Intermediate Vocational Course
First Year

TEXTILE SCIENCE AND CARE

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CLASSIFICATION OF TEXTILE FIBRES

1.1 Introduction:

Food, shelter and clothing are the basic needs of everyone. All clothing is made from "Textiles and our shelters are made more comfortable and attractive by the use of textiles.

Textiles have such an important bearing on our daily lives that everyone needs to know something about them. From earliest times, people have used textiles of various types for covering or modesty, warmth, personal adornment, to display personal wealth and even for biomedical and technical purposes.

A study of textiles will show, for example why certain fabrics are more durable and serviceable for specific purposes. Complete knowledge of textiles will facilitate an intelligent appraisal of standards and different qualities of textile products.

The word "**textiles**" comes from the Latin term textere, "woven". Today the word textile is more generalized to refer to product made from fibres.

A "**fibre**" is defined as any product capable of being woven or otherwise made into a fabric. It may be thought of as the smallest visible unit of textile production 'or' a fibre can be defined as a pliable hair like strand that is very small in diameter in relation to its length. Fibres are the fundamental units or the building blocks used in the making of textile yarns and fabrics.

Where as "**yarns**" are produced by twisting or spinning of the textile fibres and in turn a **fabric** is a planar structure produced by interlacing or interloping of yarns.

1.2 Classification of Textile Fibres

The textile industry uses many fibres as its raw materials. As a result of the development of new fibres, difficulties arise in textile industry in terms of identification, classification. Hence, classification of textile fibres was compounded by the trained manufactures to identify each of the fibres with the different trademarks.

Textile fibres are classified according to the source and the length of the fibres.

1.2.1 Classification of fibres by source:

According to the source from which textile fibres are obtained, fibres are broadly classified in two ways ex:

a) Natural

b) Manmade.

Table: 1 Natural Fibres

Natural Fibres		
Vegetable or Cellulosic	Animal or Protein	Mineral
Seed Cotton Kapok **Bast** Tencel Hemp Linen Jute **Leaf** Pineapple Sisal Agave **Nut husk –** Coir	**Hair** Wool Alpaca - Cashmer Angora Camel Hair Mohair **Extruded** Silk	Rock Asbestos

Table: 2 Man - made Fibres

MAN-MADE			
Cellulose Regenerated Viscose rayon Tencel Modified regenerated Acetate Triacetate	**Protein** Soya bean Azlon	**Mineral** Gold Silver Glass Silica Lime stone	**Synthetic** Nylon polyester acrylic spandex

TEXTILE FIBRES

Vegetable fibres 'or' Cellulosic fibres:

As the name indicates these fibres are obtained from vegetable source i.e. plants and their constitute is Cellulosic matter.

This category includes by far most important textile fibres called Cotton, which make up nearly 50% of total fibres used in world (by weight), it is considered as major fibre. This category also includes other minor much higher proportion by value. Other minor fibres in this category are Mohair, Cashmere, Angora, and Camel hair.

Mineral Fibres:

Asbestos is a natural fibre obtained from varieties of rock. It is a fibrous form of silicate of magnesium and calcium containing iron, aluminum and other minerals. It is an acid proof, rustproof, flameproof. However, the use of asbestos is now rapidly declining following the discovery of health risks from asbestos dust.

Manmade Fibres:

These refer to those fibres that are not naturally present in nature, but are synthesized.

Cellulosic Source: Fibres manufactured from a natural polymer Cellulose that is obtained from wood.

(a) Regenerated fibres: The starting product is cellulose, which is dissolved in sodium hydroxide and viscous solution is extruded through spinneret into dilute H_2SO_4.

(b) Modified Regenerated: The raw material here also cellulose, but these fibres are modified chemically so that polymer can be dissolved in an organic solvent and extruded into hot air which evaporate the solvent.

Protein Fibres: These are from the protein source but not manufacturing in present days.

Mineral Fibres: These fibres are glass, steel and carbon all of which are found in industrial end uses viz., Glass is used for low cost reinforced, Plastic for ships, cars and thermal and electrical insulation etc. Steel is reinforced rubber in tyres and belts for filters where chemical resistance is important.

Carbon fibres are used where high performance is required i.e. aircraft's parts, tennis and squash rackets etc.

Synthetic Fibres: The term synthetic means that the polymer is entirely man made from chemicals. These group fibre properties are dependent upon their chemical compositions and kinds of molecular orientation. The group includes three major fibres and several minor ones. The major ones include Nylon (polyamide produced in U.S.A in 1938), Polyester (produced in 1953), and Acrylic (produced in 1948).

1.2.2 Classification of fibres by length:

According to length fibres are classified into two types they are staple and filament.

Staple Fibres: Natural or manmade or short length fibres which measures in inches or fraction of inch e.g. ¾ to 18 inches. Expect silk all other natural fibres are staple fibres. Man made fibres is made in filament form but cut into short staple lengths.

Filament Fibres: Long fibres those measured in yards or meters are known as filaments. Silk and all man made fibres are filaments.

1.3 General Properties of Textile Fibres

Filament: Long continuous fibre strands of indefinite length measured in yards or meters.

Staple: These fibres measured in inches or centimeters and range in length from ¾ of an inch to 18 inches.

Abrasion resistance: It is the ability of a fibre to withstand

Absorbency or Moisture Regain: Is the amount of water a bone dry fibre will absorb from the air under standard conditions of temperature (70^0 F) and moisture (65% relative humidity).

Flexibility: Is the ability of a fibre to blend easily.

Chemical reactivity: Is the effect of acids, alkali, oxidizing agents, and solvents.

Cohesiveness: Is the ability of fibres to cling together during spinning. Not important in continuous filament.

Dyeability: It is the fibres receptivity to coloration by dyes

Elastic recovery: Is the ability of fibres to recover from strain

Elasticity: Is the ability of a stretched material to return immediately to its original size.

Electrical conductivity: Is the ability to transfer electrical charges.

Elongation: Is the ability to be stretched, extended, or lengthened. It varies at different temperatures and when wet or dry.

Feltability: It refers to the ability of fibres to mat together.

Flammability: Is the ability to ignite and burn.

Hydrophilic: Fibres are able to absorb water easily or water loving.

Hydrophobic: Fibres that have difficulty in absorbing water and are only able to absorb small amounts are called hydrophobic.

Example: All man made fibres expect rayon.

Hand: It is the way a fibre feels: silky, harsh, soft, crisp, dry.

Heat conductivity: Is the ability to conduct heat away from the body

Hygroscopic: Those fibres, which absorb the moisture from air.

Heat sensitivity: Is the ability to soften, melt, or shrink when subjected to heat.

Luster: It is the light reflected from a surface. More subdued than shine light rays are broken up.

Loft or compression resiliency: It is the ability to spring back to original thickness after being compressed.

Pilling: It is the balling up of fibre ends on the surface of fabrics.

Static Build Up: Problems such as sparks and clinging clothing occur with the build – up change on the fibre surface.

Thermoplastic fibre: Those fibres, melts or soften when heat is applied.

Solubility: It is the test used to identify the textile fibre by dissolving them in the respective solutions.

Tensile Strength: Is defined as the ability to resist stress and is expressed as tensile strength (pounds per square inch) or as tenacity (grams per denier)

Wicking: Is the ability of a fibre to transfer moisture along its surface.

Exercise:

1. What are fibres? How can they be classified on the basis of their origin?
2. Give differences between
   a) staple and filament fibres
   b) cotton and silk
   c) natural and man-made
3. Define fibre, yarn and fabric?
4. What is the difference between hydrophobic and hygroscopic?
5. What do you understand by tensile Strength?

CHAPTER - 2
COTTON

2.1 Introduction

Cotton is obtained plant source and it is classified as a natural, cellulose, seed, and staple measuring 10-65mm in length and white to beige in color in their natural state. Cotton grows from the surface of seeds in pods, or bolls, of a bushy mallow cotton plant hence it is called as seed hair. It is composed basically of a substance called cellulose, on burning cotton smells of burning paper and leaves a gray fluffy ash. As cotton occupies the 50% of consumption of fibres by weight in the world, it is called as the king of all fibres.

2.2 History of Cotton:

Cotton has been cultivated for more than 5000 years. Cotton industry was developed by the industrial revolution, which marked the invention of carding machine and the spinning mule in England and by the invention of the cotton gin in the United States.

2.3 Cultivation of Cotton:

Cotton is mostly grown in USA, India, and Egypt cotton. It requires 200 days of continues warm weather with adequate moisture and sunlight, frost is harmful to the plant. March and April months are suitable for plantation.

2.4 Processing and Manufacturing of Cotton:

Hand made Cotton:

The tools and appliances used by the cotton weavers consist of spinning wheel (charka) spindle (takli) and a bow shaped beater (dhun). The threads then formed are wound on a bamboo reel and from which warp of the handloom is set to weave the fabric

Machine made Cotton:

Manufacturing by machine involves the following steps;

(i) Preparation: The fibres are first removed from the seeds, leaf fragments, dirt and other materials. The seeds are removed by the cotton gin (the cotton gin was first inverted by the Eli Whitney in 1794).

(ii) Forming the laps: In this step dirt in the cotton is removed and fibres into a soft roll or lap. Then several laps are combined into one.

(iii) Carding: The fibres are drawn together to form a loose rope or sliver.

(iv) Doubling: Slivers are combined.

(v) Combing: It is continuous and refinement of the carding process. These are free from woody stalk, used for finer quality fabrics.

(vi) Drawing: Slivers are combined and smoothened, stretched that could cause too many variations if the slivers are feed singly. The slivers given first twist and wound on to bobbins.

(vii) Roving: The bobbins are placed on the roving frame where further drawing and twisting takes place, until the cotton stock is about a pencil lead in diameter.

(viii) Spinning: Done on the spinning frame where the stock passes through sets of high-speed rollers and gives the yarn of desired thickness.

(ix) Weaving and dyeing: Any variety of weaves can be used for the cotton. Dyes are applied to raw cotton at fibre, yarn or fabric stage.

(x) Finishing: Both performance finishes and functional finishes are given to the cotton.

2.5 Types of cotton: Different kinds of and types of cotton are grown in various parts of the world. The quality of cotton is based on its colour, length fineness and strength.

Upland cotton: It consists of about 99% of the United States cotton crop.

American Pima: It is used mostly for sewing thread, although a small amount is used in high quality broad cloth and other fabrics where silky, smoothness, softness and luster are desired.

Egyptian: The fibres are light brown fine and strong

Asiatic: These are coarse fibres less than 1 inch in length. It is mostly used for surgical supplies.

2.6 By products of cotton:

Cotton linters – linters are the short, fuzzy fibres that remain on the seeds after they have been separated from the fibre in the cotton gin. They are used in the manufacturing of rayon and acetates, plastics photographic film.

Hulls- These are outside portion of the cotton seeds, rich in nitrogen and used as fertilizers, paper cattle feed.

Inner seed- It yields cotton seed oil which is used as cooking oils and compound and in the manufacturing of soap.

2.7 Fibre morphology:

The microscopic appearance of cotton: The microscopic structure of the cotton fibre looks like a hoisted ribbon or a collapsed and twisted tube. These twisted or convolutions identify the cotton fibre under the microscope.

The micro structure of the cotton fibre: The cotton fibre is a single plant cell. Its cross section is oval. It consists of cuticle, primary and secondary walls and a lumen. The cuticle is the skin of the cotton. It is composed of waxy layer. The primary cell wall, lies immediately underneath the cuticle. Beneath the primary wall lies the secondary cell wall, this forms the bulk of the fibre. The hollow canal running the length of the fibre is called the lumen.

Fig: 1 Microscopic Structure of Cotton

2.8 Properties of Cotton Fibre:

Physical properties:

- **Strength:** Cotton fibre is relatively strong which is due to the intricate fibre structure and 70% crystalline.

- **Elasticity:** Cotton is relatively in elastic because of its crystalline polymer system, and for this reason cotton textiles wrinkle and crease readily
- **Hygroscopic nature /moisture regain:** The cotton is very absorbent, owing to the countless polar/oh groups in its polymers.
- **Electrical property:** The hygroscopic nature ordinarily prevents cotton textile materials from developing static electricity.
- **Heat/ thermal conductivity:** Cotton has high degree of thermal conductivity, so therefore it is a cool fibre.
- **Absorbency:** As cotton has cellulose it is a good absorbent fibre.

Thermal properties:

Cotton fibres have the ability to conduct heat energy, minimizing any destructive heat accumulation thus they can withstand hot ironing temperatures.

- **Drapability:** Cotton does not have the good body to drape well in shape. The type of construction of the fabric may improve this property.
- **Resilience:** Cotton wrinkles easily; which some wrinkle resistant finishes may offset this property.
- **Cleanliness & wash ability:** Though absorbs dust due to its rough nature, it can be washed easily in the hot water and strong soaps without the deformation of the fibre.
- **Luster:** The natural cotton has no pronounced luster. This is improved by the mercerization of the cotton (Sodium hydroxide treatment- Mercerization).
- **Shrinkage:** Cotton tends to shrink when it dries after wetting. This is over come by pre shrinkage treatments.
- **Effect to heat:** Cotton can withstand the moderate heat in ironing. So it better iron the cotton in damp or wet conditions. The temperatures of ironing should not exceed 204 ^{0}C

Chemical Properties:

- **Effects of Acids:** Cotton is not damaged by the volatile organic acids such as acetic acid, non volatile organic acids such as oxalic and citric acids will make cotton tender when heat is applied.

Concentrated and dilute mineral acids like sulphuric acids will destroy the fibre

- **Effect of Alkalies:** Cotton s are resistance to alkalies are relatively unaffected by normal laundering**.** Concentrated alkalies in the absence of air will mercerize cotton if it is kept under tension otherwise it will cause the fabric to shrink due to swelling of the cotton s by taking the alkalies molecules or radicals. Not effected by the alkalies in fact they are used in some processes of cotton (mercerization).
- **Effect of Bleaches:** These have no effect unless used in uncontrolled conditions and with heat.
- **Effect of sunlight and weather:** Ultra violet rays of sunlight affect the strength of fibre and change the color to yellow when exposed to prolonged period. Pollutants also affect the fibre.

concentrated and diluted mineral acids like sulphuric acids will destroy the fibre.

- **Effect of perspiration:** Both acidic and alkaline perspiration discolor the fibre.
- **Affinity to dyes:** Cotton generally has good affinity to dyes like vat, reactive, azoic dyes.

Biological Properties:

- **Resistance to Microorganisms:** The mildew and bacteria damage Cotton.
- **Resistance to insects:** Moths and beetles will not affect damage the cotton. But the silver fish eat the cotton cellulose

2.9 Finishes for cotton:

Improved finishes for cotton have been responsible in a large measure for cottons current popularity. Among them are the resin and non- resin finishes that give cotton the same easy or minimum care features that synthetics posses. Advances in anti bacterial, mildew resistant, and flame resistant treatments have improved the effectiveness of the performance of cotton in various end uses.

Regular finishes like singeing for smoothness, mercerization for strength, luster and affinity for dyes, sizing and calendaring for luster, stiffness, body, and smoothness. Special finish like sanforizing for maximum pre-shrinking, crease resistant, anti bacterial finishes, mildew and rot treatment, napping for softness, warmth, absorbency and moth repellent treatment are common.

Dyeing and printing: Cotton fabrics have affinity with azoic, direct, reactive, sulphur, and vat dyes.

Cotton and blends: Cotton is blended with many s like – cotton &wool, cotton and linen, cotton and silk, cotton and viscose rayon, cotton and nylon, cotton and polyester,

2.10 Consumer demand for cotton

Cotton is still remained as the king of the s even in though competition of the man-mad s. The following will explain why consumers prefer cotton much?

Versatility: Cotton can serve for food (cotton seed products**),** for clothing and for shelter. Cotton fibre can be spun alone or it can be blended with other textile fibres such as linen, wool, silk, viscose rayon, polyester, and nylon. It serves the purpose of clothing or apparel, home furnishings and industrial fabrics by giving the comfort, durability, fashion and ease for care etc

Durability: Due to its natural hoist, cotton s spin so well that it can be twisted very tightly hence tightly twisted yarns produce durable fabrics.

Comfort: Cotton conducts heat away from the body allows the cooler temperatures outside to reach the body, so it is a cool material for summer or tropical wear. Knitted cotton is used as comfortable underwear.

Fashion rightness: The countries of New York and Paris have considered cottons glamorous enough to include in their collections.

Ease of care: The factors of light, laundering, ironing and perspiration are common consideration in colour fastness to cotton.

Resistance to shrinkage: After the use of shrinkage treatment only one percent residual shrinkage remains to be into account.

Improvements in finish: Along with the basic finishes other special finishes like mildew resistance, crease resistance, wash and wear etc. made cotton more like by consumers.

Economy or price: Cotton materials are flexible to fit into all types of economic group. They buy products of cotton are also used for many purposes.

2.11 Cotton in use:

Cotton is also used for home furnishings. Towels are most common as it high in absorbency, wide range of colors, washability and durability. Sheets and pillowcases are mostly blends of cottons with polyester or made of pure cotton. Drapes, curtains and upholstery fabrics are made of cotton and its blends.

Medical supplies are frequently made of cotton. Since cotton can be autoclaved at high temperatures, absorbency, washability and low static build up are also important factors for use of cotton in hospitals.

Industrial uses include abrasives, bookbinding's, luggage and handbags, shoes and slippers, tobacco cloth, woven wiping clothes, and wall covering fabrics.

Summary:

Both the consumer and the salesperson frequently made mistakes and each failed to appreciate the inherent qualities of a fabric. The consumer will be a better buyer if he or she knows the characteristics of cotton and their effect on the finished fabrics. Sales person will improve their selling efficiency if they increase their technical knowledge of how cotton will best serve the customer and they will be better equipped to answer customers questions such as;

Will the fabric wash well?

Will the material be suitable for an evening dress?

Exercise:

1) Forecast the use of cotton in consumer goods?
2) What are the by products of cotton?
3) Discuss the advantages of cotton fabrics?
4) Name the more important varieties of cotton grown in world.
5) How would you judge cotton fabrics?
6) Explain the microscopic appearance of cotton?
7) What is meant by versatility of cotton?
8) List out the finishes commonly applied to cotton fabrics?

CHAPTER - 3
RAYON

3.1 Introduction

A rayon fibre was the first manmade fibre composed of pure cellulose, the substance of which the cell walls of such woody plants as trees and cotton are largely comprised. Rayon fibres are made from cellulose that has been reformed or *regenerated.* Consequently, these fibres are identified as *regenerated cellulose fibres.* Because of its luster and soft hand feel, it resembled silk and came to be known as 'artificial silk'. However it is more like cotton in its chemical composition hence gives the paper burning smell with after glow.

3.2 History of Rayon:

Robert Hooke, the English naturalist, had prophesied the production of a fibre such as rayon, the first of the manmade fibres, as long ago as 1664. He believed that it was possible to make an "artificial glutinous composition, much resembling, if not fully like that of silkworm secretions. In 1840, an apparatus was invented that drew synthetic filaments through small holes. In 1855, Georges Audemars, a Swiss chemist, discovered how to make cellulose nitrate. This was the first step toward the nitrocellulose process of making rayon. In 1884, Count Hilaire de Chardonnet produced the first manmade textile fibres from nitrocellulose. He became known as the "father of rayon".

In 1890, L. H. Despaisses of France developed the cuprammonium process for making rayon, which had some properties that were superior to those of nitro- cellulose rayon. Manmade textile filaments were officially recognized so, in 1925, when the Federal Trade Commission (FTC) permitted the use of the name "rayon" for yarns obtained from cellulose or its derivatives.

There were basically two groups of rayon's - one consisting of regenerated pure cellulose (viscose rayon), the other of a cellulose compound (acetate rayon). In the chemist's terminology, rayon and acetate are not synthetic because natural materials- cotton linters and wood pulp are used in their manufacture, rather than chemical elements.

3.3 Basic Method of Producing Rayon:

The natural process by which the silk- worm transforms the cellulose of mulberry trees into two fine filaments is simulated in the process of making rayon.

A liquid substance of cellulose is forced through a metal cap or nozzle about the size of a thimble. This nozzle is called a ***Spinneret*** because it performs the same function as the silkworm's spinneret. The cap is usually made of a platinum-rhodium alloy because acids or alkalies do not affect that metal; it is perforated with small holes that are almost invisible to the naked eye. Through each of the tiny holes, a filament is extruded, which is solidified by a liquid bath as it comes from the spinneret. The number of holes in the spinneret ranges from 1 to 20,000, and filaments of equal size are simultaneously produced. In a subsequent operation, twisting to make any required diameter of rayon yarn combines these filaments.

3.4 Types of Rayon:

There are now two principal methods of making rayon. The fibres differ in important characteristics because the methods differ in specific features of manufacture. This *rayon-viscose* and *high wet-modulus*-are classified as regenerated rayon because the original raw material (cellulose) is changed chemically into another form, which is then changed (regenerated) into cellulose again. These changes produce the final product-purified cellulose in fibre form.

The Viscose Process:

Fibre Production:

Viscose rayon is made from cotton fibre or wood pulp usually obtained from spruce, hemlock, and pine trees.

In the viscose process, wood chips or cotton fibres are treated to produce sheets of purified cellulose that resemble white blotters. The cellulose sheets are then soaked in caustic soda producing sheets of alkali cellulose. This substance is broken up into fluffy white flakes or grains called *cellulose crumbs,* which are aged for two or three days under controlled temperature and humidity. Liquid carbon disulfide is then added. This turns the cellulose into cellulose xanthate, a light orange substance that is still in a crumb form. The cellulose xanthate crumbs are dissolved in a weak solution of caustic soda and transformed into a thick viscous solution called *viscose,* resembling, honey in color and consistency. The viscose is aged, filtered and vacuum treated to remove air bubbles, as they would cause the filament to break. It is then forced through the holes of the spinneret into sulfuric acid, which coagulates the cellulose of the soluble cellulose xanthate to form pure regenerated cellulose filaments.

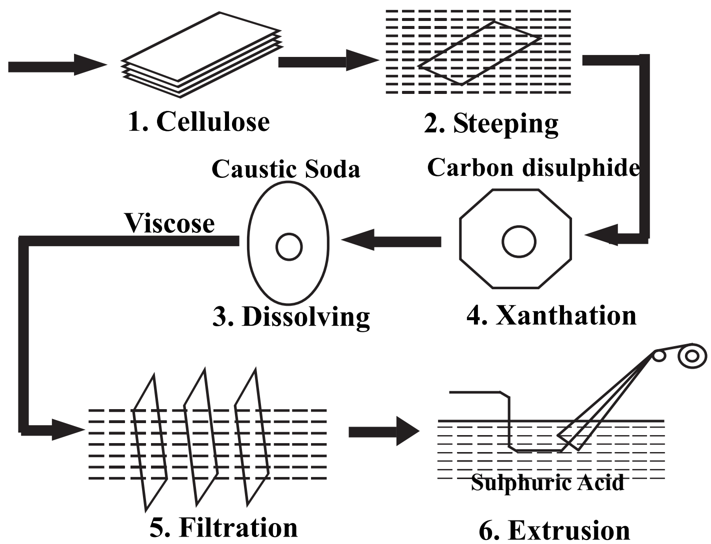


Fig : 2 Manufacturing Process of Rayon

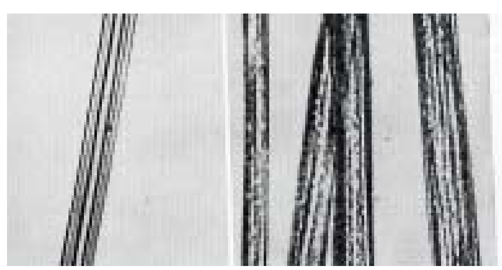


Fig: 3 Microscopic Structure of Viscose Rayon

Yarn Production:

Upon extrusion from the spinneret, the viscose rayon fibres are processed by one of several methods into **filament** or **spun staple** yarns. The fibres need not to be carded, combed nor drawn as they are produced manually.

Spinning Process:

The methods generally used are Pot, or Box, Spinning, Spool Spinning or Continuous Spinning Process.

Dyeing:

Viscose rayon can be dyed at the solution stage or at yarn or fabric or garment stage. Solution dyeing has good color fatness properties.

Weaving or Knitting:

Any type of weave can be used for making the rayon fabrics. These yarns are also used for making hosiery fabrics.

3.5 Evaluating Viscose Rayon Fabrics:

The development of a manmade fibre possessing along with the prized qualities of the natural fibres is a tribute to human ingenuity.

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 its strength is reduced 40 to 70 percent when wet. Yet it produces fairly durable, economical, and serviceable fabrics whose smoothness of surface favorably withstands the friction of wear.

Elasticity:

Viscose rayon has greater elasticity than cotton but less than wool or silk. Therefore, while viscose rayon fabrics have some inherent extensibility, undue strain might cause them to sag and even burst.

Resilience:

Viscose rayon lacks the resilience. It should be remembered that the resistance of a fabric to creasing depends on the kind of yarn, weave, and finishing process.

Drapability:

Viscose rayon possesses a marked quality of drapability because it is a relatively heavyweight fabric.

Heat Conductivity:

Viscose rayon is a good conductor of heat and is therefore appropriate for summer clothing like that of cotton.

Absorbency:

Viscose rayon is one of the most absorbent of all textiles. It is more absorbent than cotton or linen and is exceeded in absorbency only by wool and silk.

Cleanliness and Washability:

Because of its smoothness, viscose rayon fibre helps to produce hygienic fabrics that shed dirt. Some viscose rayon fabrics wash easily; and depending on the finishing they can be dry cleaned. It needs no bleaching. Since viscose rayon temporarily loses strength when wet, it must be handled with care when washed. When laundered, a mild soap or detergent and warm water should be used. The garments should be squeezed, not wrung, to remove the water.

Reaction to Bleaches:

Household bleaches containing sodium hypo chlorite (such as Clorox), sodium perborate (such as Snowy), or hydrogen peroxide may safely be used, care should be taken at amount of bleach and the temperature of water.

Shrinkage:

Viscose rayon fabrics tend to shrink more than cotton fabrics. . Spun viscose rayon fabrics shrink more, which can be given a shrink-resistant finish, such as Sanforset.

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, it begins to decompose. When ironing, it is wise to use either a moderately hot iron on a dampened fabric or a steam iron.

Effect of Light:

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

Resistance to Mildew:

Like cotton, viscose rayon has a tendency to mildew. Such fabrics therefore, should not be allowed to remain damp for any length of time.

Resistance to Insects:

Moths are not attracted to cellulose. Resistance to other insects is also similar to that of cotton. Silverfish can attack rayon.

Reaction to Alkalies:

Concentrated solutions of alkalies disintegrate viscose rayon. A mild soap and lukewarm water is therefore recommended when laundering such garments.

Reaction to Acids:

Being pure cellulose, the fabric is disintegrated by hot dilute and cold concentrated acids similar to that of cotton.

Affinity for Dyes:

Viscose rayon fabrics absorb dyes evenly and can be dyed with a variety of dyes, such as direct, acid, chrome, and disperse. It produces fast colored fabrics than silk.

Resistance to Perspiration:

Viscose rayon is fairly resistant to deterioration from perspiration.

3.6 Uses:

Rayon is mostly used in woven fabrics. From 1986, more rayon was seen in apparel, in both all-rayon fabrics as well as in blends with other fibres. As it has good drape it is used for apparels, draperies, curtains, and other household textiles. Antique-satin drapery fabrics in a blend of rayon and acetate continue to be a classic fabric in interior decoration.

The second most important use of rayon is in non-woven fabrics, where absorbency is important. Items include industrial wipes; medical supplies, including bandages; diapers; sanitary napkins; and tampons. These disposable products are biodegradable.

Summary:

Of all the synthetic fibres, rayon is the oldest. Even though its original creators were trying to make silk artificially, they actually discovered a new & distinct fibre more versatile than any natural one. Rayon can be made to imitate cotton, wool, silk & even linen with these fabrics.

Exercise:

1. What is a man-made fibre? Who was the father of rayon industry
2. What is multifilament yarn? What is spun yarn?
3. What is the source of rayon? How is the material made into a fibre by viscose process?
4. What are general characteristic of rayon fabrics?
5. Name five rayon fabrics available in the market?

CHAPTER - 4
SILK

4.1 Introduction:

Silk is the very fine strand of fibre that is a solidified *Protein* secretion produced by certain caterpillars to encase themselves in the form of cocoons. Silk is a natural continuous filament fibre, with luster and smoothness but irregular in diameter along its length.

4.2 History of Silk:

Silk is know as the 'Queen Of Fibres' as through out the development of the industry, silk had maintained a position of great prestige and considered as a luxury fibre and as a pure fibre. Silk was first discovered in china in 2600 B.C., when a cocoon fell into the cup of tea that a Chinese princess was drinking while sitting under a mulberry tree. The hot liquid softens and loosened the fibre, which the princess pulled and drew away from the cocoon as a continuous strand. Another story cites Empress Si-Ling-Chi as the first producer of silk fibre, from which she made a silk robe for her husband. From antiquity until the more recent establishment of the Chinese Republic, she was venerated as the Goddess of the Silkworm. Later Caravans introduced the silk in East and Alexander the Great carried this to Europe in fourth century B.C. After three thousand years of its origin the secret was stolen out of China. From then onwards silk became the pure prized fibre available naturally.

4.3 Silk Producing Countries:

Japan is the first country to produce the silk in large quantities, use the scientific means in production and to use the factories related to the silk production. Other silk producing countries are China, India, Italy, Spain, Bulgaria, Turkey, Greece, Syria and Brazil. Specialization of silk production is mainly due to close supervision, and reeling techniques required.

Types of silk: Silk may be classified into under two main types

1. Mulberry or cultivated silk. Eg. Bombyxmori
2. Non-mulberry or wild silk. Eg; Tassar silk, Muga silk, and Eri silk

4.4 Cultivation of Silk:

Silk is obtained from the larvae or cocoon of several moths, but the *Bombyx mori* is the only one raised under controlled conditions. These larvae feed on the leaves of mulberry tree. Raising these insects is a skilled occupation and requires countless hours of work. **Sericulture** is the name given to the production or raring of the silk worms. The life cycle of the female Bombyx mori is very simple and it is as follows;

- The female moth lays the eggs, which develops into the larva, or caterpillar – the silk worm,
- The silkworm, which spins its cocoon for protection, to permit development into the pupa, or chrysalis;
- The chrysalis, which emerges from the cocoon as the moth,
- The moth, of which the female lays eggs, so continuing the life cycle.

Actually the larvae spin the cocoon by moving its head in figure '8'motion from the outside of the body. As it spins the cocoons, larvae decrease in size and changes into the chrysalis. The silkworm extrudes the liquid fibre from two tiny orifices or **spinneret's** in its head. As the liquid emerges into the air, it becomes harden by a gummy substance called **sericin** (silk gum) are extruded by two glands in close proximity to the cocoon. Then the cocoons are ready for the further use. The cocoons are subjected into heat, which kills the chrysalis. These cocoons are then stored until they unreeled in preparation of yarn manufacturing.

4.5 Processing of the Silk Fibre:

Filature operations:

The cocoons that are raised by the silk farmers are delivered to a factory, called *Filature*, where the silk is unwound from the cocoon and the strands are collected into skeins. The filature process includes the following steps.

(a) Sorting Cocoons:

The cocoons are sorted according to the color, size, shape and texture as all these affect the final quality of the silk. Cocoons are generally range from white or yellow to grayish, depending on the source and the type of food consumed during the worm stage. Cocoons from China are white, Japanese cocoons are creamy white and yellow, Italian cocoons are yellow.

(b) Softening the Sericin:

After the cocoons have been sorted, they are put through a series of hot and cold immersions, as the sericin must be softened to permit the unwinding of the filament as one continuous thread. Raw silk consists of 80% fibroin (protein) and 20% of sericin (gum). At this stage only 1% of the gum is removed, because this silk gum is a needed protection during the further handling of the delicate filament.

(c) Reeling:

The process of unwinding the filament from the cocoon is called as reeling. The care and skill in the reeling operations prevents defects in the raw silk. As the filament of single cocoon is too fine for commercial use, three to ten strands are usually reeled at a time to produce the desired diameter of raw silk thread. Several cocoons are placed in hot water to soften the gum and the surfaces are brushed lightly to find the ends of the filaments. These ends are collected, threaded through a guide and wound on to a wheel called a reel.

(d) Throwing:

As the fibres are combined and pulled onto the reel, twist can be inserted to hold the filaments together. This is called as throwing, and the resulting yarn is thrown yarn. Fibres may be thrown in different operations.

(e) Spinning:

Short ends of silk fibres from the outer and inner edges of the cocoons and from broken cocoons are spun into yarns in a manner similar to that used for cotton.

(f) Degumming:

Sericin or gum up 30 percent of the weight of the silk fibre. It is not usually removed until after the cloth is woven because serves as a warp sizing that protects the yarns from mechanical injury during weaving. Sericin remains on the fibres during reeling and throwing. Before finishing, the gum is removed by boiling the fabric in soap and water. If stiffness is desired in the completed fabric, some of the sericin may be replaced, but this is seldom desirable, for the presence of gum or sericin increases the tendency for the silk to water spot.

Silk weighting:

Silk will readily absorb tin, aluminum and other metallic salts in water solution to increase the weight and draping quality of degummed silk without the use of more fibre.

4.6 Varieties of Silk:

Wild Silk:

Silk produced by moths of species other than Bombyx mori. It is brown in color, more uneven and coarser. It is usually called **Tussar Silk**.

Waste silk or silk noil:

Short ends of textural spun yarns or in blends with cotton or wool. Sometimes it is called waste silk.

Dupion:

Silk yarns made from two cocoons that have been formed in an interlocked manner. The yarn is uneven irregular and large than regular filaments. It is used in making shantung and duppioni.

Raw silk:

Silk that has not had any degumming.

Spun Silk:

Yarns made from short fibres from pierced cocoons and short ends and outside and inside edges of the cocoons.

4.7 Properties of Silk Fibres:

In spite of its high cost, silk has been one of the most popular fabrics because of its unique properties. Soft, supple, strong and lighter in weight than any other natural fibre, silk is prizes for its lightness with warmth, sheerness with strength, and delicacy with resiliency. Silk is a natural protein fibre. The actual fibre protein is called fibroin while the protein sericin is the gummy substance that holds the filaments together. An important aspect of silk fibre is the high degree of molecular orientation that accounts for the excellent strength of silk products.

Physical properties:

Strength:

Silk is the strongest natural fibre. It has a tenacity of 2.4 to 5.1 grams per denier. The continuous length of the filament in yarns results in strength. More over smoothness of the silk filament yarns reduces the problem of wear from abrasion. However strength of the spun silk yarn depends on the length of the silk staple.

Shape and appearance:

Silk filaments are very fine and long. They frequently measure about 1000 to 1300 yards in length and can be as long as 300 yards. The width of the silk is from 9 to 11 microns.

Elasticity:

It is an elastic fibre and its elasticity varies, as it is a natural fibre. Silk fibre may be stretched from 1/7to1/5 its original length before breaking. It returns to its original size gradually and loses little of its elasticity.

Microscopic properties:

Cultivated degummed silk viewed longitudinally under a microscopic, resembles a smooth transparent under microscopic, resembles a smooth transparent rod. Silk in the gum has rough, irregular surfaces. Wild silk tend to be quite uneven and is somewhat dark. It may have longitudinal striations.

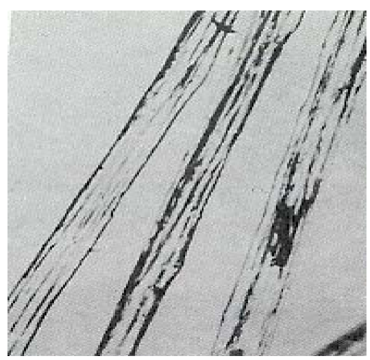


Fig: 4 Microscopic Structure of Silk

Resilience:

Silk retains their shape and resist wrinkling rather well. This is more in fabrics made from pure silk rather than spun silk or weighed silk.

Drapability:

Silk has a pliability and suppleness that, aided by its elasticity and resilience, give it excellent drapability.

Heat Conductivity:

Since silk is a protein fibre it is a nonconductor of heat like wool, hence it is used for winter apparel.

Absorbency:

The good absorptive property of silk also contributes to its comfort in warmer atmosphere. Silk generally absorbs about 11 % of its weight in moisture, which makes silk easy in dyeing and printing.

Cleanliness and Washability:

Silk is a hygienic material because its smooth surface does not attract dirt. It can also be easily cleaned using mild soaps and in dry-cleaning.

Reaction to Bleach:

Strong bleaches containing Sodium Hypo chlorite will deteriorate silk. Mild bleaches like sodium perborate and hydrogen peroxide may be used with normal caution.

Shrinkage:

Due to filament in length, smooth surface silk have normal shrinkage which can be easily restored by ironing at moderate heat and damp conditions.

Effect of Heat:

Silk is somewhat sensitive to heat. It will begin to decompose at 330^0 F. therefore it should be ironed while damp with a warm iron white silk is heated with a warm iron if white silk is heated at 231^0 F for 15 minutes it begins to turn yellow.

Effect of Light:

Continuous exposure to light weakens silk faster than either cotton or wool.

Resistance to Mildew:

Silk will not affect by mildew unless left for some time in damp state or under the extreme conditions of tropical dampness.

Resistance to Insects:

In blends of wool and silk the beetles and larvae of moths may affect it, which affects the wool.

Reaction to Alkalies:

Silk is not as sensitive as wool is to alkalies. It may be affected in concentrations and high temperatures. Cold concentrated solutions of alkali such as soda or caustic potash have slight action on silk. Heated solution dissolves silk.

Reaction to Acids:

Concentrated mineral acids dissolve silk faster than wool. Organic acids do not harm them. Medium concentrated of HCL will dissolve silk and moderate concentrated of other mineral acids cause fibre concentration and shrinkage.

Affinity for dyes:

Silk has very good affinity to acid dyes, but their light fastness is unsatisfactory.

Resistance to Perspiration:

Silk fabrics are damaged by perspiration. The silk itself deteriorates and the color is affected, causing staining.

Silk blends:

Silk and cotton, silk and polyester, silk and linen, silk and wool etc.

Finishes given to silk:

Degumming, weightening calendaring (for body and luster), embossing, singeing water repellency and stiffening

4.8 Uses of Silk:

Silk is used primarily in apparel and home furnishing items because of its appearance and cost. Silk is extremely versatile and can be used to create a variety of fabrics from shear, gossamer chiffons to heavy, beautiful brocades and velvets. Because of silk’s absorbency, it is appropriate for warm – weather wear. Because of its low heat conductivity it is used for cold – weather wear. In furnishings, silk is often blended with other fibres to add a soft luster to the furnishing fabric. Silk blends are often used in window – treatment and upholstery fabrics. Occasionally, beautiful and expensive hand made rugs will be made of silk.

Summary:

Silk as an animal fibre is the product of two distinct varieties of silkworms Wild & cultivated. Wild silk, often called tussarh silk are gummy in feeling dull in luster & have rough uneven yarns. From cultivated silkworms cocoon a fine, even, long fibre can be reeled. Dupion silk comes from one cocoon spun by two silkworms. Spun silk yarns are made from silk waste. Silk queen of the fibre & also expensive than any other fibre, it can be used in less expensive ways if it is blended with other fibres.

Exercise:

1. Name the silk producing countries?
2. Describe the life cycle of the silk worm?
3. What is the difference between weighted silk and pure silk?
4. What finishing processes are given to silk fabrics?
5. What is spun silk? How does it differ from thrown silk?
6. Name some fabrics usually made from wild silk?
7. For what purpose would you select silk rather than other fabrics? Why

CHAPTER - 5
WOOL

Introduction

Wool was the one of first fibres to be converted into fabric. Wool fibre grows from the skin of sheep it is composed of a protein known as keratin. It is crimp and has scales on its surface depending upon the breed of sheep. The natural protein fibre consists of amino acids. Wool has 19–amino acids and keratin, protein and other organic acids.

5.2 History of Wool:

Originally, wool was borne on wild species of sheep as a short, fluffy undercoat concealed by hair. When primitive people for food killed wild sheep, they used the pelts as body coverings. The fluffy undercoat probably became matted by usage, thus giving early man the idea of felting it into a crude cloth. In first century A.D. it discovered Merino sheep could be bred to improve the fleece, as the wool of wild sheep is coarse. The breeding of the animals and the production of the wool fibre into fabric are more costly processes consequently wool fabrics are more expensive. The interlocking of woolen fibres is known as felting.

5.3 Classification of wool:

Classification by sheep

Merino wool: Merino sheep produce the best quality wool which is originated from Spain

Class II wool: It is from England, Scotland, Ireland and Wales.

Class III wool: This is from U.K the fibres are about 4 to 18 inches long, coarser and less crimp.

Class IV wool: It is used mainly for carpets and rugs.

Classification by fleece:

Sheep's are shorn of their fleeces in the spring depends on age.

Lamps wool: the first fleece sheared from a lamb about six to eight months old is known as lamb's wool. Fine in quality and soft texture.

Hogget wool: 12 to 14 months old that has not been previously shorn

Pulled wool: when sheep is slaughtered for meat their wool is pulled.

Cotty wool: very poor grade wool

Wether wool: any fleece clipped after the first shearing is called wether wool.

5.4 Wool Producing Countries:

Cold weather produces a hardier and heavier fibre. Excessive moisture dries out natural grease. Insufficient or poor food retards growth. Certain countries are suitable for large-scale sheep rising and consequently produce the greatest quantities of wool. The chief wool producing countries are Australia, the U.S.S.R., New Zealand, Argentina, South Africa, Uruguay, and the United State.

5.5 Manufacturing Processes:

Shearing:

Sheep are generally shorn of their fleeces in spring, but the time of shearing rises in different parts of the world. Machine clippers remove the fleece faster, closer than the hand clippers. Superior comes from the sides and shoulders, where it grows longer, finer, and softer, is treated as one fleece; wool from the chest, belly, and shanks is treated as a second fleece

Preparation:

An average about 8 pounds of fleece is made from one sheep. Then the fibres are packed in bags or bales. The raw wool or newly sheared fleece is called ***grease wool*** because it contains the natural oil of the sheep. When grease wool is washed, it loses from 20 to 80 percent of its original weight. The grease, known as *yolk,* is widely used in the pharmaceutical and cosmetic industries for lanolin compounds.

Sorting and Grading:

Skilled workers do wool sorting. Each grade is determined by type, length, fineness, elasticity, and strength. Separating the fibre by touch and sight does it.

Scouring:

Washing of raw wool in an alkaline solution is known as *scouring.* The wool is treated with warm water, soap, and a mild solution of soda ash or other alkali to remove the dirt in the fibres.

If the raw *wool* is not sufficiently clear of vegetable, substance after scouring, it is put through the carbonizing bath. The fibres are then put through a dilute solution of sulfuric or hydrochloric acid, which destroys any vegetable. This process is known as ***carbonizing,*** and the resultant wool fibres are called *extracts.*

To remove the grease and dirt in the raw wool it is put through a series of naphtha baths followed by clear water to remove the naphtha. This is called as *Naphthlation.* It improves the dye uptake property of the wool.

Garnetting:

Recycled wool fibres are obtained by separately reducing the unused and used materials to a fibrous mass by a picking and shredding process called *garnetting.*

Drying:

Wool is not allowed to become absolutely dry. Usually, about 12 to 16 percent of the moisture is left in the wool to condition it for subsequent handling.

Oiling:

As wool is unmanageable after scouring, the fibre is usually treated with various oils, including animal, vegetable, and mineral, or a blend of these to keep it from becoming brittle and to lubricate it for the spinning operation.

Dyeing:

If the wool is to be dyed in the raw stock, it is dyed at this stage. Some wool fabrics are piece-dyed, some are yarn or skein dyed, and some are top-dyed.

Blending:

Wool of different grades or pure wool fibres and other textile fibres may be blended or mixed together at this point. All this information should present on the labels.

Carding:

The carding process introduces the classifications of *woolen yarns* and *worsted yarns.* It makes the fibre parallel and some amount of dirt is removed due to the straightening the fibres. Fibres used for the worsted yarn are more straightened than the woolen yarns.

Gelling and Combing:

The carded wool, which is to be made into worsted yarn, is put through gilling and combing operations. The *gelling* process removes the shorter staple and straightens the fibres. This process is continued in the *combing* operation, which removes the shorter fibres of 1 to 4 inch lengths (*combing noils)* places the longer fibres (*tops)* as parallel as possible, and further cleans the fibres by removing any remaining loose impurities.

Drawing:

Drawing is an advanced operation for worsted yarns which doubles and redoubles slivers of wool fibres. The process draws, drafts, twist and winds the stock, making the slivers more compact and thinning them into slubbers.

Roving:

This is the final stage before spinning. Roving is actually a light twisting operation to hold the thin slubbers intact.

Spinning:

In the spinning operation, the wool roving is drawn out and twisted into yarn. Woolen yarns 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	Worsted Yarn
Short staple	Long staple
Carded only	Carded and combed
Slack twisted	Tightly twisted
Weaker	Stronger
Bulkier	Finer, smoother, even fibres
Softer	Harder

Weaving Woolen Fabrics:

Basically, the woolen yarns are weaved using the plain weave, or sometimes the twill. Woolens are desirable for sportswear, jackets, sweaters, skirts, blankets, and similar general use. These fabrics are generally napped to give smooth and warmth effect.

Weaving Worsted Fabrics:

Worsted yarns are chiefly by means of the twill woven. They are appropriate for tailored and dressy purposes, for spring and summer coats and suits, and for tropical suits.

5.6 Wool products labeling act

The U.S. government passed the Wool Products Labeling Act in July 1941. This act, amended in 1980. The wool is variously called salvaged, reclaimed, reworked, or remanufactured, but it is best known in the textile industry as ***shoddy.*** Other definitions used for wool labeling are;

Wool: It must always mean ***new wool*** new wool comes directly from a fleece. It has never been previously spun, woven, felted, or worn.

Virgin wool: It is now used by the textile industry to designate new wool from a sheep's fleece, but the term is too all-inclusive to serve as criteria of quality i.e., low grade or high grade wool.

Pure wool: It the wool fabric made of 100 % wool fibre only.

Wool blend: It is the fabric containing both wool fibres and any other textile fibres.

Fig : 5 PURE WOOL WOOLBLEND MARK

Recycled Wool: According to the government classification recycled wool is fibre that has been reclaimed and remanufactured from used or unused wool materials.

Wool fabrics: cashmere, gabardine, jersey, home spun fleece, tweed, sharkskin, mohair, serge, and suede.

5.7 Properties of the Wool:

Strength: Wool is the weakest of all natural fibres.

Elasticity: The fibre may be stretched to 25 to 30 % of its natural length before breaking.

Resilience: Wool has high degree of resilience. Some wrinkles in the fabric can be removed with steaming.

Crimp: the wool is a crimped, fine to thick regular fibre. Fine wool –10 crimps per centimeter. Course wool -4 crimps per centimeter.

Length of the wool: the length of the wool fibre ranges from 5 cm to 35 cms.

Specific gravity of wool is 1.30

Microscopic appearance of wool: Over lapping scales structure**.**

The microstructure of wool: it consists of three main components.

1. The cuticle - Epi cuticle- outer most layer
   - Exo cuticle –formed by over lapping epithelial cells, which are largely responsible for the felting shrinkage.
   - Endo cuticle —an intermediate cell.
2. Cortex - forms 90% of the fibre volume.
3. Fibrils - It is fibrillar and spiraling structure, with in the cortical cells, which contributes towards the flexibility elasticity and durability

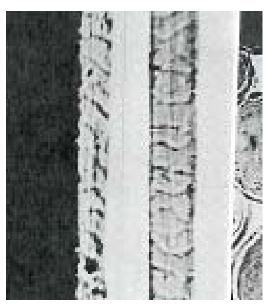


Fig : 6 Microscopic Structure of Wool

Drapability: It had excellent draping quality due to its pliability, elasticity, and resiliency.

Heat conductivity: Wool is a non-conductor of heat, they permit the body to retain its normal temperature and give warmth in cold weather. This is due to the presence of crimps on the fibre surface.

Cleanliness and Washability: Dirt tends to adhere to wool fabric. Wool requires dry cleaning or laundering if the fabric is washable. Since wool looses its 25% of strength when wet it should not be pulled in wet, they should be lifted and squeezed. Wash the wool in cool water and dry on the flat surface.

Reaction to Bleach: Hydrogen peroxide and Sodium perborate such as snowy are safe while Sodium hypochlorite or other chlorine bleaches are harmful.

Shrinkage: Shrinkage greater in woolens than worsteds, but all fabrics made of wool are subject to shrink. So it can be given treatments like Fulling, Decating or Decatizing and London Shrinking.

Effect of Heat: Wool becomes harsh at 212°F (100°C) and begins to decompose at slightly higher temperatures. It will scorch at 400°F and will char.

Effect of Light: Wool is weakening by prolonged exposure to sunlight.

Resistance to Mildew: Wool is no ordinarily susceptible to Mildew; but if left in a damp conditions, mildew develops.

Resistance to Insects: Wool fabrics are especially vulnerable to the larvae of moths and such other insects as carpet beetles. They should be protected in some manner.

Reaction to Alkalies: Wool is quickly damaged by the strong alkalies. It is imperative to use a mild soap or detergent when laundering wool fabrics.

Reaction to Acids: Although wool is damaged by hot sulfuric acid, other acids, even when heated do not affect it.

Affinity to Dyes: Wool had high affinity to dyes. The uses of chrome dyes are best.

Resistance to Perspiration: Wool is weakened by alkali perspiration. Perspiration generally will cause discoloration.

Finishes given to wool: Felting, fulling, mothproofing, crabbing, decanting, London shrinking, napping, singing and steaming.

Wool blends: wool polyester, wool acrylic, wool nylon, silk and wool.

5.8 Uses:

The majority of wool (72.8 percent) is used in apparel. Home furnishings account for 15.4 percent, industrial uses 6.7 percent, and exports 5 percent. Wool accounts for 3.3 percent of all fibres used for apparel.

The most important use of wool is for adult apparel - coats, jackets, suits, dresses, skirts, and slacks made from woven fabrics of varying weights; and suits, dresses, skirts, and sweaters made from knitted fabrics. All these gives the warm garments and with good tailored look.

In the home-furnishing area the major use of wool is in carpets and rugs where wool gives the more cover to the carpets and warm in the rugs. Blends of different synthetic fibres with wool for suiting materials are increasingly important. They result in fabrics that are more appropriate in warmer conditions. Polyester is the most important fibre used in blending with wool.

Summary:

The consumer who selects a wool fabric should be willing to pay for weaving quality, if that is the major factor governing the decision. A good quality wool is not cheap and prices are tending to rise. A good grade of reprocessed wool, however is sometimes superior to poor grade of new wool. Blends of wool with man-made & natural fibres have grown in importance. The consumer should read the percentage of each fibre & any selling points on the label.

Exercise:

1. What are the advantages of wool fabrics?
2. Why wool is warm to wear?
3. What countries supply the world with wool?
4. Name six differences between woolens and worsted fabrics?
5. Name any six woolen and worsted fabrics?
6. Discuss the wool properties that are important to consumer?

CHAPTER - 6
POLYESTER

6.1 Introduction

Polyester fibres are long-chain polymers produced from elements derived from coal, air, water, and petroleum. As defined by the FTC, these fibres are chemically composed of at least 85 percent by weight of an ester of a dihydric alcohol and terpathalic acid. Polyester is one of the most commonly used synthetic fibres. It has good strength. It is a thermoplastic in nature. It melts in flame, and forms a grey hard non-crushable bead. It is also an easy care fibre and can be made into wash and wear fabrics.

6.2 History of Polyesters:

The groundwork for the development of polyester fibres was laid by Dr. W. H, Carothers in his experiments with giant molecular structures. During the period from1939 to 1941, investigations were conducted in the laboratories of the Calico Printers Association, Ltd., Britian by *I.* R. Whin Field, *I.* T. Dickson, W. K. Birtwhistle, and C. G. Ritchie. The work resulted in the development of a polyester fibre known as ***Terylene.***

In 1946, E. I. Du Pont de Nemours & Co., the company under whose auspices Carothers had engaged in the initial research, purchased the exclusive rights to produce this polyester fibre in the United States. By 1951, the company was commercially producing this fibre, which is called ***Dacron.*** Subsequently, other companies became interested in polyester fibre i.e. *Kodel, Fortrel, etc.,*.

The polyester fibres produced by these companies may be primarily divided into two varieties: PET (polyethylene terephthalate) and PCDT (poly-1,4-cyclohexylene-dimethylene terephthalate).

6.3 Methods of Manufacture:

Generally, each company produces only one variety of polyester, though there are likely to be modifications under specific trademarks. It is interesting to note that the same polyester used to produce a PET fibre is also made in thin, transparent film form.

PET Polyester:

The principal raw material is ethylene obtained from petroleum.

PCDT Polyester:

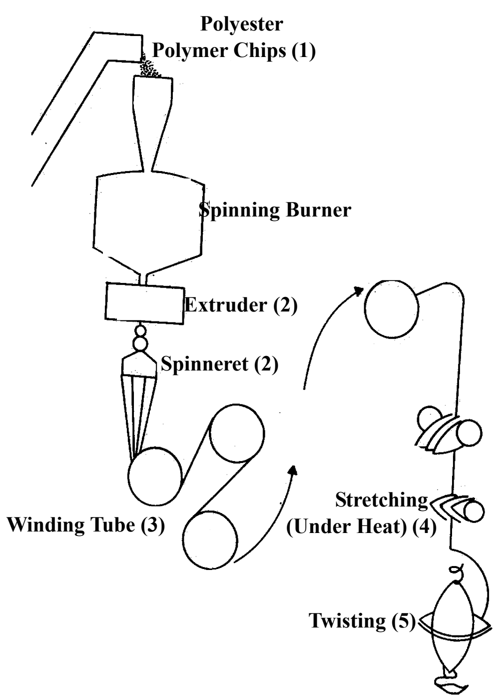
The original PCDT polyester fibre is Kodel, which is now designated as the Kodel 200 series. This form of polyester is made by condensing terephthalic acid with 1, 4-cyclohexane-dimethanol to form the tongue twister, poly-1,4-cyclohexylene-dimethylene terephthalate; hence, the convenient abbreviation PCDT polyester. As for PET polyester, PCDT is processed for melt spinning.

Spinning the Fibre:

The molten polymer is rigorously maintained in an airtight condition, as oxygen will affect its stability. The viscous melt is extruded through a spinneret, and the filaments are subsequently drawn into the desired polyester fibre. Variations in the production process depend upon the desired end results.

The holes of the spinneret may be round or modified to be trifocal, pentagonal, hexagonal, or octagonal shapes to so achieve specific effects, such as greater cushioning and insulative properties. Other properties may be obtained with the aid of specific additives to the spinning solution.

Fig : 7 Flow Chart of Manufacturing Process of Polyester



Drawing the Fibre:

Upon extrusion from the spinneret, the polyester filament does not have all the desired characteristics because of the random arrangement of the super polymer molecu1es. The fibres are therefore drawn, or elongated, with the aid of godet wheels. The temperature conditions and the extent to which the fibres are drawn depend upon the properties desired. The polyester fibres are usually drawn to 5 times their original length (which results in a fibre diameter that is one-fifth the original size upon extrusion from the spinneret).

6.4 Types of Polyester Yarn:

The diameter of the polyester yarn is determined by

- The rate of extrusion of the filaments from the spinneret,
- The number of Spinneret holes and therefore the number of filaments, and
- The rate of drawing of the filaments. The yarns come in a wide range of diameters and staple lengths.

The yarns are produced, basically as monofilament, multifilament, and spun and some times the textured yarns are also produced.

6.5 Evaluating Polyester Fabrics:

The two major forms of polyester (PET and PCDT) have certain differences between them. These differences are principally mechanical attributes rather than chemical. Hence, some of the properties are general, others are specific.

Physical properties:

Shape and appearance:

These fibres are generally round and uniform. The fibre is partially transparent and white to slightly off- white in colour.

Strength:

As a group, polyester fibres may be characterized as relatively strong fibres. The PET polyesters are, in general stronger than the PCDT Kodel 200 series polyesters hence polyester is found in the industrial uses and the highly durable fabrics.

Elasticity:

Polyester fibres do not have a high degree of elasticity, although PCDT polyester is more elastic than PET polyester. In general, polyester fibre is characterized as having a high degree of stretch resistance, which means that polyester fabrics are not likely to stretch out of shape too easily.

Resilience:

Polyester fibre has high degree resilience. PCDT polyester is resilient than PET polyester. Not only does a polyester fabric resist wrinkling when dry, it also resists wrinkling when wet.

Drapability:

Fabrics of polyester filament have satisfactory draping quality. Polyester can produce spun yarn are flexible and softer, thereby the draping quality.

Heat Conductivity:

Fabrics of polyester filament better conductors of heat. Polyester staple crimped and this does provide greater insulation in the yarns and fabrics. One of the reasons for the apparent greater warmth of polyester is its low absorbency. However, polyester crimped fibre fill or hollow staple variants can provide bulk and insulative properties.

Absorbency:

Polyester is one of the least absorbent fibres. This low absorbency has important advantages – they will dry very, suited for water-repellent purposes, such as rain- wear, and will not stain easily.

Fabrics of low absorbency generally have the disadvantage of being clammy and uncomfortable in humid weather because they will not absorb perspiration or atmospheric moisture.

Dimensional stability:

If polyester is properly heat set, it will not shrink nor stretch when subjected to boiling water, boiling cleaning solvents or ironing temperatures that are lower than heat setting temperatures.

Shrinkage:

Polyester fabrics shrink as much as 20% during wet-finishing operations and they are generally heat-set in later treatments. Consequently, finished polyester woven and knitted fabrics will not shrink. They have excellent dimensional stability

Cleanliness and washability:

Since polyester fibres generally are smooth and have a very low absorbency, many stains lie on the surface and can easily be washed by hand or machine. However, oil stains are more stubborn and under certain circumstances cannot be entirely removed. When ironing polyester fabrics, it is best to use low to medium heat.

Chemical properties:

Reaction to Alkalies:

At room temperature, polyester has good resistance to weak alkalies and fair resistance to strong alkalies. It reduces with the increase in the temperature and the concentration of the alkalies.

Reaction to Acids:

Depending upon the type, polyester has excellent-to-good resistance to mineral and organic acids. Highly concentrated solutions of a mineral acid, such as sulfuric acid, at relatively high temperatures will result in degradation

Effect of Bleaches:

Fabrics of polyester may be safely bleached because polyester has good resistance to deterioration to household bleaches. If the polyester have an optical brightener, no bleaching is necessary.

Effect of Heat:

Depending upon type, polyester will get sticky at 440F (227-242°C). Therefore, if ironing, it should be done at lower temperatures.

Effect of Light:

Polyester has a good resistance to degradation by 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.

Resistance to Mildew:

Polyester fabrics are absolutely resistant to mildew. If it formed it is due to the finishes given.

Resistance to Insects:

Polyester is unaffected by moths, carpet beetles, silverfish, or other insects.

Affinity for Dyes:

Polyesters can be dyed with appropriate disperse, azoic, and developed dyes at high temperatures, producing a good range of shades and Colorfastness. Solvent dispersion-dye also has good color fastness.

Resistance to Perspiration:

Polyester has no significant loss of strength from continued contact with either acid or alkaline perspiration.

Burning test and flammability:

The polyester is like a nylon with draw from flame before ignition so they do not flash burn. They melt and dip and the flame is carried down with the dip. A black bead forms when the melt hardens.

Polyester blends:

Polyester cotton blend, polyester wool blend, polyester rayon, polyester silk blend polyester triacetate blend, polyester and nylon are some of the common blends.

6.6 Uses of Polyester:

The most important use of polyester is in *woven fabrics*. Frequently, spun yarns blended with cotton are seen. Most of the woven fabrics are polyester/cotton blends made into durable-press fabrics. 65% polyester/ 35% cotton blends, 50% polyester 50% cotton are most commonly seen blends in the women wear. These blended fabrics are attractive, durable, and comfortable (except in very hot and humid conditions), retain their appearance well, and are easy care.The first use of staple polyester was in tropical suiting for men’s summer suits. The suits were light in weight and machine washable, something unique in men’s clothing.

Woven fabrics are very important not only in apparel but also in home-furnishing uses-polyester and polyester blends are widely used in sheets, blankets, bedspreads, curtains that match bedspreads, mattress ticking, and tablecloths. They are being used in more upholstery fabrics.

Polyester accounts for about 7 percent of carpets that are produced. When they were introduced, polyester carpets had a softer hand than most nylon carpets. The second important use of polyester is in *knitted fabrics*. Slightly more filament yarns than spun yarns are used. Polyester as well as polyester/ cotton blend yarns are used.

The third important use of polyester is in a specialized area-*fibrefill*. Used in pillows, comforters, bedspreads, other quilted household and apparel fabrics, and winter jackets, polyester has captured the major share (85 percent) of the market.

Non-woven fabrics are the fourth important use of polyester. Sewn-in interfacings, fusible interfacings, pillow covers, and mattress inter-linings are examples of uses for non-woven polyester fabrics.

Polyester is chosen for many other consumer and *industrial uses* - pile fabrics, tents, ropes, cording, fishing line, cover stock for disposable diapers, garden hoses, sails, seat belts, filters, fabrics used in road building, seed and fertilizer a bags; artificial arteries, veins, and hearts; and sewing threads (polyester /cotton core-spun thread, 100% spun polyester thread). Research is being done to increase the ways polyester is used industrially. Tire cord use of polyester. Polyester has taken a large share of the new tire market away from nylon because polyester tires do not "flat spot" like nylon tires do.

Summary:

Consumers are more aware of the fibre content of their garments with polyester & its blends. The man-made fibres with non-cellulosic base like polyester have the following plus qualities (unless the structure of the fibre is modified)

1. Dimensional stability
2. Strength & durability
3. Ease of care
4. Wrinkle resistance
5. Comfort & fit (elasticity)
6. Resistance to moths & mildew

Exercise:

1. Why do consumers buy polyester fabrics?
2. Explain the manufacturing of polyester with flow diagram?
3. Define the following

   a) Monofilament b) Multifilament c) spun polyester

   d) Textured yarn
4. List out the common blended fabrics available with polyester in the market?
5. Forecast the uses of polyester in different fields?

CHAPTER - 7

YARNS

7.1 Introduction:

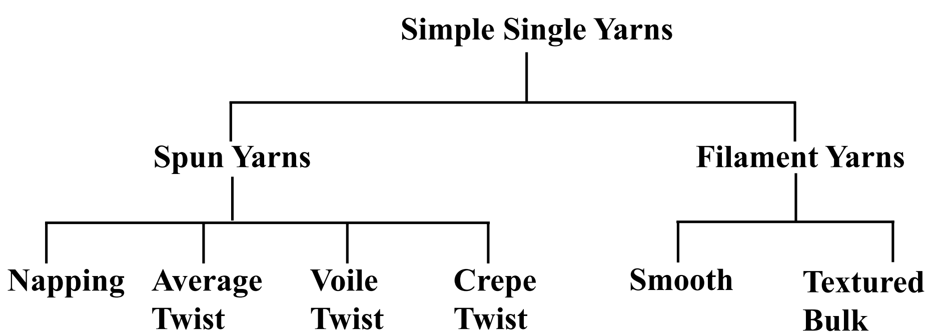
There are different types of yarn, each having its own characteristics. These characteristics vary according to the construction and the treatment given in the manufacture of the yarn. Yarns play a very important in determining the hand and performance of the fabric. Yarn is the generic name for the assemblage of fibres that is laid down or twisted together.

DEF: A *yarn is a continuous strand of textile fibres, filaments, or material in a form suitable for knitting, weaving or otherwise intertwining to form a textile fabric – ASTM 1984*

7.2 Classification of Yarns:

7.2.1. According to Length of Fibres Present In Yarn:

Yarns can be broadly classified as **staple-spun yarns** or **continuous filament yarns.** Spun yarns consist of staple fibres assembled and bound together by twist to produce the required characteristics such as strength, handle and appearance.



(Source: Norma, 1988)

Spun Yarns:

Spun yarns are made from staple fibres that are twisted together. Spun yarns are characterized by protruding fibre ends. Spun yarn strength is dependent on the cohesive or the clinging power of the fibres and on the points of contact resulting from pressure of the twist. The greater the number of points of contact, the greater is the resistance to the fibre slippage within the yarn.

They are suited to clothing fabric in which absorbency, bulk, warmth, or cotton like or wool like textures is desired. The fibre ends hold the yarn away from close contact from the skin; thus a spun yarn is more comfortable on a hot humid day than a fabric of smooth filament yarns. Protruding ends contribute to a dull fuzzy appearance, to the shedding of lint, to the formation of pills on the surface of the fabric. They soil readily and give more cover.

Filament Yarns:

The range of filament yarns is as diverse as that of spun staple yarns. The filaments yarns are divided into two type's viz., **flat continuous** filament and **textured continuous** filament yarn.

(a) Continuous filament yarns are produced from long continuous filaments. Filament yarns are primarily man-made since silk is the only natural filament and accounts for less than 1% of the fibre and yarn production. Regular or conventional filament yarns are smooth and silk like as they come from the spinneret. Their smooth nature gives them more luster than spun yarns, but the luster varies with the amount of the delustering agent used in the fibre spinning solution and the amount of twist in the yarn. Filament yarns have no protruding ends, so they do not shed lint; they resist pilling; and fabrics made from them tend to shed soil and have less cover (less opaque).

(b) Textured continuous yarns are man made continuous filament yarns that are been modified by subsequent processing to introduce crimps, coils, loops or other distortions into the filament or with high twist or low twist. The addition of twist increases bulk. Texturing gives slippery filaments the aesthetic property of spun yarns by altering the surface characteristics and creating space between the fibres. It also improves the thermal and moisture absorption of filament yarns.

7.2.2. According to the Number Parts Present in Yarn:

1. Simple Yarns:

A simple yarn is alike in all its parts. It can be described as spun or filament yarn based on the length of fibres present. The number of parts it has also can describe a simple yarn by the direction and amount of twist in the yarn and by the size of the yarn.Simple yarns are classified as single, ply, and cord.

(a) A **single yarn** is the product of the first twisting operation that is performed by the spinning machine. Spun, filament and textured yarns are each examples of simple, single yarns.

(b) A **ply yarn** is made by a second twisting operation, which combines two or more singles. Each part of the yarn is called a ply. Plying tends to increase the diameter, strength and quality of the yarn. Ply yarns are commonly used in the warp direction of woven fabrics to increase the strength of the fabric. These ply yarns are used in men's shirts women's sweaters. Two ply and three-ply yarns are found in sewing threads.

Table: 3 End Uses of Plied Yarns:

2 - Fold	3- Fold	Multi - End
Poplins Voiles Gabardines Crepes Lace Sewing thread	Sewing threads Industrial yarns Canvas as Conveyor belts Hosiery	Industrial yarns Braids Electrical Insulation Shoe laces Embroidery

(Source: Wynne)

(c) A **cord/ cable** is made by a third twisting operation, which twists ply yarns together. Some types of sewing threads ands some ropes belong to this group. Cords are seldom used in apparel fabric, but used in industrial weight fabrics

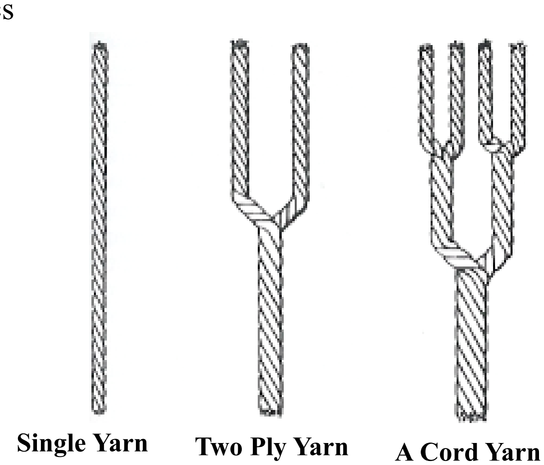
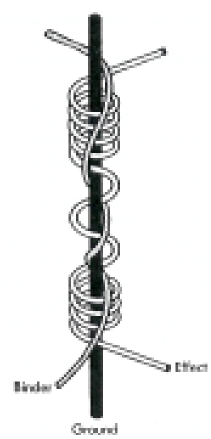


Fig : 8 Types of Yarns

Table: 4 End Uses of Corded Yarns:

Fine	Coarse
Fine sewing threads Crochet yarns Nets	Industrial cords Heavy Swing threads Tyre cords Nettings Fishing lines

Fig : 9 Yarn and its Parts:



Double Yarns:

This consists of two or more single strands treated as one in the weaving process, but the strands are not twisted together. These are used for ornamental effect as the low twist yarns produce luster and softness.

7.3 Novelty Yarns/ Fancy Yarns

May be defined as yarns that have -and that are irregular at regular intervals. They may be single, plied, or cord may be spun, filament, or textured combination of yarn types. These yarns are called as novelty yarns, because of their appearance; they lend an interesting or novel effect to fabrics made with them. Fancy yarns have been more common in drapery and upholstery fabrics than apparel fabrics.

Novelty yarns are made with twisters with special attachments that allow loose, curled, twisted, or looped areas in the yarn. Novelty yarns are usually ply yarns. If novelty yarns are used in only one direction, they are usually in the filling direction.

Novelty yarns interest to the plain weave fabrics at lower cost than if effects were obtained from weave. Novelty yarn effects are permanent. Novelty yarns are usually composed of – a base or ground, an effect, a tie or binder yarn. Base yarn controls length and stability of end product. Effect yarn forms the design or effect. Tie yarn holds effect yarn so that it will remain in position.

7.3.1 Types of Novelty Yarns:

Slub yarn: This is a thick and thin yarn made by varying the amount of twist in the yarn at regular intervals. They are found in drapery and upholstery fabrics.

Flock yarn: These are frequently called as Flake yarns. These are usually single yarns in which small amounts of fibres either different colours or luster or both are inserted into the yarn and held in place by twist of base yarn. Eg., tweed fabric. This gives a spotted and short streaky appearance.

Thick and thin yarns: These are similar to slub yarns but these are made from filament fibres unlike slub preparation from staples. The pressure forcing the spinning solution is varied the filament are thick in some places and thin in some.

Boucle yarn: These are characterized by tight projecting from the body of the yarn at fairly regular intervals. They are 3 ply yarns. The effect yarns forms irregular wavy surface and binder ties it to the base. It has a twisted core yarn.

Loop and curl yarn, gimp yarn: Gimp is same as boucle but the effect yarn is regular semi circular appearance, while in loop

Ratine: Similar to boucle but the loops are close in ratine and the loops are also smaller and are securely twisted. These yarns have rough surface appearance. The manufacturing requires 2 steps- after the yarn is first made, it is twisted in the opposite direction to establish the desired effect.

Snarl yarn or spike yarn: This is made in the same way as loop yarn using a highly twisted effect yarn, which forms snarls rather than loops.

Knop (button) yarn / Knot / Nub / Spot yarn: This feature prominent bunches of one or more of the component yarn at regular or irregular intervals. This is made on a special machine that permits the base yarn to be held almost stationary while the effect yarn is wrapped around it several times to build upon enlarged segment with brightly colored fibres added at the enlarged knot.

Seed or splash: They resemble knops or knot yarns but the knot segments are tiny in seed yarn and elongated in splash yarn.

Cloud: A two colored yarn, in which both yarns take it in turn to obscure or cloud the other, giving the appearance of an intermittent color change.

Spiral or corkscrew / Eccentric: It is made by twisting together two piles that differ in size, type, or twist. These two parts may be delivered to the twister at different rates of speed.

Chenille Yarn: These create special effects. Chenille means caterpillar in French. The yarn has a cut pile effect which is bound to the core on the loom warps are arranged in groups (2-6) which are interlaced in a cross weaving manner. Weft is inserted in normal manner. These are cut into wrap way threads.

Core and Metallic yarns: Though they do not conform to the strict definition of complex yarns but they have surface design and so are included here.

(a) Core spun yarns: In those the foundation yarn is completely encircled or wrapped by a second yarn. Eg., core- rubber wrapped by a second yarn – cotton. This gives comfort and durability. Silk wrapped with gold or silver.

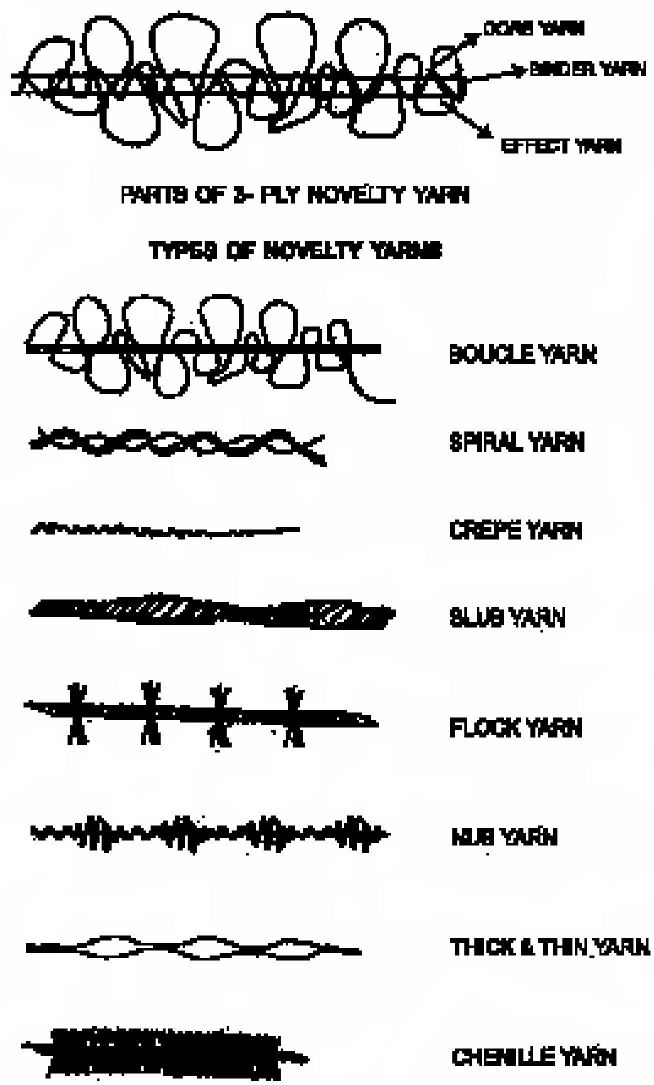
(b) Metallic yarn: These are primarily decorative. The plastic coating on it resists tarnishing, but care must be taken while pressing, as pure metals are soft, their thin films are used over a core yarn that has replaced gold and silver now. There are two methods of pressing;

The metal may be encased in a plastic coating of either polyester or cellulose acetate butyrate. Color is applied to plastic coating or directly to the aluminum with adhesive.

In this method mixing of finely ground Al, color and polyester and then laminating this to clear mylar Polyester.

of twists is referred to as *turns per inch.* They have a direct bearing

Fig : 10 Novelty Yarns



7.4 Effect of Yarn Types on Fabric:

7.4.1 Count:

Yarn number varies and it differs according to the kind of fibre. Many weaving yarns and sewing thread are numbered by the cotton system (count). Spun yarn size is referred to as number and is expressed in terms of length per unit of weight. It is an indirect system; the finer the yarn, the larger the number. The count is based on the number of hanks (1 hank is 840 yards) in 1 pound of yarn. In this system the unit of weight is remained constant.

Count = Length / one pound,
Count = No. of hanks X 840 yards / one pound.

7.4.2 Denier:

Filament yarn size is dependent partly on the size of the holes in the spinneret and partly on the rate at which the solution is pumped through the spinneret and the rate at which it is withdrawn. The size of filament yarns is based on the size of the fibres in the yarn and the number of those fibres grouped into the yarn.

The size of filament yarns is determined as *denier,* which is expressed in terms of weight per unit of length. If 9000 metes of yarn weigh 1 gram, it is then 1 denier. In this system, the unit of length remains constant. The finer the yarn, the smaller is the number

Denier = weight of yarn in gms/ 9000 meters
1 denier - 9,000 meters weigh 1 gram i.e,

7.4.3 Tex System

The International Organization for Standardization has adopted the Tex system, which determines yarn count or number in the same way for all fibre yarns and uses metric units (weight in grams of 1 thousands meters of yarn

Tex = weight in gms / 1000 meters of yarn

7.4.4 Yarn Twist:

Twist is the spiral arrangement of the fibres around the axis of the yarn. Revolving one end of a fibre strand while the other end is held stationary produces twist. Twist binds the fibres together and gives thespun yarn strength. It is a way to vary the appearance of fabrics.The number of twists is referred to as *turns per inch.* They have a direct bearing on the cost of the

Twist is the spiral arrangement of the fibres around the axis of the yarn. Revolving one end of a fibre strand while the other end is held stationary produces twist. Twist binds the fibres together and gives the yarn because higher twist yields lower productivity.

Direction of Twist:

The direction of twist is described as S-twist and Z-twist, A yarn has S-twist if, when held in a vertical position, the spirals conform to the direction of slope of the central portion of the letter "S," It is called Z-twist if the direction of spirals conforms to the slope of the central portion of the letter "Z," Z-twist is the standard twist used for weaving yarns. The majority of single yarns are spun with the twist in the Z direction.

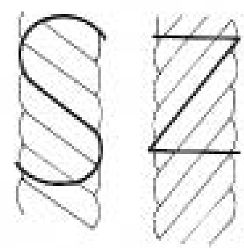


Fig : 11 S - Twist Z - Twist

Amount of twist:

The amount of twist varies with

(1) The length of the fibres,

(2) The size of the yarn,

(3) The intended use.

Increasing the amount of twist up to the point of perfect fibre-to-fibre cohesion will increase the strength of the yarns. Too much twist places the fibres at right angles to the axis of the yarn and causes a shearing action between fibres, and the yarn will lose strength. Fine yarns require more twist than coarse yarns.

Low twist:

2-3 turns per inches in spun yarns results in lofty yarns. This type of twist allows for napping of the fabric.

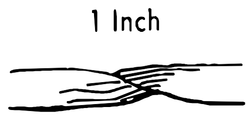


Fig: 12 Low Twist

Average twist is frequently used for yarns made of staple fibres and is very seldom used for filament yarns. The amount of twist that gives warp yarns maximum strength is referred to as standard warp twist.

Hard *twist* (voile twist) yarns have 30-40 turns per inch. The hardness of the yarn results when twist brings fibres closer together and yarn more compact. This effect is more pronounced when a twist-on-twist ply yarn is used. This means that the direction of twist in the singles is the same as that of plying twist.

Fig :13 Twist on twist 2 - Ply Yarn

Crepe yarns are made of with either staple or filament fibre. Crepe is a French word, meaning crinkle. They are made with a high number of turns per inch (40-80) inserted in the yarn. This makes the yarn so lively and kinky that it must be twist-set before it can be woven or knitted. Filament crepe yarns are used in fabrics like Georgette and chiffon.

Summary:

The type of yarns used has an effect on the fabric texture, hand, warmth, weight, resiliency, durability & luster.

Specifications for a particular yarn are determined by end use of the fabric. Yarn differs in weight and fineness and in smoothness, fuzziness, and elasticity all varied to create qualities required in the final fabric yarns may be classified according to structure or use.

Exercise:

1. What is a yarn?
2. What is the difference between spun and filament?
3. Define novelty yarns? What are the different types of novelty yarns?
4. What are the three parts of a yarn? Describe with diagram?
5. Define the following terms

   a) Count b) Denier c) Twist

CHAPTER - 8

WEAVING

8.1 Introduction

A fabric is a pliable, plane- like structure that can be made into garments and household textiles, and for the industrial uses. Fabrics are made from the solutions, fibres, yarns, and combinations of these elements with a previously made fabric or cloth. Fabrics are usually available to the consumer by the yards or meters.

The fabric–forming/ construction process determines the appearance and texture, the performance during use and care, and the cost of a fabric. The process often determines the name of the fabric; for example- felt, lace, double knit, and jersey. The cost of fabrics in relation to the construction process depends upon the number of steps involved and the speed of the process; the fewer the steps and the faster the process the cheaper is the fabric. The fabric construction methods include; weaving, knitting, lace making, felts, and non-woven.

Two or more sets of yarns are interlaced at right angles to each other to make into fabrics are called as weaving. The fabrics made of weaving are termed as woven fabrics. The yarns running parallel to the length of the fabric are called *warp yarns* or *ends*. Those running perpendicular or across to the warp yarns are called *weft yarns* or *picks or filling* yarns. Weaving is done on a machine called a *loom.*

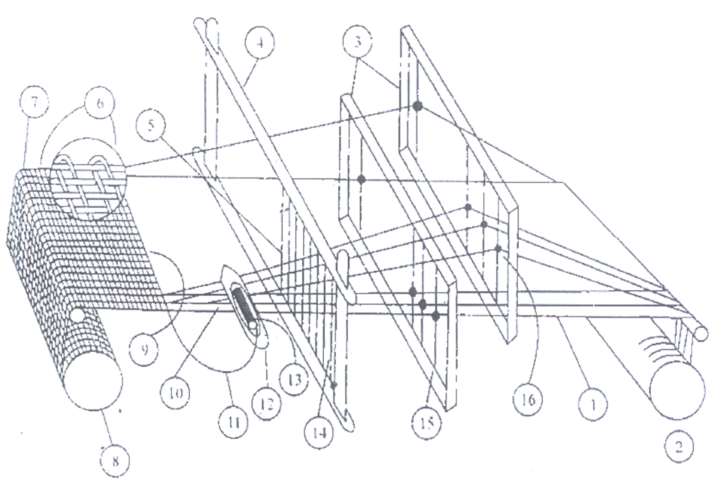


Fig: 14Structure of the loom and its parts

1. Warp yarn
2. Warp beam
3. Harness
4. Batten
5. Reed
6. Selvedge
7. Woven cloth
8. Cloth beam
9. Fell or edge of the cloth
10. Shed
11. Weft
12. Shuttle
13. Bobbin
14. Dent
15. Heddle
16 Heddle eye

8.1 Parts of the modern Loom:

- *Warp beam* – located at the back of the loom on which the warp yarns are wound holding the warp yarns between them.
- A *harness* - is a frame to hold the heddles.
- A *heddle* - is a wire with a hole in the center through the warp yarn goes. There are as many heddles as there are warp yarns in the cloth, and the heddles are held in two or more harnesses. The warp is raised and lowered by a harness – heddle arrangement. When the harness is raised *shed* is formed through which the filling yarn can be inserted.
- A *shuttle - carries* the filling through the shed.
- A *reed* or *batten* - beats the filling yarn into the cloth to make the fabric firm. A *reed* is a set of wires in the frame and the spaces between the wires are called as *dents.*
- *Cloth beam* – which is located at the front of the loom nearest to the weaver on which the woven cloth has been wound.

8.2 Loom Motions:

1. *Shedding:* Raising one or more harnesses to separate the warp yarns and form a shed.
2. *Picking:* Passing the shuttle through the shed to insert the filling yarn.
3. *Beating up:* Pushing the filling yarn into place in the cloth with the reed.
4. *Let off:* Warp yarns are released from the warp beam so that weaving may be carried out.

5. *Take up:* Winding finished cloth on the cloth beam

8.3 Characteristics of woven fabrics:

Yarns:

Warp and filling have different characteristics, and the fabric performs differently in the warp and filling direction. Stronger yarns are used in the warp- wise direction, as they undergo more tension and friction than weft yarns.

Most fabrics stretch less in the warp direction. The warp yarns lie straighter in the fabric because of loom tension. They show less crimp. Decorative or special function yarns, yarns with slack twist; yarns with little twist are usually the filling. Warp yarns tend to be smaller, with higher twist.

Grain:

The grain indicates the direction of the warp or weft yarns. Lengthwise grain is a position along the warp yarns. Crosswise grain is along the filling yarn.

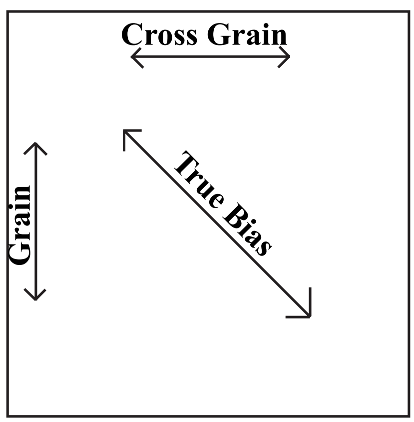


Fig: 15 Indication of Grain on the Fabric

Fabric Count/ Thread Counts:

Fabric count or count is the number of warp and filling yarns per square inch of gray goods. Count is written with the warp number first and followed by weft number. Fabric count is an indication of the quality of fabric - the higher the count, the better the quality for any one fabric and less potential shrinkage and less raveling of seam edges.

Balance: Balance is the ratio of the warp yarns to filling yarns in a fabric. A fabric is said to be well balanced if the number of warp yarns and filling yarns are almost equal,

For example, a piece of muslin with a thread count of 64 x 60 is considered well balanced.

Selvedge:

The lengthwise finished edges where yarns are closely packed are called *selvedges*. It is the self-edge of a fabric formed by the filling yarn when it turns to go back across the fabric. The conventional loom has the selvedge on both sides of the fabric. Usually the selvedge can be done in four different ways – *Plain Selvedge* (similar to the rest of the fabric), *Tape Selvedge* (*done* with larger or pile yarn to give strength), *Split Selvedge* (done for narrow width fabrics after cutting and finished with the machine chain or hem) *Fused Selvedge* (heat sealed edges of ribbon).

Fabric Width:

The loom determines the width of the fabric. It is measure from selvedge to the selvedge. Hand woven fabrics are generally 27-36 inches wide.

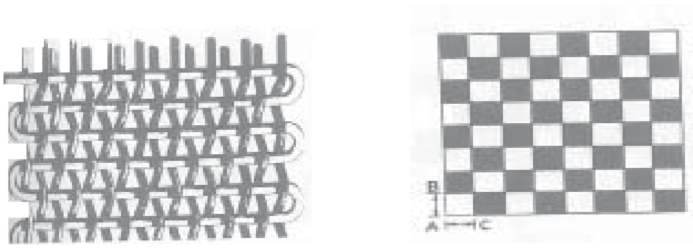
8.4 Weave Types

A *Weave* describes the pattern in which the warp and the weft yarns are interlaced. The weaves are generally classified into *Basic weaves and Complex weaves.*

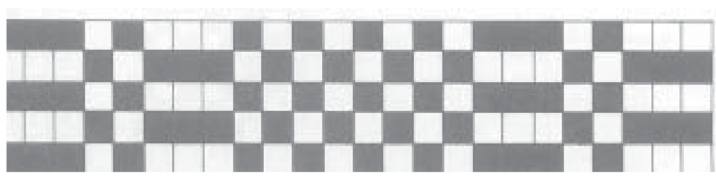
8.4.1 Basic Weaves: There are three basic weaves – *Plain weave, Twill weave and, Satin weave.*

Plain weave: It is the simplest weave having the most basic interlacing; each weft goes over a warp and then under a warp yarn. It gives the firm flat structure. The fabric looks alike from the face and back and is therefore reversible. Using different colored yarns in warp and weft direction can create checks and stripes. The two main variations of the plain weave are *Basket weave, Rib weave.* In basket weave two or more yarns are taken as one and are interlaced in plain weave pattern. Whereas, rib effect is produced by using several yarns as one or a thick yarn in either warp or weft direction which create ridge like effect.

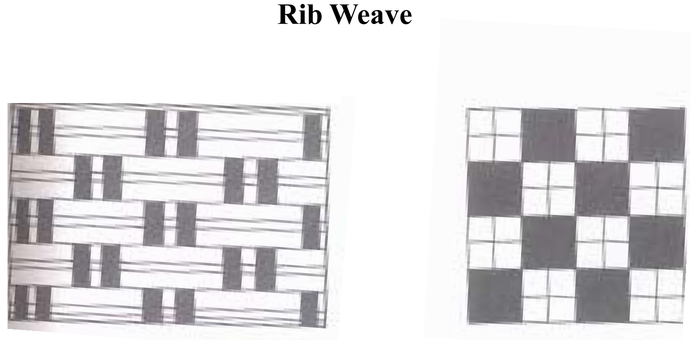
Fig: 16 Types of Weaves



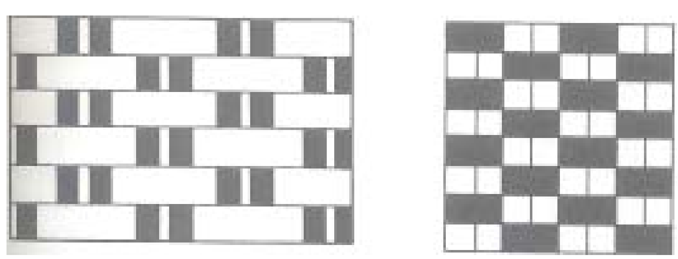
Plain Weave



Rib Weave

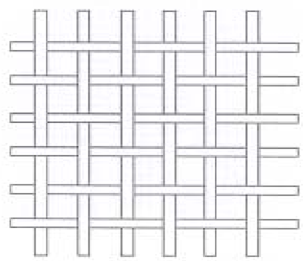


Basket Weave (2/2)

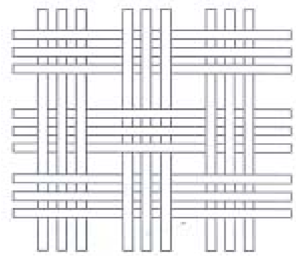


Basket Weave (2/1)

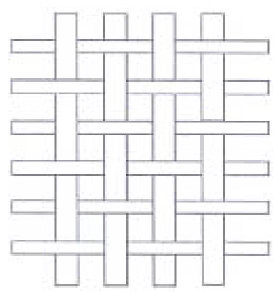
Plain Weave



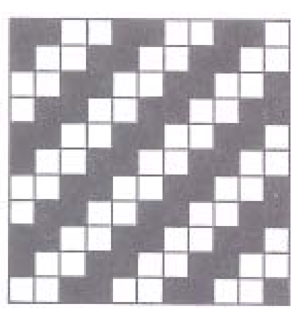
Basket Weave



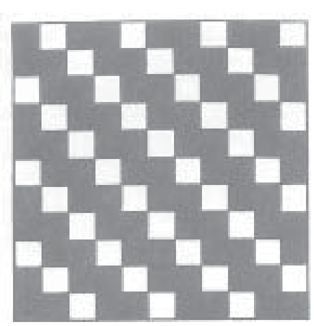
Rib Weave



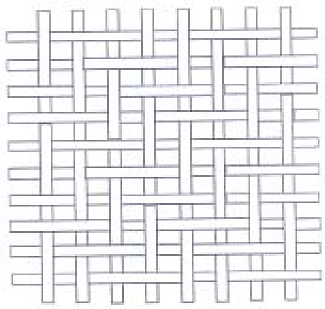
Twill Weave: A twill weave is characterized by diagonal lines on the face or the back of the fabric. For example denim. This weave requires a minimum of three harnesses for manufacturing. High strength and compact weaving characterize twill weave. These fabrics have good abrasion resistance and are durable. The direction of the twill can be varied to create interesting effects such as right hand twill weave, left hand twill weave, broken twill weave, pointed twill, herringbone etc.,



Right Hand Twill

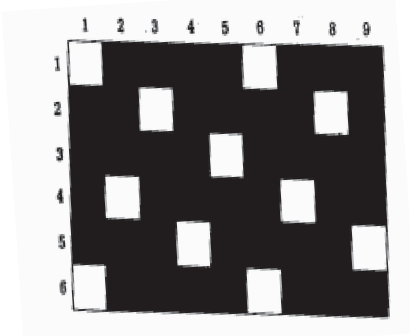


Left Hand Twill

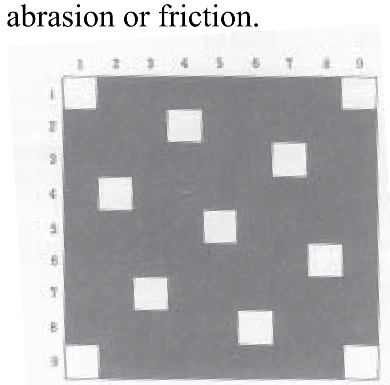


Twill Weave

Satin Weave: Satin weave is characterized by a smooth, shiny and slippery surface created as a result of long floats present on its structure. Satin weave requires 5 to 12 harnesses. These fabrics have low durability as the floats on the surface get damaged with abrasion or friction.

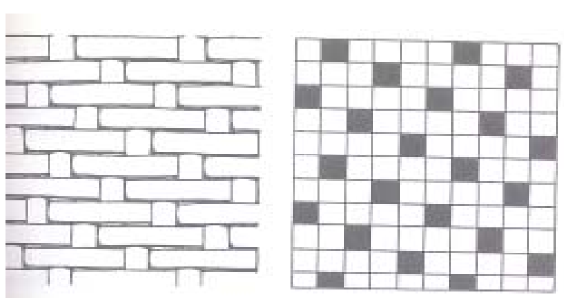


Four Float Satin Weave



Seven Float Satin Weave

Sateen weave: Sateen weave is characterized by a smooth, shiny and slippery surface created as a result of long floats on filling side of the fabric present on its structure.



Short Float Sateen Weave

Cloths made in satin & sateen weaves:

The materials that are made with the satin weave are antique satin (millions of yards per year), bridal satin, cotton satin, dress satin, satin bengaline, satin crepe, satin faille, slipper satin, and Venetian satin. Sateen is made in the sateen weave.

Summary:

The type of yarns used has an effect on the fabric texture, hand, warmth, weight, resiliency, durability & luster.

Specifications for a particular yarn are determined by end use of the fabric. Yarn differs in weight and fineness and in smoothness, fuzziness, and elasticity all varied to create qualities required in the final fabric yarns may be classified according to structure or use.

Exercise:

1) Construct designs for variations of the plain weave and twill weave?
2) Describe the various parts of a loom and basic loom structure?
3) Explain the basic loom operations?
4) Give differences between
    a) plain and twill
    b) pain and satin
    c) warp and weft
5) Define the following
    a) Balance of the cloth
    b) Fabric width
    c) Grain
    d) Thread count
    e) Selvedge

CHAPTER - 9
SOAPS AND DETERGENTS

9.1 The origin of soap

Soap is the most widely used cleanser of fabrics. The origin dates back ground the age of written records. A legend has it that at Sappo Hill, near ancient Rome, fatted calves and lambs were burnt as sacrifices to the Roman gods. The malted fat or tallow from these burnt animals ran down the side of the hill to the river's edge, where Roman women did their washing. After a time these Roman women noticed that there was a kind of substance on the ground which when noticed that there was a kind of substance on the ground which when used with water helped them to get their clothing cleaner. At first they thought that Sappo Hill had divine power, but after a time they discovered that a combination of fat with alkali potash produced a material with cleansing qualities. The wood ashes from the sacrificial fires on Sappo Hill, mixed with the drippings from the sacrificial fires on Sappo Hill, mixed with the drippings from the fat of the burnt animals, naturally provided the necessary ingredients (alkali and fat) or what has since been known as soap.

9.2 Manufacture of Soap:

Whatever method of manufacture is employed, there are two basic phases in soap-making. Firstly the production of soap in molten form and secondly the shaping of the molten soap into different sorts of finished products – hard soaps, toilet soaps, powders, flakes etc.

Full Boiled Process in Making Soap:

Most of the soap marketed today is made by this process. This method requires close attention and control. The fatty stock, concentration of alkali of alkali solution, temperature, amount of salt and time of setting are all influencing factors.

Briefly it consists of the following steps:

(i) Emulsification of the oil mixture with the caustic soda solution of suitable strength

(ii) Actual saponification, a process which takes place when a fat is acted upon by caustic alkali. The fat is split up into fatty acid and glycerine, and the fatty acid combines with the alkali to form soap.

(iii) Graining or the separation of the soap from unused alkali and glycerine formed in the reaction

(iv) Closing of fitting, where the level of salt is finished soap is brought down.

Step one: The natural fats are melted**,** the imparities allowed to settle, and the clear fats run or are pumped with the soap into kettles and heated with an open steam coil. A 10 to 15 percent solution of caustic soda is added. The mixture is further heated by steam until the saponification is about 90-95 percent complete. Boiling may be continued for two or three days.

Step two: The reaction mass in the soap pan now contains soaps, glycerine, excess alkali, water and organic impurities. Salt is now added to the mass. This makes the thick liquid soap rise to the top. The liquid underneath is a mixture of salt, glycerine and unused alkali, which is known as 'spent lye'. The steam is now turned off. The soap curd which rises to the surface is allowed to collect for a while and then the 'spent lye' below is drawn off, and glycerine recovered from it. The soap is then boiled with water or steam to make it into a paste again.

Step three: The soapy layer will contain a certain amount of unsaponified fat, so it is boiled again with more soda to make certain of complete saponification. The mixture is allowed to settle and the half 'spent lye' sinks to the bottom. This contains excess alkali with a small amount of glycerine and salt from the last process. This is used with fresh alkali in the next soap making.

Step four : soap is again boiled with more water and steam, and after standing, 4 layers will separate out the top layer which is forth is skimmed off and the neat soap below is tapped out of the kettle by means of a swing pipe into a crunch which again is nothing but a mechanical mixer. The third layer, known as 'nigre' consists of impure dark coloured soap solution, and at the bottom is some alkaline liquid.

Step five: The next hot soap in the pan is mixed with either sodium silicate solution or sodium carbonate which may not exceed about 4-5% expressed as sodium carbonate or silicate. Additions such as colouring matter, scent, may also be added when the liquid soap is in the pan. After through mixing,

Step six: The cooled soap which will be in the form of blocks is then out by means of machine into slabs and then into bars and tablets by used of machines and finally stamped.

Step seven:

Genuine soap contains about 30% water and 60-64% combined fats, as in fresh bar soap.

9.3 Composition:

Soaps are sodium salts of fatty acids.

1. Soap is made from a combination of fat or oil with an alkali. Both animal and vegetable fats are used in the manufacture of soap. The former include tallow, grease, and olein, and the latter, coconut, cotton seed, castor, linseed, olive, soybean, palm and oils.
2. Sometimes naphtha and little mineral oil, such as paraffin oil, may be added to help in its cleansing properties and in the removal of grease.
3. Resin and naphthelic acids (obtained from petroleum) may also be added to improve the effectiveness of soap. Their presence makes the soap yellow and translucent. These products being cheaper than soap the cost is reduced. The chief drawbacks of resin are that it has less cleansing power than soap and is also likely to cause discoloration in white articles, especially when combined with calcium from hard water.
4. The chief alkalies used in soap manufacture are caustic soda and caustic potash.
5. Water is present in all soaps- the percentage varies with different soaps.
6. Other substances include disinfectants, such as carbolic, solvents as in solvent soaps, and substances used for filling, such as sodium silicate and sodium carbonate (washing soda) and phosphate. Sometimes certain colloidal clays and colloidal organic materials and cleansing powders are added to soaps. They serve both as detergents and as mechanical aids in cleaning operations. These together with certain mineral oils, waxes and starches are often added for the express purpose of cheapening the soap, when they are regarded as 'fillers'.

The cold process:

This is a quick method of soap-making. Coconut or palm leaf oilis acted upon by caustic soda. The well proportioned mixture is stirred well for some 24 hours, during which heat, given out by the chemical action, prevents it from hardening. Cold process is essentially suited for small initial outlay required for the plant and the simplicity and speed of the entire process. The soaps produced are hard and contain glycerine. They also contain free caustic soda. Soaps of this type not only are cheap to make but also have the advantage of forming good lathers in both cold water and in hot water. Coconut and palm oil soaps are soluble in salt water also. Hence their special use is as marine soaps.

9.4 Properties of Laundry Soap:

It is surprising how many kinds of soap may be positively harmful. The housewife is often faced with soaps of an unknown quality which ought never to have a place in laundry work.

Good laundry soap especially suitable for washing clothes should be used for cleaning. The soap purchased for wool work should be free from alkali. Even one percent alkali is enough to be disastrous on coloured skills for instance. The quality of soap can be judged in the following way:

1. The soap should be of clear pale colour. Dark coloured soap may contain impurities.
2. The soap should feel firm when pressed with the finger. If bar soap is softer than it should be, it may contain and excess of water, in which case it will be a wasteful in use.
3. Many hard soaps, especially cheap makes, owe their hardness to substances such as sodium silicate, with which they have been filled to disguise the low percentage of soap, which otherwise would make them soft.
4. On storage, good laundry soap dries with a firm unspeckled surface. Soap that develops white crystals on the surface should not be used, as this shows the presence of excessive alkali, which may be harmful to the fabric.
5. A rough but quite indicate test of good oil soap is first to break a bar across your knee, examine the fracture, and then taste it.

Although various types of soaps are available, they are broadly classified according to their 'strength'.

1. Mild soaps are those in which fat and alkali are in almost equal balance such as lux flakes.
2. 'All purpose' soaps have a greater proportion of excess or free alkali

Method of use: The correct amount of flakes should be measured out and dissolved in a little boiling water. The solution is poured into the given amount of water in the vessel and whipped up to form a good lather. It must be remembered that if any flakes remain undissolved when washing water is used (particularly in the case of woolen articles) Particles of soap may find their way into the fabric, resulting in the appearance of greasy marks on the garment.

9.5 Soap powder:

Soap powder is made of pumping molten soap blended with other ingredients, such as silicates and phosphates to the top of a tower through which either hot or cold air is blown. The soap, which is sprayed through high pressure nozzles into uprising currents of air, solidifies and falls as granules on to a conveyor belt at the bottom. The air is extracted by fans and any particles of soap carried over are trapped in a dust collection system and subsequently recovered.

A large variety of soap powders are available today. They consist of powdered soap and sodium carbonate. The amount of soap present may range from 5 to 30 percent. In the cheaper varieties sodium bicarbonate, sodium silicate and Fresh chalk may be included. They also contain bleach which acts through the release of oxygen.

Soap powder must be used carefully, according to the direction on the pocket. Although no apparent harm may be done in a single wash, the continued use of an inferior washing powder may gradually shorten the life of an article, and when the powder contains sodium silicate, lime and iron salts may be deposited on the fabric.

9.6 Soapnut or reetanut solution:

8 Oz. Reetanut

Two pints of boiling water.

The dry fruit is stored. It is excellent for washing coloured silks and cottons, but is not good for washing woolens or white silks.

Method: Crack the nuts, remove the seeds, breakup the shells, add boiling water, stir well use, when cold, instead of soap solution.

Value of reetanut : Reeta nuts are fleshy berries from either the 'Sapindus Mukorossi', a moderate sized tree, which grows in northern India, or the handsome tree 'Sapindus Laurifolius' which grows in central and southern India and Ceylon. The fruits of both trees behave similarly. Reetanut is slightly acid unlike soap, which is alkaline. Delicate fabrics like wool and silk often bleed even with the best of soaps like Lux, but do not do so with reetanut solutions, and wash better. This is because these fibres can withstand a trace of acid better than that of alkali.

The lather produced by the solution is better than that of soap, for it is less affected by the hardness of water than is soap. Reeta pulp is used by the soap industry.

The cleansing agent in reeta is saponin a compound of milk, sugar and sapogenin. The solution is excellent for washing gold and silver too. It is also used as a shampoo for the hair.

9.7 Shikakai:

Another of Nature's gift for cleansing fabrics is shikakai. It is a soap pod from 'Acacia' concina, a prickly bush found in south India. Its qualities and value are similar to the reeta. It is excellent for removing grease and washing coloures cottons and silks. The luster of silk is retained and the fabric gets back their new freshness.

A mixture of powdered reetanut and shikakai, soaked in warm water, makes an excellent hair shampoo.

The pod (dark chocolate brown in colour) is dried in the sun, and powdered fine. A tablespoon of powder is added to a pint of water and boiled to a thick paste.

Shikakai is often combined with reetanut powder to wash one's hair and also to clean silver ware and gold.

Non-Soap Detergent Products (NSD):

These non-soap detergent products are becoming popular today and are used as soap substitutes. Examples of NSDs are sodium salts of sulphonated fatty alcohols.

9.8 Soap less detergent:

Because of this problem of hard water and insoluble soaps, chemists have been working for many years to find new chemicals that would have all good qualities of soap but would give soluble salts calcium, magnesium and the other metals that are present in hard water. About 1930, German scientists found that certain organic derivatives of sulphuric acid had properties similar to soap, such as foaming, wetting and cleaning, but the calcium and magnesium salts of these derivatives were soluble in water.

During World War II, however fats and oils became very scarce and the production of soap became increasingly more difficult. But as soap less detergents could be produced from organic products not found in oils and fats, such as petroleum fractions, every effort was made to develop this new line of materials, since this early beginning, which was about 1940, the manufacture and use of soap less detergents has increased enormously. The great advantages they showed when used with hard water have helped the rapid growth of this new industry. Today there is a very large variety of soap less detergents in the market.

What is a detergent?

Most of us are familiar with the well known physical experiment in which a dry clean needle is placed very gently on the surface of a glass of water, and if care is taken, can be made to float for a very long time. This needle is buoyed up by the skin of outer molecules present at the water surface. If a tiny trace of soap or similar product is added to the water to the needle will immediately sink. This takes place because the soap dissolves in the water and changes the nature of the skin of outer molecules. We say technically that the surface tension of the water has been lowered. Both soaps and synthetic detergents can bring about this lowering of the surface tension of water. This is one of the important characteristics of a detergent. Thus soap is classified as a detergent just as are the so called ‘synthetic’ detergents like surf, rin det, point etc.

The word detergent is described in the dictionary as a ‘product that is capable of cleansing’. Thus one can understood why soap must be classified as a detergent. Soap, however, is made from natural fats, oil and waxes, while ‘synthetic detergents’ are made from chemicals that are produced synthetically in a chemical factory.

How detergents do their cleansing?

In the discussion on soap it was pointed out that the fatty acids were made up of a long chain of carbon atoms linked together with hydrogen atoms attached. We have used the letter 'R' as an abbreviation for this long chain. It was also pointed out that there was a carboxys group in which the hydrogen has been replaced by sodium or potassium. The 'R' part of the molecule is vaguely called the 'tail' of the molecule and the smaller – COONa or – COOK is referred to as the 'head'. If a small amount of soap is dissolved in a droplet of water it has been shown that the molecules of soap on the surface of the water droplet are water it has been shown that the molecules of soap on the surface of the water droplet are all arranged so that the 'heads' of the molecules point towards the center, while the 'tails' all stick outwards as if they were hairs, thus:

It is believed that the free 'tails' are capable of hanging on to dirt so that when we rinse away the soap we carry dirt away with it.

Speaking more technically, we say that the 'tail' of the soap molecule is 'hydrophobic' (which means water –repelling), which means water attracted.

9.9 Manufacture of soap less detergent

Surfactant ingredients:

Soap less detergent, which are made in both powdered and liquid form, are based on one of several types of surfactant. As we have seen, the most common in use in this country is that obtained by sulphonating alkylbenzene. The process is as follows:

The sulphonator cooler, oleum (fuming sulphuric acid), reacts with alkylbenze (a hydrocarbon) to give sulphonated alkybenzene (ahydrocarbon) to give sulphonated alkyibenze and sulphuric acid. Diluted with water, the sulphuric acid separantes and is removed to the spent acid tank. Caustic soda solution neutralizes the sulphonated alkybenzene, producing a paste.

A second group of surfactants used in soapless detergents is that of sulphated fatty alcohols. The difference between sulphonation and sulphanation is that in the former reaction the sulphur atom is linked directly to the carbon atom, and in the latter it is linked via an oxygen atom. During sulphation of surfuric acid is added slowly to the fatty alcohol in the reactor.

The reaction temperature is regulated by cooling water and the speed at which the sulphuric acid is added. The sulphated fatty alchol is again neatralised with caustic soda.

The final group of active ingredients consists of the non-oinics, whose importance has recently increased considerably. (Both sulphonates and sulphates are anionics). A common non-ionic is that produced by adding ethylene oxide to alkyphenol, a long-chain alcahol (known technically as ethoxylating alkylphenol). The reaction is carried out at a temperature of 180^{o} C using an alkaline catalyst. The quality of ethylene oxide added determines the length of the ethoxylation chain, which in turn determines the characteristics of the product. Thus detergents based on non-ionics can easily be tailored to suit specific requirements. An important feature of these products is that they unit good detergent power with low foaming power. For this reason they are used in brands specially designed for washing machines.

9.10 Other ingredients:

Several other ingredients must be added to the surfactant to give a successful detergent. These include:

a) Phosphates: These help to remove dirt by forming soluble complex resins which give a repulsive charge to the fibre and help to loosen particles from its surface. Phosphates also soften the water, which means that the dirt removed from the fibre will remain in suspensi0n and not resettle.

b) Sodium per borate: This acts as a bleaching agent to remove stains.

c) Sodium sulphate and sodium silicate: Both these substances ensure that the power dries out crisply and becomes free flowing.

d) Sodium carboxyl methyl cellulose: This helps to suspend dirt in water. The balance consists of water small amounts of perfume, fluorescent materials to contract the natural discoloration of fabrics, foam stabilizers and colouring matter.

Making soap less detergent powder:

All ingredients, except the perfume and sodium per borate, are added to the sulphonate, sulphate or non-ionic surfactant, and the mixture, called a slurry, is pumped through nozzles at the head of spray drying towel. This tower consists of a long cylinder with a cone at the top and bottom. Hot air rising up the tower dries the moisture in the droplets of slurry which fall as hollow granules of powder to the bottom of the tower. The power is cooled in a pneumatic conveyor white lifts it to a settling vessel. Perfume and sodium perborate, which would not withstand the heat of the drying tower, are added during the final mixing stage. Any fine powder which is carried over from the spray-drying tower or setting vessel is trapped and used again. The final product is then packed into cartons in a high-speed packing unit.

Spray drying produces a uniform and dust-free product which is easily dissolved in water. The blending and processing conditions made it less liable to lake by absorbing moisture from the air during storage.

9.11 Advantages offered by modern soap fewer detergents:

1. Greater cleansing efficiency is achieved with modern detergents. They do not combine (as soap so) with the calcium, magnesium and other salts present in varying degrees in any water, and thus are not wasted. All the detergent is available for washing.
2. If soap deposits have left clothes shift and gray looking, soap less detergent will remove the soapy deposits. As a result, clothes feel soft and fluffy look new again.
3. Greater efficiency against acids (particularly body acids) is another important point in favour of detergents. They wash effectively, even in an acid medium. This is a definite advantage with girdles and slips for instance that generally become impregnated with acid soil.
4. Detergents are soluble in cold water. Though family laundry is usually done in hot water, sometimes it is desirable or necessary to wash in cool or cold water. Even then, modern detergents dissolve rapidly and go to work immediately to clean clothes. Unlike soaps, detergents work effectively even in hardest or coldest water.
5. Rinsing may be omitted when water supply is limited if one prefers not to rinse. More than one deep, clear water rinse is unnecessary. When it is expedient to omit rinsing, the tiny amount of detergent left in a garment, after efficient wringing, won't weaken or discolor the garment during ironing or storage.
6. Detergents some times form a small amount of foam on the rinse water. This does no harm. Most detergents foam readily, even at very low concentrations. They are easy to rinse out.

7. High penetrating action is a gesture of present day detergent solutions. They penetrate right into the fibres of a garment and effectively remove soil. Because the detergent solution has a lower surface tension, it penetrates into places that have become coated with oils and greasy oil.
8. Rapid removal of grease is a very desirable characteristic because much of the dirt on clothes is of greasy nature. Detergents, being highly efficient wetting agents, disperse the oil so that form globules on top of the wash solution. Detergents lower the surface tension of the water and remove grease more readily.
9. Sweetest smelling washes result from using modern soap less detergents. They leave the wash clean and sweet smelling with no heavy or chemical odour. A very slight, pleasant odor is noticeable when the clothes are ironed or after they are dried.
10. Detergents are better for special washing specially blankets gird less and fine fabrics. They dissolve readily, even in cool water start removing dirt immediately. So, one need not resist the deteriorating effects of hot water on rubberized garments and delicate fabrics.
11. Detergents dissolve instantly in all degrees of temperature and hardness. Most modern detergents give instant, rich suds even in hardest or coldest water. The wash solution does not feel grainy when you use a good modern detergent. And there are no dissolved beads to stick to your clothes.
12. Greater economy is a big plus for detergents. They do not combine with mineral salts in all water as soaps do. Thus, the entire product goes for washing none for softening the water. You need less of any modern detergent than of any soap to get clothes, dishes, mirrors, woodwork sparkling clean.
13. Detergents do not react with hard water to form the insoluble compounds which often cause graying, whitening, speckling of clothes and household linens.
14. Detergents, because they do not form these insoluble compounds, do not dog the pumps, drains and pipes of washing machines with deposits of lime soap, nor do they build up such deposits on metal surface of tubs.

15. Again, when washing dishes in detergents there are no lime soaps to leave dishes looking dull. After a quick rinse, dishes, glasses, pots and pans dry sparkling bright without wiping.

9.12 Making a liquid soap less detergents

Liquid soap less detergents products do not present many technical problems, only simple mixing equipment being required for their manufacture, but they are more difficult to formulate, the difficulty being to produce a dispersion of the required constituents in a sufficiently stable form. Dish –washing requirements are relatively easily met, and so-called light duty liquid products are widely popular. They contain, besides the normal sulphonate, small qualities of a very soluble active detergent, a foam stabilizer, and a solubilizer to promote stability in the dispersion.

What's in detergents?

Leading detergents sold today contain not only soil removal ingredients, but protective ingredients as well. The following are the six major components in heavy duty detergents.

1. Active ingredients to remove soil and produce foam or suds. By themselves, these active ingredients are not powerful. Enough to do a heavy duty wash, but they are adequate for light laundering or for dish washing by hand. For heavy duty wash, a second major component is necessary a Builder.
2. Builders are of two types, inorganic and organic. The inorganic builders are primarily phosphatus, but they do not foam or sud. They do increase detergency organic builder stabilize the foam or suds of the active ingredients Builder also act as water softeners.
3. Anti deposition agent which is needed to keep soil suspended once it has been removed.
4. Sodium silicate is used to protect aluminum pots and pans (when used for dish-washing by hand) and aluminum washer parts such as agitators, fans tubs, etc., from pitting or attack by inorganic builders.
5. Brightener or optical bleach for white effect.
6. Corrosion inhibitor to prevent silverware from becoming stains in use for dish-washing by hand.

These are a greater and wider horizon for detergents it is generally felt that detergents are better than soaps because they:

1. Can be used in hard or soft water.
2. Leave no soap scum or sud on tub or clothes.
3. Dissolve freely even in cool water, rinse freely even in hard water.
4. Greatly increase soil removal.
5. Contain superior built-in optical bleach or brightener which eliminates the need for excessive use of chlorine bleach or for bluing.
6. Are active emulsifiers of motor grease?
7. Do an effective and safe job keeping even synthetic fabrics brighter and whiter.
8. Are 'one-package' products containing not only detergent but also builders, optical bleach and water –softener all 'built-in' to do a superior soil – removal job.

Summary:

Soap is the most widely used cleanser of fabrics. Good laundry soap especially suitable for washing clothes should be used for cleaning. The soap purchased for silk and wool should be free from alkali. The quality of the soap can be judged by experience in washing with soaps and detergent powders. Non soap detergents products are becoming popular today. It is generally felt that detergents are better than soaps.

Exercise:

1. What is soap? What all ingredients are required for making soap explain?
2. What is the composition of soap? Give an account of the different methods by which soap is manufactured?
3. What is saponification ? Explain the process in detail?
4. What are soap less detergents and how they are prepared?
5. Write in detail the types of soap and their action?
6. What are the advantages offered by modern soap with few detergents?

CHAPTER - 10

BLEACHES AND THEIR USE

10.1 Introduction

Bleaching is the process by means of which coloured or discoloured fabrics are made white. The only object in using bleach is to remove stains, which do not respond to normal washing processes. Bleaching should be carried out carefully on all fabrics. The correct rate and intensity of bleaching is essential so as to avoid damage to the fabrics. It is not possible to bleach dirt from work.

Bleaching agents can be divided into two classes.

1. Oxidizing bleach: it provides oxygen, which combines with the stain to form a colour less compound. All fibers are readily affected by oxidization; so oxidizing bleach must be in contact with a fabric. Only until the stain is removed. Longer contact will weaken the fabric.
2. Reducing bleach: are those, which are capable of removing oxygen from the coloring matter in the stain.

10.2 Oxidizing Bleaches:

Open air and sunlight:

The world's oldest method of bleaching is that of treating fabrics in the open air. In many parts of India the fabrics are still spread out on grass, sprinkled with water and left in the open, exposed to rain and dew until they are bleached. The housewife can keep the good colour of white clothes by the use of out door drying. Sunlight bleaching can be used for stain removal from bleached cotton and linen fabrics. When an article is laid on grass or spread over a bush, additional bleaching may be due to the chlorophyll in the leaves, as it plays its part in the making of starch for the life of the plant.

Sodium hypochlorite bleach or Javelle water:

1. Lb washing soda
2. 1/4 lb chloride of lime
3. 1 quart boiling water
4. 2 quarts cold water

Method of preparation and use: Dissolve the washing soda in the boiling water. Mix the chloride of lime with the cold water, allow it to settle, strain off the clear liquid without stirring. Mix together the dissolved washing soda and the filtrate from the chloride of lime. Allow the precipitate of calcium carbonate that is formed to settle. Strain off the clear liquid and store in dark coloured bottles as it is unstable to light. This liquid called Javelle water is sodium hypochlorite, which readily gives off nascent oxygen, a powerful bleaching agent.

It should be used for bleaching white cottons and linens: it must never be used on any other fabrics. Use half Javelle water and half hot water. Leave the stain in the bleach till it is removed. Do not allow the article to soak for more than twenty minutes. To hasten the action, a few drops of vinegar may be added to the bath. Rinse very thoroughly: never allow the bleach dry into the fabric.

A small amount of ammonia in the rinsing water will help to remove the smell of the bleach from the fabric.

Cautions:

1. Do not use on silk or wool as these fabrics are dissolved in Javelle water.
2. Do not use odd coloured fabrics, as many dyes are not fast to chloride bleaches.
3. Do not boil fabrics in the solution as it may weaken the material.

Hydrogen peroxide bleach:

Hydrogen peroxide is effective bleach, not harmful to most fabrics. It can be used in various concentrations, depending upon the amount of bleaching required. One pint to a gallon of water is an average quantity. Rinse thoroughly.

A teaspoonful of concentrated ammonia solution or sodium per borate added to each gallon of the solution makes the action stronger.

Sodium per borate bleach:

This is formed from borax, caustic soda, and hydrogen peroxide. Sodium per borate, which is used in many oxygen-washing powders, dissolves in water making an alkaline bleaching solution, which contains hydrogen peroxide.

Preparation of bleach: One ounce of sodium per borate is dissolved in one gallon of water. If animal fabrics are to be treated, the solution is neutralized with acetic acid, and then, to assist the bleach, it is made slightly alkaline with a little ammonia.

Method and use: One teaspoonful to one pint of water.

1. Articles are steeped in the bleach for a few minutes. In the case of animal fabrics, a blood heat solution are used, ½ oz of potassium permanganate dissolved in one gallon of water. For cotton and linen the solution is hot, 1oz of agent in the same quantity of water.
2. The bleach is rinsed out of the fabric, which has now stained the characteristic brown colour.
3. The article is dipped in one of the following solutions until the staining disappears, which should happen almost at once: (a) sodium hydrosulphite (see below) , (b) oxalic acid 1 oz to 1 gallon of water or (c) 2- volume hydrogen peroxide , acidified with acetic acid, 1 teaspoon of vinegar to 1 pint of bleach.
4. Thorough rinsing must fellow.

10.3 Reducing Bleaches:

Sodium hydrosulphite:

This is a valuable agent for bleaching all fibres. It is particularly useful for wool and silk, which cannot be treated with sodium hypochlirite.

Action of bleach:

The sodium hydrosulphite takes oxygen out of the stain, especially when dissolved in hot water, and becomes sodium Meta bisulphate, which when exposed to air is split up into sodium sulphite and sulhurdioxide, the latter substance being itself a reducing agent.

Method of use:

The storage of sodium hydrosulphite calls for some attention. It must be air- tight, free from moisture and away from heat; otherwise it tends to decompose owing to absorption of oxygen. In extreme circumstances it may take fire, hence work should be carried out near an open window if possible, since the sulphur dioxide, which is given off, is pungent and cause irritation to the throat and lungs.

The bleach can be used in concentrated form for spotting or in solution. Hydrosulphite solutions find application in the spotting treatment for many stains due to grass, dung, hard court, leather, boot polish, mildew, coloured ink, potassium permanganate and dye stains. For bleaching in solution, the articles are steeped for a few minutes in a bath containing 1 to 4 teaspoons of the bleach to 1 pint of cold, hot or boiling water according to the resistance of the stain to be removed and the nature of the fibre. The article must be rinsed thoroughly in water containing a high concentration of soap .If a stain is being treated on an article which is coloured in part, it may happen that the bleach accidentally runs into the colour and changes it. Immediate dipping in an alkaline solution of the immediate application of soap may rectify the trouble. When colour is taken out by a reducing agent, sponging with acetic acid can restore it.

Care must be taken to see that it must be used in contact with metal, for this causes a black stain on all fabrics. Only vessels of wood or earthenware should be used.

Sodium bisulphate:

This is a mild reducing agent, which results from the partial neutralization of sulphurous acid by caustic soda. Its bleaching action is due to the fact that it yields sulphur dioxide, which takes oxygen out of the stain.

Method and use:

It must be used in the proposition of 2 tablespoonfuls' to 1 of water, Neutralization or thorough washing must follow, otherwise sulphuric acid will appear in the fabric through the action of oxygen.

Sodium thiosulphate: (hypo) for cottons

¼ oz sodium thiosulphate

/8 oz 36%acetic acid

2 quarts water

10.4 Over Bleaching:

The over bleaching of cotton and linen goods during laundering is one of the main causes of general weakness of the fabrics. The fibres become brittle and harsh, and give a distinct crackle when rubbed together.

How to avoid over bleaching

Use a bleach of known strength. Never exceed strength of 5 grains per gallon. Keep the temperature below 140^0 always measure quantities of bleach accurately; dilute bleach and add gradually. Although most over bleaching is due to the use of chlorine bleaches, it must be understood that all the oxidizing agents have the same effect on cotton and linen. It is a fallacy to consider that hydrogen peroxide is safe bleach.

Chlorine bleach should not be applied at too high temperature. It should not exceed 160^0F.

Summary:

The object, of course is to whiten the clothes, which comes from the loom grayish brown in colour. In expensive cottons are often merely washed and pressed after coming from the loom and are sold as unbleached goods bleaching is used in laundry for the purpose of covering or neutralizing the yellowish tint of white fabrics weak alkalis such as hypochlorite or chlorine bleach are not detrimental to the cotton fiber. Silk, wool should be bleached with the safest bleach with hydrogen peroxide

Exercise:

1. Name the bleaches that can be used for different fabrics and fibres?
2. What are the types of bleaches? Explain the oxidizing bleaches in detail?
3. How to avoid over bleaching?
4. What method of bleaching is preferable? Is there any advantage in buying unbleached fabrics?
5. Why is finishing process necessary?

CHAPTER - 11

LAUNDRY BLUES

11.1 Introduction

White fabrics often lose their pleasing whiteness and develop a yellow tint. Bleaching is used in laundry for the purpose of covering or neutralizing the yellowish tint of white fabrics. This tint may be due to one of the following causes.

1. Incomplete washing on which bluing would cause no improvement, but a probable deterioration.
2. The deposition of lime or iron soaps on the fabrics.
3. The reappearance of the natural colouring of the original fibres after repeated washes in which no bleach has been used, or the effect of course alkaline soap upon fabrics, damaged by cover bleaching.

Contrary to the generally notion, bleaching does not whiten clothes, it merely corrects the yellow tinge, which white clothes may develop owing to one of the above-mentioned reasons. Blue is the complementary colour to white.

Blues used for laundry purpose fall into two classes:

1. Insoluble in water, e.g., ultramarine
2. Soluble in water, e.g., several coal-tar dyes, methyl violet and methylene blue, and Prussian blue.

11.2 Ultramarine blue:

The housewife generally uses ultramarine blue. It is a safe blue to use, because it is not harmful to fabrics. It is not affected by alkalies. It is sometimes used together with soap in the boil so that the blue is boiled in. Blueing with ultramarine may cause trouble by large particles forming specks on the fabric. This may be avoided by applying the blue before the last rinse. The care required with ultramarine has caused the abandonment of its use in many laundries in favour of the more simple application of soluble blues florescent washing powders.

11.3 Prussian blue:

This is also insoluble in water. Its use is undesirable as it is a compound of iron and is decomposed by alkaline substance and turns brown owing to the liberation of iron oxide. The result is that the fabrics treated with Prussian blue are likely to develop ironmould stains if steeped in soda water before washing, or if insufficient rinsed after washing.

11.4 Soluble blues:

These are actually dyes and are marketed in great variety by manufacturers. They have the advantage of being easy to prepare, control and apply. Since they produce an even colour and leave no sediment, they are widely employed in large-scale power laundries. These blues can be obtained in concentrated solutions or in powder form- purplish blue being the most popular shade, as it gives a whitish appearance. These aniline dyes have a great affinity for materials and must be used with care. However, owing to their great solubility they are easily removed by thorough rinsing, and correction for over-blueing is no trouble.

11.5 The blueing process:

Great care must be taken to see that blueing done only when the fabrics is free from soap. The process, therefore, follows the last rinse. The blue is tied in a piece of muslin and squeezed in cold water until the required depth of colour is obtained. Ultramarine blue being insoluble in water, the colouring matter is held in suspension, and so the water must be stirred each time before use.

The article is dipped up and down in the solution once or twice in such a way that the water is not retained in pockets or other bag shaped parts. Articles should not be allowed to remain in the bath, but must be moved about all the time. Blueing and starching process may be combined where necessary. The blue should be tied in a piece of thick material to prevent the too free passage of the particles of blue into the water. Squeeze the blue bag in cold water until a pale blue colour results.

Yellow articles should not be blued, since they turn greenish. Over blueing is easily removed from fabrics by treatment with acetic acid. Sunlight is the best natural bleach. In India, where there is strong sunlight for nine months in the year, blueing should not be necessary for properly washed goods.

Summary:

Contrary to the general notion, bleaching does not whiten clothes; it merely corrects the yellow tinge. Blue is the complementary colour to white. Ultramarine blue is generally safe to use by house wife. Pressian blue is insoluble and the result is that the fabric treated with this likely to develop iron mould stains in processing of washing. Soluble blues are actually dyes and they have the advantage of being easy to prepare, control and apply. Since they produce colour and leave no sediment. They are widely employed in large scale laundries

Exercise:

1. What are blues? Explain the method of blueing?
2. What are the causes of yellowish tint formation in white clothes?
3. Explain the types of blues with examples?
4. How will you remove over blueing?

CHAPTER - 12

STAIN REMOVAL

12.1 Introduction

The need to clean and care for a household is always with us. For a successful stain removal, prompt action is important; the more quickly one deal with a stain, the more likely one is to be able to remove it simply. With most stains, try cold water first, flushing the water through the material if possible. Make sure that one should know about the cleaners one use. Availability doesn't mean that a household substance is harmless, to one or to the environment: some do a good cleaning job but need to be used with respect and an awareness of their dangers, if at all. But as a general rule, if one can safely eat it- for example, lemon juice, vinegar, and bicarbonate of soda it's environmentally kind as a cleaner.

Stain removal and spotting is a skill which calls for factors in stain removal to be considered are:

1. The composition and colour of the fabric.
2. The nature and age of the stain.

Stain is spot or discoloration left on fabrics by the contact and absorption of some foreign substance. Stains have to be classified according to the substance that causes them. Broadly speaking they can be divided into

a) Animal

(b) Vegetable

(c) Grease

(d) Dye and

(e) Mineral.

Animal stains are those caused by blood, egg, and milk and meat juice. As these contain protein matter, heat must be avoided in removing them; otherwise the protein matter will get fixed in the stain.

Vegetable stains include those caused by tea, cocoa, coffee fruit and wine. These are acidic and therefore, require alkaline reagents to remove them.

Grease stains may be just grease spots or some colouring matter fixed with grease. These include butter, curry, oil paint, varnish, and tar stains. In removing these stains, some grease solvent or an absorbent is first used to dissolve or absorb grease before the removal of the colouring matter. A solvent soap is also very effective for removing these stains from washable fabrics.

Dye stains may be acidic, and so the nature of the stain is ascertained before a specific removing reagent is used.

Mineral stains, such as ironmould, black ink and certain medicine stains are compounds of a metal and dye. These are first treated by acid reagent to act on the metal, and then by an alkaline solution to neutralize the acid reagent and act on the dye.

12.2 General directions:

1. All stains are easily removed when fresh.
2. If the nature of the stain is unknown the least harmful methods first passing should treat it from one process to the next until an effective agent is reached before it is passed from one solution to another.
    a) Soak in cold water.
    b) Soak in warm water.
    c) Bleach in the open air, if time permits.
    d) Treat with an alkaline solution
    e) Treat with an acid solution
    f) Treat with oxidizing bleach, if the above fail.
    g) Treat with reducing bleach.
    h) In the event of stain persisting, which is unlikely processes (d) and (g) can be repeated.
3. Known stains should be treated by their specific reagents.
4. Bleaching treatments should only be tried as the last resort, and these should take the form of several applications of weak solution rather than the use of strong solution in one application.
5. Reagents may be spread on to white cotton and linen fabrics and boiling water may be poured through the fabric.
6. Reagents must be made into a solution when used on coloured

linen, wool, silk, and rayon.

7. The fabric should stay in the reagent only the stain is removed, and the fabric should be taken out at once. If the reagent is allowed to dry into the fabric it may damage it.
8. An acid stain removed agent should be neutralized by an alkaline rinse.

12.3 Common stains

Artificial flowers:

Place grubby artificial flowers in a large paper bag add lots of salt and shake vigorously. Then run water through the flowers and watch the dirt just wash away.

Ballpoint ink:

Dab the mark with methylated sprit, then rub &rinse.

Blood:

A fresh bloodstain on clothing can be rinsed out in cold salt water .If the stain is dried bleach with a drop of hydrogen peroxide.

Stained brass:

A greener way is to rub with a piece of lemon sprinkled with salt; rinses dry then rub with olive oil.

Butter:

Scrape off as much as one can. Iron with a warm iron between layers of absorbent paper.

Candle wax:

Put in a plastic bag in the freezer for an hour or two. Then place fabric between sheets of blotting paper and iron with a warm iron.

Cane furniture stains:

Cane furniture can be cleaned and tightened by scrubbing it with hot salted water.

Chewing gum:

Put the garment in a plastic bag in the freezer for a while or put an ice pack on the gum. Crack off the solid pieces. Sponge the remainder with dry cleaning fluid.

Chocolate:

On clothing, scrape off the solid chocolate with a blunt knife. Pour boiling water from a height or use detergent and work from back of the stain.

Coffee:

Sponge stains with borax and pour hot water through the fabric.

Curry:

Soak stain with methylated spirit, diluted ammonia or white spirit.

Fly spots:

Cold tea will remove fly spots from mirrors.

Hair dye:

Rinse fabric immediately with cold water, then wash in warm water with liquid detergent and ammonia.

Perspiration:

Stain can be removed by eucalyptus oil with few drops of ammonia.

Iron stains:

To clean the outside of your iron, use toothpaste as the iron cools.

Jam stains:

Remove jam stains from washable clothes by soaking in a solution of borax and water; then wash as usual.

Lipstick:

For lipstick on fabric, try cold water first and, if that fails, put glycerin on the stain, leave overnight, then wash in warm to hot sudsy water.

Ointment stain:

Try dry cleaning solution, then rinse in cold water. Then work in liquid detergent and rinse again.

Ink (black and blue):

a) Rub the stain with a cut tomato, wash.

b) Rub salt& wash.

c) Repeat the process till stain is removed
d) Soak the stain immediately in sour milk or curd for half an hour. Do not allow the curd or milk to dry. Wash with soap and water.
e) Apply salt and lime juice and leave it for half an hour & wash.

Tar

Use kerosene

Grease, oil and ghee

Wash with hot water and soap. If washable same as white cotton. For un washable treat with grease absorbent. Spread French chalk or fuller's earth on the stain leaves it for one hour. Brush off the powder

Pan

a) Treat with $KMNO_4$ solution
b) Treat with sodium perborate

Use hydrogen peroxide, wash with soap water.

Medicine

a) Steep in warm water
b) Steep in oxalic acid and wash with borax solution
c) Steep in methylated alcohol or surgical sprit

Turmeric

a) Soak in hot soapy water and dry in the sun or grass.
b) Apply a few drops of hydrogen peroxide, leave for few minutes. Rinse thoroughly and dry in the sun.
c) Treat with oxalic acid

Curry

a) Wash with soap and water
b) Bleach with sunlight and air
c) Bleach with Janelle water

Shoe polish

Scrape off the stain if dry. Apply little grease and wash with hot water and soap.

Egg

Wash in cold water and then in warm water and soap. Apply salt and pour warm water through.

Rust

(a) Steep in oxalic acid and then rinse with dilute borax solution
Steep in solution of salt and lemon

Scorch

(a) Bleaching in the sunlight is best. Apply soap lather to the stain and place it in the sun. Keep the stain with moisture while it is in the sun

(b) Rub dry borax and wet muslin over the stain.

(c) Steep in dilute ammonia.Place the stain in the sun for bleaching

Nail polish

Apply any acetate to the stained area with a cotton wool pad this must not be used on acetate rayon fabric.

Ice cream

(a)Wash in cold water and soap.

(b)Steep in warm borax solution

(c)Sponge with petrol or carbon tetrachloride.

Perfume

(a) Treat with ethyl alcohol

(b) Bleach with hydrogen peroxide

Summary:

The well informed consumer is the one who can recognize and interpret the inherent characteristics of a textile fabric in the light of its intended use. With knowledge of facts about the stains one can judge its probable removing methods. One can also try indigenous methods by using household reagents.

Exercise:

1. What is a stain? Explain the classification of stains with examples?
2. What are the general directions to be followed while removing known and unknown stains?
3. List out any six common stains and their removing reagents.

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