CHAPTER I

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1.1 Brief History

It is well-known fact that Woven fabrics must have outstanding comfort and at the same time have desirable physical properties which ensure a reasonable life span for its service. Fabrics made only from cotton may provide comfort but it has many undesirable properties like wrinkles, less durability and dimensionally not stable. On the other hand fabrics made only from synthetic yarns are not comfortable and it is difficult to apply fabric finishes on them, even though they have many good properties like higher strength, dimensional stability and more durability. Nowadays most of the apparel fabrics are produced with blends of cotton and synthetic fibres to combine the properties of both cotton and synthetic fibres. Though improved fabric properties are obtained with blended yarns as regards fabric strength, elongation, abrasion resistance, crease resistance etc., still fabrics are not comfortable as compared to 100% cotton woven fabrics [2].

In order to get maximum comfort and high physical characteristics in the yarn, some other techniques of yarn production is necessary. Sheath-core spinning can be considered as one of the best methods to reach the target and accomplish the desired output. In sheath-core yarn a continuous filament yarn or staple yarn/fibre can be used as a core and staple fibres as sheath materials that can be well wrapped over the core. This type of yarn gives higher strength than yarn made from virgin fibres due to presence of high tenacity continuous filament at the core and additionally it provides comfort due to presence of cotton staple fibre on the surface. Additionally, due to the presence of natural fibres at the sheath it is possible to apply surface finish
like flame retardants without significant loss of strength. When such yarns are converted to fabric improvement of many properties of fabrics was observed. Considerable change in fabric strength, elongation, tearing resistance and simultaneously excellent comfort properties are observed in sheath-core yarn fabric. Generally, the selected core material, usually a synthetic fibre, provides the required mechanical and functional characteristics, while the cover, which typically made of cotton, provides the desired excellent aesthetic, comfort and especially substrate (required for application of special chemical finishes and/or adhesives) properties. Along with the strength and comfort, other properties like elongation, abrasion and flame resistance are also improved. It is therefore required to have a detailed discussion on the manufacturing techniques of sheath-core yarn.

1.2 Different Spinning Techniques to Produce Sheath-Core yarn

For the production of sheath-core yarn different spinning techniques can be used. The spinning Techniques, which can be used to produce the sheath-core yarns, were as follows.

1.2.1 Ring spinning

Sheath-core yarn can be prepared on conventional ring frame by passing the synthetic filament through the nip of the front roller or spun synthetic fibre through the drafting rollers along with the sheath fibres used for sheath-core yarn production. The details will be elaborately described in the literature review and experimental work.

1.2.2 Rotor spinning

A method for manufacturing a sheath-core yarn in an open-end spinning device is different than the ring spinning system. In this process a continuous filament is supplied to the spinning rotor axially from the back side of the rotor through the hollow tube of the rotor and taken through the naval tube and by means of a pair of take up roller to the front side of the machine. There is a difference of speed between the take up roller and that of the feed roller. Due to more feed speed and centrifugal speed the filament forms loop inside the
rotor. The loop maximum point then comes nearer to the fibre deposition groove and thus collects the deposited staple fibres on the surface. With the take up speed and rotation of the rotor the fibres wrapped over the core and advances in the direction of take up rollers.

1.2.3 Friction spinning

Friction spinning machine uses two drafting systems for the core and wrapper fibres of the yarn. The core fibre drafting systems uses a combination of drafting rolls and aprons (placed at the back side of the m/c) and the wrapper fibre drafting system (placed at a higher position than the friction drums) uses a set of rollers and two metallic wire covered cylinders to furnish and individualize the fibres to wrap the core fibres. The core and wrapper fibres meet at the nip of the rotating perforated cylinders and form the sheath-core yarn. According to Louis et al. [31] it is easy to produce yarn consisting of 70% core and 30% wrap fibre in the friction spinning yarn than any other ratios of core and sheath fibres in the yarn. The causes are not been explained by the author.

1.2.4 Air-jet spinning

Sheath-core yarn can also be prepared on air-jet spinning machine. In air-jet spinning a filament is passed through the front roller nip by two ways, either by negative feeding or by positive feeding. When the drafted staple fibre coming from the back side to the front side of the machine, it is covering the core yarn by the twisting action of the nozzle and thus produce a sheath-core yarn. It is very difficult to process 100% cotton yarn through the air-jet machine. For 100% staple yarn production minimum 52mm fibre length is required to sustain the continuity of the yarn while passing through the spinning nozzle. Efforts were made in the present work to produce sheath-core cotton/filament yarn to establish whether short staples can be spun along with filament through the air-jet spinning system.

Though sheath-core yarn can be prepared by using different technology till today most of the sheath-core yarns were prepared using ring frame technology.
1.3. Sheath-Core Yarn Structure

Sheath-Core yarn structure consists of two components, one of which forms the centre axis or core of the yarn and other is the covering as shown in Figure 1.1, shows the cross-sectional view of sheath-core yarn and Figure 1.2 shows the longitudinal view of sheath-core yarn. Continuous multifilament yarn is generally used as a core, while staple fibre such as cotton and wool are used for covering the filaments or they are used as sheath material.

Figure 1.1 Cross sectional view of sheath-core yarn structure

Figure 1.2 Longitudinal sheath-core yarn structure
1.4 Uses of Sheath-Core Yarn

Sheath-core yarns can be used in military protective cloth. The sheath-core yarn fabrics can be used as apparel fabrics where the sheath material is 100% cotton and core material is polyester/nylon a stronger filament.

Sheath-core yarns are stronger and durable. Flame-retardant fabrics are used for military tents which has an almost 100% cotton surface and contains only 10% ultra strong, gel-spun polyethylene staple fibre (mostly in the yarn core). A flame retardant, cotton-rich fibre glass filament-core yarn fabric for protective covering, providing an excellent fire barrier; and an absorbent, yet strong and durable foundation cloth made with cotton covered polyester-core yarn for use in industrial abrasives and sandpapers.

A sheath-core yarn comprises of Aramid fibres/Silica fibres (having the thermal performance of a refractory material) is useful in woven or knitted safety garments which provides protection under severe conditions as splattering molten steel.

In this way it can be seen that there are enormous applications of sheath-core yarns both in apparels and in industrial uses. Still many properties of sheath-core fabrics are yet to be established to provide readymade information to the users.

1.5 Aim of Thesis

From the previous discussions it was understood that because of strong continuous filaments present at the core, the yarn strength is superior to 100% cotton and due to the presence of cotton fibre over the filament surface comfort and other physical properties of yarn/fabric are improved.

The objectives of the research are

1. To optimize the sheath-core ratio so that the fabrics made from cotton/filament sheath-core yarn would provide maximum comfort with highest strength
2. To predict fabric properties from given yarn properties.
3. To develop sheath-core yarn on ring frame and air-jet machine.
4. To compare the physical properties of sheath-core yarns and fabrics from ring spinning and air-jet spinning systems and to establish whether air-jet sheath-core yarn could replace the ring spun yarn in apparels.

5. To study the physical properties of the fabrics and compare each of them with 100% cotton yarn fabric.

6. To establish the best fabric properties obtained from particular sheath-core yarn or yarns to satisfy the users as per its feel/hand will be the last aim of this present research work.

1.6 Out Line of Chapters

Chapter 2    Literature review
Chapter 3    Experimental work
Chapter 4    Physical properties of sheath-core yarn
Chapter 5    Physical properties of sheath-core yarn fabrics
Chapter 6    Low stress mechanical properties sheath-core yarn fabrics
Chapter 7    Conclusions & Scope for future work
Chapter 8    References
Chapter 9    Annexure