TEXTILE SCIENCE

Class - XI

Text Book & Practical Manual

CENTRAL BOARD OF SECONDARY EDUCATION
Shiksha Kendra, 2, Community Centre, Preet Vihar, Delhi-110 092 India

•BUILDING SKILLS•BUILDING FUTURE•

Textile Science

Text Book

Class XI

CENTRAL BOARD OF SECONDARY EDUCATION

in collaboration with

NATIONAL INSTITUTE OF FASHION TECHNOLOGY

TEXTILE SCIENCE

Textile Science, Text Book & Practical Manual Class XI

First Edition: October 2013

CBSE, India

Copies: 1000

Price : ₹ 260/--

Paper used : 80 Gsm CBSE Water mark white Maplitho

Published By : The Secretary, Central Board of Secondary Education, Shiksha Kendra, 2, Community Centre, Preet Vihar, Delhi-110092

Design, Layout : Multi Graphics, 8A/101, WEA Karol Bagh, New Delhi-110005 Phone: 011-25783846

Printed By : Kalyan Enterprises D-20, Sec. B3, Tronica city Gzb (U.P.)

TEXTILE SCIENCE

भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक सम्पूर्ण [1][प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता
प्राप्त कराने के लिए
तथा उन सब में व्यक्ति की गरिमा
और [2][राष्ट्र की एकता और अखंडता]
सुनिश्चित करने वाली बंधुता बढ़ाने के लिए

दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई॰ को एतद्द्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

भाग 4 क

मूल कर्त्तव्य

51 क. मूल कर्त्तव्य – भारत के प्रत्येक नागरिक का यह कर्त्तव्य होगा कि वह –

(क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;

(ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;

(ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;

(घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;

(ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;

(च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परीक्षण करे;

(छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;

(ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;

(झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;

(ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले;

[1](ट) यदि माता–पिता या संरक्षक है, छह वर्ष से चौदह वर्ष तक की आयु वाले अपने, यथास्थिति, बालक या प्रतिपाल्य के लिये शिक्षा के अवसर प्रदान करे।

1. संविधान (छयासीवां संशोधन) अधिनियम, 2002 की धारा 4 द्वारा (12.12.2002) सें अंतः स्थापित।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1]**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the[2] [unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "unity of the Nation" (w.e.f. 3.1.1977)

THE CONSTITUTION OF INDIA

Chapter IV A

FUNDAMENTAL DUTIES

ARTICLE 51A

Fundamental Duties - It shall be the duty of every citizen of India-

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

[1](k) who is a parent or guardian to provide opportunities for education to his/her child or, as the case may be, ward between age of six and forteen years.

1. Ins. by the constitution (Eighty - Sixth Amendment) Act, 2002 S.4 (w.e.f. 12.12.2002)

Preamble

Since clothing and home furnishings make up a major portion of the family budget, a knowledge of textiles is as appropriate for consumers who wish to purchase wisely as it is for those whose career interests lie in textiles and marketers of textile fibers, fabrics, and finished goods must all be familiar with the manufacturing methods, construction, and finishing techniques which affect the performance of textile products.

The objective of this course is to understand the textile raw material like fibers, fiber source and properties. The conversion of fiber into yarn and yarn spinning process as well as conversion of yarn into varies fabric developments like woven, knit and other forms of fabrics. At the end of the course the students will be able to understand integration of fiber, yarn and various forms of fabrics and integrate their properties, characteristics, performances and behavior according to various end uses of apparel and home furnishing products.

CBSE

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Foreword

The Indian Textiles Industry has an over whelming presence in the economic life of the country and is one of the leading textile industries in the world. India earns about 27% of its total foreign exchange through textile exports. Further, the textile industry of India also contributes nearly 14% of the total industrial production of the country. It also contributes around 3% to the GDP of the country. India textile industry is also the second largest provider of employment in the country in terms of after agriculture.

As per the 12th Five year plan, the integrated skill development scheme aims to train over 2,675,000 people within the next 5 years. This scheme would cover all sub sectors of the textile sector such as textiles and Apparel, handicraft, handlooms, jute and sericulture.

In order to match the increasing requirement of skilled personnel, CBSE has initiated to introduce "Textile Design" as a vocational course for Class XI and XII. The course aims to introduce students to Elements of Design, Fabric science, Woven textiles, Dyeing & Printing procedures and introduction to our traditional textiles. This will help students to join the industry after Class XII or they can pursue higher education in this field.

The Faculty of the National Institute of Fashion Technology has developed the curriculum and the learning Material. I place on record the Board's thankful acknowledgement of the services rendered by Shri P. K. Gera, Director General, NIFT, Sr. Prof Banhi Jha, Dean- Academics, Project In-charge and Ms. Savita Sheoran Rana, Chairperson, Textile Design Department, Project Anchor - Textile Design. The course is developed and prepared by faculty members from Textile Design Department across NIFT centers. CBSE also acknowledges the contribution by Prof. Anupam Jain, Hyderabad, Ms. KislayChoudhary, Assistant Prof. Bhopal; Ms. Shubhangi Yadav, Associate Prof, Gandhinagar, Mohammad Javed, Associate Prof., Mumbai; Shri. Arnab Sen, Assistant Prof, Bhopal, Mr. Debojyoti Ganguly, Assistant Prof., Bhopal and Shri. Shivalingam.

I would like to appreciate Dr. Biswajit Saha, Associate Professor and Programme Officer, Vocational Education Cell, CBSE and Ms. Swati Gupta, Assistant Professor and Assistant Programme Officer, Vocational Education Cell, CBSE and other members of Vocational Education Cell, CBSE is also deeply appreciated.

Comments and suggestions for further improving the curriculum are always welcome

Vineet Joshi
Chairman

Textile Science

Unit 1: Overview of textile industries and textile fibers

Objectives

- To familiarize the background of textile industries in Indian context
- To learn and understand textile terminology
- To understand the sources, properties of textile fibers
- To predict the performances and characteristics of fabrics according to fiber content for various end uses

Learning Outcome

After finishing the course, the students shall be able

- To use appropriate terminology used in textile application
- To understand the interrelationships in textile business
- To get the overview of textile industries in India.

Course Content

- The major Textile Production Segments in India. Sources of Fabrics.
- Classification of Textile Fibers according to origin and chemical composition; Essential Properties and Performances of Textile Materials like Aesthetic, Durability, Comfort, Safety and Care and Maintenance Properties.
- Properties of Cotton, Flax, Hemp, Jute.
- Properties of Silk, Wool, Mohair and Other Natural Fibers.
- Properties of Viscose Rayon, Lyocell, Acetate.
- Properties of Polyester, Nylon, Acrylic, Spandex.

Unit 2: Textile Spinning and Yarn

Objectives

- To familiarize yarn spinning process
- To understand the properties and characteristics of various types of yarns

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Learning Outcome

After finishing the course, the students shall be able

- To understand basics of yarn manufacturing
- To predict and select different types of yarn for fabric development according to various end uses

Course Content

- Classification of Yarns; Spun Yarn Production Process; Carded and Combed Yarns; Wollen and Worsted Yarns; Mono Filament and Multi Filament Yarns.
- Yarn Numbering Systems; Cotton Count, Metric Count, Denier, Tex and Deci-Tex. Single and Plied Yarns; Yarn Twist; Amount of Twist and Direction of Twist.
- Textured Yarns; Core spun yarn; Novelty and Fancy Yarns; Blended Yarns; Sewing threads.

Unit 3: Textile Weaving and Woven Fabrics

Objectives

- To familiarize the weaving process involved to produce woven fabrics
- To understand the properties and characteristics of various types of woven fabrics

Learning Outcome

- To predict and select different types of woven fabrics according to various end uses
- To recognize and identify different types woven fabrics

Course Content

- Preparatory to weaving including high speed machines in winding, warping, sizing and beaming, weft winding.
- The Loom; Types of Looms, classification and selvedge formations
- Basic motions of the loom including the application of Dobby and Jacquards. Non-automatic loom, automatic loom, shuttle less weaving machines, terry looms and drop box loom
- Introduction to Basic Weaves; Plain, Basket, Rib; Twill, Satin, Sateen, Dobby, Jacquard. Crepe, pique, seer sucker, Terry, Velvet and Velveteen.

Unit 4: Other Forms of Textiles

Objectives

- To familiarize the basics of different types of knitting and properties of knitted fabrics, and other forms of textiles like non-woven, felt, lace and braids

Learning outcome

- To predict and select different types of knitted, non-woven, felt, and braid according to various end uses
- To recognize and identify different types knitted, non-woven, felt, and braid fabrics

Course content

- Differences between woven and knitted fabrics. General knitting terms types of knitting machines; circular and flat machines. Types of Knitting Stitches.
- Properties of Weft Knitted Fabrics; Jersey, Rib, Purl and Interlock. Comparison and properties of Warp Knitted Fabrics;
- Non-Woven Fabrics; Methods and Materials to Manufacture Non-Woven Fabrics; Felt; Embroidery; Tufted Fabrics, braids and other narrow fabrics.

Methodology of teaching

- Illustrated lectures with sides and visuals along with fibers, yarns, woven, knitted, non-woven, lace and braid fabric samples. A teacher would be expected to create a library of fabrics to explain and conduct the classes.
- Visit to textile mills & Industry

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UNIT 1

Overview of Textile Industries and Textile fibers

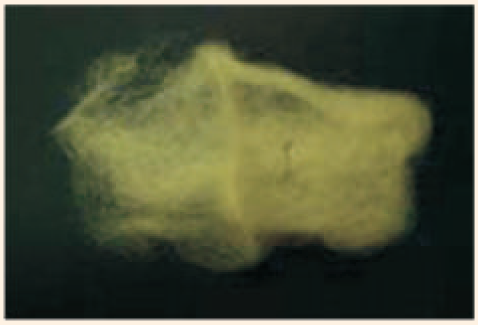
1. Introduction

Food, shelter, and clothing are the basic necessities for the survival of human civilization. Textiles play important role in making of clothing and making the shelters more comfortable and attractive. Also they are used in the production or processing of many items used in day-to-day living, such as food and manufactured goods.

An ideal starting place to gain an understanding for textiles is given by definitions of several basic terms.

1.1 Fiber

It is defined as thin, fine and hair like substance, natural or manufactured, with a high length-to-width ratio and with appropriate properties for being processed into a fabric.



1.2 Yarn

It is defined as a linear form of fibers, twisted as a continuous strand that can be made into a fabric.

1.3 Fabric

A fabric is produced from a yarn by performing mechanical operations as interlacing or interloping or intermeshing process. At this stage the fabric is referred as a grey cloth.

1.4 Dyeing

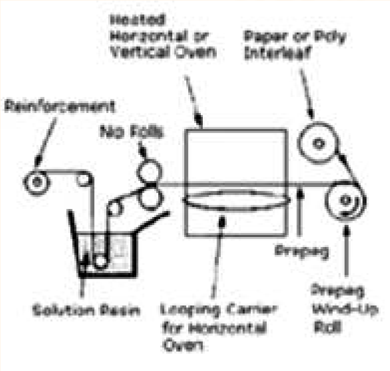
It is a colouration of textile substrates for the purpose of improving the aesthetic features. It is a chemical process of applying colour to textile substrates like fiber, yarn, fabric or garment by using natural or synthetic dyes.

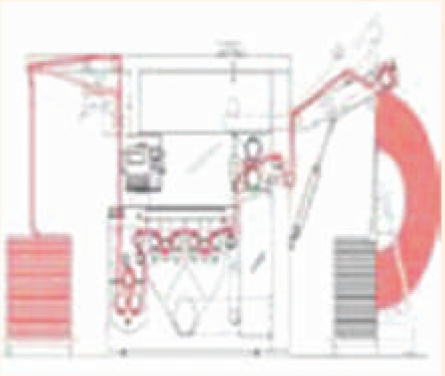
1.5 Printing

It is a chemical process of applying design to the fabrics for further enhancement of aesthetic features by using various techniques.

1.6 Finishing

It is a final stage of chemical or combination of mechanical and chemical processes to make the fabric ready for the particular intended end use. Thus the fabric is referred as a finished fabric ready for the product conversion operations like apparel, home furnishings and industrial products.





Textile is a term originally associated only to woven fabrics, but now is generally applied to fibers, yarns, fabrics, or to the products made up of them.

Textile fabrics can be beautiful, durable, comfortable, and easy to take care of. Knowing the components used in textile products and how these components were made will provide a better basis of knowledge for their selection and an understanding of their limitations. A user will be more satisfied with a more appropriate and better product with the knowledge of textiles and their production.

It is important to understand fibers and their performance because fibers are the basic unit of most fabrics. Fabrics contribute to the aesthetic appearance, the influence on durability, comfort, retention of appearance, impact on care environment, and cost. Successful textile fibers should be readily available, constantly in supply, and cost effective. They must have sufficient strength, pliability, length, and cohesiveness to be processed into yarns, fabrics, and products.

Natural fibers are those fibers that are in fiber form as they grow or develop from animal, plant, or mineral sources. The manufactured fibers or man-made fibers are made from chemical compounds produced in manufacturing facilities.

Natural fibers or the manmade fibers are developed from the textiles processes like spinning, weaving, knitting, dyeing, and finishing.

1.7 Essential and Desirable Properties of Fiber

Fiber content in the fabric is the primary factor that will affect properties, characteristics, behaviour and performance of a fabric according to various end uses. For example, strong fibers contribute to the durability of fabrics. Absorbent fibers are used for skin-contact apparel, towels and diapers. Fire-resistant fibers are used for children's sleepwear and firefighters' clothing.

The properties of fiber are determined by the nature of their physical structure, chemical composition, and molecular arrangement.

1.7.1 Length

Fibers are sold by the fiber producer as staple, filament or filament tow. Staple fibers are short fibers measured in inches or centimetres. They range in length from 2 to 46cm. All the natural fibers except silk are available only in staple form. Filaments are long, continuous fiber strands of indefinite length, measured in yards or meters. They are either monofilament (one fiber) or multifilament (a number of filaments). Filaments may be smooth or bulky. Smooth filaments are used to produce silk like fabrics whereas bulky filaments are used in more cotton like or wool-like fabrics.

1.7.2 Fineness

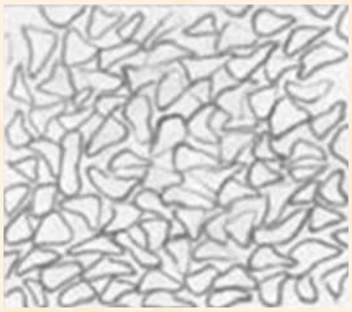
Fiber fineness plays an important role in determining the performance and hand of a fabric (how it feels).Coarse or thick fibers give crispness, roughness, body, and stiffness. Large fibers resist crushing, an important property in products like carpets.

1.7.3 Cross-sectional shape

These shapes may be round, dog-bone, triangular, bean-shaped, flat, or straw like.

The natural fibers derive their shape from,

1. The way the cellulose is built up during plant growth,
2. The shape of the hair follicle and the formatting of protein substances in animals, or
3. The shape of the orifice through which the silk fiber is extruded. The shape of manufactured fibers is controlled by the shape of the spinneret opening and the spinning method.



Silk

1.7.4 Crimp

Fiber crimp refers to the waviness, bends, twists, coils, or curls along with the length of the fiber. Fiber crimp increases cohesiveness, resilience, and resistance to abrasion, stretch, bulk, warmth, also the absorbency and skin comfort but reduces lustre.

Stretching, or drawing, increases their crystallinity and orients them, reduces their diameter, and packs their molecules together. Fiber properties related to the degree of crystallinity and orientation include strength, elongation, moisture absorption, abrasion resistance, and dye ability. Oriented and crystalline fibers are strong and stiff. They are difficult to elongate, but have good elasticity.

Fibers that are amorphous are relatively weak and easily elongated. Amorphous fibers also have good moisture absorbency and dye ability, good flexibility, and poor elasticity. Examples of amorphous fibers include wool and rayon.

1.7.5 Aesthetic Properties

Similar to the human sensory organs, such as touch and sight assist in perception, the aesthetic properties assist in perception of the textile. The consumer usually checks whether the appearance is appropriate for the end use for evaluating the aesthetics of a textile product.

Touch and sight, are the main components to determine the quality of any textile product. The aesthetic appearance is involved in the choice of its fiber.

1.7.6 Luster

It results from the way light is reflected on the fabric's surface. Shiny or bright fabrics reflect a great amount of light. Lustrous fabrics reflect a fair amount of light and are used in formal apparel and furnishings.

1.7.7 Drape

It is the way a fabric falls over a three-dimensional form like a body or table. Fabric may be soft and free-flowing like chiffon, or it may be stiff and heavy like satin. It may fall in graceful folds like chintz. Fibers influence drape to a certain extent, but yarns and fabric structure affect the drape to a greater extent.

1.7.8 Texture

It describes the nature of the fiber surface. It is identified by both visual and tactile senses. Fabrics may have a smooth or rough texture.



1.7.9 Hand

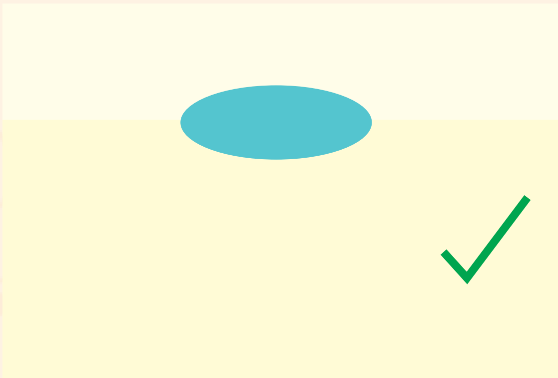
It is the way a fabric feels to the skin. Fabrics may feel warm or cool, bulky or thin, slick or soft etc. as many other adjectives may be used here. Hand may be evaluated by feeling a fabric between the fingers and thumb.

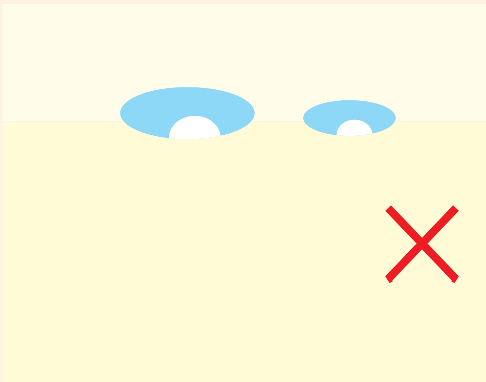
1.7.10 Comfort Properties

A textile product should be comfortable as it is worn or used frequently. This is primarily a matter of personal preference. The individual perception of comfort depends upon the climatic conditions as well as degree of physical activity, also on characteristics such as absorbency, heat retention, density, and elongation.

1.7.11 Absorbency

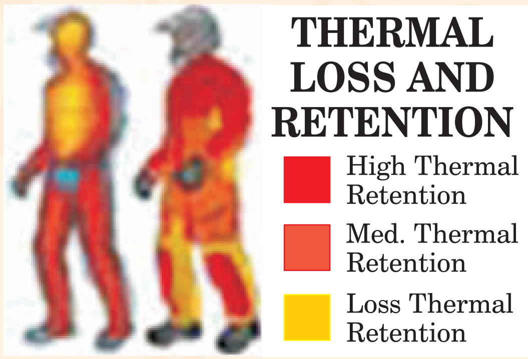
It is the ability of a fiber to absorb moisture from the body or from the environment. It is measured as moisture regain where the moisture in the material is expressed as a percentage of the weight of the moisture-free material. Absorbency is also related to static buildup. Hydrophilic fibers absorb moisture readily. Hydrophobic fibers have little or no absorbency. Hygroscopic fibers absorb moisture without feeling wet.





1.7.12 Heat or thermal insulation

It is the ability of a fabric to hold heat. People want to be comfortable regardless of weather conditions. A low level of thermal retention is favoured in hot weather and a high level in cold weather. Thus, people use different types of textiles depending upon the season. Yarn and fabric structure and layering of fabrics affect heat and thermal retention.

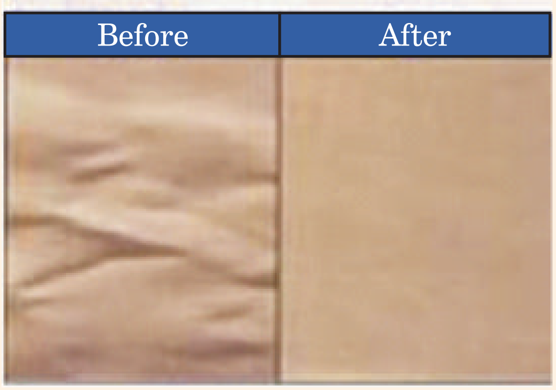


1.7.13 Heat sensitivity

It describes reaction of a fiber when it is exposed to heat. Some fibers soften and melt; others are heat resistant. These thermal properties determine safe pressing temperatures for a fiber.

1.7.14 Appearance Retention Properties

A textile product should be able to retain its original appearance during its use, care, and storage.



- **Resilience** is the ability of a fabric to return to its original shape after bending, twisting, or crushing. A resilient fabric springs back. It is wrinkle resistant if it does not wrinkle easily. It has good wrinkle recovery if it returns to its original look after having been wrinkled. A fabric that wrinkles easily stays crumpled in your hand. When it flattens out, wrinkles and creases are apparent.

- **Dimensional stability** is defined as the ability of a fabric to retain a given size and shape through use and care. Dimensional stability is a desirable characteristic that includes shrinkage resistance and elastic recovery.

- **Resistance to chemicals** Fibers differ in their reaction to chemicals. Some fibers are quite resistant to most of the chemicals. Other fibers are resistant to one group of chemicals but easily harmed by other groups of chemicals. Resistance to chemicals determines appropriateness of care procedures and uses of fibers.
- **Resistance to light** Exposure to light (both natural sunlight and artificial light) may damage fibers. The energy in light, especially in the ultraviolet region of the spectrum, causes irreversible damage to the chemical structure of the fiber. This damage may appear as a yellowing or colour change, a slight weakening of the fabric or, eventually, the complete disintegration of the fabric.

1.7.15 Care Properties

Any treatments that are required to maintain the new look of a textile product during use, cleaning, or storage are referred to as care. Improper care procedures can result in items that are unattractive, not as durable as expected, and uncomfortable too.

1.8 Classification of Textile Fibers

Natural or man-made textile fibers can be classified according to their origin and their chemical constitution.

1.8.1 Natural Fibers

Natural fibers are materials that grow in nature such as cotton, flax, hemp, jute, silk and wool. Plants contain fibrous bundles that give strength and pliability to the stems, leaves, and roots. Natural proteins fibers are from the animal origin e.g. wool is obtained from the hair and fur of animals, silk is the secretion of the silkworm. These fibers undergoes various processes of harvesting, sorting, cleaning and milling, and get prepared for spinning to produce yarn and further textile processing.



1.8.1.1 Composition/Origin of Natural Fibers:

	Fiber Type	Origin
Cellulosic/Vegetable Fibers	Cotton	Cotton boll/Seed hair
	Hemp	Hemp or Abaca stalk/Bastfiber
	Jute	Jute stalk/Bastfiber
	Flax	Flax stalk/Bastfiber
	Ramie	Rhea or China Grass/Bastfiber
	Pina	Pineapple leaf/Leaf Fiber
	Sisal	Agava leaf/Leaf fiber
	Coir	Coconut hush/Nut hush fiber
Animal/Protein Fibers	Silk	Cultivated, wild silk worms
	Wool	Sheep
	Specialty Hair Fibers	Camel and goat family animal
Mineral Fibers	Asbestos	Varieties of rock Silicate of magnesium and calcium
Rubber Fibers	Natural Rubber	Rubber plant

1.8.2 Man-made Fibers

The fiber-forming ingredients of man-made fibers are extruded, twisted or spun to form a long chain polymer. The liquid substance, forced through a spinnerets (or spinning jet), hardens to produce a long continuous filament fiber.

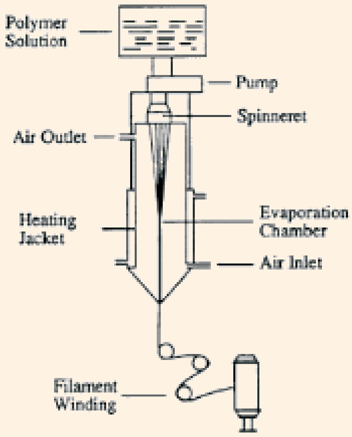


There are three processes used to produce man-made fibers:

- Dry Spinning Process
- Wet Spinning Process
- Melt Spinning Process

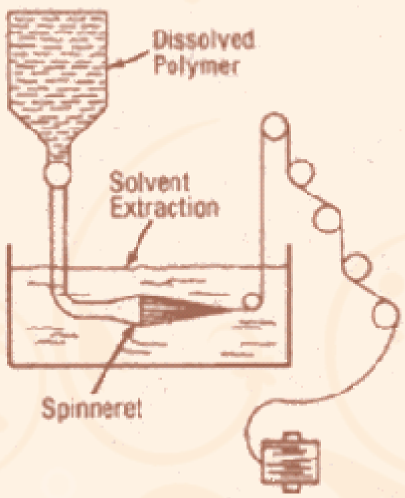
1.8.2.1 Dry Spinning Process

Filaments emerging from the spinnerets are solidified. This is done by drying them with warm air. This process is applicable for procuring acetate, acrylic, modacrylic, triacetate.



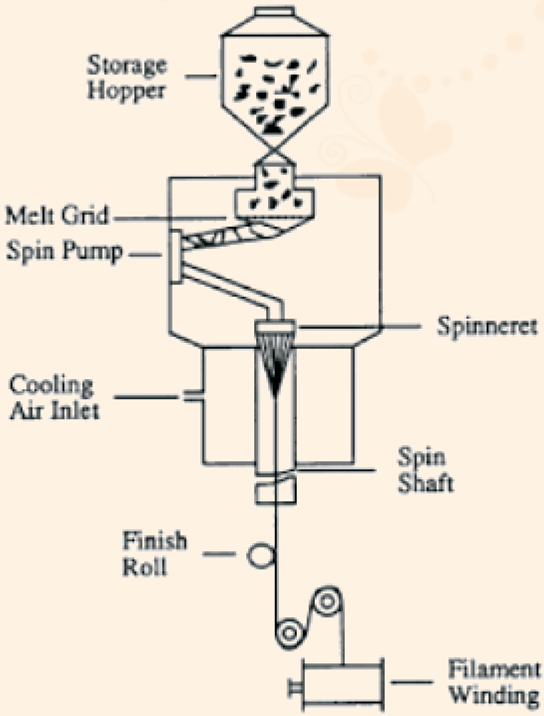
1.8.2.2 Wet Spinning Process

Filaments emerge from the spinnerets and are passed directly into a chemical bath where they are solidified or regenerated. This process is applicable for producing acrylic, rayon.



1.8.2.3 Melt Spinning Process

Fiber-forming substance is melted for extrusion and hardened by cool air. This process is applicable for producing nylon, polyester, olefin, aramid, and glass.



1.8.2.4 Composition/origin of Man-Made Fibers:

	Fiber Type	Origin
Regenerated Cellulosic/ Vegetable fibers	Acetate	Cotton Linters or Wood
	Rayon	Cotton Linters or Wood
	Triacetate	Cotton Linters or Wood
Synthetic Polymer Fibers	Acrylic	Acrylonitrile (85%)
	Modacrylic	Acrylonitrile (35%-84%
	Nylon	Polyamide
	Polyester	Poly-ethylene terephthalate
	Spandex	Polyurethane (85%)

Protein Fibers 	Azlon	Corn or Soybean
Mineral Fibers	Ceramic	Minerals
	Glass	Silica, Sand, Limestone
	Graphite	Carbon
Metal Fibers	Metallic	Aluminum, Silver, Gold, Stainless Steel
Rubber Fibers	Rubber	Man-made/Synthetic

1.9 Textile Fibers and Properties

1.9.1 Cotton

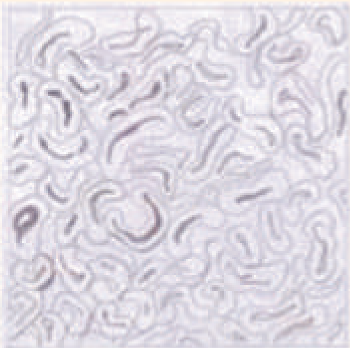
1.9.1.1 General Features

It grows in seed pot of the Cotton plant, composed with 90% of Cellulose. Length of Cotton fibers varies from ½"- 2½".

1.9.1.2 Properties and performance of Cotton fabrics

- Basically, Cotton fabrics have poor luster due to its natural colour.
- Drape, luster, texture, hand etc are affected by type of yarn, yarn count, fabric structure and finishes.
- Feels cool, inelastic, soft and dry
- Poor resilience: Cotton fabrics wrinkle easily.

- Poor dimensional stability: Shrinks easily.
- No problem with pilling but Cotton fabrics has 'lint'
- Good strength and abrasion resistance- In wet condition, strength is increased by 20%
- Hydrophilic and good wicking absorbs moisture quickly and dries quickly.
- Good resistance to alkalis and organic solvents; Poor resistance to Acids. Easily attacked by fungus and mildew; Poor resistance to sunlight.
- It can be handled by machine wash and dry clean (apparel); Steam of dry clean with caution (furnishing)



Microscopic virus of cotton fibre cross section

Longitudinal view of cotton fibre

1.9.1.3 Cotton in Common Use

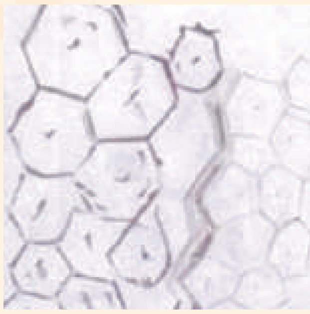
In apparel, cotton provides garments that are comfortable, strong, readily dyed in bright, long lasting colours and easy care. The major drawbacks are dull appearance, shrinkage and poor wrinkle resistance. As the cotton is versatile, the chemical processing technology helps to control shrinkage, enhance luster. Durable press properties may be imparted by chemical treatment or by blending cotton with more wrinkle resistant fibers, such as polyester.

In home furnishings cotton fabrics provides durable, comfortable, moisture absorbent and homely environment. Cotton fabrics have been mainstays of bed linens and towels. Polyester/cotton blends provide easy care no-iron sheets and pillowcases that retain a crisp and fresh feel.

1.9.2 Flax

1.9.2.1 General Properties

Flax comes from the stem of the flax plant, and mainly composed of cellulose. The natural colour of flax varies from light ivory to tan colour. Flax fibers are spun and twisted to form a yarn and woven to get the finished fabric called 'Linen’



flax/500x

1.9.2.2 Properties and performance of linen fabrics

- Excellent Strength: Twice as long as Cotton; fabric wears evenly; 20% stronger in wet condition; Fair resistance to abrasion and fair elasticity "Not as durable as Cotton" and Poor resilience; Good hand and high natural luster.
- More hydrophilic than Cotton, 'Good fabric for hot weather' ,Excellent moisture regain; Absorb moisture quickly and dries quickly
- Completely washable and dry cleanable; Highest safe ironing temperature 234 C; Adequate dimensional stability; No pilling and static problems; Attacked by mildew and silver fish

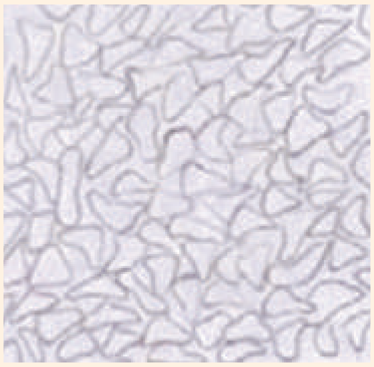
1.9.2.3 Linen in Consumer Use

Because of its high production cost and the fact that it wrinkles easily, the use of linen in apparels is in limited extend. However, linen fabrics being strong, light weight, can be draped well, feel cool in touch, and resists soiling, they are well suited for higher quality fashion aspects or professional wear, summer apparel and household linen such as bed, table and bath items.

1.9.3 Silk

1.9.3.1 General Features

Silk is a natural animal fiber composed of protein and obtained from Silk cocoons. They are found in natural colour like Grey or yellow because of a gum substance called 'sericin' present in them.



Silk

1.9.3.2 Properties and Performance of Silk fabrics

- Silk is an only natural fiber available as filaments. One cocoon will yield 1000 - 2500 yards of filament. It takes luxurious appearance and high brightness after sericin is removed.
- Excellent drape gives graceful appearance, good resilience. Silk ranks next to wool. It wrinkles hangout fairly readily but not as quickly as wool. Luxurious hand, warm feels, crispy, smooth and dry fabrics are the other properties.
- Strongest animal fiber, looses 15% - 20% when wet; Good resistance to acids. Poor resistance to alkalis; better than wool; Good resistance to dry cleaning solvents;
- Poor resistance to sun light, prolonged exposure results in change of colour; Very elastic, Poor recovery if stretched beyond 2% of elongation

- Usually dry cleaned; could be laundered depending upon finishing agents, fabric structure and garment construction.

1.9.3.3 Silk in Consumer Use

Silk is versatile. It may be woven or knitted into sheerest chiffon or lingerie or the heaviest velvets. For apparels, silk offers high strength, excellent drape, comfort, luxurious hand, a pleasing luster and beautiful colours.

In home furnishings, silk fabrics provide pleasant hand, brilliant colours and luster, comfort and durability. They are treated as high profile products because of their cost and complex maintenance.

Spun silk is less elastic, dull in appearance and stiffer than regular silk filament. It is also less expensive and more comfortable. It is used for summer apparel, drapery and upholstery.

1.9.4 Wool

1.9.4.1 General Features

Wool is a natural animal fiber composed of protein. Most wool fibers are between 2 - 20cm staple lengths. The surface of the fiber is covered with scales. Wool is white; however it may be found in gray, brown and black.

Wool

1.9.4.2 Properties and Performance of Wool fabrics

- The appearance is dull in general that depends on quality of fiber. Worsted fabrics drape well than woolen fabrics. It has good wrinkle resistance and poor pilling resistance. Wool fabrics feel warm, springy rough and dry.

- Relatively weak fabric but strong yarns can be produced due to long staple fibers. Though it has good abrasion resistance the resistance to chlorine bleaches is poor. It can be damaged by oxidizing bleaches, carpet bleaches and moths. It gives good resistance to acids, oil-borne stains but poor resistance to alkalis.

- Hydrophilic fiber, Wool is a warm fabric. The high level crimp and loose structure of wool yarn results air to be trapped on the outer surface of the fabric. This 'Trapped air' has insulating behaviour.
- Felting: Felting means interlocking of fibers due to scales when subjected to wet mechanical action. The result is a "progressive shrinkage" when subjected to the tumbling action of a washing machine and later followed by shrinking in large extent of wool garments. Dry cleaning is preferred for this fabric.

1.9.4.3 Wool in Consumer Use

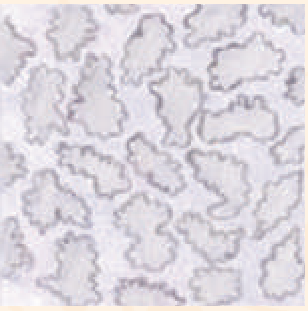
In apparel, wool is used in outer wear for its warmth and durability.

- It is used in men's and women's suits for being wrinkle resistant, comfortable and durable.
- Also used in socks for it being abrasion resistant and its ability to absorb moisture.
- In home furnishings, wool provides resilience, durability, hand, and dye ability for floor coverings and carpets.
- Wool and wool blends provide long life, excellent comfort and wonderful esthetics to upholstery.

1.9.5 Viscose Rayon

1.9.5.1 General Features

Viscose Rayon is regenerated cellulose. It is a man-made fiber and it consists of almost entirely cellulose. It is a reduced form in both filament and staple fiber. It is found in naturally white colour and can be produced in dull, semi dull and bright colours.



Multilobol

1.9.5.2 Properties and Performance of Viscose Fabrics

- Bright and luxurious appearance can be modified according to end uses by adding de-lustering pigments during manufacturing.
- Good drape: Wrinkles easily when worn; Pleasant, soft and cool to touch. Poor strength abrasion resistance and loses 30 - 40% of strength in wet condition.
- Easily damaged by strong acids. Hot dilute mineral acids or cold concentrated acids damage the fabric.
- May be attacked by silver fish and insects but resistant to moths.
- Dry cleaning preferred for highly value added apparels; May be laundered for low priced seasonal apparels.
- Hydrophilic; absorbs moisture quickly and dries quickly too.
- Poor dimensional stability; due to high swelling in water, it causes 20-30% shrinkage followed by "Progressive Shrinkage".

1.9.5.3 Rayon in Consumer Use

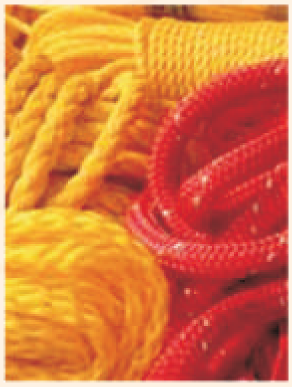
Viscose rayon is widely used in apparel, home furnishings and automobile tires. Rayon fibers may be used for lightweight summer blouses and skirts as readily as for heavy, bottom-weight fabrics for trousers for apparel use. In home furnishings, filament and spun yarns of rayon provide fashion appeal with bright, long-lasting colours and pleasing luster. Tightly constructed heavy rayon fabrics give satisfactory durability and ease of care. Rayon is one of the least expensive fibers. Blending rayon with polyester and nylon, yields fabrics that are softer, more comfortable, and inexpensive. It is highly flammable, thus it is not used in children's sleepwear.

1.9.6 Nylon

1.9.6.1 General Features

Nylon has a synthetic Polyamide molecular structure and produced as filaments and staple. It generally has round cross-section, but can be engineered into any shape. It is naturally white in colour. The most common and heavily produced polyamides are Nylon 6, Nylon 6 6, which are almost identical.

TEXTILE SCIENCE



Nylon

1.9.6.2 Properties and Performance of Nylon fabrics

- High natural luster; but it may de-luster.
- Good Drape; Good crease resistance and good recovery from wrinkling or creasing;
- Feels cool, elastic, smooth and slick; Susceptible to pilling.
- Subject to static build up; produces electric charges.
- Exceptionally strong in both wet / dry condition;.
- Weakened by strong acids; not affected by alkalis and by oxidizing / reducing bleach. May be harmed by Chlorine / strong oxidizing bleaches.
- Resistant to moths, fungi and insects. Excellent abrasion resistance.
- Poor resistance to sunlight and prolonged exposure can weaken and cause deterioration of colour and strength.
- Poor absorbency: Hydrophobic in nature. Rate of absorption of moisture is slow and rate of Drying is quick.
- Good Elasticity and recovery; Good Dimensional Stability. On heating, it has the ability to maintain shape and "No Shrinkage".
- Easy to launder or dry clean; dries quickly, Machine dry at low temperature, safe ironing temperature limit is 122 degree Celsius.

1.9.6.3 Nylon in Consumer Use

- Widely used in hosiery and household furnishings.
- Mainly used for outer wear and swim wear fabrics, ski pants and active sportswear.

- Used for lining material in coats, jackets because of excellent durability however it is expensive.

1.9.7 Polyester

1.9.7.1 General Features

It has synthetic Polyethylene terepthalate molecular structure, staple length and is produced as filament. Under microscope it looks like having shape of a rod. It is smooth, even and naturally white in colour.

1.9.7.2 Properties and Performance of Polyester fabrics

- It drapes well
- Good crease resistance as it has a very good recovery from wrinkling or creasing
- Feels cool, elastic, smooth and slick; Susceptible to pilling.
- Subject to static build up as it produces electric charges
- Exceptionally strong in both wet and dry condition; Excellent Abrasion resistance. Poor absorbency.
- Hydrophobic in nature. Rate of absorption of moisture is slow and rate of drying is quick.
- Good Elasticity and recovery;
- Good Dimensional Stability: It can be heat set to maintain shape with " No Shrinkage
- Weakened by strong acids while not affected by alkalis; Not affected by oxidizing or reducing bleach but may be harmed by Chlorine or strong oxidizing bleaches.
- Resistant to moths, fungi and insects and poor resistance to sunlight as prolonged exposure can weaken and cause deterioration of colour and strength.

Polyester

- May be laundered or dry cleaned. It is easy to launder. Drying is quick as machine dry is at low temperature. The safe ironing temperature limit is 122 degree Celsius.

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1.9.7.3 Polyester in Consumer Use

- Spun yarns are blended with Cotton & rayon is made in to a durable press / wrinkled free fabrics.
- Top and bottom weight men's / women's formal / casual wears, in sky jackets, lingerie.
- Filament yarn fabrics are used in glass curtains because polyester has excellent light resistance.
- Smooth textured filaments are used in uniforms, shirting, and tricot structure.
- Used in men's suiting of fine gauge polyester warp, in knits of women's dresses, blouses.
- Lingerie have proved very successful in Ski Jackets,
- Used in outer wear, sportswear as improved wicking provides good comfort performance for intimate / body fit / sportswear.

1.9.8 Acrylic

1.9.8.1 General Features

It is a manufactured fiber and is composed of at least 85% by weight of Acrylo nitrile units. It is produced in both staple and filament fiber with round cross section or bell shaped cross section. It is found in white or Off-white colour.

1.9.8.2 Properties and Performance of Acrylic fabrics

- Products bulk to light weight fabric
- Appearance & hand similar to wool
- High natural luster but may be de-lustered.

- Good drape and crease resistance; Good abrasion resistance.
- Feels cool, elastic, smooth and slick;
- Susceptible to pilling. Subject to static build up;
- Slow absorption and quick drying
- strong in both wet or dry condition;
- Safely bleached by all household bleaches;
- Good resistance to mineral acids alkalis and organic solvents
- Excellent resistance to sunlight and weathering;
- Good resistance to fungus and micro organisms and insects
- Produces thick, fluffy, bulk fabric to lightweight and used to make warmer clothes for winter season.
- Good resistance to flame; slowly burns;
- Washes well and dries quickly. Easily dyed with bright colours and is available at cheaper prices.



1.9.8.3 Acrylic in Consumer Use

Fleece fabrics frequently used in jogging outfits and active sportswear sweaters and socks. Thick, snuggy furs are used for coats, jackets, linings. Upholstery fabrics may be flat woven fabrics or velvets and drapery fabrics. This is an appropriate and growing end use for acrylics because of their good sunlight resistance and weathering properties.

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1.9.9 Spandex (Lycra)

1.9.9.1 General Features

It has Segmented Poly Urethane Synthetic molecular structure. Spandex is a salt, flexible rod with little internal structure. The cross section varies in dog-bone or peanut shape and it is produced as mono filament / multi filaments.

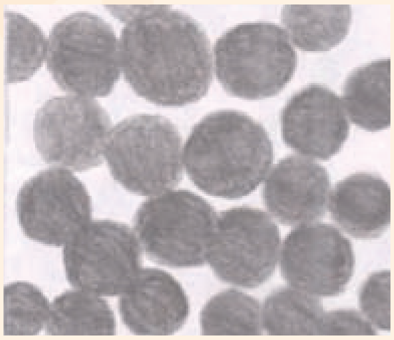
1.9.9.2 Properties and Performance of Spandex (Lycra) fabrics

- Fibers may be stretched at least 200% before they break and rapidly recover when tensile forces are released. Power stretch fabrics in which the high restrictive forces of the electrometric cloth can shape and control body contours in particularly for Body fit garments.
- Excellent elastic properties up to 500% Elongation at break. 100% recovery;
- Very good resilience and highly flexibility; Very good abrasion resistance.
- Good dimensional stability in wet condition; however some types shrink with the exposure to the high temperature.
- Good resistance to household bleaches and most acids but are damaged by hot alkalis as it causes rapid deterioration. It is resistant to dry cleaning solvents;
- Superior dye ability with brilliant colours.
- Poor strength; poor absorbency;
- White spandex becomes yellowish from prolonged exposure to air; Ironing should be done quickly with low temperature setting.

1.9.9.3 Spandex in Consumer Use

- Lycra in swimwear, innerwear and active sportswear means providing fitting clothes with comfort and freedom of movement.
- It also improves the quality of Knitted / Woven fabrics as it prevents bagging and accelerates wrinkle recovery.
- Lycra in swimwear, innerwear and active sportswear means providing fitting clothes with comfort and freedom of movement.

- It also improves the quality of Knitted / Woven fabrics as it prevents bagging and accelerates wrinkle recovery.



Lycra

SUMMARY

This chapter gives an overview of the textile industry and the backbone of it, which are the various fibers used. Starting from fiber, it talks about all forms of textiles through yarns to fabrics and includes all processes, mechanical and chemical, involved in conversion stages, in sections 1.1 to 1.6. Section 1.7 deals with the basic parameters that governs the yarn and fabric properties, or in other words, the final functional properties of a textile material. In section 1.8, the classification of all fibers is dealt with whereas under 1.9, almost all the common fibers used worldwide are talked about.

QUESTIONS

1. Multiple Choice Questions- choose any one among the options given as answer to the individual questions (correct answers are in bold and highlighted).

i. Example of a natural fiber is:-

a) Polyester b) Silk

c) Spandex d) Nylon

ii. Fiber with extremely high stretch ability is:-

a) Spandex b) Cotton

c) Viscose d) Nylon

iii. A fiber that is very comfortable to wear is:-

a) Spandex b) Polyester

c) Jute d) Cotton

iv. A fiber that is highly lustrous is:-

a) Silk b) Acrylic

c) Jute d) Spandex

v. A fiber that can replace wool for warmth and bulk is:-

a) Jute b) Cotton

c) Nylon d) Acrylic

2. Fill up the blanks in the following questions:

a) ________________ is an example of regenerated cellulosic fiber.

b) Camel and goat hairs are examples of ________________ fibers.

c) Asbestos is a ________________ fiber.

d) ______________ describes the nature of the fiber surface.

e) _______________ refers to the waviness, bends, twists, coils, or curls along with the length of the fiber.

UNIT 2

Textile Spinning and Yarn

2. Spinning and Yarn

2.1 Properties and characteristics of yarn depend on:

- Composition of fiber
- Length of fiber (staple or filament)
- Type of yarn (spun or filament)
- Count (thickness or fineness)
- Number of strands of yarn (single or plied)
- Amount of yarn twist
- Direction of yarn twist
- Construction of yarn (simple, complex or textured)

2.2 Selection of yarn for fabrics depends on:

- Performance expectation of fabric
- End use of fabric
- Type of fabric
- Need or demand of fabric
- Cost of fabric

2.3 Ring Spinning

Spun Yarn Manufacturing

All staple fibres must be subjected to certain mechanical processing steps during yarn manufacture. The processing of the fibres may be by the cotton spinning system or by the wool spinning system. The two systems differ in that their machinery has been designed to operate with different fibre types. The cotton spinning spinning system machines is made to process short, strong and smooth fibres. The wool spinning system is designed to operate on long, weak and crimped fibres; however, the basic steps of processing are essentially the same. The processing of staple fibres in to yarn requires the following steps.

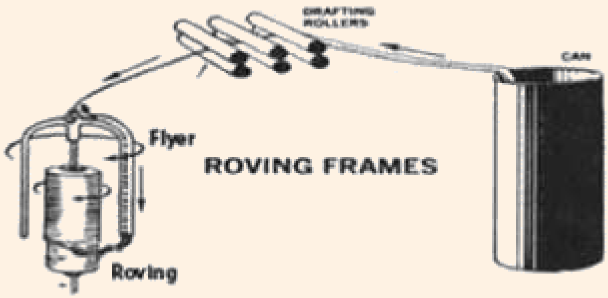
Blow room process: sorting, opening, separating, cleaning, and blending of fibres

Carding: intensive cleaning through individualization of fibres

Drawing: alignment of fibres through doubling and drafting of fibres

Combing: micro cleaning and alignment of fibres through parallelization

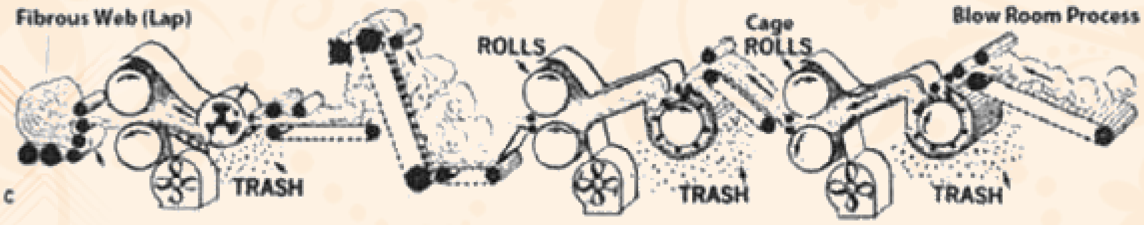
Roving: attenuating drawn slivers



Spinning: twisting drafted roving in to yarn

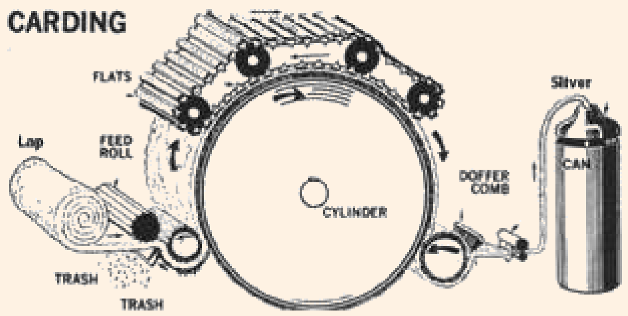
2.3.1 Blowroom Process

Cotton fibres that have been compressed into large bales are delivered to the spinning mill from a number of suppliers. These fibres differ in quality and spin able properties like staple length, fineness, flexibility, strength and trash content. In order to insure uniformity and quality of the product, the spinner must sort the fibers as to grade, remove the impurities like dirt, leaves and sand particles, and blend the fibres from different bales. This is done by feeding fibres from different bales in to the chute of the opener, an enclosed chamber containing a rotating cylinder equipped with spiked teeth or set of oscillating toothed bars. The tufts are pulled apart so the fibres are loosened from each other. At the same time, impurities and trashes are separated from the fibres. At the end of this process the bulk of fibres either converted in to thick lap or opened loose fibres are fed into a carding process by means of chute feed system.



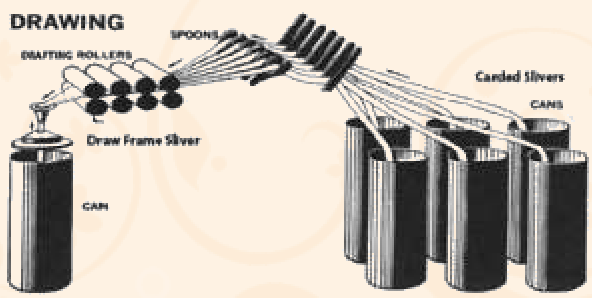
2.3.2 Carding

In carding the tufts of fibres are individualized by means of carding action for efficient removal of fine trash particles. The carding action is achieved by the fibre tufts caught between a cylinder which is covered with fine needles and flat strips. The cylinder and flat strips rotate at different speeds so that the fine needles individualize the fibers effectively. The sheet of carded fibres is drawn through funnel in to a soft, bulky untwisted strand called a sliver.



2.3.3 Drawing

Six or more slivers are fed to the drawing frame, where they are combined, drafted and condensed in to single sliver. The drawing frame contains three or four drafting rollers rotating at successively increasing speeds. The slivers are flattened, stretched out (drawn) and re combined as they pass through the rollers. The final thin web is pulled through a funnel and condensed into a soft and bulky sliver similar to the original sliver. However, the resultant drawn sliver is six or more times longer than original sliver.

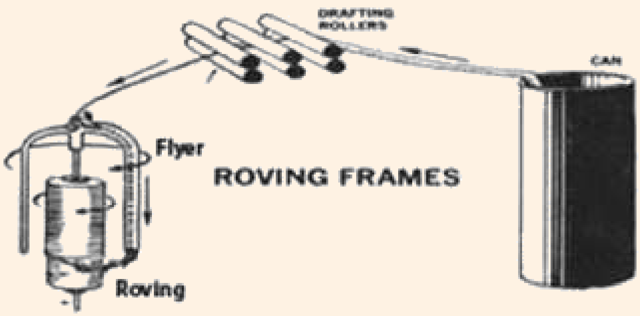


2.3.4 Combing

For producing yarns for fine quality fabrics with better uniformity, luster; less hairy texture and strength, carded slivers are subjected to combing process. Prior to this process the carded slivers are fed into lap former where they are reformed in to thin fibrous web, later it is processed in combing. During combing process the short fibres, micro dust particles, neps and other foreign matters are removed at maximum extent. Combed sliver is better aligned, more uniform than carded sliver.

2.3.5 Roving

The carded or combed sliver is delivered to the ROVING FRAME. Here the sliver is passed through another set of drafting rolls, which produce roving by reducing the diameter and increasing the length of the material. A small amount of twist is inserted in the material at this stage known as roving as it is being wound onto a rotating spindle. The roving is about one-eighth the diameters and eight times the length of the sliver.

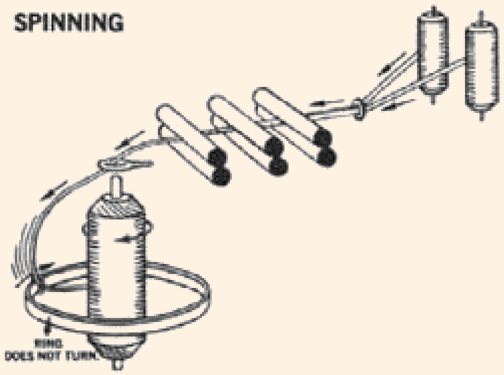


2.3.6 Spinning

The roving is mounted on the RING SPINNING FRAME and fed through another set of drafting rolls. The final pair of rollers spins at about thirty times the speed of the first pair. The highly attenuated yarn is fed onto a high-speed spindle by a traveler, which rotates on a ring surrounding the spindle. The traveler rotates at a speed slightly slower than the spindle and is capable of an up-and down-motion .the difference in speed between the traveler and the spindle determines the degree of the twist of the yarn. The oscillating motion of the traveler winds the yarn into a neat package.

A more rapid method of preparing spun yarns uses an integrated spinning frame which converts sliver to yarn without the necessity for drawing and drafting .the steps in processing the fibers are essentially the same as in the standard process, but they take place in one machine. Yarns made in this manner are not as fine as those made in the standard way, but processing costs are greatly reduced.

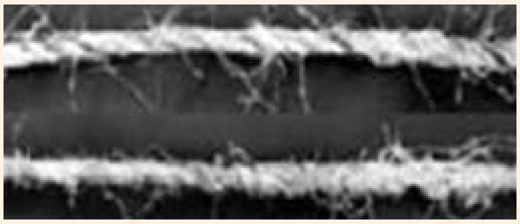
It is obvious that with so many steps involved in the spinning of the fiber to yarn manufacturers are constantly searching for more rapid and expensive methods. The integrated carding device and the integrated spinning frame mentioned above are the two of the means for reducing cost and increasing productivity. They are currently used for making coarser yarns, but in the future they may be used more and more for finer yarns.



2.4 Classification of yarns

2.4.1 Spun Yarns

It is composed of staple fibers. It is made from natural cotton, flax, or wool staple fibers, also from natural (silk) or manmade filaments which are cut into short lengths.



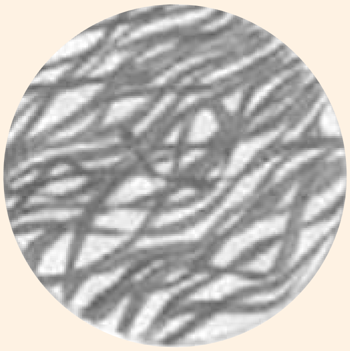
- It is bulkier than filament yarns. It is more hairy and fuzzy in appearance. The fiber ends protrude from surface with more imperfections or irregularities.
- It has more amounts of twist and dull appearance than filament yarns. It is rough or soft to touch depends on amount of twist.

- Carded spun yarns:

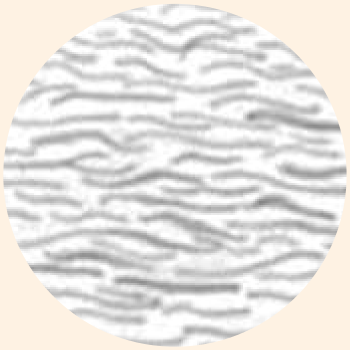
  They are made from short staple cotton fibers and are more coarse or thicker. It has more imperfections or irregularities and produces loose or napped fabric structure. It has dull, uneven appearance.

2.4.2 Combed Yarns

It is made from long staple cotton fibers. It is a smooth and finer yarn with more uniformity and less imperfections and irregularities. It has a bright and an even look with more twists and durability.



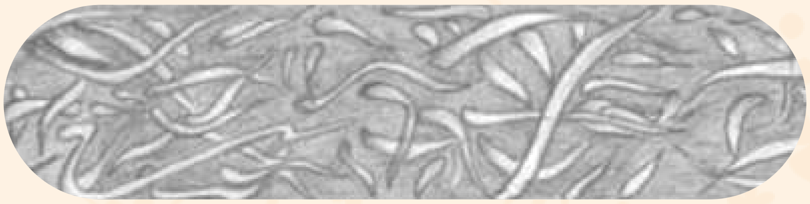
Carded cotton yarn



Combed cotton yarn

2.4.3 Woolen Yarns

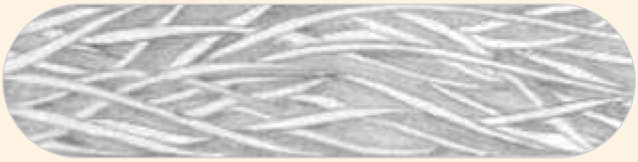
They are made from short staple wool fiber, and are coarse / bulky / thicker/ fuzzy with dull appearance and uneven look. It is an uneven yarn with more imperfections/irregularities and more hairiness. It produces loose or napped fabric structure with insulating properties. It provides warmth, resists wrinkling and do not maintain desired crease.



Carded wollen yarn

2.4.4 Worsted Yarns

They are smooth, finer and highly twisted yarns made from long staple wool fibers. It has more uniformity/ less imperfections and irregularities, and has insulating properties & providing less warmth. It maintains desired creases and offers better formability and shape retention.



Combed worsted yarn

2.4.5 Filament Yarns

They are loosely twisted yarns made from natural silk or manmade filament fibers. They are fine and smooth, more pliable and more uniform in diameter than spun yarns. They are lustrous and shiny in appearance. Filaments can be separated when untwisted and can be counted. They produce high seam and yarn slippage. They are Stronger than spun yarns of the same diameter and fiber content.

2.4.5.1 Monofilament Yarn

It is a single strand of filament yarn and cannot be separated as it is an indivisible component.

Monofilament Yarn

2.4.5.2 Multi Filament Yarns

Yarns are composed of two or more filament strands twisted together to form one yarn. When untwisted, each filament can be counted.

multifilament/multiple strand yarn

2.5 Yarn Quality Parameters

2.5.1 Yarn count/size/fineness

Yarn count expresses the fineness or linear density of yarn. Yarn count is measured by a direct and indirect system of measuring.

2.5.1.1 Direct Numbering System

Fineness of yarn is measured in weight per unit length.

Denier

It is defined as weight in grams of 9000 meters length of yarn. As the number increases, the yarn gets thicker or coarser and is mainly used for filament yarns.

Tex

It is defined as weight in grams of 1000 meters length of yarn. As the number increases, the yarn gets thicker or coarser. It is applicable for all types of fibers, yarns and global markets.

2.5.1.2 Indirect Numbering System

Fineness of yarn is measured in length per unit weight.

Cotton count-Ne

Defined as number of hanks weigh in 1 pound weight of yarn

1 Hank = 840 yards

As the number increases, the yarn gets thinner or finer. It is mainly used for cotton spun yarn, silk spun yarn, manmade / synthetic spun yarn and cotton/synthetic blended spun yarns.

Metric count-Nm

Defined as number of units weigh in 1 kilo gram weight of yarn

1 unit = 1000 meters

As the number increases, the yarn gets thinner or finer. It is mainly used for woolen and worsted yarns.

2.5.2 End-uses of Yarn Counts

Yarn denier	Use
40 -70	Sheer hosiery, Tricot lingerie, blouses, shirts, sheer curtains
75 - 120 140- 200	Crepe, chiffon, georgette, satins Men's / women's wear medium weight
250 -520	Outer wear, draperies
600- 840	Upholstery
1040	Carpets, some knitting yarns

2.5.3 Filament Yarn Count

Cotton Count	Range	End uses
1s -20s	Coarser	Heavy weight fabrics like denim, canvas
21s-40s	Medium	Sheeting, drill, gingham, matte and hopsack
41s - 100s	Finer	Light weight fabrics like shirring's, sheets
More than 100s	Super finer	Very light weight fabrics like shirring's, sheets, voile, percale

2.6 Yarn Twist

Twist is the spiral arrangement of fibers around the yarn axis. Twist binds the fibers together and contributes strength to the yarn. The amount or degree of yarn twist is measured in number of turns per inch (TPI).

Degree of yarn twist the following characteristics of fabrics

- Hand
- Appearance
- Texture
- Drape
- Durability

2.6.1 Amount of yarn twist and end uses

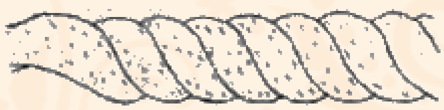
Low twist	Filament yarns;	Smooth
2-3 tpi	Napping twist	Warp; 12 tpi
Weft; 6-8 tpi	Bulky, soft and weak	
Average twist	Warp; 25-30 tpi	
Weft; 16-20 tpi	Most common, smooth,	
Regular, durable and comfortable		
Voile twist	High twisted singles 35-40 tpi are plied with 16-18 tpi	Finer yarns, strong and harsher hand
Crepe twist	Singles 40-80 or more tpi are plied with 2-5 tpi	Snarling or kink
Fabrics with good drape and texture		

2.6.2 Direction of Yarn Twist

- S - Twist, when held in vertical position and twist flows upwards in left-hand direction;
- Z - Twist, when held in vertical position and twist flows upwards in right hand direction.

S-twist/left-hand twist

Z-twist/right-hand twist



Single/one-ply yarn

Directions of twist mainly affect the light reflecting qualities, texture and hand of the fabrics. Z - Twist is more common in both woven's and knits.

2.6.3 Single-Ply Yarn

A yarn is composed of single strand, which is produced by the spinning process and when untwisted, the fibers can be separated.

2.6.4 Plied yarn

A yarn is composed of two or more single strands that are twisted together and when untwisted, single strands can be counted. Plied yarns are identified as two, three, or four ply yarns.

2.6.4.1 Objectives of plied yarns

Plied yarns are obtained by blending different fiber yarns such as by combining spun and filament yarns and then introducing textured or novelty yarns. To improve the strength of yarn, minimize irregularities and utilize multi strands of fine yarns to produce thick strand. Modify texture and colour composition.

2.6.4.2 Characteristics of Plied yarns:

- Thicker, heavier and courser;
- Differ in count; Less flexible than single yarn;
- Affect drape of the fabric;
- May differ in amount of twist and direction of twist

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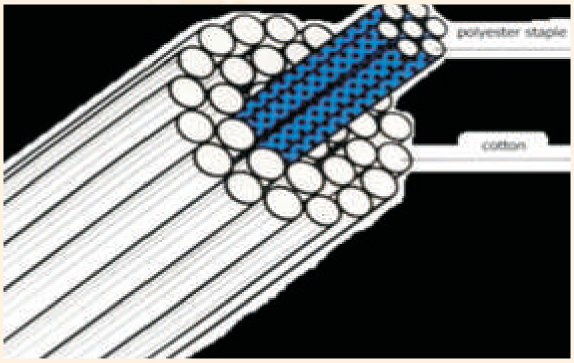
2.7 Core-spun yarn

A yarn, which has one type of fiber, wrapped around another yarn with strength and / or stretch. The structure consists of a core, which could be spandex or any other type yarn, and outer layer is usually of natural, man-made or blended fiber yarn. The inherent property of yarn is influenced by inner core. The outer layer determines the hand and texture.

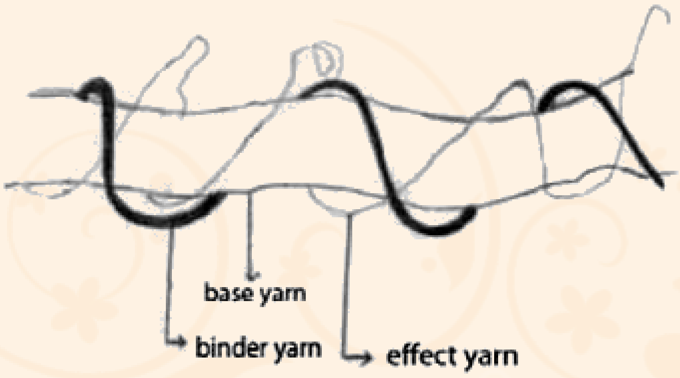


2.8 Fancy / Novelty Yarns

Novelty Yarns are single or plied yarn structures characterized by intentionally introduced irregularities in size, twist and multi coloured effects.

2.8.1 Novelty yarn construction

- Base yarn - to control length and stability
- Effect yarn - to add texture and aesthetic value
- Binder yarn - to hold effect yarn with the base yarn



2.8.1.1 Texture and aesthetics of novelty yarns depends on

- Changing type and count of yarn
- Changing the amount of twist / direction of twist Adding metallic yarns
- Adding different coloured yarns

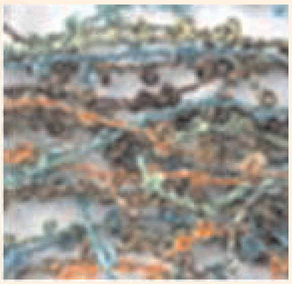
2.8.1.2 Characteristics of novelty yarns

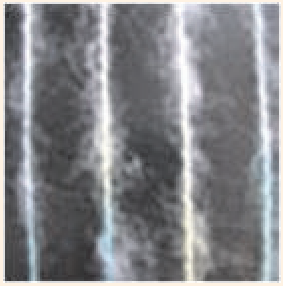
- Enhances texture and design to fabric
- Produces surface interest, variation in styling and unusual appearance in fabric
- Hand varies soft to light and harsh to rough
- Strength varies different part of the fabric
- Non-uniform thickness throughout the fabric
- Uneven performance in wear. Reduced abrasion resistance;
- Pilling and snagging is critical problem.

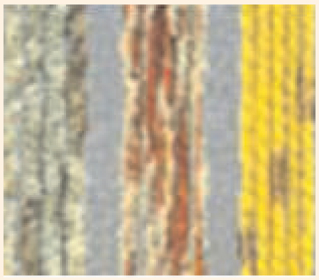
2.8.1.3 Types of Novelty Yarns

- Boucle Yarn: A three-ply yarn with small, tight loops protruding from the body of the yarn at widely spaced intervals.
- Brushed / Napped Yarn: A staple yarn in which the short fibers of the yarn are brushed to the surface to form a soft bulked effect.
- Chenille Yarn: A yarn with pile fibers held between plied core yarns producing a hairy or velvety effect.
- Corkscrew Yarn: A two-ply yarn consisting of one slack twisted and one hard-twisted fine yarn where the different size yarns are twisted together at a different rate with the thinner yarn twisting around the thicker yarn.
- Flock / Flake Yarn: A single yarn
- Nub Yarn: A multiple-ply yarn in which one yarn is twisted around the other yarn several times forming a built-up enlarged or knotted effect on the surface of the base yarn. Which round or elongated tufts of fibers are inserted at regular intervals; the tufts are held in place by the twist of the base yarn.

- Ratine Yarn: A core yarn with a rough surface effect in an overall appearance in which the small loops are closely spaced and securely twisted to the core yarn. A yarn is twisted over a base yarn at regular intervals.
- Seed Yarn: A tiny, round or oval enlarged nub produced by crimping and twisting a yarn repeatedly over a base yarn at regular intervals.
- Slub Yarn: A thick and thin yarn with randomly spaced soft, lofty portions produced by irregular intervals of twist and lack of twist in the yarn formation.
- Spiral Yarn: It is a two-ply yarn consisting of the staple twisted soft, thick yarn and one hard-twisted fine yarn. Where the thick yarn is twisted and wound spirally around the fine yarn.
- Splash Yarn: An elongated enlargement or nub produced by crimping and
- Blended Yarns: Yarns are prepared from fiber blends in order to improve their performance by drawing upon the best available properties of both fibers and also to reduce the cost of fabric as well as to create interesting surface texture by utilizing the technique of chemical processing.

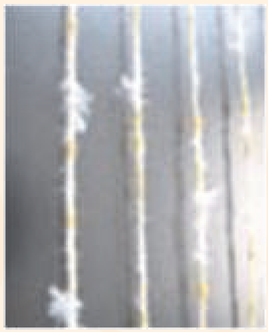

Boucle Yarn


Brushed Yarn


Spiral Yarn


Chenille Yarn


Seed Yarn


Nub Yarn


Corkscrew Yarn

SUMMARY

Unit 2 deals with the overview of conversion of fibers to yarns. While sections 2.1 and 2.2 talk about properties of yarns which determine their characteristics, section 2.3 deals with the ring spinning process, which is most common worldwide. Section 2.4 classifies the yarns based on their different processes of manufacturing. Section 2.5 deals with parameters that are to be controlled to guide the yarn properties. In section 2.6, we have details of yarn twist. Section 2.7 includes information about core spun yarn while section 2.8 talks about fancy yarns.

QUESTIONS

1. Multiple Choice Questions- choose any one among the options given as answer to the individual questions (correct answers are in bold and highlighted).

i. Which of the following yarns of same fineness is supposed to have highest strength?

a) Novelty yarn　　b) Ring spun yarn

c) Carded yarn　　d) Woollen yarn

ii. Novelty yarns are used for:-

a) Strength　　b) Aesthetics

c) Both　　d) None

iii. Example of indirect count is:-

a) Metric Count　　b) Denier

c) Tex　　d) Microdenier

iv. 2/40s yarn is:-

a) Single yarn　　b) Spun Yarn

c) Monofilament Yarn　　d) Plied yarn

v. Cost of plied yarn as compared to single yarn of same fiber and having same fineness is:-

a) Higher　　b) Equal

c) Lesser　　d) No comparison

2. **Fill up the blanks in the following questions:**

a) Cotton yarn can be classified as ____________ yarn only.

b) In between cotton and polyester, monofilament yarn is possible with ____________ only.

c) In indirect count, a higher number of yarn fineness denotes a __________ yarn.

d) Z-twist is caused by ______________ rotation of yarn about its longitudinal axis.

e) A high twist may result in ______________ feel of the yarn.

UNIT 3

Weaving and Woven Fabrics

3. Weaving and Woven fabrics

Out of the many innovative techniques that man has adopted from nature, weaving is one. It is a simple method of producing a net-like structure that is stable and durable. In order to achieve that, the process of weaving makes two sets of threads or yarns interlace with each other at right angles. Such an interlaced structure ensures strength and durability to the fabric, referred to as the woven fabric, which is produced. The nature of this interlacement can be varied on the basis of the frequency of interlacing points and their distribution over the plane of the fabric. These parameters determine the major properties of a woven fabric.

3.1 The Loom

The process of manufacturing a fabric from different sets of yarns is termed as weaving. It necessarily involves the interlacing of two sets of yarns at right angles to each other, termed as the warp and the weft yarns respectively. In order to achieve this, the machine that has been developed over the ages is known as the Loom. A loom traditionally used to be a wooden frame where the warp sheet will be laid down from one end to the other under tension. After the warp sheet is set, the weft yarn will be introduced one by one by allowing appropriate gaping in the warp sheet. The distribution of these gaps may be according to a predetermined interval, and the nature of these intervals determines the weave of the fabric being produced. One problem with the traditional looms, termed often as handlooms, is low productivity. In order to improve on that count, many new and different looms have been developed that are automated and fast with very high productivity. They will be discussed later.

Figure 3.1- Front view of a handloom for weaving sample fabrics

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Figure 3.2- Rear view of a handloom
for weaving sample fabrics

Figure 3.3- The warp yarns through
the heald eyes of the heald shafts

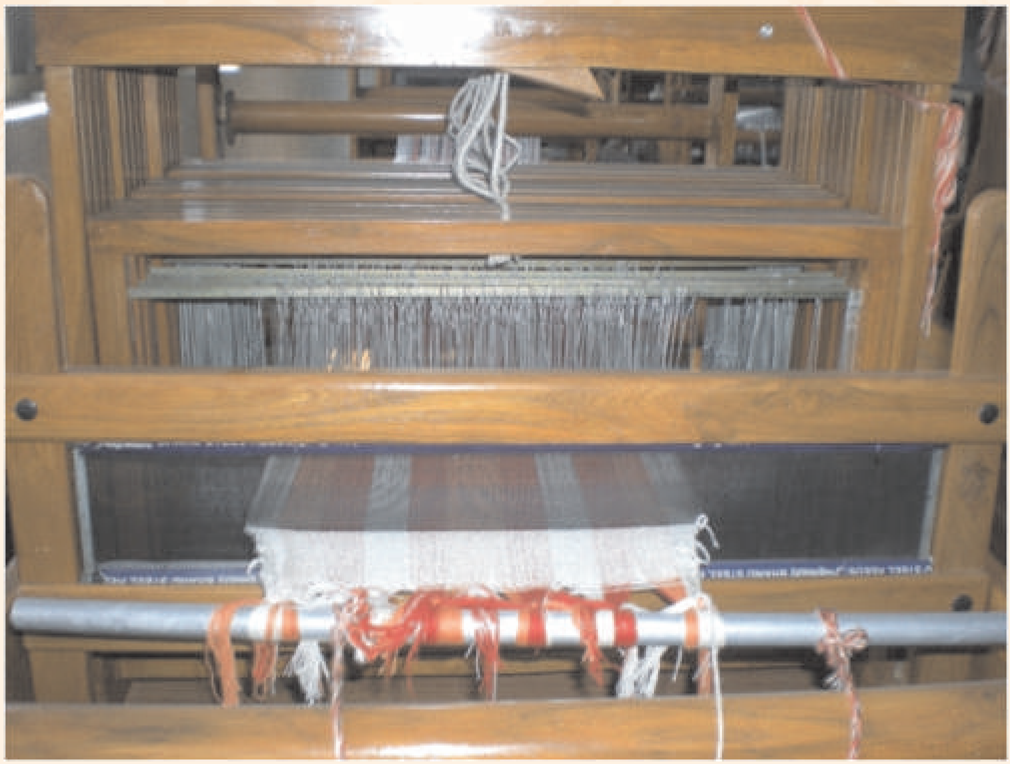


Figure 3.4- The Reed

3.1.1 Basic Motions of the Loom

In order to achieve the technique of fabric manufacturing as described above briefly, the working of a loom has been divided into three basic motions:-

(i) Shedding: This is the operation that helps in opening up the warp sheet creating the gaps through which the weft yarns will pass. In order to do this operation, primitive looms had the wooden shafts that were lifted by hand or by leg-driven pedals, as in handlooms. In power looms, this is done with the help of electricity, and the shafts were cam-driven initially. But this hampered the loom productivity as well as the design size was limited. So, later on, developments have evolved the dobby and then the jacquard mechanisms for shedding. In dobby, the design size is larger, giving the weaver or designer an increased scope for design exploration. The productivity is also higher. In jacquard, the design size is virtually unlimited and productivity even higher. But jacquard designs are more complicated to be set up on a loom and hence, dobby looms are preferred in most cases, owing to comparative simplicity and lesser cost.

(ii) Picking: This is the operation in which the weft or the pick, also referred as the fill, passes through the open warp sheet. There are various methods of carrying the weft across the full width of the loom. In the most primitive way, a shuttle was used, which a wooden missile-like structure with a weft pirn would carry the weft yarn inside it. The shuttle was mechanical thrown from one side to the other. Low productivity and associated health hazards caused it to be replaced with other improved devices like the projectile, the rapier, the air-jet and the water-jet looms. They are described in brief later.

(iii) Beat-up: This is a very important operation of the loom. After shedding and picking, the beat-up action is to ensure that the newly introduced weft is closely packed in the body of the fabric, and hence, a mechanical force or thrust is exerted on the new weft by a device called the reed to embed it into the main fabric already woven, closely with the prior weft yarns.

3.1.2 Types of Looms

Looms can be classified based on a number of parameters, as follows:

(i) Shedding mechanism: On the basis of this, looms can be classified as:

(a) Hand looms- shedding done manually by leg-driven pedals.

(b) Cam looms- shedding done with the help of cams. They are less productive and limited in design repeat size, although less complicated.

(c) Dobby looms- shedding done by dobby mechanism. Design repeat size increases along with productivity, but it is complicated and costlier that cam looms and hand looms.

(d) Jacquard looms- shedding done by jacquard mechanism. Costliest of all, but design repeat size is virtually unlimited. Although a complicated mechanism, they give fabrics with very rich look and texture.

(ii) Picking mechanism: Based on this, the looms are classified as follows:

(a) Shuttle looms- the picking is done by wooden shuttles. This is common in handlooms and primitive power looms.

(b) Projectile looms- here, the picking is done using a mechanical device called a projectile. It is a small and light weight device that can move fast, thus increasing the loom productivity and decreasing power consumption.

(c) Rapier looms- here, the picking is done by a rod-like or sword-like mechanical device, that carries the weft yarn at its tip and enters the shed when it is open, withdrawing after delivering the weft end at the other end as the shed closes. Instead of one, there may be two rapiers from both sides in case of wider looms, transferring weft from one rapier to the other in the middle of the shed. They help in increasing productivity, but power consumption also increases.

(d) Air-jet looms- here, picking is done using compressed air. Thus, power consumption is very low, but the distance up to which the weft can travel gets limited, thus also limiting the loom width.

(e) Water-jet looms- here, picking is done using compressed water jets. Here also, the loom width is limited, and only hydrophobic fiber yarns can be used as a weft.

(iii) Number of sheds: In order to increase productivity, it has been thought of to develop looms with more than one shed at the same time, producing more than one fabric simultaneously. Thus, looms can be classified on the basis of this as:

(a) Single shed looms- only one shed and one fabric produced at a time.

(b) Multiple shed looms- more than one shed occurs at a time, one weft being introduced in each at the same time; thus, more than one number of fabrics produced simultaneously. These looms are used chiefly in making industrial fabrics, as the fabrics are very costly and the looms highly complicated.

3.2 Preparatory Processes for Weaving

For efficient weaving without defects, preparatory processes for weaving are of extreme importance. The preparatory processes essentially involve the following:

(i) Warping: in this process, several warp yarns are set on a creel, from where they are pulled simultaneously on to a small beam, called the warper's beam. The number of warp yarns and their length are predetermined as per the requirement in the fabric.

(ii) Sizing: often, the warper's beam is subjected to sizing, in which size paste is applied to the warp yarns. The size paste adds strength to the warp yarns to withstand the wear and tear during weaving. It also reduces abrasion among warp yarns during weaving and related damage like deterioration of fabric appearance. In case of coarse warp yarns, the process may be omitted, as they have enough strength to withstand the wear and tear during weaving. But in case of fine yarns, it is a must. Previously, natural size paste was used that were obtained, for example, from boiled rice. Now, artificial size paste is employed.

(iii) Weaver's beam: after sizing, the warper's beams are combined to form a larger beam, the weaver's beam. It is difficult to prepare the weaver's beam at one go because mainly of the huge number of warp yarns that have to be wound on to it. Besides, sizing of the weaver's beam that is of huge mass, can lead to excessive usage of power. Thirdly, the massive force required to rotate the weaver's beam fast during sizing can cause the warp yarns to break or lose strength. The weaver's beam is attached to the loom at the rear for further weaving.

(iv) Drawing: the warp yarns are drawn through the heald eyes individually. The heald eyes connect the individual warp yarns to the shafts available for shedding. The distribution of the individual war yarns among the heald shafts depends on the weave chosen for the fabric. Drawing is a time consuming process and difficult to be made automatic. Even today, it is mostly done manually.

(v) Denting: after drawing though the heald eyes, the warp yarns have to be drawn through the dents in the reed as well. Denting controls whether a fabric will be woven as a dense one or a less dense light fabric.

3.3 Classification of Woven Fabrics

The nature in which interlacements occur between the warp and the weft is referred to as the weave of the fabric. Based on the different types of weaves that are possible, fabrics can be broadly classified into the following categories:-

(i) Fabrics with plain weave.

(ii) Fabrics with twill weave.

(iii) Fabrics with satin weave.

3.3.1 Specification Of Woven Fabrics

Like chemicals, a woven fabric also needs to be identified uniquely for easy understanding and communication. However, unlike the IUPAC system in chemistry, there is no hard and fast way of woven fabric nomenclature. The different fabrics are well known across the globe by their common names like muslin, poplin, denim, canvas, velvet, terry pile and many others. Although these names are successfully used to communicate and refer to the different fabric in between a buyer and a seller in the same country, when one has to deal with cross country orders, sometimes there can be confusion. This is owing to the fact that in different parts of the world, the meaning of these common names can vary slightly or majorly. In order to be more specific when referring to fabrics, the industry depends on the technical specifications of the woven fabrics, instead of the common names.

A woven fabric is referred to by its technical specifications that include fabric width, ends/inch or cm. X picks per inch or cm, nature of weave, warp and weft fiber content, warp count X weft count, GSM and type of finish applied. A typical example is as follows:-

- Width- 149 cm.
- EPI X PPI- 120 X 84
- Weave- twill
- Fiber- 65/35 P/C X 100% Cotton
- Count- 1/24s X 2/40s
- GSM- 200
- Finish- Emery

In the above nomenclature, the value for warp is always written first as a convention, followed by the weft value. Thus, the fabric with the above nomenclature is 149 cm wide with ends per inch 120 and picks per inch 84. The weave of the fabric is twill and the fiber content of 65/35 P/C indicates a blended yarn of Polyester and Cotton in the warp, with Polyester: Cotton ratio of 65:35 by weight, while 100% Cotton indicates the fiber content of the weft yarn. Similarly, count of 1/24s X 2/40sindicates the warp yarn to be a single yarn of 24 English or Cotton Count and the weft yarn to be a 2-plied or double yarn of40English or Cotton Count. The fabric weight is 200 grams per square meter and the fabric is given emery finish, which is a type of mechanical finish.

3.4 Fabric Weaves and Properties

3.4.1 Plain weave

The woven fabrics that have the maximum extent of interlacements fall in the category of plain weaves. In a basic plain weave, each weft yarn goes over a warp yarn and under the consecutive warp yarn, so that there is no single space in the fabric that has a weft yarn passing over or under any two consecutive warp yarns. The same is true for the warp yarns too.

Due to such high frequency of interlacements, the woven fabrics made out of this weave and its variations are very firm and stable. They have very high strength and durability properties. Due to the high number of intersections among warp and weft yarns, these fabrics generally tend to be stiff and have less extent of drape. This renders them unsuitable for ladies wears in most cases. However, by using finer counts in warps and wefts, their drape can be improved, like in case of georgette, chiffon and voiles that are very popular as ladies' dresses.

	X
X	

Figure 3.5 Plain weave

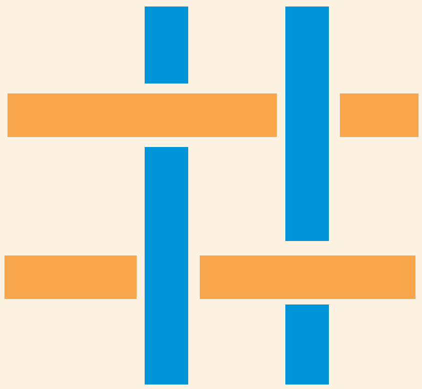


Figure 3.6 Thread path in a plain weave

Besides the basic weave, there are variations within this class of woven fabrics, which have been incorporated in order to increase their scope of usage, and overcome certain shortcomings. These are discussed in details below.

3.4.2 Rib weaves

In the simplest of variations, a rib weave is formed when any one of the warp or the weft is made to pass over or under more than one consecutive threads of the other set. Thus, when a weft moves over or under two or more consecutive warp threads at regular intervals along the fabric, the weave is called a weft rib. In case of two consecutive warp threads, the weave is denoted as 1X2 weft rib; in case of three consecutive warp yarns, it is denoted as 1X3 weft rib, and so on.

Similarly, when the warp is made to pass over and under two or more consecutive threads of weft, the weave is referred to as a warp rib. In case of two consecutive weft yarns, the weave is denoted as 2X1 warp rib; for three consecutive weft yarns, it is denoted as 3X1 warp rib, and so on.

The ribbed fabrics gain higher drape ability in the direction of the rib. Thus, a weft ribbed fabric is more flexible in the direction of the weft while a warp ribbed fabric is so along the warp. This happens due to the floats that appear in the fabric out of such weave. A float is defined as the path of a yarn, either warp or weft, when it travels over or under more than one consecutive yarn of the other set without any interlacement. Thus, if a weft passes over or under two consecutive warp yarns, the float that is created is said to be of two threads. Similarly, a warp passing over or under four consecutive weft threads is said to be having a float of four threads, and so on. Due to the floats in a ribbed fabric, it has lesser number of interlacements in one direction (warp or weft) as compared to the other, and hence, higher flexibility or drape in that direction.

	X		X
	X		X
	X		X
X		X	
X		X	
X		X	

Figure 3.7- A regular warp rib weave

	X		X
	X		X
X		X	
X		X	
X		X	
X		X	

Figure 3.8- An irregular warp rib weave

X	X	X			
			X	X	X
X	X	X			
			X	X	X

Figure 3.9- A regular weft rib weave

X	X	X		X	
			X		X
X	X	X		X	
			X		X

Figure 3.10- An irregular weft rib weave

3.4.3 Basket weaves

In further variations of plain weaves, if the fabric has floats in both directions at the same time, a basket weave results. It is also referred to as a matt weave. Thus, in a fabric, if the warp passes over and under three consecutive wefts alternately all over the fabric, and at the same time, the weft passes over and under three consecutive warp yarns, the fabric weave is said to be 3X3 basket or matt weave (figure 3.11).

A basket weave may be regular or irregular. They are also sometimes referred to as balanced and unbalanced basket or matt weaves respectively. In a regular or balanced basket or matt weave, the number of floats in the warp and the weft is equal in all the boxes created; examples are 2X2, 3X3, 4X4 basket weaves, etc. If the warp and weft floats are unequal in the different boxes, then an irregular or unbalanced basket or matt weave results; examples are 2X3, 3X4, 4X2 basket weaves, etc.

Due to the increased number of floats, basket weaves have a larger surface area exposed and hence, their absorption quality increases. Thus, among two fabrics made out of same fiber, the one with a basket weave will show higher absorbency to water than the other with plain weave. The ribs lie intermediate in between plain and basket weaves with respect to this property. This is one reason why ribs and basket weaves are preferred for hand-made towels and kitchen wipes that need high absorbency.

			X	X	X
			X	X	X
			X	X	X
X	X	X			
X	X	X			
X	X	X			

Figure 3.11- A regular basket weave

				X	X
				X	X
X	X	X	X	X	X
X	X	X	X		
X	X	X	X		
X	X	X	X		

Figure 3.12- An irregular basket weave

3.4.4 Twill weaves

Twill weaves have lesser interlacements than the plain weaves, and hence, they have floats, but they also have directional properties. In the basic twill weave, the weft travels over at least two consecutive warp threads, and under the next, and again over two consecutive warps, and so on. The next weft yarn does the same, but starting with the second warp thread, and so on. Thus, a diagonal line appears in fabric, either in left-to-right direction, or the reverse, as we go from bottom to the top of the fabric. Such a twill weave is called weft-faced twill, as the proportion of weft yarns on the fabric surface is higher. They are denoted as 1X2, 1X3, etc. the second digit in each set indicating the length of the weft float.

In case of a warp-faced twill, the warp yarn moves over two or more consecutive weft yarns. For example, in 3X1 twill, the warp yarn moves over three consecutive weft yarns before moving under the next weft, and repeats this regularly. Other examples are 4X1, 2X1, etc.

It is not so that the a weft or a warp has to move under only one warp or weft respectively in order to give a twill weave. A weft yarn can move over four consecutive warps and then under three consecutive warps in regular intervals to give a 4X3 weft-faced twill weave. Similarly, a warp yarn can also move over 2 consecutive weft yarns and under 3 consecutive weft yarns to give 2X3 warp-faced twill.

All the above twill weaves are examples of irregular or unbalanced twill weaves that have unequal proportions of warp and weft yarns on the face of the fabric. If they are present in equal proportions, then a regular or balanced twill results, like 2X2 or 3X3 twill.

A twill weave can also be classified based on its direction. A left to right twill weave, as we go from bottom to top of the fabric along its face, is called a right-handed twill, abbreviated as RHT, while a twill weave with diagonal lines running from right to left as we go from bottom to top of the fabric along its face, is referred to as a left-handed twill or LHT.

	X	X
X	X	
X		X

Figure 3.13- A unbalanced twill weave

		X	X
	X	X	
X	X		
X			X

Figure 3.14- A balanced twill weave

	X	X	X
X	X	X	
X	X		X
X		X	X

Figure 3.15- A warp-faced twill weave

			X
		X	
	X		
X			

Figure 3.16- A weft-faced twill weave

3.4.5 Satin weaves

These are weaves that have a large number of floats. Among all weaves, the satin weave has least number of interlacing. The rule for satin weave is that an individual warp can interlace with any one weft only once in a single design repeat, and vice versa.

The term 'satin' is used when the weave is warp-faced, i.e., when all the warp yarns pass above the weft yarns except for at the points of interlacing. For weft-faced such weave, where all weft yarns pass above the warp yarns except for at the point of interlacing, the term used is 'sateen'.

Satin weaves are known for high extent of drape, due to enormous number of floats available. Their tensile and bursting strengths are low due to very less number of interlacing, but their tear strength is highest among all weaves due to high amount of floats present. Their appearance is also much more lustrous as compared to other weaves owing to the floats present.

			X	
	X			
				X
		X		
X				

Figure 3.17- A 6-end sateen weave

3.5 Dobby Weaves

In a loom that works on shafts either driven by cams or by hand, the width of the design repeat is limited. Ideally a maximum of up to 12 shafts can be accommodated in a loom, and since one shaft controls only one warp thread, the design repeat cannot be beyond 12 warp yarns. This puts a constraint on the designer's ability to explore newer designs. This can be overcome in dobby weaves. The special mechanism of controlling the warp yarns in a dobby mechanism enables the designer to increase the width of design repeat to up to 32 or even 40 warp yarns.

In dobby looms, the shedding mechanism is modified and improved as compared to traditional looms. In a dobby loom too, there remain shafts, but their controlling mechanism is much improved so that 32 to 40 warp yarns per repeat can be operated during a single shedding operation. As a result, various intricate and large designs are possible on dobby looms. Dobby weaves are very popular in making men's shirts, women's tops, curtains, bed spreads, cushion and sofa covers.

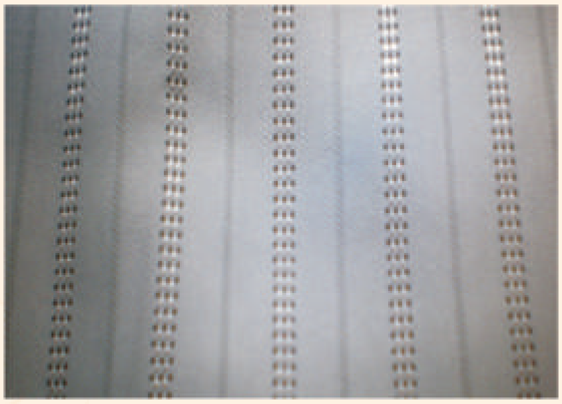


Figure 3.18- A dobby weave on a shirt

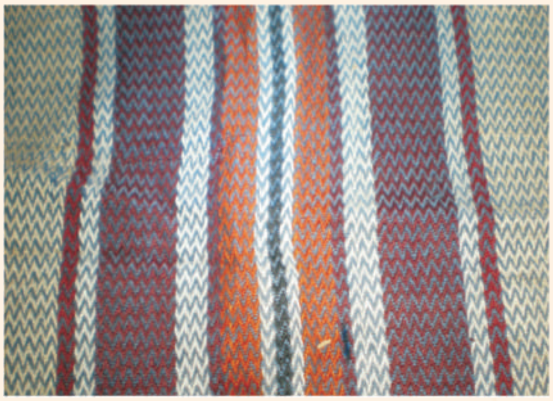


Figure 3.19- A Dobby weave on a home furnishing textile

3.6 Jacquard Weaves

The major limitation of dobby weaves is again the size of the design repeat. A designer cannot go beyond 32 to 40 warp yarns in a design repeat even when dobby mechanism is used. To make the scope of exploration of the designer wider, the jacquard mechanism was invented. It is also a shedding mechanism in which each warp yarn is a warp sheet is controlled individually during the shedding operation. Thus, a huge design can be created, like weaving a single big flower all over a bed spread or curtain. Jacquard weaves are thus very intricate, delicate, highly aesthetic and rich in feeling, and hence, costly.

Figure 3.20- A jacquard woven sari

Figure 3.21- A jacquard weave on a bag

Figure 3.22- A jacquard weave on a sleep wear

Figure 3.23- A jacquard woven sari

3.7 Pile Fabrics

These fabrics are different from the normal fabrics in the way that their surface texture is different. Pile fabrics have surfaces with raised hair-like yarn structures. Thus, these fabrics resemble a two-dimensional structure lesser and are more like a 3-D structure. This unique structure helps in many ways like increasing the surface area of exposure if the fabric and hence, the water absorbency, also making the fabric soft to touch.

Pile fabrics are created by raising any one of the warp or weft set of yarns above the surface level of the fabric. This raising is done mostly during weaving, after shedding and before beat-up. Such raising of yarns causes them to form loop-like structures that are termed piles. Thus, pile fabrics can be broadly divided into two types, warp-pile fabrics and weft-pile fabrics.

3.7.1 Terry Fabrics

They are the type of pile fabrics in which the loops are left uncut. Thus, they remain as loops on the surface of the fabric, increasing absorbency and making the fabrics feel sifter. Such terry pile fabrics are commonly used in bath wear, towels and napkins.

Figure 3.24- A terry pile fabric for towel

3.7.2 Velvet and Velveteen

In case of velvet or velveteen, the loops formed in a pile fabric are cut. This causes the fibers to get separated from each other in the yarn at the point where they are cut. Thus, they tend to fray and give rise to a unique surface texture to the fabric. If the cut piles are left to stand erect, we call the fabric as velvet. If the cut piles are made flat by external pressure, the fabric is termed velveteen. Such fabrics have a very rich look and luster besides a highly soft texture. They are thus used for many high end products like wedding dresses. They are also very popular as high end interior designing fashion fabrics.

3.7.2.1 Characteristics of velvet and velveteen

The extra yarns used to produce the pile ad weight, stiffen the fabric, and give a fuller body and more pleasing drape characteristics. The fibers ends from the pile yarn produce mild, pleasurable, prickling sensation. The multitudes of fibers that form the pile trap a large amount of air, which acts as insulator to give a cloth its warmth.

In addition, because of their durability, velvets Soil resistance or standing of velvet and velveteen fabrics is poor than flat woven fabrics. This is mainly due to the pile yarns have large exposed area to make contact with the soil. Dry cleaning is preferred to laundering because excessive agitation in the laundering process may destruct the pile yarns.

Uses: Velvet and velveteen fabrics provide a warm, luxurious hand for such end uses as full - length gowns and jackets for formal wear. They are also popular for home furnishings, particularly in drapery and upholstery. This fabric is recommended for higher - quality applications.

3.7.3 Corduroy

Corduroy is a corded weft pile fabric and is produced by extra weft yarns which float over one or more warp yarn. This fabric differs from velveteen is that the pile yarns are aligned so as to give a warp wise corded stripe on the surface. Corduroy may be produced with v or w interlacing. The ground cloth may be of twill or plain weave construction .The raised portions of the pile are called wale. Varying the length of the floats when the pile yarns are getting inserted may change the spacing between them.

Corduroy is expected to be heavier fabric than velvet and velveteen. It is usually made with coarser yarns. This yields a fabric that has a stiffer drape and rougher hand than velveteen. Corduroy is easily laundered and may be ironed.

Figure 3.25- A corduroy trouser

3.8 Seersucker

In weaving two warp beams are used. The yarns on one beam are held at regular tension and those on the other beam are held at slack tension. The yarns are wound onto the two warp beams in-groups of 10 to 16 for a narrow stripe. As the reed beats the weft yarn into place, the slack yarns crinkle or buckle to form a puckered stripe, adds the regular - tensioned yarns form the flat stripe. The stripes are always in the warp direction. It is a low profit, high cost item because of its slow weaving speed. Seersucker's are made in plain colours, stripes, plaids and prints. Seersucker is used in summer suiting like dresses, curtains and sportswear.

Figure 3.26- A seersucker women's top wear

3.9 Pique Weaves

Pique weave produces a fabric with ridges, called Wales or cords, that are held up by floats on the back. Cords or Wales usually run in the lengthwise direction. Stuffer yarns are laid under the ridges in better quality pique fabrics to emphasize the roundness. Their presence or absence is one way of determining quality. The stuffer yarns are not interlaced with the surface yarns of the fabric and may be easily removed when analyzing a swatch of fabric. Pique fabrics are woven on either dobby or jacquard loom depending on the complexity of the design. Pique fabrics are more resistant to wrinkling and have more body than flat fabrics. Better quality pique fabrics are made with long staple combed yarns and have at least one stuffer yarn.

Bedford cord is a heavy fabric with wide warp cords used for bedspreads, upholstery, window treatments, slacks, and uniforms. Its spun warp yarns are coarser than the weft yarns.

3.10 Crepe Weaves

Crepe is a class of weaves that present a distinct weave effect but give the cloth the appearance of being sprinkled with small pots or seeds. The appearance resembles crepe made from high twist yarns. Fabrics made on a loom with a dobby attachment. Some are variation of satin weave, with weft yarns forming the irregular floats. Some are even-sided and some have a decided warp effect. Sand crepe is a common medium to heavy weight crepe weaves fabric, of either spun or filament yarns. It has a repeat pattern of 16 warp yarns and 16 wefts yarns and requires 16 harnesses. No float is greater than two yarns in length. Moss crepe is a combination of high twist crepe yarns and crepe weave. The yarns are plied yarns with one ply made of high twist single yarn. Moss crepe is used in dress and blouses.

SUMMARY

Unit 3 deals with different types of woven fabrics and the various processes of weaving. Section 3.1 deals with basics of the loom and its basic motions. Section 3.2 talks about the preparatory processes before the loom while section 3.3 deals with classification of woven fabrics. In section 3.4, different types of basic weaves are dealt with. Section 3.5 deals with dobby fabrics, section 3.6 with jacquard fabrics and section 3.7 with pile fabrics. Sections 3.8 to 3.10ll be preferable deal with a few more special weaves.

QUESTIONS

1. **Multiple Choice Questions- choose any one among the options given as answer to the individual questions (correct answers are in bold and highlighted).**

   i. Which one among the following weaves has the highest tensile strength, all other factors remaining constant?

   a) Plain b) Twill

   c) Satin d) Matt

   ii. Which among the following types of looms can give us the maximum size of a design repeat?

   a) Rapier loom b) Dobby loom

   c) Air-jet loom d) Jacquard loom

iii. Which of the following weaves has maximum luster?

a) Plain b) Twill

c) Satin d) Basket

iv. Which of the following weaves has diagonal line effect?

a) Plain b) Twill

c) Satin d) Matt

v. Which of the following fabrics show maximum absorbency?

a) Pile fabrics b) Denim fabrics

c) Seersucker fabrics d) Corduroy fabrics

2. Fill up the blanks in the following questions:

a) Velvet and terry cloths are made up of ________________ weaves.

b) A loom that uses compressed air for picking is known as a _____________ loom.

c) A fabric with crinkled effect is called a ___________ fabric.

d) A loom that runs totally on manual energy is known as a ______________.

e) A bed sheet with a huge floral design on it is generally made out of ____________ looms.

UNIT 4

4 (a) Knitting and Knit Fabrics

4(a) Knitting and Knit Fabrics

Knitting is the formation of a fabric by the interlocking of one or more sets of yarns. Knitting has been the traditional method of producing some items, such as sweaters, underwear, hosiery, and baby blankets. The trend towards a more casual lifestyle is reflected in the increased uses of knits in furnishings and apparel.

A unique advantage of knitting is that a complete product can be fashioned directly on the knitting machine. Sweaters and hosiery are good examples.

The rate of production of knitting machines is relatively high, about four times as many square yards or meters per hour as for looms since machine width is not related to operating speeds.

Knitting is a very efficient and versatile method of making fabric. This versatility has resulted from the use of computer-aided design systems wherein electronic patterning mechanisms to machines permit rapid adjustment to fashion changes.

Electronic controls identify the type of stitch for each needle, the yarn to be used in the stitch, and the tension on the yarn. Electronic controls for knitting machines make knitting faster, more efficient, and more practical. These machines are more versatile than other machines and changing patterns is much simpler and quicker.

Other major advantages of knits are comfort and appearance retention. Comfort is based on the ability to adapt to body movement. The loop structure provides the fabric with outstanding elasticity (stretch/recovery) that is distinct from any elastic properties of the fibers and yarns that are used.

Knitted fabrics have higher potential shrinkage than woven fabrics. The accepted standard is 5 per cent for knits, whereas 3 per cent is standard for wovens. The bulky structure of a knit provides many air-trapped cells for good insulation but still a wind-repellent outer layer is needed to prevent chill winds from penetrating.

4.1 Knitting

Knitting is a fabrication process in which needles are used to form a series of interlocking loops from one or more yarns or from a set of yarns. Filling, or weft, knitting is a process in which one yarn or a set of yarn is carried back and forth (or around) and under needles to form a fabric. Yarns run horizontally in the fabric. Warp knitting is a process in which a warp beam is set into a machine and yarn sets are interloped to form a fabric.

In knitted fabrics, yarns do not move in both directions as they do in weaving; there are no warp and no filling yarns in a knitted fabric. When a woven fabric is unravelled, both warp and filling yarns are removed. When a knit fabric is unravelled, a row of loops is removed. Try unravelling a knit and a woven to see the differences between the two structures.

4.1.1 Needles

Knitting is done by needles, such as spring-beard, latch, or compound. Most filling knits are formed with the latch needle. The spring-beard, or bearded, needle may be used to produce fully fashioned garments and knit-fleece fabrics. Spring-beard needles are usually used with fine yarns, whereas latch needles may be used in making coarse fabrics. A double latch needle is used to make purl loops. The compound needle is used primarily in warp knitting.

4.1.2 Stitches

Needles make stitches or loops. The stitches are named based on the way they are made. Stitches may be open or closed, depending on how the stitch is formed. Open stitches are most common in filling knitting. In warp knitting either of the kind may be found, depending on the design of the knit.

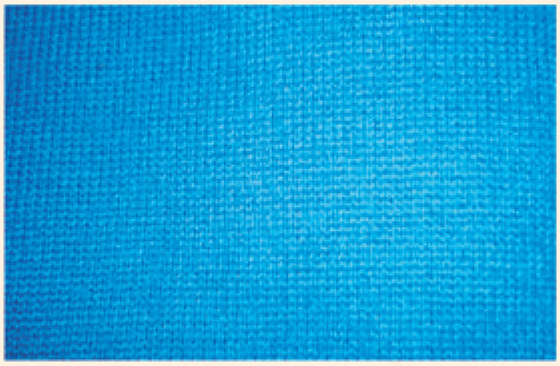


Figure 4.1- A weft-knitted fabric

4.2 Fabric characteristics

Fabric density is defined by describing the number of stitches, not yarns, in a specific direction. Wales are vertical columns of stitches in the knit fabric. Courses are horizontal rows of stitches.

Fabric density is often designated as wales by courses. For example, a T-shirt jersey might have 32 wales per inch and 44 courses per inch. This fabric would have a density of 32 x 44.\

Cut, or gauge, indicates the fineness of the stitch. It is measured as the number of needles in a specific space on the needle bar and often expressed as needles per inch (npi). Cut is often used in the textile industry to describe knit fabrics. The higher is the cut, or gauge, the finer is the fabric.

It may be difficult to identify the technical face of the fabric. The following list identifies some characteristics that may help in determining the technical face of a knitted fabric. Technical face refers to the outer side of the fabric as knitted. This may not be the side used as the fashion side in a product.

1. The technical face side has a better finish.
2. If two kinds of yarn or fibers are used, the more expensive one is used on the face side.
3. If floats are present, the least snaggable ones are on the face.
4. Finer yarns are on the face.
5. If the two sides differ, the design is on the face side.
6. If the fabric curls, it curls to the technical back side, parallel to the wales.

4.2.1 Filling (or Weft) Knitting

Filling knitting can be either a hand or a machine process. In hand knitting, a yarn is cast (looped) onto one needle, another needle is inserted into the first stitch, the yarn is positioned around the needle, and by manipulating the needle the new stitch is taken off onto the second needle. The process is repeated with all the stitches being taken off from one needle to the other.

In machine knitting, many needles (one for each wale) are set into a machine and the stitch is made in a series of steps. By the end of the series, one needle has gone through a complete up and down motion, and a new stitch has been formed. In the running position, the needle moves up and the old stitch begins to slide down the needle. In clearing, the old stitch is moved down to the stem or base of the needle and the needle is in its highest position. During the yarn-feed step, the new yarn is positioned in front of the hook part of the needle and the needle has begun its downward stroke. In the knock over step, the old stitch is removed from the needle. The final step is the pulling step, when the new stitch is formed at the hook of the needle and the needle is in its lowest position. These five steps are repeated in a continuous up and down motion to form a knit.

Knitting can be flat, in which the yarn is carried back and forth on a flatbed machine, or circular, in which the yarn is carried in a spiral like the threads in a screw on a circular machine.

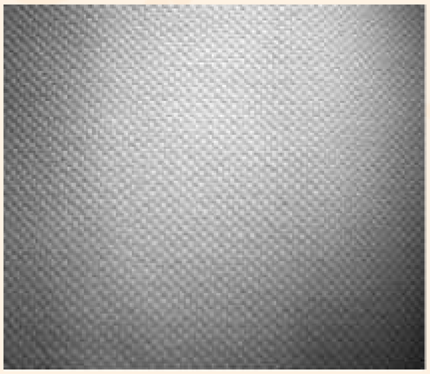


Figure 4.2- A weft-knitted fabric

4.2.2 Machines used in filling knitting

Machine knitting is done on single-knit and double-knit circular and flatbed machines. The circular machines are faster in production. Circular machines are described by the diameter of the fabric tube they produce. Greater flexibility demands by the industry have resulted in machines that make a variety of tube diameters. Diameters can be changed with minimal down time. New yarns can be fed into the structure at any point on the diameter.

Circular machines primarily make yardage, but are also used to make sweater bodies, panty hose, and socks.

Figure 4.3- Circular knitting machine

Flatbed machines also knit a variety of fabric widths. Most flatbed knits are 100 or more inches across. These machines are slower than circular machines, but they produce less skew in the fabric and have the ability to fashion or shape garment or product parts.

Finally, knitting machines may be described by the type of fabric they produce, such as simple jersey for T-shirts or more complex fabrics such as knit terrycloth. Patterned knits may be produced on machines like mini-jacquards for simple patterns or jacquards for more complex patterns. Electronic controls decrease flaws in the structure, increase machine flexibility, and decrease time for changing patterns.

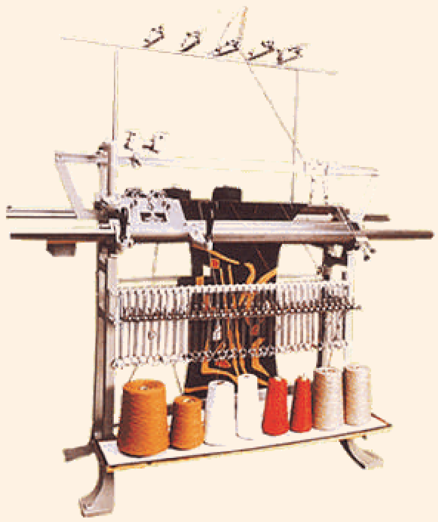


Figure 4.4 Flatbed knitting machine

4.2.3 Filling-Knit Structures - Stitches

The first stitch is the knit stitch. This is the basic stitch used to produce the majority of filling-knit fabrics. These fabrics have greater elongation crosswise and less elongation lengthwise. The sides of the stitches appear on the face of jersey and the back is comprised of the tops and bottoms of the stitches. When jerseys are printed, they are printed on the face since that is the smoothest and most regular surface. However, many jerseys, especially the pile types, are used with the technical back as the fashion side because of the loop formation.

The tuck stitch is used to create a pattern in the fabric. In the tuck stitch, the old stitch is not cleared from the needle. Thus there are two stitches on the needle. In a knit fabric with tuck stitches, the fabric is thicker and slightly less likely to stretch cross-wise than a basic-knit fabric with the same number of stitches. Tusk stitches create bubbles, blisters, or puckers for visual interest, which may be incorporated in a pattern or added randomly to create texture. These are usually referred to as jacquard jerseys.

The float or miss stitch is also used to create a pattern in the fabric. In the float stitch, no new stitch is formed at the needle while adjacent needles form new stitches. The float stitch can be used when yarns of different colours are used to crate patterns. A knit fabric with float stitches is much less likely to stretch cross-wise than a basic-knit fabric with the same number of stitches. In jacquard jerseys, float stitches are very common because of the combination of colours in the fabric. For example, if a fabric incorporates two or more colours in a pattern, float stitches are necessary as one colour comes to the face and the other floats in this area.

The purl, or reverse, stitch forms a fabric that looks like the technical back of a basic-knit fabric on both sides. The fabric is reversible. Purl-knit fabrics are relatively slow fabrics to make and expensive to produce because they require special machines. Since the face and back of a purl fabric look like the back of a jersey, manufacturers often use the technical back of a jersey as the fashion side when a purl-like appearance is desired. These imitation "purl" fabrics pass a casual inspection by consumers and are competitive in price with other knit structures. So the consumer does not pay more for this special look.

UNIT 4

4 (b) Nonwoven Fabrics

4(b) Nonwoven Fabrics

Nonwoven or fiber web structures include all textile-sheet structures made from fibrous web, bonded by mechanical entanglement of the fibers or by the use of added resins, thermal fusion, or formation of chemical complexes. Fibers are the fundamental units of structure, arranged into a web and bonded so that the distances between fibers are several times greater than the fiber diameter. Nonwovens are not like paper; they are more flexible than paper structures of similar construction.

The properties of nonwovens are controlled by selection of the geometrical arrangements, properties of the fibers used in the web and the properties of any binders that may be used.

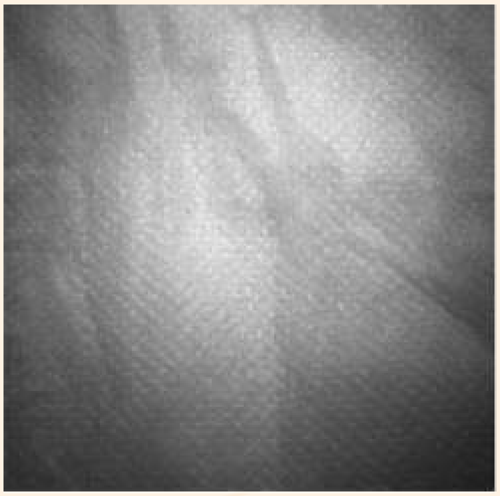


Figure 4.5- A non-woven fabric

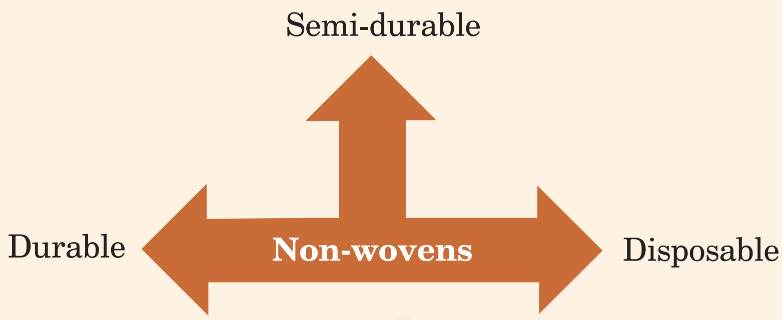
4.3 Production

Fiber webs are quick and inexpensive to produce. When compared to woven fabrics, nonwovens of the same weight and fiber type are generally 50 percent cheaper.

The basic steps include selecting the fibers, laying the fibers to make a web, and bonding the web together to make a fabric. Any fiber can be used to make the web. The inherent characteristics of the fibers are reflected in the fabric. Filaments and strong staple fibers are used where strength and durability are important while rayon and cotton are used for absorbency whereas thermoplastics are used for spun-bonded webs.

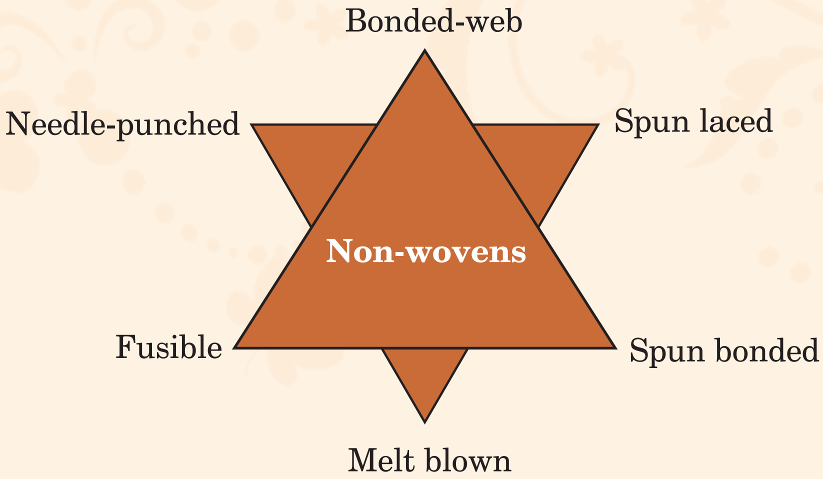
Web formation can be a more involved process. The five techniques are dry laid, wet laid, spun bonded, spun laced, and melt blown. Fiber orientation is an important factor in controlling web characteristics. Fiber orientation describes both the degree of parallelism among fibers in the web and the degree of parallelism between the fibers and the machine direction. Machine direction describes the direction of movement of the supporting conveyor belt. Webs with fibers parallel to each other are oriented. Webs whose fibers are highly parallel to each other and are parallel to the machine direction are oriented in the lengthwise direction. Webs with fibers that are not parallel to each other are random. Length-wise-oriented webs have a grain that strength and drape properties are related to their orientation.

Non-woven fabrics can be classified in two ways. In one, they may be categorized on the basis of their life-span, as follows:



Most of the non-wovens are disposable due to their low strength and durability, like the face wipes and absorbent napkins. However, owing to their unique properties like high water absorbency and soft feel, semi-durable and durable non-wovens are being tried to be made successfully. The disposable ones are those that can be used only once; semi-durable ones are those that can last or be re-used for 3-5 times; the durable ones are those that can last at least 10 times of repeated usage.

In another way, non-wovens can be classified on the basis of their methods of preparation, as follows:-



This classification is more accepted and widely used. The various classes are discussed in detail as follows:-

4.3.1 Bonded-web non-wovens

They can be further subdivided into dry-laid and wet-laid fiber webs, depending on the laying technique, as follows:

4.3.1.1 Dry-laid fiber webs

They are made by carding or air laying the fibers in either a random or oriented fashion. Carding is similar to the process used in producing yarns to achieve a parallel arrangement of fibers. Webs can be cross-laid by stacking the carded web, so that one layer is oriented lengthwise and the next layer crosswise to give added strength and pliability. Cross-laid webs do not have a gain and can be cut more economically than woven or knitted fabrics. Air-laid, or random, webs are made by machines that disperse the fibers by air. This web is similar to the cross-laid web but has a more random fiber distribution. Oriented webs have good strength in the direction of orientation, but poor cross-orientation strength. Since random webs have the fibers oriented in a random fashion, strength is uniform in all directions. End uses for dry-laid fiber webs include wipes, wicks, battery separators, backing for quilted fabrics, interlining, insulation, abrasive fabric bases, filters, and base fabric for laminating and coating.

4.3.1.2 Wet-laid fiber webs:

They are made from slurry of short, paper-process-length and textile-length fibers and water. The water is extracted and reclaimed, leaving a random-oriented fiber web behind. The advantage of these webs is their exceptional uniformity. Typical end uses for wet-laid fiberwebs include laminating and coating bases, filters, interlining, insulation, roofing substrates, adhesive carriers, wipes, and battery separators.

4.3.2 Spun-bonded webs

They are made immediately after fibers are extruded from spinnerets. The continuous hot filaments are laid down in a random fashion on a fast-moving conveyor belt in their semi-melted state, and fuse together at their cross points. They may be further bonded by heat and pressure. Spun-bonded fiber webs have high tensile and tear strength and low bulk. Typical end uses for spun bonded fiber webs include carpet backings like Yypar by Du Pont, geotextiles, adhesive carriers, envelopes like Tyvek by Du Pont, tents and tarps, wall coverings, house-wrap vapour barriers, tags and labels, bags, protective apparel, filters, insulation, and roofing substrate.

4.3.3 Hydro entangled or spun laced webs

These are similar to spun-bonded webs except that when jets of water are forced through the web, it causes shattering of the filaments into staple fibers and producing a woven-like structure. These webs have greater elasticity and flexibility than spun-bonded fabrics.

These fabrics are also known as water-needled fabrics. This technique can make those products that are not possible with any other process. Water from high-pressure jets on both sides of the fabric and entangle the fibers. The water is reclaimed, purified, and recycled. The degree of entanglement is controlled by the number and force of jets and the fiber type. Computer controls maintain a uniform quality of the fabric. Hydro entangled textiles are used in medical gowns and drapes, battery separators, interlinings, roofing substrates, floppy disk liners, mattress pads, table linens, household wipes, wall coverings, window treatment components, protective clothing, and filters. Sontara is hydro entangled polyester produced by DuPont. Another DuPont product, ComforMax IB, combines microdenier olefin and hydro entangling to produce a fabric that is impermeable to wind, cold, and liquid water. It is used in active wear.

4.3.4 Melt-blown fiber webs

They are made by extruding the polymer through a single-extrusion orifice into a high-velocity, heated-air stream that breaks the fiber into short pieces. The fibers are collected as a web on a moving conveyor belt and are held together by a combination of fiber interlacing and thermal bonding. Because the fibers are not drawn, fiber web strength is lower than might be expected for a specific fiber. Olefin and polyester are the fibers commercially used with this process to produce hospital/medical products and battery separators.

Webs become fabrics through the use of a mechanical needling process, the application of chemical substances or adhesives, or heat.

4.3.5 Needle punching or needling

It consists of passing a properly prepared dry-laid web over a needle loom as many times as is necessary to produce the desired strength and texture. A needle loom has barbed needles protruding 2 or 3 inches from the base. As the needles stitch up and down through the web, the barbs pull a few fibers through the web, causing them to interlock mechanically with other fibers. The construction process is relatively inexpensive.

Blankets, carpeting, and carpet backing are examples of needle-punched products. Fiber denier, fiber type, and product loft may be varied. Indoor/outdoor needle-punched carpeting made of olefin is used extensively for patios, porches, pools, and putting greens as it is impervious to moisture. Needled carpet backings are used with some tufted carpets.

Needled fabrics can be made of a two-layer web with each layer a different colour. By pulling coloured fibers from the lower layer to the top surface, geometric designs can be made. If the fibers are pulled above the surface, a pile fabric gets formed. The military has developed a ballistics-protective vest for combat use from needle-punched fabrics. Needle-punched fabrics are finished by pressing, steaming, calendaring, dyeing, and embossing. Solution-dyed fibers are often used.

4.3.6 Fusible Nonwovens

Fusible nonwovens contribute body and shape to garments as interfacing or interlinings in shirts, blouses, dresses, and outerwear.

A fusible is a fabric that has been coated with a heat-sealable, thermoplastic adhesive. It also may be a thin, spider web-like fabric of thermoplastic filaments. The fusible fabric is applied to the back of a face fabric and the layers are bonded by heat and pressure.

The adhesives used are polyethylene, hydrolysed ethylene vinyl acetate, plasticized polyvinyl chloride, and polyamides. The adhesive may be printed on the substrate in a precisely positioned manner to give the desired hand to the end product.

Fusible eliminates certain areas of stitching, such as zigzag stitches used in coat and suit lapels. Less skilled labour is required in garment production, and when the proper technique and correct selection are combined, it increases productivity. However, fusible may generate problems for producers and consumers. The layers may separate during care. Adhesives may bleed through to the face fabric. The layers may shrink differently during care. The change in hand and drape are difficult to predict.

4.4 End-uses of Nonwovens

Nonwovens are used for disposable goods, such as diapers and wipes, durable goods that are incorporated into other products, or alone for draperies, furniture, mattresses, mattress pads, and some apparel.

To summarize, nonwovens are:

- Produced by bonding and/or interlocking fibers by mechanical, chemical, thermal, or solvent means, or combinations of these processes.
- Cheaper than woven or knitted fabrics. Widely used for disposable or durable items. May have grain but usually do not.
- Used for apparel, furnishing, and industrial purposes.

Figure 4.6- a non-woven fabric

4.5 Felt

True felt is a mat or web of wool or part-wool fibers held together by the interlocking of the scales of the wool fibers. Felting is one of the oldest methods of making fabrics. Primitive people found that by washing wool fleece, spreading it out in wet condition, and beating it until it had matted and shrunk together in fabric form. In modern factories, layers of wool or wool blends are built up until the desired thickness is attained and then heat, soap, and vibration are used to blend the fibers together. Finishing processes for felt resemble those for woven fabrics.

Felts do not have grain; they are stiff and less pliable than other structures; they do not ravel. Felts are not as strong as other fabrics and vary in quality depending on the quality of the fiber used.

Felt has many industrial and some clothing uses. It is used industrially for padding, soundproofing, insulation, filtering, polishing, and wicking. In the past, felt was used under practically all machinery to absorb sound. Foams, being much cheaper, have replaced felt in this end use.

Felt is not used for fitted clothing because it lacks the flexibility and elasticity of fabrics made from yarns. Felt has wide use in such products as hats, slippers, clothing decorations, and pennants. Because felt does not freaky, it needs no seam finish. Coloured felt letters or decorations on apparel often fade in washing and should be removed or the garments need to be sent to a professional dry cleaner.

The following characteristics summarize felt:

- Wool fibers are carded (and combed), laid down in a thick bat, sprayed with water, and run through hot agitating plates that cause the fibers to become entangled.
- Felt has no grain; it does not fray or ravel.
- Felt has poor pliability, strength, and stretch recovery.
- Felt is used in apparel accessories, crafts, and industrial matting.

4.6 Net like structures

Net like structures include all textile structures formed by extruding one or more fiber-forming polymers as a film or a network of ligaments or strands. In the integral-fibrillated-net process, the extruded and non-coagulated film is embossed by being passed through a pair of heated rollers that are engraved to form a pattern on the fabric. When the film is stretched bi-axially, slits occur in the fabric, creating a netlike structure. In the integral-extruded-net process, the spinneret consists of two rotating dies. When the polymer is extruded, the fibers form a single strand that interconnects when the holes of the two rotating dies coincide. The process produces tubular nets which are used for packaging fruit and vegetables, agricultural nets, bird nets, and plastic fencing for snow and hazards.

4.7 Fabrics from yarns

4.7.1 Braids

Braids are narrow fabrics in which many yarns are interlaced lengthwise and diagonally. They have good elongation characteristics. They are very pliable, curved around edges nicely, and are used primarily for trims, shoelaces, and coverings on components in industrial products like wiring and hoses for liquids like gasoline and water. Three-dimensional braids are made with two or more sets of yarns. Their shape is controlled by an internal mandrel.

The characteristics of braid include the following:

- Yarns are interlaced both diagonally and lengthwise.
- Braid is stretchy and easily shaped.
- Braid can be flat or three-dimensional.
- Braid is used for trim and industrial products.

4.7.2 Lace

Lace is another basic fabric made from yarns. Many fabrication methods may be used. Yarns may be twisted around each other to create open areas. Lace is an open-work fabric with complex patterns or figures, handmade or machine made on special lace machines or on Rachel knitting machines.

Lace was very important in men's and women's fashion between the 16th and 19th centuries, and all countries in Europe developed lace industries. Lace remains important today as a trim or accessory in apparel and furnishings. The names given to lace often reflect the town in which the lace was originally made.

SUMMARY

Units 4(a) and 4(b) deal with other types of fabrics besides woven. In section 4.1, knitted fabrics are dealt with. Section 4.2 deals with characteristics of knitted fabrics and its different types. It also includes the various knitting machines. Unit 4.3 deals with manufacturing techniques of non-woven fabrics. Section 4.4 talks about their various end uses while sections 4.5 to 4.7 covers different types of special non-woven fabrics.

QUESTIONS

1. Multiple Choice Questions- choose any one among the options given as answer to the individual questions (correct answers are in bold and highlighted).

i. Among the following types of fabrics, which one is most extensively used for personal healthcare products?

a) Woven fabrics b) Non-woven wipes
c) Jute fabrics d) Knitted fabrics

ii. Fabrics made directly from fibers are known as:-

a) Mali fabrics b) Non-woven fabrics
c) Woven fabrics d) Knitted fabrics

iii. Fabrics made up of only one set of yarns is known as:-

a) Knitted fabrics b) Broadcloth
c) Laid-in yarn fabrics d) Woven fabrics

iv. Fabrics that have maximum extension is:-

a) Weft knits b) Sail cloth
c) Crepe de chine d) Muslin

v. Fabrics that have maximum absorption are:-

a) Poplin b) Warp knits
c) Weft knits d) Non-wovens

2. Fill up the blanks in the following questions:

a) A layered fabric structure in which a face fabric is joined to a backing fabric with an adhesive that does not significantly add to the thickness of the combined fabrics is known as ______________________ material.

b) A fabric that is soft and has great absorbency is generally a ___________ fabric.

c) A fabric that has very high extension in all directions is a ____________ fabric.

d) A fabric that suffers from very low durability and hence has use and throws applications is a ______________ fabric.

e) A fabric that costs less due to only one set of yarns used is a ______________ fabric.

Glossary

Aesthetic Properties: They are those properties of a textile material that are aimed at fulfilling certain properties related to look, feel and appearance of the wearers. For example, fabrics like voiles, georgettes, suede fabrics, velvets, satins, emery or diamond finished fabrics are for aesthetic purposes.

Amorphousity or Amorphous Region: It is the amount of non-crystalline portion, by weight or by volume, in a polymer matrix. It determines absorbency, dyeability and moisture uptake in a fiber.

Apparel: It is a garment that is used to wear and cover the body. It can have several classifications like men's, women's, kids', sportswear, winter wear, casual wear, etc.

Beam: It is a big-sized package made out of metal that can hold a warp sheet or a fabric onto itself. It can be of various diameters starting from 12', 18', 24', and even bigger.

Bursting Strength: It is the force that acts in multiple directions along and across the plane of a fabric.

Care Properties: It is the recommended ways or techniques to wash, clean, iron and/or maintain the fabric's original look, drape and color for longer duration. It is a list of do's and don'ts for maintenance of a fabric.

Crystallinity: It is the amount by volume or by weight of a polymer that has formed crystals. It helps in determining the strength and durability of a polymer.

Dimensional Stability: It is the rigidness of size of a textile fabric. A fabric generally shrinks when washed in water. Dimensional stability is a measure of this shrinkage.

Drape: It is the fall or the ability of a textile material to take up a curvature or a body shape.

Durability: It is the ability of a textile material to withstand external forces like abrasion, tensile and tear strength that tries to damage it.

Fiber or Yarn Fineness: It is the thickness of a yarn or fiber.

Filament Fibers: They are those fibers that can be infinite in length theoretically but practically, they are finite but of much longer length than staple fibers. All regenerated and manmade fibers can be made into filament fibers. They may also be cut into staple fibers if required.

Functional Properties: They are those properties of a textile material that are aimed at performing or fulfilling certain specific functions. For example, fabrics which are stain resistant, oil resistant, water repellent, flame resistant, etc. are functional fabrics.

Garment: It is synonymous to apparel, used to wear or cover the body for various functional and aesthetic purposes.

Hand: It is the feel of a fiber, yarn or fabric. A rough hand is generally dull and harsh while a smooth one is brighter and more comfortable.

Hydrophillicity: It is the tendency of a textile material to attract moisture and form weak bonds at molecular level.

Hydrophobic: It is the tendency of a textile material to repel water. So, the water molecules cannot enter these materials and form weak bonds at molecular levels.

Luster: It is the shine of any material or fiber. The shine of a fiber determines the gloss of a yarn and a fabric in turn. It is dependent largely on the cross-sectional shape of the fiber.

Orientation: It is the alignment of long chain molecules in a polymer matrix. For textile fibers, unidirectional orientation is desirable along the length of the fiber. A well oriented polymer can give fibers with good strength and durability.

Shrinkage: It is the tendency of a textile material to reduce in dimensions when in water or heated, or treated otherwise.

Spindle: It is a package to hold yarn coming out of ring frame or winding machines. They come in various shapes and sizes, depending on type and fineness of the yarns. They are mostly paper or plastic made.

Sportswear: It is apparel suitable for wearing during performing various sporting events. Its properties are notably different from those used to wear generally.

Standard Testing Conditions: It is a condition in a textile testing lab in which the temperature is maintained at 20O +/- 2OC and the relative humidity at 65% +/- 2%.

Staple Fiber: They are those fibers that are practically finite in length. Most of the natural fibers are staple fibers, while the regenerated and manmade fibers can be converted into staple fibers by cutting.

Strength: It is the ability of a textile material to withstand external forces from breaking it.

Tear Strength: It is the force that acts transverse to the plane of a textile fabric.

Tensile Strength: It is the force that acts along the length of a textile material. For fibers and yarns, it is generally along the length, while for fabrics, it is along the plane of the fabric.

Texture: It is the nature of the surface of a textile material. It can be rough or smooth.

Twist: It is the turns imparted to a yarn in order to make the component fibers coherent and increase its strength.

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Experiment –1

Objective:

- To determine the chemical nature of fiber by burning test.

Materials required:

Fibers of three different classes

- cellulosic (cotton, flax, hemp, jute, ramie)
- protein (wool, silk)
- synthetic non-cellulosic non-protein fiber (polyester, nylon)

Equipment required:

- A candle.
- A bucket of water (to put of flame if required).

Method:

Take a lump of loose fibers of any one class and hold its one end in the flame of the burning candle. The lump of fiber will catch fire and burn. In case of cellulosic fibers, it will give out the odor of burning paper with ash. In case of protein fibers, the odor will be that of burning hair with ashes. In case of non-cellulosic non-protein synthetic fibers, there will be no smell and beads will be formed which may be crushable or non-crushable, black or white, etc.

Learning outcome:

Student will be able to identify the class of fiber or presence of blends in an apparel or textile product by burning test.

Experiment -2

Objective:

- To determine the variation in staple lengths of natural fibers.

Materials required:

- Loose fibers of natural sources like cotton, wool, silk, jute, hemp, ramie, flax, etc.

Equipment required:

- A black board of size A4.
- A microbalance.
- A pair of forceps.
- A measuring scale.

Method:

Collect a lump of any one type of natural fiber of weight 10 mg. approximately. With the forceps, pluck individual fibers out of the lump one by one and measure the length. On the black board, put the fibers one after the other in a descending order of staple length to get the final form that is somewhat close to the following:-

Learning outcome:

Student observes the extent of variation of staple length in natural fibers and the importance of the effects of variation.

Experiment -3

Objective:

- To determine the yarn fineness using direct count system.

Materials required:

- Cones of yarns of various fineness.

Equipment required:

- A weighing balance of range up to 0.01 mg.
- A wrap reel.

Method:

Draw the free end of the yarn from any one cone and tie it to the wrap reel. Rotate the wrap reel several times to form a lea of yarn and note the number of rotations. Weigh the lea on the microbalance and note down the weight. Calculate the length of yarn in the lea by finding out the circumference of the wrap reel from its diameter as:-

$$\text{Circumference} = \pi \text{ X } (\text{diameter}/2)^2$$

Length of yarn in the lea=Circumference X number of rotations

Find out the weight of 9000 meters of yarn (for denier) or 1000 meter of yarn (for tex) in grams.

Learning outcome:

Student can determine the fineness of a yarn and decide its end-use.

Experiment -4

Objective:

- To determine the yarn fineness using English count system (indirect).

Materials required:

- Yarns cones of various fineness.

Equipment required:

- A weighing balance of range up to 0.01 mg.
- A wrap reel.

Method:

Draw the free end of the yarn from any one cone and tie it to the wrap reel. Rotate the wrap reel several times to form a lea of yarn and note the number of rotations. Weigh the lea on the microbalance and note down the weight. Calculate the length of yarn in the lea by finding out the circumference of the wrap reel from its diameter as:-

$$\text{Circumference} = \pi \text{ X } (\text{diameter}/2)^2$$

$$\text{Length of yarn} = \text{Circumference X number of rotations}$$

Find out the weight of the lea and calculate how much length will be required to weigh 1 pound. Divide that length by 840 yards to get the English Count of the yarn (indirect).

Learning outcome:

Student can determine the fineness of a yarn and decide its end-use.

Experiment -5

Objective:

- To convert yarn fineness from direct count system into indirect count system and vice versa.

Materials required:

- Yarn cones of different fineness.

Equipment required:

- A weighing balance of range up to 0.01 mg.
- A wrap reel.

Method:

In case of converting direct count system to indirect count system, follow the method as in experiment#3 to determine the direct count. Then use the following formulae for conversion:-

English Count= 5315/Denier

English Count= 590.55/Tex

In case of converting English (indirect) count system to direct count system, follow the method as in experiment#4 to determine the English count. Then use the following formulae for conversion:-

Denier= 5315/English Count

Tex= 590.55/English Count

Learning outcome:

Student can perform the inter-conversion of yarn fineness between direct and indirect count systems.

Experiment -6

Objective:

- To determine the twist direction in yarn.

Materials required:

- Cones of different single yarns.

Equipment required:

- A yarn twist tester.

Method:

Mount a length of yarn on the twist tester in between the stationary and the movable jaws. Rotate the movable jaw in clockwise direction and then in anti-clockwise direction to see in which direction, the yarn untwists.

If the untwisting happens in clockwise direction, then the twist must have been in anti-clockwise direction and thus, Z-twist. If the untwisting happens in anti-clockwise direction, then the twist must have been in clockwise direction, i.e., S-twist.

Learning outcome:

Student can determine the direction of twist in a yarn.

Experiment -7

Objective:

- To determine the twist per unit length of a yarn.

Materials required:

- Cones of different single yarns.

Equipment required:

- Yarn twist tester with a digital counter.

Method:

Mount a length of yarn from the cone on the twist tester in between the two jaws. Note the length between the jaws. Then untwist the yarn by rotating the movable jaw in either clockwise or anti-clockwise direction, depending on the direction of twist in the yarn that can be determined as in experiment 5. Keep the movable jaw rotating slowly until the yarn breaks after attaining zero twist level. Note down the number of rotations of the jaw on the digital counter. Divide the number of turns of the jaw by the length of the yarn to get the twist per unite length (cm or inch).

Learning outcome:

Student can determine the twist per unit length of a yarn and decide its end-use accordingly.

Experiment -8

Objective:

- To determine the difference between a staple fiber yarn and a filament yarn.

Materials required:

- Cones of various types of staple fiber yarns and filament yarns.

Equipment required:

- Yarn twist tester.

Method:

Mount a staple fiber yarn on the twist tester and untwist it after determining the yarn direction as per experiment#6. After attaining the zero twist level, the yarn will break.

Now, mount a filament yarn and untwist. After attaining the zero twist level, further untwisting or rotation of the movable jaw will twist the yarn in the opposite twist direction, but the yarn will never break owing to continuity of the filament.

Learning outcome:

Student will learn to differentiate between a staple fiber yarn and a filament yarn.

Experiment -9

Objective:

- To differentiate between a single staple fiber yarn and a plied staple fiber yarn.

Materials required:

- Cones of different single and plied yarns.

Equipment required:

- Yarn twist tester.

Method:

Mount a single yarn on the twist tester and untwist it as per experiment 6. At zero twist level, it will break. In case of a plied yarn, after untwisting, the yarn will never break as the constituent yarns will still have enough twist to maintain continuity of the yarn.

Learning outcome:

Student will learn to identify between a single and a plied yarn.

Experiment -10

Objective:

- To determine the sequence of process and material flow in yarn manufacturing.

Method:

A visit to a nearby textile spinning or yarn manufacturing mill is required. Students must be shown all the stages of yarn manufacturing from blowroom through carding, draw frame, combing (optional), finisher draw frame (optional), speed frame, ring frame, winding and twisting machines, packing department, etc.

Students have to prepare a process and material flow chart for the same using MS Word or PowerPoint.

Learning outcome:

Student will have an overview of the various steps and their importance in yarn manufacturing.

Experiment -11

Objective:

- To measure the thread density in different kind of fabrics and compare according to end uses.

Materials required:

- 10 different samples sourced from the market.

Equipment required:

- pick glass
- pick needle
- Worksheet.

Method:

First the fabrics are placed over a plane. Then a pick glass is placed over the fabric with min 10x magnification power. After that under the pick glass with the help of a pick needle the thread density is calculated. 10 data are taken in 10 different positions of the fabrics in both the warp way and weft way direction. After that with the help of a calculator mean, standard deviation and coefficient of variation were measured. List the fabrics in numeric order on the worksheet. Fill in the yarns per inch and the method of counting used.

Learning outcome:

Student learns that the thickness of the fabric is dependent upon the thread density of the fabric.

Experiment -12

Objective:

- To identify the possible end-uses of woven, knitted and non-woven fabrics.

Method:

Using the internet, the different end-uses of woven, knitted and non-woven fabrics are to be identified. The images for various end-uses can be collected, like images of apparels, home furnishings and other textiles. Apparels can be classified as men's and women's wear. Each of these can be further classified as men's shirts, women's tops, men's and women's bottom wear; western and oriental wear; bridal, party or casual wear, etc.

Home furnishings can similarly be classified into curtains, bed spreads, sofa covers, pillow covers, rugs and carpets, kitchen wear, bathroom wear, wall hangings, etc. Other textiles can similarly be classified as cosmetic textiles, medical textiles, geotextiles, agricultural textiles, architectural textiles, etc.

3 good quality images for each of these end-uses are to be accumulated into a presentation and submitted.

Learning outcome:

Student learns that the thickness of the fabric is dependent upon the thread density of the fabric.

Experiment -13

Objective:

- To measure grams per square meter (GSM) of different quality of fabrics and compare the weight according to end uses.

Materials required:

- 10 different samples sourced from the market ranging from low weight fabric to heavy weight bottom weight.

Equipment required:

- GSM pad and GSM cutter
- worksheet
- weighing balance

Method:

This GSM Cutter is circular fabric sample cutter with which uniform circular fabric is cut without measuring. The specimen which is cut with the help of fabric GSM cutter is 100 cm2 areas. The instrument is equipped with a set of four replaceable blades and normal cutting pads. The material to be cut is placed between the Sample Cutter and a Cutting Board. When the safety catch is released, light downward pressure on the hand wheel brings the multiple blades into contact with the material. Specimens are cut by rotating the hand wheel under a light and even pressure. After cutting the fabric weight is taken from the weighing balance, List the fabrics in numeric order on the worksheet.

Learning outcome:

Different fabric has different weight according to the fineness and the yarn density of the fabric.

Experiment -14

Objective:

- To analyze the design of different fabric samples.

Materials required:

- 3 different samples sourced from the market.

Equipment required:

- pick glass
- pick needle
- graph Paper

Method:

First the fabrics are placed over a plane. Then a pick glass is placed over the fabric with min 10x magnification power. After that under the pick glass with the help of a pick needle both the warp and weft threads are unraveled from the fabric and the design of the fabric are plotted on a graph paper. The same process is repeated till the full motifs have been completed. After the design has completed in a graph paper expected drafting and lifting plan is drawn in the graph paper.

Learning outcome:

Designs of the fabric is totally depends upon the drafting and lifting plan in a loom. After taking any factor constant and varying the other factor designs can be changed.

Experiment -15

Objective:

- To visit a fabric store or fabric department within a store and survey the various woven fabrics on display and note the wide variety of fabrics and possible end uses.

Materials required:

- 3 different samples sourced from the market.

Equipment required:

- pick glass
- pick needle

Method:

Examine ten different woven fabrics and note the following about each (a pick glass will be helpful):

- Name (if indicated)
- Fiber content (check label)
- Yarn type
- Weave
- Width
- Cost
- Possible end use

(Be sure all are not apparel fabrics and upholstery, decorative pillow, drapery also are included)

Learning outcome:

Fabrics of different end users have different physical properties.

Experiment -16

Objective:

- To find the fabric thickness of different fabrics.

Materials required:

- Ten different samples sourced from the market ranging from low weight fabric to heavy weight bottom weight.

Equipment required:

- A Fabric Thickness Tester.

Method:

The fabric sample that is to be measured is kept on an anvil. The press foot is gently lowered on to the specimen. The reading of the dial gauge is taken to get the thickness of the specimen. The flat circular indenter of the micrometer exerts the specified pressure on the fabric sample. The Dial Indicator measures the thickness in mm. The above procedure is repeated to obtain the values of thickness at least at 3 different locations. The mean value of all the readings of thickness determined to the nearest 0.01m is calculated and the result is the average thickness of the sample under test.

Learning outcome:

Students learn that the thickness of the fabric is depended upon the thread density of the fabric, Yarn count, type of weaves,

Experiment -17

Objective:

- To evaluate the wale and course per inch with the help of a pick glass.

Materials required:

- Ten different knitted samples sourced from the market.

Equipment required:

- pick glass
- pick needle
- worksheet

Method:

First the knitted fabrics are placed over a plane. Then a pick glass is placed over the fabric with min 10x magnification power. After that under the pick glass with the help of a pick needle the wale and course per inch are calculated. Ten data are taken in ten different positions of the fabrics in both the wale and course direction. After that with the help of a calculator mean, standard deviation and coefficient of variation were measured. List the fabrics in numeric order on the worksheet.

Learning outcome:

Record the wale and courses per inch for each fabric in numeric order on the worksheet.

Experiment –18

Objective:

- To source fifteen different nonwoven fabrics from the market physically evaluate their possible end-uses.

Method:

- Source fifteen nonwoven fabrics from the market and physically characterize them and identify as per their end uses.

Learning outcome:

After this experiment an idea will generate among different end uses of nonwoven as per their physical characteristics.

Experiment -19

Objective:

- To prepare a flow chart for weaving or knitting process in the industry.

Method:

- Visit a weaving or knitting industry nearby and make a note of all the processes sequentially. Submit the same as a flow chart.

Learning outcome:

Student learns about the process sequence in a weaving and knitting industry and also the importance of each and every step.

Experiment -20

Objective:

- To estimate the drape of various fabrics.

Materials required:

- Ten different fabrics of varying drape that include woven, knitted and non-woven fabrics.

Method:

Take each of the ten fabric samples on the palm such that the fabric hangs around the palm in all directions. Note visually the ease of curvature of various fabrics and rate them on a scale of 1 to 5, 1 being the poorest rating given to least drape or most stiff fabric, and 5 being the best rating given to maximum drape or least stiff fabric.

Also, note the difference between drape of woven, knitted and non-woven fabrics.

Learning outcome:

Student learns how to estimate the drape of a fabric practically and visually without any instrument, and thus how to choose fabrics based on drape for different end-uses.

TEXTILE SCIENCE

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