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SEMESTER – IV

SKILL ENHANCEMENT COURSE

SERI – TEXTILE TECHNOLOGY (Unit -2)

TESTS FOR IDENTIFICATION OFFIBRES

STRUCTURE:

- OBJECTIVES
- INTRODUCTION
- RANGE OF TESTS TO IDENTIFY A WIDE RANGE OFFIBRES
- MICROSCOPICTESTS
- BURNINGTESTS
- SOLUBILITYTESTS

A. Objectives

- Identify fibres using a wide range oftechniques.
- Observe the longitudinal and cross sectional microscopic view of different fibres with their respective uniquefeatures.
- Understand the different burning characteristics of fibres.
- Distinguish between the fibre types using the criterion of solubility in a chemical.
- Distinguish fibres on the basis of density and melting temperatures on the basis ofdata.

B. Introduction

In recounting the history of textiles, it is generally not appreciated that till about 100 years ago, it used to be an age of natural fibres dominated by cotton, linen, jute, wool and silk fibres. As shown later in Table 3.1, because of some unique features (like peanut like cross section of cotton, scaly structure of wool fibre, triangular cross section of silk, etc.) these fibres could be identified by examining their longitudinal and cross sections on a low-magnification microscope. The first man-made fibre, viscose rayon, dates back to the end of the 19th Century and it also had a distinctly different cross-sectional geometry compared to the natural fibres of that time. However, as synthetic fibres were discovered and commercially produced - the first being nylon 66 in 1938 followed by nylon 6 in 1939, acrylic fibre in 1949, polyester fibre in 1943, polypropylene in 1957 – fibre identification became more complex because most of these synthetic fibres were smooth with circular cross sections and a rather featureless geometry. It therefore became necessary to extend the range of tests so that given an unknown fibre, its exact identity should bespecified.

A number of interesting developments that have taken place in the textile industry have made the process of identification more complex. Only two of these will be pointed out here. Large quantities of fabrics are now made from blended yarns, *e.g.* the blend of cotton with polyester fibre represents a very popular product in which cotton confers comfort mainly due to its high moisture absorbing capacity and polyester fibre gives the fabric a number of other desirable characteristics, e.g. the requisite mechanical properties like strength and durability. Also because of the ability of polyester fibre to dry quickly (drip-dry) and its resistance to creasing, the fabric containing polyester fibre acquires the well-known wash and wear characteristic. Yarns taken out from these fabrics will thus contain both cotton and polyester fibres and the tests must be able to identify both of them. The second development worth mentioning is that of bicomponent fibres in which a single filament may contain two different fibre-forming polymers - a core of polypropylene encased in a sheath of polyester. Both there will be revealed during the test. These and other developments have thus added a degree of complexity in the attempts made to identify the fibres and one must take note ofthis.

C. Range of Tests to Identify a Wide Range ofFibres

There are around twenty fibres that must be considered whenever an identification exercise for an unknown fibre is on. These include the natural fibres, viz. cotton, wool, silk, linen, and jute (it may be mentioned that jute is being blended in small amounts with other firbes for some textile fabric production). Pineapple fibre is not included in this list as only very small amount of this fibre is used. The second category comprises man-made fibres based on natural feedstock, the major fibre in this category being viscose rayon. As noted earlier, this is made by regenerating pure cellulose fibre from cellulose xanthate. A direct route has now been found and Tencel and Lyocell are the trade names for man-made cellulose fibres through the direct route. The two important chemically-modified cellulose fibres that are made in small quantities are cellulose diacetate and cellulose triacetate fibres. The third important category is that of synthetic fibres and includes polyamides (nylon 66 and nylon 6), polyester (mainly Polyethylene terephthalate or PET and small quantities of polybutylene terephthalate), acrylic (polyacrylonitrile) and modified acrylic (modacrylic), polyolefin (polypropylene and polyethylene) and polyurethane (Lycra, Spandex). Amongst inorganic fibres asbestos, glass, metallic and carbon fibres are worth mentioning. So given these twenty or so fibres, it is unlikely that a single test will lead to its identification – there is a need to have a range of tests and the following have been found to be particularlyuseful:

a. Microscopic examination of the longitudinal and cross sections of the fibre,

b. Burning test in a flame,and

c. Solubility tests in chemicalreagents.

In addition to these three tests, the following four tests also provide useful information:

d. Elementidentification

e. Densitymeasurement

f. Determination of melting point,and

g. Feeling test.

In practice, identification tests are used in combination. The various tests listed above will now be briefly described.

D. MicroscopicTests

The microscopic test reveals the macroscopic features of the fibre. When observed along the length (longitudinal section), the surface features are revealed. When a fibre is cut in the perpendicular direction and a thin cross-section examined on the microscope, the shape of the cross-section and the macroscopic features in the cross-section can help identifying some fibres.

An optical microscope with a magnification of at least 100 is generally used. A projection microscope is however, preferred since it gives an enlarged view on the screen, which can be traced on a tracing paper. If the microscopes are of the polarizing type, the contrast is sharper and more information can be collected. Thus polarizing projection microscopes allow greater amount of detail and are therefore generally used.

To examine the fibre in the longitudinal direction, a few fibres (or a few short lengths of cut filaments) are straightened and parallelized and placed on a glass slide. They may be secured with the help of cellotape on both ends. To reduce scattering of light, the fibre is immersed in a drop of inert liquid having a refractive index close to the refractive Index of the fibre and covered with a cover glass. The sample is then mounted on the microscope stage and its focused image observed on the screen. The longitudinal texture may then be traced on tracing paper.

The cross-section can be made as follows: A bundle of straight and parallel fibres is embedded in a cork with the help of a needle in which the yarn or filaments are threaded. A thin section of the cork is then carefully cut using a new blade and this thin section is then placed on a glass slide and secured with cellotape. The assembly is mounted on a microscope. The cross sectional view, when combined with the corresponding longitudinal view, may then assist in identifying the fibre. The cross-sectional (top) and longitudinal sectional (bottom) views of cotton, wool and silk fibres taken on a scanning electron microscope are shown in Fig. 3.1 and it is interesting to observe that the characteristic features of these fibres are quite different and thus can assist in theiridentification.

The characteristic features shown by some other fibres are shown schematically in Fig. 3.2.

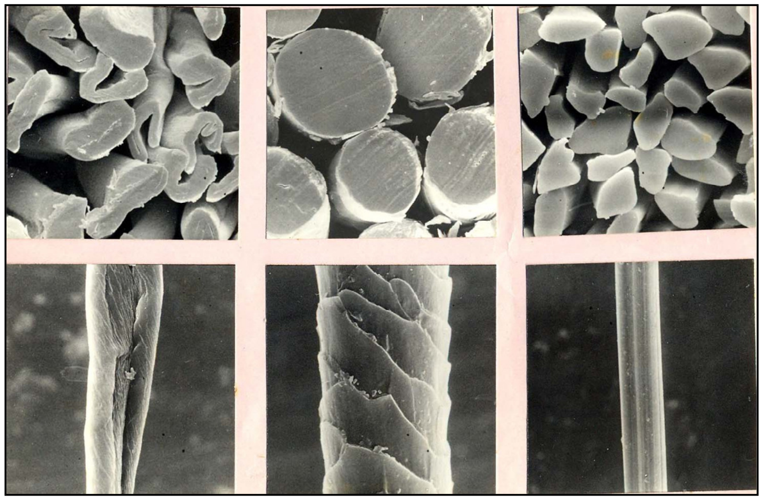

Fig. 3.1 Cross section (top) and longitudinal section (bottom) of cotton (left), wool (middle) and silk (right) fibres.

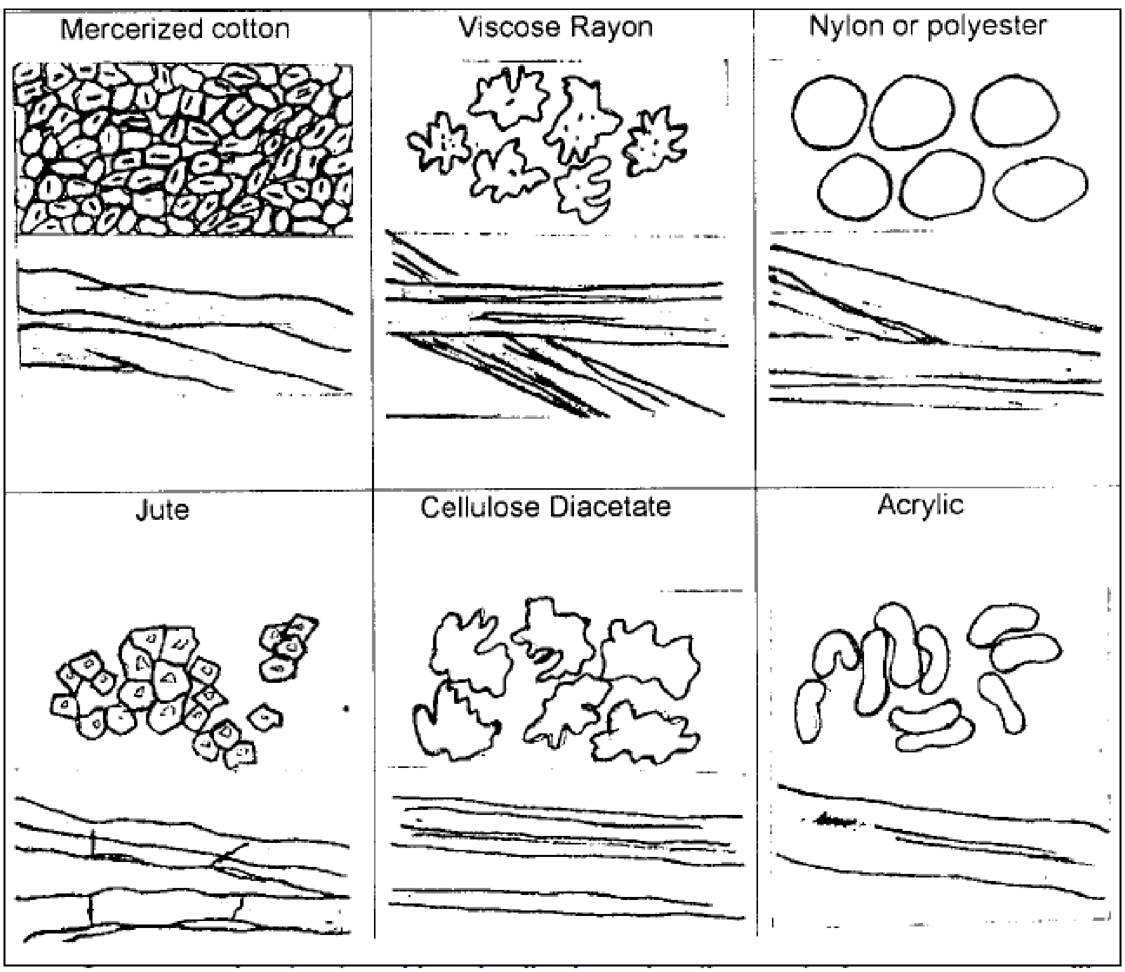

Fig. 3.2 Cross- section (top) and longitudinal section (bottom) of some common fibres.

It may be added that important synthetic fibres like polyester and nylon are generally made with circular cross section and their longitudinal and cross sectional views are featureless and are not of great assistance in identifying them. However, it is worth pointing out that fibres with non-circular cross-sections (trilobal, triangular, octagonal, etc.) are also made in smallquantities.

The common observations that may be made from an examination of the longitudinal and cross sectional views of a number of fibres are summarized in Table 3.1.

Table 3.1
Microscopic Appearance of Some Common Fibres

Fibre	*Longitudinal Section: Appearance*	*Cross-section: Appearance*
Cotton	Flat, irregular convoluted ribbons which change direction with the twist (mercerised cotton is smoother and lessirregular)	Peanut or bean shaped with lumen* running through the*length.
Wool	Rough surface with scales protrudingout	Nearly round, medulla present in coarse fibres is concentric and irregular in size.
Silk (degummed)	Smooth with distinct lengthwise striations.	Mostly triangular, irregular.
Viscose Rayon	Striated, smooth	Irregular, serrated
Nylon, polyester, polypropylene	Smooth, rod-like	Regular, round
Acrylic	Flat, irregular striations	Irregular, dog-bone shape

E. BurningTests

The fibres being chemically different, they show different burning characteristics which can be used to identify them. The burning test is a relatively simple test as all that is needed is a flame and a keen observer who should carefully watch and note down the observations made (a) when approaching the flame, (b) on the burning behaviour inside the flame, (c) during removal from the flame, (d) relating to the smell emitted, and (e) on the residue left behind after the fibre has burnt out.

The observations made on the burning behaviour of some common fibres are summarised in Table 3.2

Table 3.2
Burning Behaviour of Common Fibres

Fibre	*Approaching flame*	*In Flame*	*Behaviour outside the flame*	*Smell*	*Residue*
Cellulose Fibres (Cotton, viscose)	Do not shrink	Burn readily without melting	Continue to burn, after-glow	Burning hair	Small amount of light gray ash

Wool, silk	Curl away	Burn slowly sputter	Self-extinguishing	Burning hair	Easily crushable black bead
Asbestos	Does not shrink	Does not burn, glows	Retains shape	None	Same as original
Polyester	Shrinks away from flame	Melts, burns slowly, drips	Burns, drips, may extinguish because of dripping	Sweet smell of ester	Hard, tough, graybead
Nylon	-do-	-do-	-do-	Pungent, burning beans	Hard, tough, light colour
Polypropylene	-do-	-do-	Continues to burn	Burning plastic	Hard, tough, tan bead
Acrylic	-do-	Burns readily, sputters	-do-	Acrid	Irregular, hard, blackbead

F. SolubilityTests

The solubility of fibres in some specific chemical reagents (acid, alkali, bleaching agent, solvent) provides a definite means of identification, if not for a specific fibre, then for a generic group. When combined with the results of microscopic and burning tests, the results of solubility test make it possible to identify the fibres in most cases.

There are different schemes for making solubility tests-of course they must be carried out in a prescribed order as they work on the principle of elimination. The following represents one such scheme meant to identify an unknown fibre:

Step 1: Treat the fibre sample with 0.25-0.50% sodium hypochlorite solution. If soluble, they may be wool or silk. (To distinguish between the two, treat the fibre in cold 70% sulphuric acid- if soluble, it is silk, otherwise wool. Alternately, test the fibre for sulphur, which is present in wool). If the fibre is insoluble in sodium hypochlorite, go to Step2.

Step 2: Treat the fibre with cold acetic or glacial acetic acid. If soluble, the fibre could be cellulose diacetate or cellulose triacetate. (To distinguish between the two, treat the fibre with methylene chloride. If soluble, it is cellulose triacetate, if not cellulose diacetate). If the fibre is insoluble, go to Step 3.

Step 3: Treat the fibre with cold (heat if necessary) formic acid. If soluble, the fibre is nylon 66 or nylon 6. (To distinguish between the two, treat the fibre with boiling dimethyl formamide (DMF). If soluble it is nylon 6, otherwise nylon 66. Alternately determine their melting points. Nylon 6 melts at 218º C, nylon 66 at 265ºC). If the fibre is insoluble, go to Step4.

Step 4: Treat the fibre in cold DMF. If soluble it is acrylic fibre, if insoluble, go to Step 5.

Step 5: Boil the sample in chlorophenol. If soluble, it is poly (ethylene terephthalate) (polyester) fibre. If insoluble, go to Step 6.

Step 6: Treat the fibre with 70% sulphuric acid. If soluble, it could be cotton or viscose rayon (To distinguish between the two, treat them with sodium Zincate. If soluble, it is viscose rayon). If insoluble in step 6, go to step 7.

Step 7: Put the sample in water. If it floats, it could be polypropylene (PP) or polyethylene (PE). PP is soluble in boiling carbon tetrachloride, PP is soluble in boiling xylol.