LESSON 5 MANUFACTURE OF FILAMENT YARNS AND THEIR TEXTURING

STRUCTURE

5.0 OBJECTIVES
5.1 INTRODUCTION
5.2 TYPES OF YARNS
5.3 MANUFACTURE OF FILAMENT YARNS
   5.3.1 SILK YARN
   5.3.2 MAN-MADE FILAMENT YARNS
5.4 FILAMENT VS. STAPLE FIBRE
5.5 TWIST IN FILAMENT YARNS
5.6 LIMITATIONS OF SYNTHETIC YARNS
5.7 TEXTURING OF FILAMENT YARNS
5.8 ASSIGNMENTS
   5.8.1 CLASS ASSIGNMENTS
   5.8.2 HOME ASSIGNMENTS
5.9 SUMMING UP
5.10 POSSIBLE ANSWERS TO SELF-CHECK QUESTIONS
5.11 TERMINAL QUESTIONS
5.12 REFERENCES AND SUGGESTED FURTHER READING
5.13 GLOSSARY
5. **MANUFACTURE OF FILAMENT YARNS AND THEIR TEXTURING**

In the previous lesson, the manufacture of staple yarns and the effect of twist on their properties were described. In this lesson, the manufacture of filament yarns and their texturing will be considered. In the next and final lesson of this unit on yarn manufacture, the manufacture of fancy yarns will be described.

---

5.0 **Objectives**

After going through this lesson, you will be able to:

- Understand what filament yarns are.
- Recognize different types of yarns.
- Gain an understanding of the filament yarn manufacturing processes.
- Appreciate the role of twist in determining the properties of filament yarns.

5.1 **Introduction**

As stated in the previous lesson, yarns may be made from short staple length fibres or from continuous filaments. The short staple yarns are also called “spun yarns” and are manufactured either on the cotton system, when the fibres are relatively short (less than 6 cm) or in the woollen system or the worsted system when the staple length is relatively long (greater than 6 cm).

If continuous filaments are used, the yarn may contain a single filament in which case it is called a monofilament or it may be a multifilament yarn containing several filaments.

The only continuous filament produced by nature is silk which may have a typical length of around a kilometer or so. Almost all man-made fibres are produced as continuous filaments. When these have to be blended with cotton or wool, they are cut into the desired short length and blended yarns are produced from the blended fibres. The most popular blend of this type is that of polyester staple fibre with cotton, blended usually in proportions of 65/35 or 50/50.

Man-made continuous filament yarns may be modified by subsequent processing to introduce durable crimps, coils, loops or other distortions into the filament. These are called textured yarns and the standard filament yarns are known as flat filament yarns. In this lesson we will deal with both the flat yarn and the textured yarn.
5.2 Types of Yarns

The primary classification of yarns is as filament or staple yarns. These terms are on the basis of length of fibres, as discussed previously.

a) Filament yarn – they are made from long continuous filaments. Monofilament yarns are made from single filament. Multifilament yarns are made by aggregating many filaments together. They can be given low twist or high twist.

b) Staple yarns – staple or spun yarns are made from staple fibres. Being short they are held together by twisting in order to form a long continuous strand. They have been described in the previous lesson.

Yarns are further classified on the basis of their structure as simple yarns or complex yarns. The latter are also called novelty yarns or fancy yarns and are described in the next lesson. Simple yarns have uniform size and regular surface. They are even in size and have an equal number of turns per unit length throughout their length and are relatively smooth. The fancy yarns, on the other hand, have an irregular structure. The simple yarns are classified on the basis of number of yarns as single, ply and cord yarns.

**Single yarn**: It is made from simple assemblage of filament or staple fibres. It is suitable for operations such as weaving and knitting.

**Ply yarns**: When two or more simple single yarns are twisted together, they are called ply yarns. They are termed two-ply, three ply, four ply and so on, according to the number of simple single yarns twisted together. Ply yarns are made on a machine called the doubling machine or doubler. All sewing threads are made of ply yarns. The single yarns are twisted to form a firm and more uniform thread.

**Cord yarns** (Fig. 5.1): When two or more ply yarns are twisted together, the resultant yarn is called cord. These yarns are hard, tough and strong. Cord yarn is used in making rope or for reinforcing rubber tyres.

In addition to the types above, there are a number of other yarns like textured yarns. They will be described later in this lesson.
Self-check Questions

1. How will you classify yarns on the basis of the length of the fibre?
2. How are ply yarns made?

5.3 Manufacture of Filament Yarns

5.3.1 Silk yarn

As stated earlier, the only continuous filament produced by nature is silk. The silk worms produce cocoons. Silk filaments are unwound from the cocoons in a manufacturing plant called a filature. Several cocoons are placed in hot water to soften the gum (sericin) and the surface is brushed lightly to find the ends of the filaments. These ends are collected, threaded through a guide and wound on to a wheel called a reel. The process thus gets its name reeling. A tasar silk reeling set-up is shown in Fig. 5.2.

Fig 5.2 Silk reeling

The next operation is throwing. As the filaments are combined and pulled onto the reel, twist may be inserted to hold the filaments together. This is called throwing and the resulting yarn is known as thrown yarn.

Short ends of silk fibres from the outer and inner edges of cocoons and from broken cocoons are spun into yarns in a manner similar to that described for cotton.
5.3.2 Man-made filament yarns

The production of man-made filaments was considered earlier in Lesson 1 of this course. As described there, such filaments are produced either by melt spinning or by solution spinning. Polyester and nylon filaments are made by melt spinning while viscose rayon and acrylic filaments are produced by solution spinning. As shown there in Fig. 1.4, for example, a large number of melt-spun filaments emerge from the spinneret and are wound on a number of packages. The melt spinning speeds vary; say from 600 meters per minute to 8000 meters per minute. The filaments spun at the lower speed have low molecular orientation and therefore do not have the properties required of a commercial product. They are therefore drawn say from 3 times to 8 times their original length on a drawing machine, one such machine is shown in fig 5.3. The filament drawn at higher speeds need a lower degree of draw.

The drawing machine may not always be equipped with a twisting device. Usually filament yarns are produced with low twist and further twist is inserted in a separate operation.

Processing of filament yarns demands greater attention and care than that given to a spun yarns due to the smooth and delicate nature of these yarns having low twist level. The most common forms of polyester filament yarns in use are:

i) 76/24/0, i.e. 76 denier, 24 filaments, 0 twist.

ii) 80/34/0 i.e., 80 denier, 34 filaments, 0 twist.

5.4 Filament vs. Staple Fibre

It is interesting to note that while nylon finds most of the uses in the form of filaments; acrylic is mostly used in the staple form. In polyester, both staple yarn and filament yarn are in demand with continuous filament yarn production being larger than the staple yarn produced. The man-made staple fibres are used to a significant extent for blending with natural fibres like cotton and wool. As stated
earlier, cotton–polyester blend is extensively used for dress material and that explains why large quantities of polyester filaments are cut into staple. Similarly acrylic fibre has come to be known as artificial wool and therefore most of the acrylic filament produced is also cut into staple fibres. As far as nylon filaments are concerned, they are extensively used in the industrial sector, mainly because of their high toughness and also in the apparel sector light weight and sheer garments have been produced from nylon fibres for a long time where their low modulus and high strength and abrasion resistance characteristics are of particular importance. Preset fabric made from monofilaments of 7 to 15 denier is used as ladies stockings: they show excellent shape retention due to high elasticity of nylon filament. Their low modulus makes them comfortable.

In the technical and industrial field, nylon fabrics are widely used for conveyer belts, light weight canvas for luggage, parachutes, ropes and cordage. Tyre cord is one of the important applications for nylon, so are tooth bristles and zippers.

**Self-check Questions**

3. Which are the two common forms of polyester filament yarns?

---

### 5.5 Twist in Filament Yarns

The degree of twist in filament yarns has a wide range and is given keeping the type of application in view. Based on the number of twists per unit length, the twisted yarns may be classified into three categories:

i) Low twist yarns: up to 230 twists per meter

ii) Medium twist yarns: 230 to 900 twists per meter

iii) High twist yarns or hard yarns: above 900 twists per meter

The utilization of twisted yarns of different structures and kinds has considerably increased and improved the range of woven and knitted fabrics available in the market. Some of the main applications of twisted man-made fibres are as weft with 150 twists per meter or as warp with 150 to 230 twists per meter. They are used to manufacture muslin with twist of 600 to 800 turns per meter (used for light dress fabrics) and crepe with 1500 to 2300 twists per meter. There are a number of other applications based on textured yarns (described later in section 5.7) of different types.

As we have already seen, the manufacture of man-made twisted yarns differs greatly from the manufacture of twisted yarns of natural fibres. Twisting frames of many different types are available for making a whole range of twisted yarns.

### 5.6 Limitations of Synthetic Yarns
In general, synthetic filament yarns are thin, smooth, lustrous and staple fibre yarns are thicker and non-lustrous. However, filament yarns have a number of limitations. They have a synthetic look, lack of bulkiness and clothing discomfort due to poor water absorption and permeability. The compactness of the continuous filament yarn makes them very uncomfortable in a typical humid climate. There are two ways in which this problem is addressed. First, filaments may be cut into short lengths as staple fibres and then spun into yarns. They can also be blended with other “comfort-giving” fibres like cotton before spinning into a yarn. The second approach is to subject continuous filament yarns to texturing. Like spun yarns, textured yarns give textile fabrics the desired aesthetic comfort, durability and feel. This process will now be described.

Self-check Questions

4. Classify the twisted yarns on the basis of twists per unit length.

5. Give some shortcomings of synthetic filament yarns.

6. How are the limitations of the synthetic filament yarns overcome?

5.7 Texturing of filament yarns

If we take a polyester multifilament yarn, say 76/24/0 (which was described earlier) and insert, say 3000 twists per meter by applying a torque and then leave the yarn free, the twists will disappear. However, if the yarn is heat set in this twisted condition, the twists will be stable and will stay. If, after setting, the yarn is untwisted, a number of loops, curls and other types of distortions will appear and give an open structure to the yarn. This is the twist-set-untwist method of texturing a thermoplastic multifilament yarns. However, this is a very slow method of texturing. Methods which are now followed in industry, do texturing at running yarn speed of 1000 meter / minute. The principle of this method is illustrated with the help of a schematic sketch shown in Fig. 5.4.
Fig. 5.4(a) shows a filament which is stationary and secured at both ends with a spindle attached to it in the middle. As the spindle is rotated in the direction shown, extensive twisting occurs-S twist in the bottom half and Z twist in the top half. The sketch shown in Fig. 5.4(b) is that of a running yarn moving in the direction shown. If a torque is now applied, the twist flows on the bottom half but since the yarn is moving upwards, the yarn untwists as it comes out of the spindle.

This is because as shown in Fig. 5.4(a) an equal and opposite twist develops in the upper portion, which is now neutralized and hence the yarn becomes untwisted and develops the characteristics of a textured yarn.

![Fig. 5.5 The Texturing machine](image)

This becomes obvious from an examination of Fig. 5.5 which shows a texturing machine which has a rotating spindle. It is a false twist texturing machine and produces textured yarn at high speed. The types of yarn produced are shown in Fig. 5.6 which shows polyester yarn with different degrees of openness as a result of different heat setting treatments.

![Fig. 5.6 Textured yarns](image)

It may be noted that compared to the multifilament yarn shown earlier in Fig. 4.1, it will allow much greater permeability of water vapour and air.

Texturing of polyester and nylon multifilament yarns brings them closer to a spun yarn in terms of comfort and feel. Sportswear is generally made from textured nylon yarn while textured polyester yarns are considered very good for dress material.
5.8 Assignments

5.8.1 Class assignments
   i) What are the pros and cons of multifilament yarns when used for apparel wear? How are their shortcomings removed?

5.8.2 Home assignments
   i) Write an essay on production of multifilament yarns

5.9 Summing Up

Yarns made from filaments represent an important textile material for fabric production. The manufacture of filaments yarns from silk and from manmade filament has been considered in this lesson. Consideration of the limitations of filament yarns for apparel uses led to two approaches to overcome them. The first was to cut them into staple fibres and to make yarns from them or from their blends and the second to make textured yarns from the flat yarns by false twist texturing method. All these have been described in this lesson.

5.10 Possible Answers to Self-check Questions

1. The classification of yarns on the basis of length is as follows: filament yarns made from long continuous filaments and staple or spun yarns made from short or staple fibres.

2. Ply yarns are made by combining simple yarns on a machine called the doubling machine or doubler.

3. The two most common forms of polyester filament yarns in use are:
   i) 76/24/0, i.e. 76 denier, 24 filaments, 0 twist.
   ii) 80/34/0 i.e., 80 denier, 34 filaments, 0 twist.

4. Based on the number of twists per unit length, the twisted yarns may be classified into the following three categories:
   i) Low twist yarns : up to 230 twists per meter
   ii) Medium twist yarns : 230 to 900 twists per meter
   iii) High twist yarns or hard yarns: above 900 twists per meter

5. Synthetic filament yarns have a synthetic look, lack of bulkiness and clothing discomfort due to poor water permeability.

6. These are two ways in which the limitations of synthetic filament yarns can be overcome. First, filaments may be cut into short lengths as staple fibres
and then spun into yarns. They can also be blended with other “comfort-giving” fibres like cotton before spinning into a yarn. The second approach is to subject continuous filament yarns to texturing.

5.11 Terminal questions

1. Write an essay on textured yarns and their characteristics.
2. Explain the process of manufacture of filament yarns.

5.12 References and Suggested Further Reading


5.13 Glossary

1. Apparel Personal outfit, garments, clothing or attire.
2. Cone A conical support on which yarn is wound, a conical sackage of yarn wound on a conical support.
3. Linear Density The mass per unit length of linear textile material.
4. Technical Textiles Textile material and products manufactured primarily for their technical performance.
5. Textured Yarn A continuous filament yarn that has been processed to introduce durable crimps, coils, loops or other fine distortions along the length of the filaments.
6. Abrasion Resistance The ability of a fibre to withstand everyday rubbing or abrasion.
7. Acetate  A manufactured fibre in which the fibre – forming substance is cellulose acetate.

8. Acrylic  A manufactured fibre in which the fibre – forming substance is a long- chain synthetic polymer of at least 85% by weight of acrylonitrile units.

9. Blended Fabric  A fabric that consists of two or more generically different fibre types.

10. Crepe  Refers to any fabric with a puckered, crinkled, grainy surface.

11. Elasticity  The ability of a strained material to recover its original size and shape immediately after removing stress.

12. Elastic Recovery  The ability of fibres to recover from strain.

13. Elongation  The ability of a fibre to be stressed extended or lengthened.

14. Modulus  The resistance to stress / strain to which a fibre is exposed.

15. Muslin  A firm, medium-to heavy weight , plain weave cotton fabric made in a variety of qualities.

16. Strength  The ability to resist stress and is expressed as stress at failure.

17. Thermoplastic  Describes a fibre’s sensitivity to heat, fibres that soften or melt on heating and again solidify on cooling.