulated from the central vacuum system in a receiving tank which feeds a horizontal bale press. The various waste products of the yarn manufacturing industry can be recycled or reused by other industries. For example, spinning can be used in the waste spinning industry to make mop yarns, garnetting can be used in the cotton batting industry to make batting for mattresses or upholstered furnitures.

YARN NUMBERING SYSTEM

Yarn numbering system defines the relationship between the length and weight of the yarn. It can be classified into two types namely direct and indirect system.



Yarns.

Yarn Numbering System:

There are two types of yarn numbering system.

1. Direct system
2. Indirect system

1. **Direct system:**

It is used for the measurement of linear density that is the weight per unit length of yarn. In this yarn numbering system yarn length is kept constant and weight is variable. Here count is calculated by measuring weight of fixed/definite length. Tex, Denier and pounds/spindle are the name of direct system yarn count.

2. **Indirect system:**

It is used for the measurement of length per unit weight of the yarn. In this system, weight is kept constant while length is variable. The indirect system, yarn thickness and yarn number are inversely proportional. This means that as the yarn count increases the yarn weight decreases and hence yarn becomes finer.

The indirect system is also known as English system of counting. Here count is calculated by measuring length of a fixed/definite weight. English (Ne), Metric (Nm), woolen and worsted are the name of indirect system yarn count.

Denier

Denier is the weight in grams of 9000 meters of the material.

Tex System

The Tex number is de ned as the weight in grams of one thousand meters of the material.

UNIT: IV

WEAVING MECHANISM

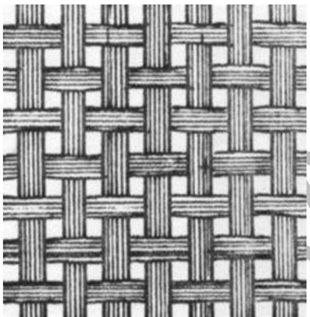
Methods of Fabric Formation

We derive the word textile from the Latin word, “texere”, which means “to weave”. It is one of the different ways of producing or “forming” textile fabrics. After the intensive process of producing the material, from livestock that provides cotton, wool, or silk, to even chemists that create fabric through chemical means, the fibre is converted to yarn and is dyed, when it is finally ready for fabric formation.

Weaving, knitting, braiding, tufting, and bonding are the most widely used fabric-making techniques. Let’s look at each of these, including the difference between weaving and knitting!

Weaving

Weaving, two separate sets of yarn (called “warp” and “weft”) are interlaced together to form the fabric. Usually, a loom is used to weave these together. It holds the warp thread in place and weaves the surrounding weft, and both are held at right angles with each other. The fabric types used for weaving are cotton, wool, silk, and even nylon. There are three types of weaves used: plain weave, satin weave, and twill weave. A single weft thread is referred to as a pick, while a single warp thread is called an end.



Knitting fabric

Knitting fabric is not the same as weaving. In woven fabric, strands are sewn at right angles with each other. Under knitting, one yarn strand is interlocked with another, into rows and columns (called, courses and wales respectively). You have surely seen your grandmother knit sweaters or socks.

Knitted fabric is used to make sweaters, hosiery, and underwear/lingerie. The advantages of knitted fabric over woven are that they are more stretchable, which allows comfort and fitness. The pattern of the fabric traps air such that knitted fabric is warmer, and absorbent too. Knitted fabrics, however, are quick to unravel. If even one loop unravels, then the entire fabric falls apart. Knitted fabrics are also prone to shrinking.

The two types of knitting used are weft knitting and warp knitting.

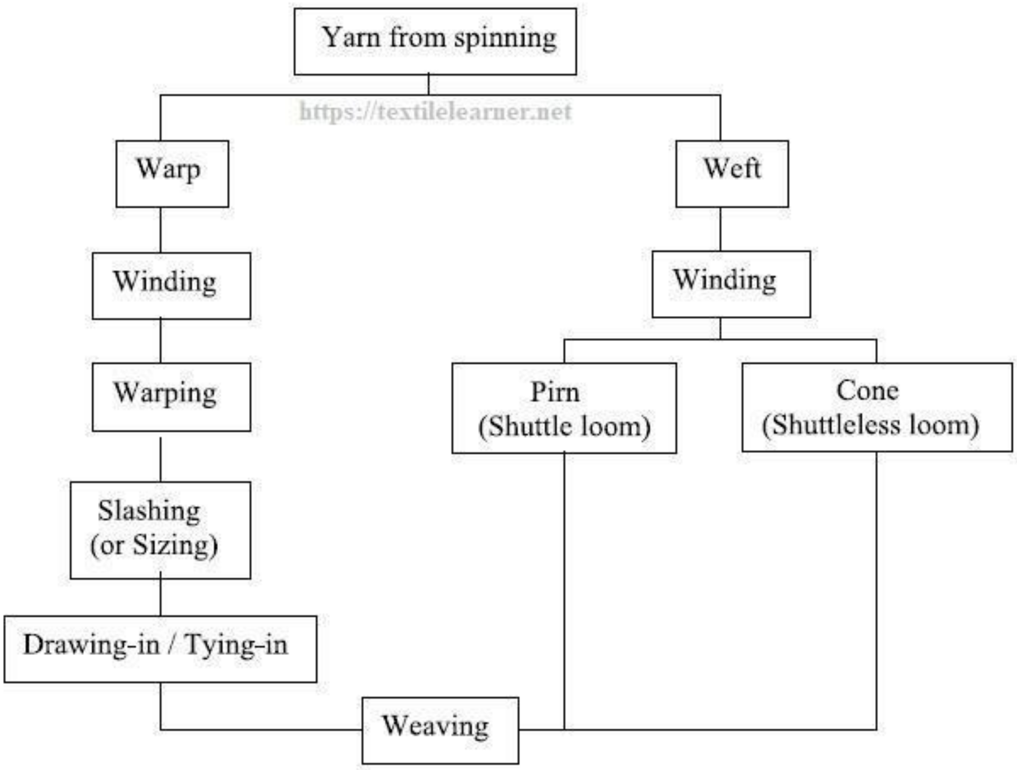
Other methods:

Braiding- One of the simplest ways of fabric formation, it is the process of diagonally interlacing yarn. There are two sets of yarn, and they both move in different directions. Of course, there can be more than the complexity of the fabric increases.

Tufting- Used mostly in the procedure of manufacturing carpets, it is when the fabric is sewn along a hard-backed fabric. The loops of thread are arranged in vertical and horizontal columns

Bonding- This one is interesting. Chemical bonding methods are used to bind polymers, fibres, yarns, or filaments into porous and flexible structures.

Weaving Preparatory Flow Chart Yarn Production



Weaving preparatory process:

Weaving is the most popular technique of fabric manufacturing. In case of weaving, two sets of yarn are required to produce a fabric. One is warp, which runs along the length of the fabric and the other is weft, which runs along the width of the fabric. Warp yarns are usually stronger and more compact than the weft or filling yarns. Yarns as manufactured and packaged are not actually suitable for direct use to form fabrics. It is necessary to prepare it to be handled efficiently during fabric formation. Thanks to the technique of weaving, the warp yarns are subjected to much higher stresses because of the more rigorous treatments meted out to them than the weft yarns in a weaving machine.

In order to make the warp yarns aptly prepared for that, they require extra and more elaborate preparation. The weft yarns in contrast, are subjected to far less stresses in any type of weaving system and are thus, easily prepared for the weaving process. Moreover, the feed package of weft yarn for weaving, pin or cone, is made from the single yarn whereas, the warp beam is made from a few thousand warp ends Therefore, the preparations of the warp and weft yarns for weaving are significantly different and the preparation of warp beam demands more precise and uniform control of tension of all the constituent warp yarns. Figure-1 indicates the process flow chart for preparation of the warp and weft yarns for weaving.

With the advent of new methods of spinning viz. open-end, air-jet and friction spinning, the spun yarns are wound on large packages. In such cases the packages of weft yarns may not be required to be prepared further and are taken straight to the weaving process with shuttle less looms.

There are three main steps of weaving preparatory process:

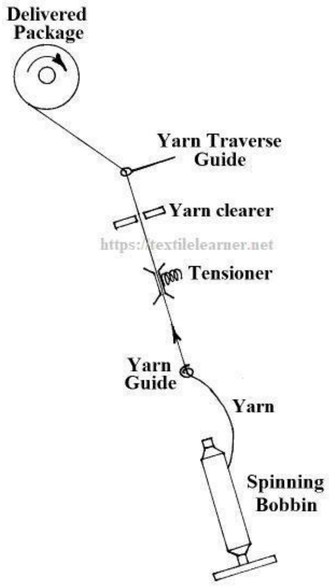
Winding

Warping Sizing

Without these process Drawing-in and Tying-in are also done in weaving process.

Winding process:

The first stage of weaving preparatory process is winding, where the yarn, warp or weft spun in the spinning process is wound to make a suitable package for the next processing. The yarn from the spinner's package called ring tube or bobbin, produced in the ring spinning, is transferred into a cheese, cone or spool depending on the requirement at the next stage of processing. Winding is, thus, primarily the transfer of yarn from one form of package to another but, under proper tension and in proper manner, as illustrated



Objects of winding:

To transfer yarn from one package to another suitable package, this can be conveniently used for used for weaving process.

To increase the efficiency of yarn for the next processes.

Removing objectionable faults present in yarn contained in the supply package like hairiness, naps, slabs, foreign matters.

To clean yarn.

To increase the quality of yarn.

To get a suitable package.

It is used to reduce end breakage.

To store the yarn.

Building a package of suitable dimensions compatible with the downstream processes.

The fundamental difference between weft winding for shuttle loom and warp winding is the relative sizes of the feed and delivered packages. In case of weft winding a fairly large feed package like cheese or cone is used to produce a comparatively small delivered package like pirn, while in case of the other, the feed package, ring tube or bobbin is very much smaller than the delivered package, cheese or cone. However, if the delivered package of weft is made for shuttle less looms, then the large package like cone is used straightway.

Warping process:

After finishing the yarn winding, selected cones are transported to next process, i.e. warping. Warping is an essential weaving preparatory process in weaving mill. This is a very common say about warping, "good warping finishes fifty percent weaving."

Indicated in Figure-1, while the preparation of weft for shuttle looms ends with pirn winding after the normal winding, preparation of warp proceeds to warping following winding. From here onwards, many warp ends are processed together to produce a warp package in the form of a beam, which in warping is the warpers' beam. Each warpers' beam is required to contain as much yarn as possible and hence, each beam has to be prepared hard and compact (except however, those for dyeing). Although any type of yarn package can be used on the creel of the warping machine, the cone is the most suitable for high speed operation because of the reasons stated earlier.

Objectives of warping:

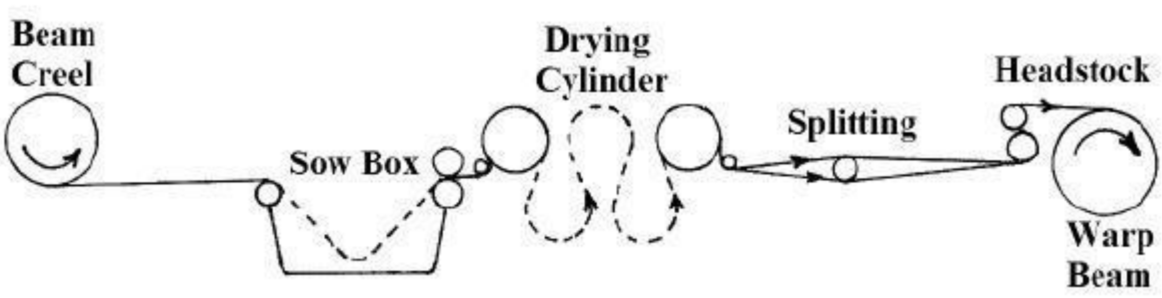
The major objective of warping is to prepare a warp sheet of desired length containing a desired number of yarns that are wrapped on a flanged barrel in such a manner that tension in each yarn and density of yarn mass in the cylindrical assembly are maintained within a given tolerance level throughout the wrapping of the warp beam which can be used for sizing or next process. The process of warping is dedicated to the conversion of cones into a beam of given specifications.

Sizing or slashing process:

Warp yarns are used to supply on looms where warp threads are subjected to repeatedly occurring various stresses like cyclic strain, flexing, and abrasion. These unavoidable stresses cause frequent warp breaks which consequent in the form of loom stoppages and finally, efficiency loss and fabric faults come in account. To minimize these problems, warp yarns are needed to be sized.

Warp yarn sizing is an essential process to coat warp yarns with elastic film and bind fibers of yarns and lowering fluff or hairiness so that the yarns may become so strong that they can resist the mechanical strain in weaving process, and/or maintain or improve weaving efficiency. In other words, sizing is done to provide a protective coating and to lubricate the surface of the yarn to enable it to withstand the abrasive action which occurs in the weaving process. These facts define that the sizing process is very important for a successful woven fabric manufacturing.

Final preparation of the warp beam for weaving is carried out in slashing or sizing process. Depending on the total number of warp ends required for weaving, one warp beam is prepared from a number of warpers' beam. Although many of the faults of the warp yarns are removed mainly at winding and perhaps to some extent at warping and the qualities of the yarns are thus much improved, the yarns are not yet good enough to withstand the rigorous abrasive actions at weaving. This is taken care of at slashing or sizing, where the abrasion resistance of the yarns in addition to their strength is increased and their hairiness is reduced by applying a protective coating that is, size, on them. Slashing process consists of five main working zones as indicated in simple diagrammatic form in Figure-3.



Objectives of sizing:

The main objective of sizing is to form a uniform layer of protective coating over warp yarn and lay down protruding fibers that project out of its surface

Other objectives of sizing are as follows:

To increase the strength of yarn

To get the required number of ends

To cover the hairiness of yarn

To make yarn surface smooth and pliable.

To maintain flexibility in yarn

Drawing-in and Tying-in:

Drawing-in is the process of providing each end with a drop wire, a heddle in the proper harness and a dent in the reed. In short it is the process of threading each end through the drop wire, heddles and the reed.

Tying-in is merely the cutting-off of the old warp and the end-to-end tying of the yarns from the new beam to the corresponding warp yarns already in place on the loom. This operation generally occurs at the loom. When the mill is producing long runs of the same fabric, tyingin is most prevalent.

Weaving preparatory process plays major roles in achieving the desired performance at weaving. Ultimate packages of warp and weft yarns prepared at these stages are used as the feed materials for looms, where the yarns are unwound during the course of weaving. How best the yarns can be unwound from their respective packages depend on how best the packages have been prepared at the various preparatory processes. Requisite shape and size of a yarn package needed for a given type of loom can be prepared if the yarn is wound under optimum tension with as little variation as possible. Too low winding tension will result in soft packages and cause irregular withdrawal of the yarns while, too high winding tension will destroy much of the extensibility of the yarn and make the yarn vulnerable to breakage. The qualities of the feed materials for weaving have become even more stringent after the introduction of the high speed shuttle less weaving machines, which with relatively small depth of shed, demand greater uniformity in tension of all the warp yarns and smooth withdrawal of the weft yarn from its package for faultless insertion. It may therefore, be said that properly prepared warp beams and weft packages assure half the desired performance of a loom.

Primary, secondary, auxiliary motion of a loom

Motion of a loom

Machines called looms are used to weave cloth. To weave a fabric, they are intended to interlace two sets of threads at right angles. A variety of motions must be used throughout the weaving process in order to create the required cloth. Primary motion, secondary motion, and auxiliary motion are three main categories into which these motions might be divided. We shall go into great depth about these motions in this essay.

Primary Motion

The motion that drives the warp threads, which are the strands that run longitudinally across the cloth, is the main motion of a loom. The shed, or the gap between the warp strands through which the weft yarns, which run transverse across the fabric, are passed, is a result of this action. The weft threads are beaten up by the main action, which involves pressing the freshly inserted weft yarns up against the previously woven fabric.

Usually, a loom’s main motion is produced by the operation of the cam or dobby mechanism. A number of cams, which are formed bits of metal or plastic that are attached on a revolving shaft, make up the cam mechanism. The cams press against various loom components as the shaft rotates, lifting and lowering the warp yarns in a certain order to produce the shed.

The warp yarns are managed by a sequence of hooks and levers in the dobby mechanism, in contrast. The dobby mechanism is more costly and complex than the cam mechanism, but it can produce more intricate designs.

Secondary motion

The motion that pulls the weft threads through the shed created by the primary motion is known as the secondary motion of a loom. The weft threads are precisely inserted into the cloth by means of this action. The action of the shuttle, rapier, air-jet, or water-jet mechanism produces the secondary motion.

The most established and conventional way of introducing weft yarns is the shuttle mechanism. The weft threads are shuttled through the shed using a boat-shaped shuttle. A picking mechanism or the energy held in a spring move the shuttle through the shed.

The weft yarns are transported through the shed by the rapier mechanism, which makes use of a rigid or flexible rod. A motor, pneumatic, or hydraulic system powers the rapier.

The weft yarns are propelled through the shed by the air-jet mechanism, which employs a high-pressure air jet. An special nozzle that is installed on the loom produces the air-jet.

The weft yarns are propelled through the shed by the water-jet mechanism using a high pressure water jet. A unique nozzle positioned on the loom produces the water-jet.

Auxiliary Motion

The motion employed by a loom to carry out numerous supporting tasks including selecting, beating up, and taking up is known as the auxiliary motion. Typically, different processes like the picking mechanism, the take-up mechanism, and the let-off mechanism work together to produce the auxiliary motion.

The weft yarns are chosen and Inserted into the cloth by the picking mechanism. Usually, it is propelled by the loom's main action.

The newly woven cloth is wound onto a roll or beam by the take-up mechanism. Usually, the loom's secondary motion serves as its power source.

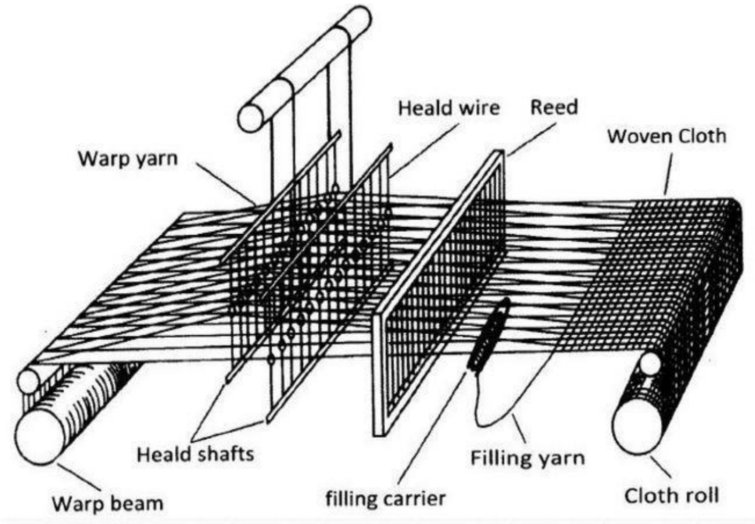
The let-off mechanism is in charge of regulating the warp strands' tension as they are woven into the cloth. Usually, a separate motor or the main weaving motion of the loom is used to power it.

Finally, the complex patterns and designs that are produced by a loom depend on the coordination of its primary, secondary, and auxiliary actions

Parts of Loom and Their Functions

Textile Weaving Machine Parts:

Weaving is the process of interlacement between the weft and warp in fabric according to a design of fabric. This process is done by using weaving machine or loom machine. This article has presented all the parts of loom machine or weaving machine with their functions.



Different Parts of Weaving Machine in Textile:

Weaving machines consist of the below parts:

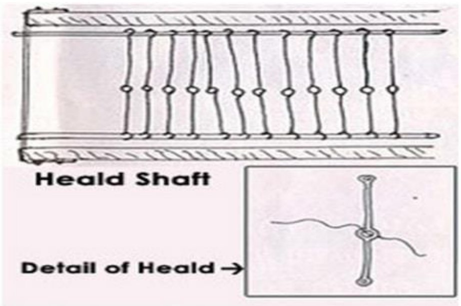
1. Heald shaft,
2. Sley or lay,
3. Shuttle,
4. Shuttle ox,
5. Reed,
6. Picker,
7. Warp beam,
8. Back beam,
9. Breast beam,
10. Cloth beam.

Functions of the Parts of a Loom:

Functions of all the above loom parts have described in the following:

1. Heald Shaft:

This part is related to the shedding mechanism. In textile weaving industry, heald shaft is produced by using metal such as aluminium or wood. It carries a number of heald wires through which the ends of the warp sheet pass. The heald shafts are also termed as 'heald staves' or 'heald frames'. The total no. of heald shafts varies according to the warp repeat of the weave. It is decided by the drafting plan of a weave during weaving.



Functions of Heald Shaft in Weaving:

Heald shaft helps in weaving shed formation.

It also maintains the sequence or order of the warp threads.

Heald shaft determines the warp thread density in a fabric, i.e. the numbers of heald wires per inch determine the warp thread density per inch.

It apprehends the order of lowering or lifting the necessary no. of healds for a pick. It helps in forming the design or pattern in a fabric.

Heald shaft is useful in identifying broken warp threads in weaving.

Sley of Lay:

It is made of wood and consists of the sley race board or sley race, reed cap and metal swords carried at either ends. The sley mechanism swings to and fro.

Functions of Sley of Lay:

Sley is responsible for pushing the last pick of weft to the fell of the cloth by means of the beat up motion during.

When moving towards the fell of the cloth the sley moves faster and moves slower when moving backwards. This unequal movement is termed as 'eccentricity of the sley'.

In order to perform the beat up and also to give sufficient time for passage of shuttle to pass through the warp shed sley is needed in textile weaving.

Functions of Reed:

Reed pushes the lastly laid pick of weft to the cloth fell.

It determines the fineness of the cloth in conjunction with the healds.

Reed acts as a guide to the shuttle which passes from one end of the loom to the other.

It helps to maintain the position of the warp threads.

Reed determines the openness or closeness of the fabric.

3. Functions of Picker:

Picker is a piece made either of synthetic material or leather. Picker may be placed on a grooves or spindle in the shuttle box. Picker is used to drive the shuttle from one box to another. While entering the box it Functions of Warp Beam:

Warp beam is also known as the weaver's beam. It is fixed at the back of the loom. The warp sheet is wounded on to the warp beam. The length of warp in the beam may be more than a thousand meters.

Functions of Back Beam:

Back Beam is also known as the back rest. It is placed above the weaver's beam. Back Beam may be of the floating or fixed type. The back rest merely acts as a guide to the warp sheet coming from the weaver's beam in the first case. Back beam acts both as a sensor and as a guide for sensing the warp tension in the second case.

Functions of Breast Beam:

Breast beam is also termed as the front rest. At the front of the loom, it is placed above the cloth roller and acts as a guide for the cloth being wound on to the cloth roller. It maintains proper tension to facilitate weaving.

Functions of Cloth Beam:

Cloth beam is also called as the cloth roller. The woven fabric is wounded on to this roller. Cloth beam roller is placed below the front rest. It is also termed as the cloth roller.

The woven fabric is wounded on to this roller. This roller is placed below the front rest.

Shuttle Loom Advantages

The Shuttle less weaving is becoming more and more popular due to the following advantages compared to conventional looms

…High labour and machine productivity due to high speed and wider width of looms

…Reduced labour cost due to higher allocation of looms and productivity

…Defect free cloth for longer length

…Better environment due to low noise level

…Pirn winding process is eliminated

..Less value loss of fabrics

…Low consumption of stores and spares

…Less space requirement per metre of cloth

…More colours in weft direction (unto 12) by Pick and Pick method

…Wider width fabrics and multi width fabrics can be woven,.

High degree of flexibility to suit a wide range of fibres and counts

…Easily adaptable for market trends

…Bigger flanges can accommodate 3 times more yarn. Due to less beam changes lower down-time and lesser wastages

…Less dependency on labour skill

…Higher design capabilities dut to microprocessor and electronic controls

…Easy maintenance and less work load for Jobbers

…Lesser accidents

ADVANTAGES OF AUTOMATICSHUTTLE LOOMS

- Automatic weft replenishing mechanism.
- Less loss of production.
- Weaver is able to attend more looms. Soless weavers are required and hence lesswage bills.

- Automatic let-off motion. So the warp tensionis maintained constant throughout the fabric.
- Automatic warp stop motion, which stops theloom within 2-3 picks after end breaks.
- Better quality of fabric compared to non-automatic looms. Type of shuttle less shuttles looms

Shuttle less loom

In the shuttle less loom, other objects or mechanisms are used to pass the weft into the shed formation.

In the projectile, the rapier is the object that works instead of the shuttle while the air jet and water jet are fluid mechanisms that are used for fabric formation.

Rather than this, multiple-weft thread passing is also possible with another type of loom.

Projectile loom:

In this type of loom, standard steel projectiles are used for picking motion. The projectile has small Grippers for the grip of the weft pick.

In this loom, the picking and the projectile units are separated from the moving sley. In this loom, a specialized projectile rod in a projectile picking mechanism is used for passing the weft thread. The weft is drawn directly from a large stationary cross-wound package with or without an accumulator.

The gripper projectile is picked across the warp shed at a very high speed, the picking energy being derived from the energy stored in the metal torsion bar which is twisted at a predetermined amount and released to give the projectile at a high rate of acceleration.

Picking always takes place from one side but several projectiles are working on the conveyor chains underneath the warp shed.

Rapier loom:

Use a rigid or flexible rapier head to bring in the grip and guide the weft. Rapier loom in addition to suitable for weaving plain and textured fabrics, its characteristics are easy color change, suitable for multi-color weft fabrics, suitable for dyed, double velvet fabrics, terry fabrics and decorative fabrics.

Air Jet loom:

Air-jet loom is a revolutionary system in loom machines. A jet of air is used to insert the pick in the picking mechanism. A filtered jet of air at very high pressure is used via various nozzles in this loom.

It is useful weaving technology for medium to coarse cotton and spun yarns. A leno selvedge with a fringe of about 1/8 inch or 0.33 cm length is produced during this jet weaving.

Air-jet looms have higher RPM, therefore it gives more production as compared to other looms. In addition, it has better productivity, more control over parameters with the help of Microprocessor-based controls, and high efficiency.

Air-jet loom machines are generally helpful for the production of certain fabrics such as Denim, PV dress Materials, Polyester Dress Materials, and Cotton Shirting.

Water Jet loom:

Water jet looms are modifications of air-jet looms. It is widely used for economic and bulk production of Polyester Sarees and Dress Materials, Shirting, etc. In this loom, a jet of water can be used to insert the pick in the picking mechanism. For jet filtered water is used at very high pressure.

Water -jet loom is more suitable for medium to fine Denier Polyester yarns. (However, Cotton and Viscose fibre yarn weaving were difficult to commercial acceptance.)

UNIT: V

KNITTING AND NON-WOVEN FABRICS

KNITTING

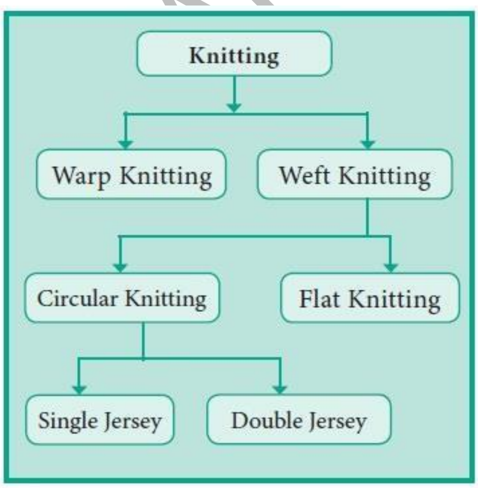
The second most important fabric construction method after weaving is knitting. Knitting is the process of making loops and throwing the yarns through loops to form a fabric. In the earlier days knitting was con-sidered as a unique technique of making fabric using wool fibres. The oldest knitted products are socks found in Egypt tombs. Knitting is done using long stick like nee-dles. The first knitting machine was invented in 1589, by Reverend William Lee. It slowly developed and today the market is filled with complex knitting machine to produce a huge range of knitted fabric

Classification of Knitting

Knitting is divided into two main groups as warp and weft knitting. Warp knitted fab-rics are produced by a series of yarn forming loops in the lengthwise direction of the fab-ric. Weft knitted fabrics is produced when one continuous yarn forms the loops in the crosswise directions. The most common types of warp knitt fabrics are Tricot knit, Raschel, Milanese and Simples knit. The different kinds of weft knits are plain, purl and rib. Both weft and warp knitting can be incorporated in the jacquard mechanism to produce fancy knitted fabrics.

Knitted Fabric Making

Knitted fabric is constructed by forming the yarns into loops. The vertical rows of loops stitches in knit fabric are known as wales and the horizontal rows of loops are called courses. The loops are formed by a group of needles or shafts, which are arranged one after the other in the knit-ting machine on the needle plate. The needles are evenly placed. Sinker is used to pull the needles down, which pulls the yarn into the previous loop. The knitted fabric is pulled down and rolled at the base of the machine and collected for further use.

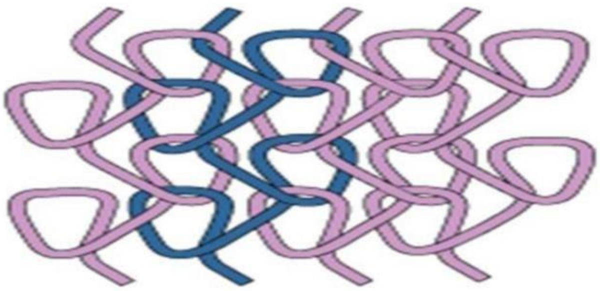


Uses of Knitting

Knitted fabrics are used for

- Clothing (Underwear, Sweaters)
- Home furnishing (Curtains, Towels)
- Medical textiles (Grip Bandages)
- Industrial textiles (Wipes, Absorbent Pads)

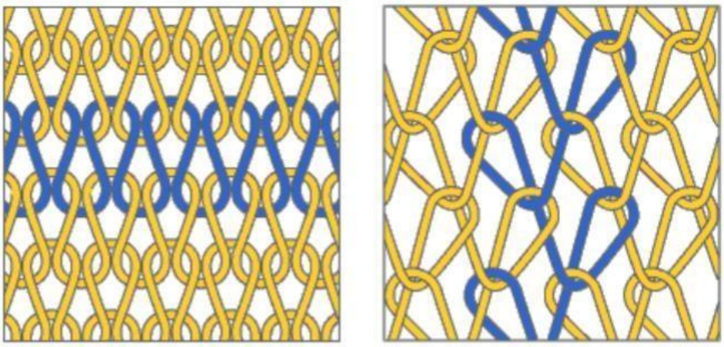
Warp knitting



Warp knitting represents the fastest method of producing fabric from yarns. Warp knitting differs from weft knitting in that each needle loops its own thread. The needles produce parallel rows of loops simultaneously that are interlocked in a zigzag pattern. Fabric is produced in sheet or flat form using one or more sets of warp yarns. They are fed from warp beams to a row of needles extending across the width of the machine. Two common types of warp knitting machines are the Tricot and Raschel machines. Raschel yarns machines are useful because they can process all yarn types in all forms. Warp knitting can also be used to make pile fabrics often used for upholstery. History Credit for the invention is usually given to a mechanic called Josiah Crane in 1775. He likely sold his invention to Richard March who patented (No. 1186) a warp frame in 1778. In the intervening three years March likely had discussed the device with Morris who submitted a similar patent (No.1282) for a twisting machine for making Brussels point lace. These early machines were modifications of the stocking frame with an additional warp beam. In 1795, the machine was successfully used to make lacy fabrics

Difference between weft and warp knitting

The main difference between the warp knitting and weft knitting is the way of intermeshing of loop. Weft knitted fabric is formed by the intermeshing the loops in horizontal direction where warp knitted structures are formed by intermeshing the loops in vertical direction. Basically it is little bit complicated to analyse the fabric is weft knitted but after observing it with the help of peg glass it can be analysed by observing the way intermeshing of loops. Weft knitted fabric is used for inner wears as well as for t-shirts, whereas warp knitted fabric are used for seat covers etc.



Weft Knitting   Warp Knitting

Properties of Warp Knitted Structures Warp knitting offers:

- Higher production rates than for weaving.
- A wide variety of fabric constructions.
- Large working widths.
- A low stress rate on the yarn that facilitates careful handling of fibres such as glass, aramid and carbon (particularly when using weft-insertion techniques).
- Conventional warp knitted structures that can be directionally structured.
- Three-dimensional structures that can be knitted on double needle bar raschels with weft insertion, uni-axial, bi-axial, multi-axial and composite structures that can be manufactured on single needle bar raschels.

Principle of Warp Knitting:

Compound lapping movements are responsible for the production of warp knitted fabric. The compound lapping movement is composed of two separate motion.

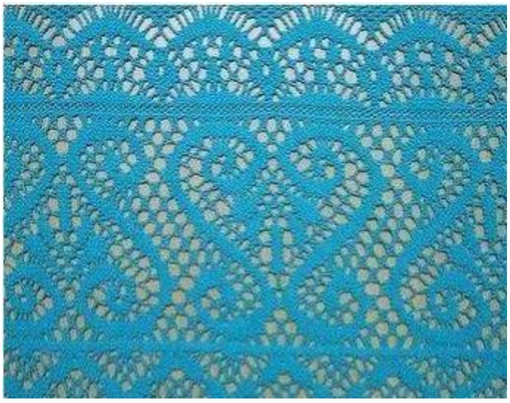
- Swinging motion (backward & forward motion)
- Shogging motion (the lateral motion or side way movement) The swinging motion is obtained from the main cam shaft while the shogging motion is obtained from the pattern wheel or pattern drum provided at one side of the machine. The no. of pattern wheels or no. of endless pattern chain links will be equal to the no. of guide bars used. The lateral movement of the guide bars along the needle bars or parallel to the needle bars called a shogging motion

The amount of yarn supplied to the guide bar for a definite number of courses is called run-in or amount of yarn required (inch) to 480 courses (1 rack) is termed as run-in.

Types Warp knitting

1. Tricot Knit: Tricot fabric is soft, wrinkle resistant & has good drapability. Tricot knits are used for a wide verity of fabric weights & design. It makes light fabric weighting less than 4 ounce/square yard. Some examples of tricot fabric are sleepwear, boluses, dresses etc.

2. Raschel Knit: The Raschel knit ranks in importance of production with tricot but it makes varieties of products ranging from laces, power nets for foundation garments, swimwear to carpets. Raschel knitting is done with heavy yarns & usually has a complex lace-like pattern.



3. Crochet Knit: This basic stitch is used in hand crochet. This construction is used in a wide variety of fabrics ranging from nets & laces to bed spreads & carpets, various types of edgings or trimmings lace are also produced

Uses of warp knitted fabric:

- Inner wears (brassieres, panties, camisoles, girdles, sleep wear, hook & eye tape.)
- Apparel (sportswear lining, track suits, leisure wear and safety reflective vests.)
- Household (mattress stitch-in fabrics, furnishing, laundry bags, mosquito nets & aquarium fish nets.)
- Shoes (inner lining and inner sole lining in sports shoes and industrial safety shoes.)
- Automotive (car cushion, head rest lining, sun shades and lining for motorbike helmets.)
- Industrial (pvc/pu backing, production masks, caps and gl ove s (for the electronic industry.)

Advance Application of warp knitting

- Warp-knitted spacer fabrics in car seats
- Composite reinforcements (Sandwich-constructions)
- Containers
- Tanks
- Boats
- Aircraft
- Sport shoes
- Medical textiles and mattress

Weft Knitting

Weft knitting is the simplest method of converting a yarn into fabrics. Weft knitting is a method of forming a fabric in which the loops are made in horizontal way from a single yarn and intermeshing of loops take place in a circular or flat form on a crosswise basis. In this method each weft thread is fed, more or less, at right-angle to direction in which fabric is formed. Each course in a weft knit builds upon the previous knitted course. Most of the weft knitting is of tubular form. It is possible to knit with only one thread or cone of yarn, though production demands have resulted in circular weft knitting machines being manufactured with upto192 threads.

Types of weft knitting

- Plain Knit
- Purl Knit
- Interlock Knit
- Rib Knit

Plain Knit

If a weft knitted fabric has one side consisting only of face stitches, and the opposite side consisting of back stitches, then it is described as a plain knitted fabric. It is also frequently referred to as a single jersey fabric (single fabric). Plain knitted fabrics are produced by using one linear array of needles. As such all the stitches are meshed in one direction. These fabrics tend to roll at their edges. They roll from their technical back towards the technical front at the top and lower edges. They also roll from their technical front towards the technical back at their selvedges (the self-finished left and right-hand edges of the fabric). The structure is extensible in both lateral and longitudinal directions, but the lateral extension is approximately twice that of the longitudinal extension.

Purl Knit

If on both sides of a relaxed weft knitted fabric only reverse stitches are visible, then this is defined as a purl knitted fabric. Purl fabrics are produced by meshing the stitches in adjacent courses in opposite directions either by using special latch needles with two needle hooks or by transferring the fabric from bed to bed between each knitting action. When the fabric is stretched lengthwise, then the face stitches are visible. The fabric shrinks more in the direction of wales, and once it is released, it relaxes to hide the face stitches between the courses. The interloping of the stitches of adjacent courses in opposite directions results in the courses of a purl knitted structure closing up. The structure, therefore, has a large longitudinal extensibility.

Interlock Knit

Interlock knitted structures could be considered as a combination of two rib knitted structures. The reverse Stitches of one rib knitted structure are covered by the face stitches of the second rib knitted structure. On both sides of the fabric, therefore, only face stitches are visible, and it is difficult to detect the reverse stitches even when the fabric is stretched width wise. The geometry of the yarn path influences the stretch behaviour of the knitted fabrics. The change of direction of the meshing of the stitches in adjacent wales results in the wales of a rib knitted fabric closing up giving it better stretch properties width wise as opposed to other basic knitted structures. The combination of two rib knitted structures in the interlock structure gives very little or no room at all for the wales or courses to close up and therefore the interlock fabrics shows relatively poor stretch properties in both directions.

Rib Knit

If on both sides of a relaxed weft knitted fabric only face stitches are visible, then it is referred to as a rib knitted fabric. It is produced by meshing the stitches in adjacent wales in opposite directions. This is achieved by knitting with two needle systems which are placed opposite to one another other. As such these fabrics are also known as double jersey or double face fabrics. When the fabric is stretched width wise, both sides of the fabric show alternately face and reverse stitches in each course. Once the fabric is released, it shrinks in its width, thus hiding the reverse stitches between the face stitches. These fabrics do not curl at their edges. The simplest rib structure is 1 x 1 rib shown on the right (click on a thumbnail to view an interactive 3D image and examine the structure). The longitudinal extensibility of the rib structure equals that of a plain knitted structure. The geometry of the yarn path influences the elastic behaviour of the knitted structures. The change of direction of the interloping of the stitches of neighbouring wales (cross-over points) results in the wales of a rib knitted structure closing up. This gives rib structures better width wise stretch properties than other basic knitted structures.

Knitting machine elements

Knitting machine with needles and yarn feeds organized in a circle for knitting fabrics, hosiery, sweaters, and underwear. A knitting machine is used to make knitted fabrics. The device carries and coordinates the movement of a number of mechanisms and gadgets each performing specific characteristic which contributes towards the efficiency of the knitting action.In this article I will discuss what is knitting machine and knitting machine parts name and works.

The body or frame either circular or rectilinear according to needle bed shape supports the bulk of the mechanisms of the machine.

The machine driving system which coordinates the power for the drive of various gadgets and mechanisms.

The yarn supply device or creel for holding the yarn packages, yarn tensioning gadgets, yarn feed control, and yarn feed carriers or guides

The knitting gadget incorporates includes the housing and driving of knitting elements in addition to the selection gadgets of the needles and garment length control gadgets.

The attachments like stop motions, automatic lubricator, etc., highest rolling as well as first-rate of the products.

Knitting machine parts name:

- Creel
- Feeder
- Cam
- Cam box
- Needle
- Sinker
- Sinker box
- Single lap
- Cylinder
- Auto stopper

- Base plate
- Motor
- Take-up roller
- Yarn guide
- VDQ pulley
- Body
- Dial
- Legs
- Tensioner
- Fabric spreader
- Fabric withdraw

Creel:

Creel means the assembly on which all the yarn packages are held in the working position with necessary guides. Two types creel used in knitting machine 1.top creel 2. Side creel

The creel, placed at the pinnacle of the machine, is called top creel. Top creel looks like an umbrella – so it's also named as umbrella creel. When the creel is located at one side of the machine as an alternative positioning at the top of the device, the creel is referred to as side creel.

Tensioner:

Any element or machine element on which the yarn passes applies a few tension and acts as a tensioner. But technically an attachment that is used intentionally to use and maintain preferred tension to the yarn is called yarn tensioner. The loop length and compactness of the fabric largely depends on the tension of the yarn.

Guide:

Guides are there mainly to give and maintain proper route and alignment of yarn so that yarn can flow smoothly from the bundle to the knitting zone for fabric formation. The inner or operating surface of the guides ought to be smooth sufficient in order that neither yarn is damaged nor much tension is developed because to friction.

Feed plate:

Feed plate or feeder is a small metal plate with a hollow at the center. Passing of yarn via the feed hole. The yarn passes through the hole earlier than being caught by the needle. The main causes of the use of the feed plate is to maintain a proper direction and alignment of the yarn in order that needles after getting cleared can catch the brand new yarn at tuck height level for loop formation without fail.

Stop motions:

The number of such stop motions in a device is identical to the number of feeders .the presence of each feed yarn is for my part detected and motion is taken to stop the machine while the same is either broken or subjected to very high tension variation.

Needle:

The needle is the main element in the knitting. The needle which actually makes the loop. Three types of needle used in knitting (a) latch needle, (b) bearded needle and (c) compound or bi-partite needle.

Cam:

Cam is the most important element in knitting. The cam is the mechanical device that converts the rotary device pressure into a suitable reciprocating movement for the needle. The needle moves through the cam. Two types of cam used in knitting

1. Engineering cam

2. Knitting cam.

Sinker:

Sinker is the second important element in knitting. It is a thin metal plate positioned in among the needles. The sinkers typically move to and fro in horizontal, at 90° to the path of motion of needles and maintain a fixed height. The sinker holds the needle while creating the loop.

Take down mechanism:

After the formation of every course, the cloth is withdrawn from the knitting zone, typically in a downward direction, and wound on the fabric roller. The mechanism used for this reason is a known take-down mechanism.

Fabric spreader:

After knitting, the circular fabric in tubular form going downward for rolling into a roller as flattened double layered fabric. During such conversion, tension variation takes region across the width of the fabric because of distance variation version which ends up in unwanted, crease mark and stitch deformations to overcome this problem, knitting machines give with spreader or stretcher board for applying nearly uniform tension to the fabric. It is used to partly stretch the fabric same time as shrinking after coming down from the knitting zone.

Open width fabric winding:

Eliminate the fold mark in the fabric especially made with lycra and alike yarn and at the identical time to reduce the rate of alternate in diameter of the fabric roller to roll the equal period of fabric with a comparatively lower final diameter of the fabric roller.

Advantages of this system:

- Higher Productivity
- Excellent fabric quality with wider GSM range
- Easy Lycra plaiting and excellent Lycra plaiting quality – lower rejection
- Easy access to knitting head – higher efficiency Speed Factor:
- The value of the speed factor depends on the.
- Quality of yarn used
- Construction of a knitting system
- Design of the fabric
- Environmental or climatic conditions
- Cleanliness of the machine
- Type of machine lubrication

Classification of knitting machines.

Knitting, a process of making fabrics (textiles) that is generally done inter-looping of yarns. Knitting is primarily classified as weft knitting and warp knitting. Knitting can be done by hand or by machine. Knitting is done by creating loops of yarn in a row, either flat or in the round. In this article, we will show you a list of different types of industrial knitting machines available for making knitted fabrics.

The knitting machines are classified based on fabric formation techniques (warp knitting, weft knitting, single jersey, double jersey). Further machines are classified based on machine configuration. We have come out with this knitting machine classification after exploring a couple of blogs and websites. To keep this article simple, we are not displaying images of different types of knitting machines. Knitting machine images are shown in this post.

Knitting machine classification

1. **Weft Knitting**

1-1. Circular Knitting Machine

Single Jersey Circular Knitting Machine

1-1-1-1. Plain Single Jersey

1-1-1-2. 2 Track 4 Track

1-1-1-3. Terry and Fleece

1-1-1-4. Jacquards

Double Jersey Circular Knitting Machine

1-1-2-1. Rib knitting machine

1-1-2-2. Interlock knitting machine

1-1-2-3. Pique fabric knitting machine

1-2. Straight Bar Knitting Machine

1-2-1. Single Needle Straight Bar Knitting Machine

1-2-2. Double-Needle Straight Bar Knitting Machine

1-3. Flat Bar Knitting Machine

1-3-1. Flat Bed or V-Bed

1-3-2. Single-Bed

1-3-3. Unidirectional Bed

2. Warp knitting machines

1. Rachel warp knitting machine

2-2. Tricot warp knitting machine

3. Socks knitting machines

4. Whole garment knitting machines

Circular knitting machine

It is the most popular type knitting machine, widely used for manufacturing fabric for garments and apparel purposes since it is circular in shape it is known as a circular knitting machine. Components of circular knitting machines are latched needle, compound needle, sinker (single jersey), cam, cylinder, dial. Machine diameter varies from 12 to 60 inches Single jersey

Plain knitting machine

It is the most widely used variety of machines used in manufacturing knitted fabric. It has a set of latch needle and a set of the sinker. Both revolve according to the knitting cam system that results in a precise up and down motion. Here only one 1 track of cam operates and produced fabric as per the required density and thickness of the fabric.

Two-track and Four-track single jersey

This type of machine can produce a variety of knitted fabric designs, with a high sped production. Here no. of cams can be altered. It has a separate motion for each sinker and needle respectively with a stationary cam system. It is used for manufacturing t-shirts, polo shirts, underwear, and swimsuits, etc

Terry knitting machine:

It consists of different types of sinkers, motor, inverter, oiler, yarn storage device. Fabric produced are of different loop height. A device named CSA (central adjustment system) monitors the uniform fabric density, cylinder diameter ranges from 26 to 34 inches. Terry knitting machine generally produces terry towels and even with lycra yarns, it produces smoother fabric.

Jacquard Single Jersey Circular Knitting Machine:

It operates with the three needle positions namely knit, tuck, and miss. It can produce a textured design that usually includes flowers, brocade, matelassé, paisleys, damask, and animal patterns. Modern machines are computerized with a USB system information storage of design patterns.

Double jersey circular knitting machine

Rib knitting machine:

A rib knitting machine is one of the widely used knitting machines for manufacturing fabric for apparel items. It is a double bed machine, with one set of needles in each bed and one cam track for each bed, respectively.

Needles are in the opposite phase that is they are situated perpendicularly in the machine. Cylinder needles move vertically while the dial needles move vertically. Fabric produced are comparatively more stretchable than single jersey and interlock fabric.

Interlock knitting machine:

Knitting takes place in double bed machine, there are two sets of needles in each bed, short needles and long needles and two cam tracks in each bed. Purl structures can also be made in the interlock machine by allowing dual-ended latch needles and special devices of a drive. Fabric produced from this machine has the same surface on both face and back, and this fabric is widely used in inner-wears, track pants, etc.

Pique circular knitting machine:

Fabric produced from this type of knitting machine shows a waffle weave look. The fabric also shows a rough texture, widely used for making polo- shirt

Straight Bar Knitting Machine:

Straight bar knitting machines have bearded needles on a vertical bar. Movement is controlled by the precisely constructed cam system. Divisions are equally distributed along the length of the machine. These machines are also known as hand flat, widely used in making sweaters just like handloom weavers.

In a straight bar knitting machine, there are two variety namely single needle straight bar and double-needle straight bar. Rib and single jersey fabric can also be produced in this type of fabric. Speed is comparatively slower than the industrial flat bar machine.

Flat Bar Knitting Machine

This machine is generally utilized for manufacturing 3D structured knitted fabric. Fabric produced is quite similar to the circular knitting machine. Needles are arranged on a straight bar, which follows a back and forth movement. These machines are used for making collars, arm-bands (cuff), and even in some case sweaters too. There is a separate cam for each needle bed.

Flat Bed or V-Bed Flat Knitting Machine

This machine has two flat needle beds consisting of upside-down motion looking like English alphabet V. Needle beds can stretch up to 2-3 meters wide. A forward and backward movement known as CAM-box works to move the knit, tuck, and also, in transferring stitches. Angular cams of a bi-directional cam system are used

Warp knitting machine:

If the yarns run in a length direction, i.e. the direction of fabric formation during knitting, the process is called warp knitting like the warp yarns in woven fabrics. Fabric is made by forming loops from yarns coming in parallel sheet form which run in the direction of fabric formation

Raschel knitting machine

Latch needles are commonly used but compound needles may also be used. Sinkers are used to ensure that the fabric stays down when the needle rises. More number of warp beams and guide bars are used than tricot machines. Warp beams are positioned at the top. Here gauge is defined as needles per two inches. Machine speed is comparatively lesser than tricot machines.

Tricot knitting machine

Bearded or compound needles are used in this machine where sinkers control the entire knitting cycle like single jersey knitting machines. Lesser warp beams are used in tricot machines than raschel machine. Warp beams are positioned at the back, the gauge is generally defined as needle per one inch. (Sadhan Chandra Dey -Wood head).

Socks knitting machine

The principles of socks knitting machines are like circular knitting. Good quality products can be produced only when stop-motion and yarn-feeding functions are set properly. In circular weft knitting, needles knit one after the other in sequence, and loops are formed horizontally by needles knitting around the cylinder, forming a tube.

Whole Garment knitting machine

Besides these, all types of knitting machines in recent days Seamless knitting machine is in the trend where a full garment is being knitted due to which there no need for stitching of fabric is cut components during garment manufacturing. Companies like Santoni, Shima-Seiki are these seamless knitting machine manufacturers.

These types of machines are widely used for manufacturing inner-wears and sportswear. Seamless technology provides highly elastic knit fabric used for underwear and elastic sportswear technology, neck, waist, buttocks, and other parts that do not need to seam molding classification of basic weft knit structure

Characteristics of plain single jersey knitted fabrics:

1. Appearance o face and back are different

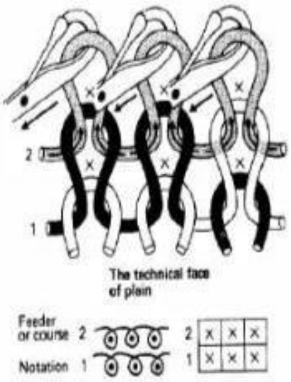


Fig. 7.1 The technical face of plain weft knitted fabric.

2. Wales are clearly visible on the face side of the fabric
3. Extensibility in widthwise is approximately twice than lengthwise.
4. Curl or roll of fabrics occurs at the edges.
5. Unraveling of fabric course by course from either side is possible
6. Thickness of fabric is approximately twice the diameter of yarn used.
7. There is only one series of knitted loop per courses in the fabric.

Derivatives of single jersey:

1. Single lacoste
2. Double lacoste
3. Single pique
4. Polo pique/Double pique
5. Two thread fleece
6. Three thread fleece
7. French terry etc

Characteristics of 1x1 rib knitted fabrics:

1. The appearance of face and back are identical

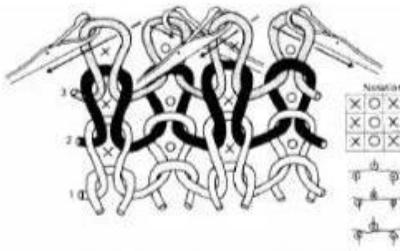


Fig. 7.8 Face and reverse loop wales in 1 × 1 rib.

2. Fabric length wise and widthwise extensibility is approximately twice that of single jersey
3. Fabric does not curl at edges
4. Fabric thickness is approximately twice than single jersey
5. There are two series of knitted loops arranged into two parallel lines in a course.
6. Combination of wales of face loops and back loops are present on the both side of the fabric.

Derivatives of rib:

1. 2×2 rib
2. Half cardigan or Royal rib
3. Full cardigan or Polka rib
4. Swiss double pique
5. French double pique
6. 5×1 Derby rib

Characteristics of 1x1 interlock knitted fabrics:

1. Interlock has the technical face of plain on both sides. So the appearance of face and back are same.
2. The wales of each side are exactly opposite to each other and are locked together.
3. Widthwise and lengthwise elongations are approximately the same as single jersey.
4. The fabric does not curl at the edges.
5. The fabric can be unraveled from

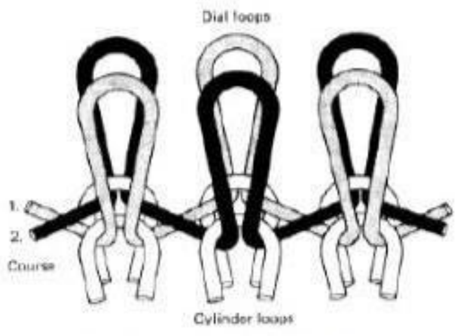


Fig. 7.14 Interlock fabric structure.

the end knitted last.

6. Two yarns must be removed to unravel a complete repeat of knitted courses.
7. Fabric thickness is approximately twice than that of single jersey.

Derivatives of interlock structure:

1. Single pique or cross tuck interlock
2. Jersey cord
3. Eight lock
4. Texi pique

Characteristics of 1x1 purl fabrics: Purl fabrics are also referred as link-link fabrics.

(NB The same needle has been drawn twice to show its two possible knitting bed positions)

Fig. 7.17 Purl knitting using sliders.

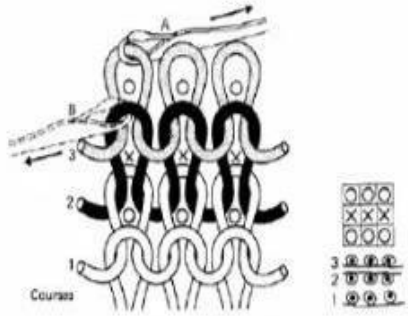


Fig. 7.18 Purl fabric structure.

1. Purl is reversible structure i.e. its appearance on both sides is same.
2. Extension in all directions is more
3. The fabric does not curl at the edges.
4. The fabric will run in the wale direction starting from either end.
5. Unraveling of fabric course by course from either side is possible.

Derivatives of Purl structure:

1. 2×2 purl
2. 4×2 purl
3. Seed stitch
4. Basket purl

Introduction to nonwovens

According to the American Society of Testing Materials (ASTM D 1117-80), nonwovens are defined as follows:

‘A nonwoven is a textile structure produced by the bonding or interlocking of fibers, 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.’ Nonwoven are still increasing in importance; production is increasing at the rate of 11% per annum.

One of the major advantages of nonwoven is that it is carried out swiftly directly from the raw material to the finished fabric generally however there are exceptions. Naturally, this leads to low labor cost as there is no role of material handling unlike other textile processes. All the nonwoven processes involve two stages, initially the fibers are prepared into a suitable form in order for them to bond. There are various different methods of processing a fiber, different processing exudes its own particular characteristic in the final fabric. There are number of different bonding methods which have notable effect on the finished fabric properties. Almost all the fiber processing methods can be combined with all bonding methods allowing wide range of final properties in the material

In the fiber processing the very first step involves making a thin layer of fiber which is termed as a web. When several layers on web are placed on each other it forms a batt, which directly goes to the bonding. The first step of nonwoven processing is normally called batt production

Applications of nonwovens:

Nonwovens have variety of application which includes:

Nonwovens are used in diaper stocks, feminine hygiene products and other absorbent material. They are also used in carpet backing and in composites (marine sail laminates, table cover laminates). These days it is widely used in shopping bags as the society is heading toward a sustainable approach.

Medical application of nonwoven includes isolation gowns, surgical gowns, surgical masks. Nonwovens are also used filtration purpose like in pharmaceutical industry, mineral processing, and vacuum bags.

In geotextiles; nonwoven geotextiles containers (sand bags) are used for soil stabilizers, frost protection for canal water bodies, land fill liners. Nonwovens are advantageous compared to that of woven, they are more robust than woven bags of the same thickness.

Uses of Non-Woven

1. Disposable nonwovens are essentially made for one time use; but some, such as dust cloths, may be laundered and reused a few times.
2. General applications include personal hygiene products, such as diapers and sanitary napkins; medical products such as surgical gowns and drapes; surgical and industrial masks, bandages, wipes and towels; bibs and even costumes for special events.
3. Durable nonwovens have wide applications. Consumer durables include both household goods and home furnishings, such as for draperies, furniture upholstery, mattress padding, towels, table cloths, blankets and carpet backing and clothing and apparel, such as for caps, linings, interlinings, interfacings and the reinforcement of other fabrics.
4. Many industrial uses include filters, insulation, packing materials, roadbed stabilization sheeting or road-building materials geo-textiles and roofing products.

Interlock Knit

Interlock knitted structures could be considered as a combination of two rib knitted structures. The reverse stitches of one rib knitted structure are covered by the face stitches of the second rib knitted structure. On both sides of the fabric, therefore, only face stitches are visible, and it is difficult to detect the reverse stitches even when the fabric is stretched width wise. The geometry of the yarn path influences the stretch behaviour of the knitted fabrics. The change of direction of the meshing of the stitches in adjacent wales results in the wales of a rib knitted fabric closing up giving it better stretch properties width wise as opposed to other basic knitted structures. The combination of two rib knitted structures in the interlock structure gives very little or no room at all for the wales or courses to close up and therefore the interlock fabrics shows relatively poor stretch properties in both directions.