SOME FACTS ABOUT FIBRE SHEDDING IN KNITTING PROCESS

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Abstract: *Some specific cotton fibre characteristics namely short fibre percentage by number; fineness and immature fibre content are observed at the different stages of the ring spinning process. These fibre properties may have some direct or indirect influence to shed fibre fly in the knitting process. Another study on specific hair lengths of cone package and fibre fly shows a good correlation. Further, the study on the hair angles from cop to fabric stage shows that the angle increases in the subsequent process which may affect the fibre shedding by increasing the bending stress during interactions with machine elements. Scanning electron microscope (SEM) study on the cotton fibres at the different stages of spinning process is revealed that the surfaces of fibres are damaged due to the mechanical interactions. Further, the SEM study on fibre fly shows that the fibres having the microcracks on their surfaces, torn and broken due to catastrophic failure.*

Keywords: *Fibre fly, short fibre content (SFC), fineness, immature fibre content (IFC), Hair angle, catastrophic failure.*

1. Introduction

Staple spun yarns have an inherent hairiness characteristic that composed of fibre ends and fibre loops protruding from the yarn surface. When the staple spun yarn is used to manufacture knitted fabric, the yarns follow the complicated path from its cone package to loop formation zone, where the protruding fibres on the yarn surface face the cohesive and tensile forces at the unwinding zone of the cone package as well as friction, bending and abrasion at the guides, feeders, sinkers, needles and other outer interferences during knitting. As a result, some fibres are broken or pulled out from the surface of yarn as fibre fly, and deposited in and around the unwinding zone, guide zone, knitting zone, and other parts of the knitting machine. Consequently, liberated fly affects the performance of process by lowering the machine efficiency 5-10%, affecting the fabric quality by increasing the fabric fault 15-25% along with reduction in weight of fabric 0.5-1.0% (*Rainsford, 1983*). Furthermore, it pollutes the indoor atmosphere which has a negative impact to the working personnel by exposing to dust particles and small broken fibres during knitting process *(Parnell et al., 1986)*.

As per findings (*Bhowmick and Ghosh, 2007*) on collected fibre fly from cone unwinding zone and knitting zone, the researcher found that the cotton fly basically are shorter in length, finer and immature in nature as compared to their parent fibres. They also reported that the presences of short fibre are 97.6% and 98.9% in total fly in respective zones. However, nothing is reported whether there is any direct correlation between individual parent fibre properties and fibre shedding.

The investigation by the researchers *(Ghosh and Bhowmick, 2009*) reported that the shedding of fibre fly is affected by entanglement of long protruding hairs from yarn surface rather than the level of yarn hairiness present in yarn during cone unwinding in knitting. However, the fact is still unknown that whether the specific lengths of hairs or all protruding fibres from the staple yarn structures are contributing to shed fibre fly in knitting process.

Further, to search the possible causes of fibre shedding in guide zone and knitting zone, researchers said that native cotton fibres are processed under random loading and unloading of different natures during spinning and winding operations. This may cause the surface of the cotton fibre damaged and may contribute to shed as fibre fly during the knitting. On the basis of this, the main aim of this study is to find the causes of fibre shedding from the cotton yarn during the knitting process.

2. Experimental

Cotton samples were collected at the different stages of the spinning process from mixing stage to final drafting in ring spinning machine. Some specific fibre characteristics (fibre length, short fibre content, fineness, immature fibre content and maturity ratio) were measured from individual samples by AFIS (Advance fibre information system). Sufficient yarn samples were processed in knitting machine to collect fibre fly in unwinding zone, guide zone and knitting zone. Fibre fly characteristics were measured by AFIS. The distribution of specific hair lengths and hair angles in yarns from cops and cone packages were measured by the image analyzer. The same process was followed to measure the length distribution of fibre

fly. The surface characteristics of the cotton fibre obtained from mixing to final yarn and fibre fly were investigated by the scanning electron microscope.

3. Results and Discussion

3.1 Correlation between cotton fibre and fibre fly characteristics

From the Figures 1(a, b and c), it is immediately apparent from the examination fibre fly characteristics i.e. SFC (n) %, fineness and IFC % of the different zones (cone unwinding zone, guide zone and knitting zones) tend to increase as the parent cotton fibre characteristics are increased.

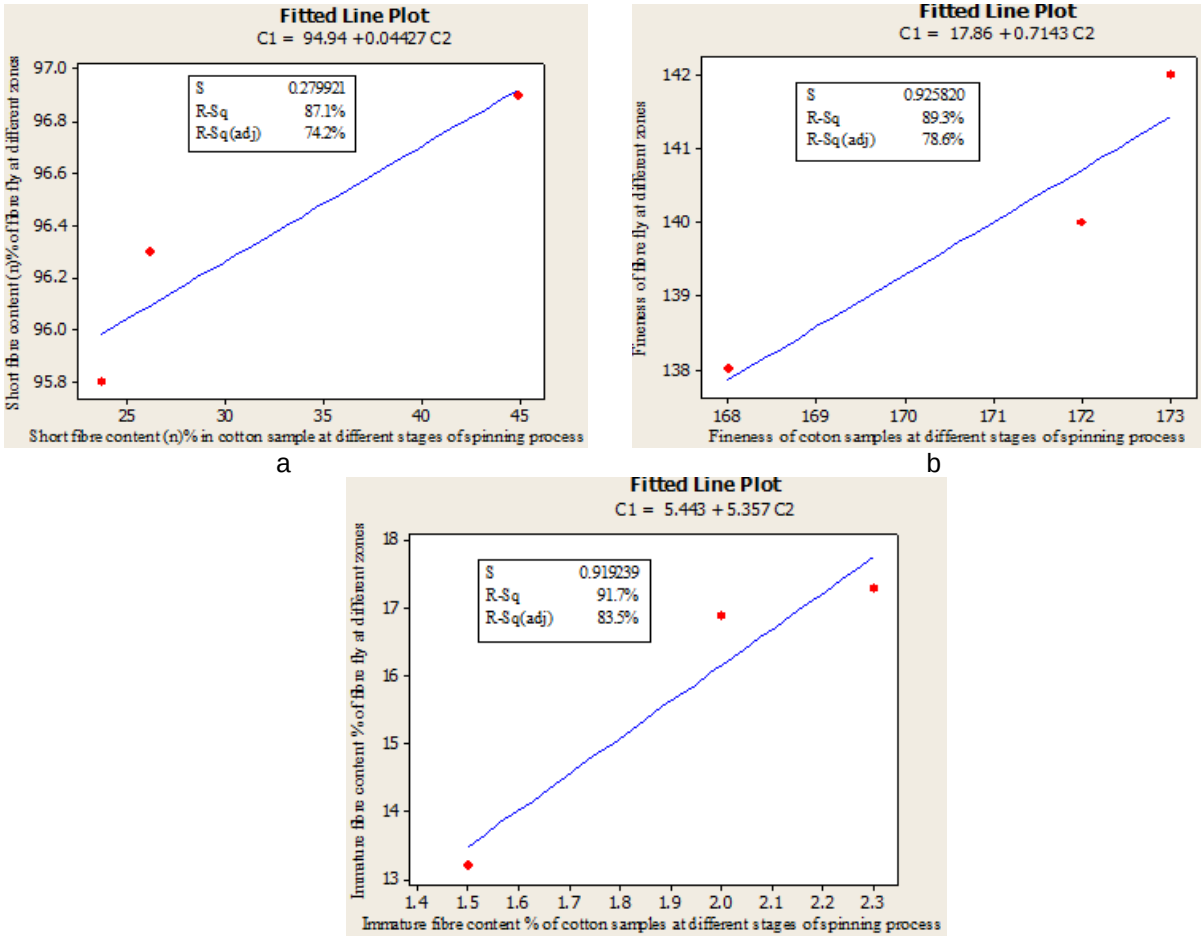

Figure 1: a. Correlation between SFC (n) of cotton fibre and short fibre content percentage by number in fibre fly, b. Correlation between cotton fibre fineness and fineness (mtex) of fibre fly, and c. Correlation between cotton fibre IFC and immaturity fibre content of fibre fly

3.2 Correlation between specific hair lengths of cone and fibre fly

From the Figures 2 (a, b and c), it is observed that the long hairs of cone yarns show a higher correlation with the collected fibre fly deposited at the different sectors (cone unwinding zone, guide zone and knitting zone). The values of correlation coefficients (r) are 0.95, 0.98 and 0.96 respectively.

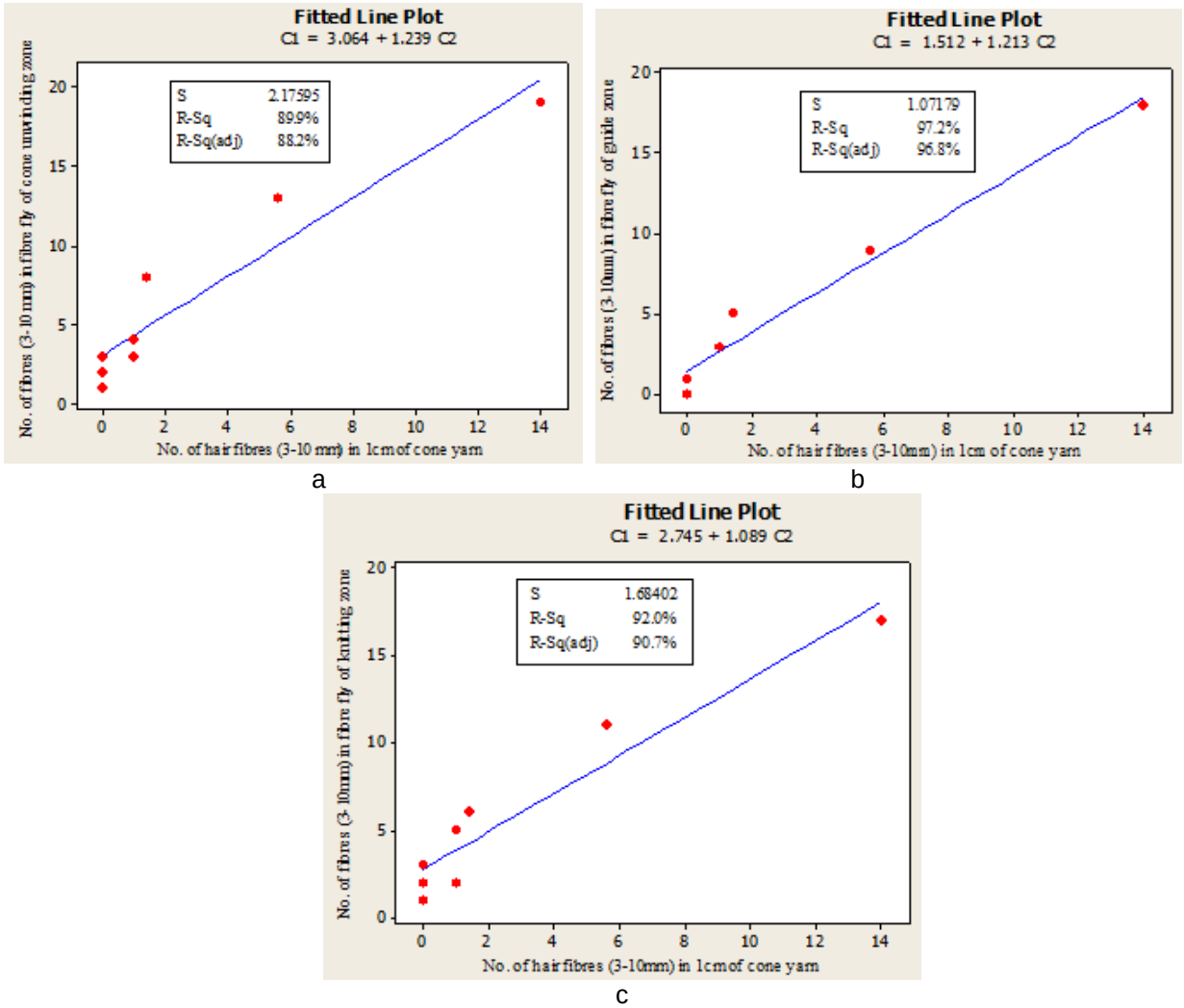

Figure 2: (a, b and c) Correlation between specific hair lengths of cone yarn and lengths of fibre fly at cone unwinding zone, guide zone and knitting zone

3.3 Analysis of specific hair angles at the different stages

The specific hair angles from the yarn surface of cop, cone and knitted fabric are measured. It has been observed that the hair angles are increasing as yarn proceeds to fabric formation as shown in Figure 3.

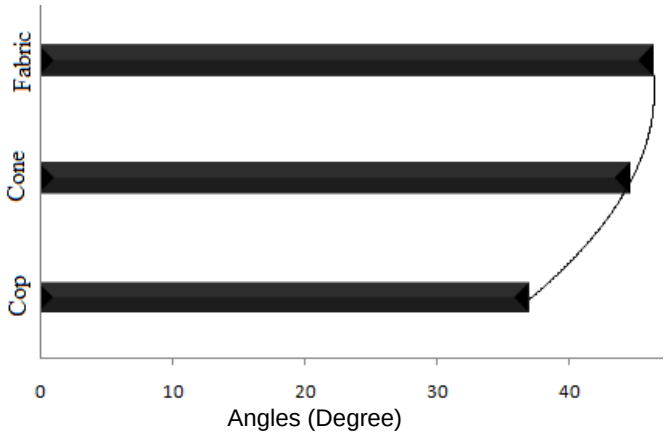

Figure 3: Specific hair angles at the cop, cone and knitted fabric yarn

3.4 Impacts of mechanical interactions

The scanning electron microscopic (SEM) observation of virgin cotton fibre to final yarn is shown in figures. It is observed that due to the mechanical interaction some of the fibres are badly damaged during the

subsequent processes of spinning as shown in the figures. As results, the edge fibres in the yarn structures are basically weak and highly prone to break under external causes.

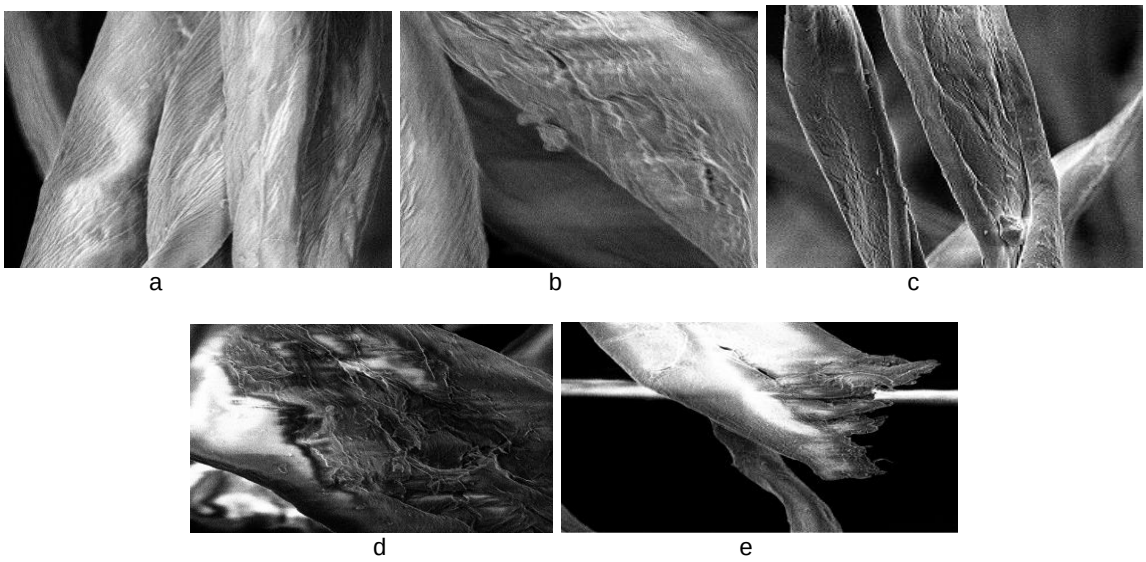

Figure 4: a. Scanning electron microscopic view of fibres a. Virgin fibres, b. Card sliver, c. Ring drafted web, d. Ring yarn e. Ring yarn

Whereas, SEM observation of fibre fly at different places (cone unwinding zone, guide zone and knitting zone) of knitting machine is shown in figures 5. It is observed that the fibre fly are found as broken and these fibres are broken from their weakest points due to tensile pulling in cone unwinding zone, bending stress and strong abrasion in guide and knitting zones. This fact may be supported by the nature of fibre fly found which are shorter in length with fibril failure, torn and catastrophic failure in nature.

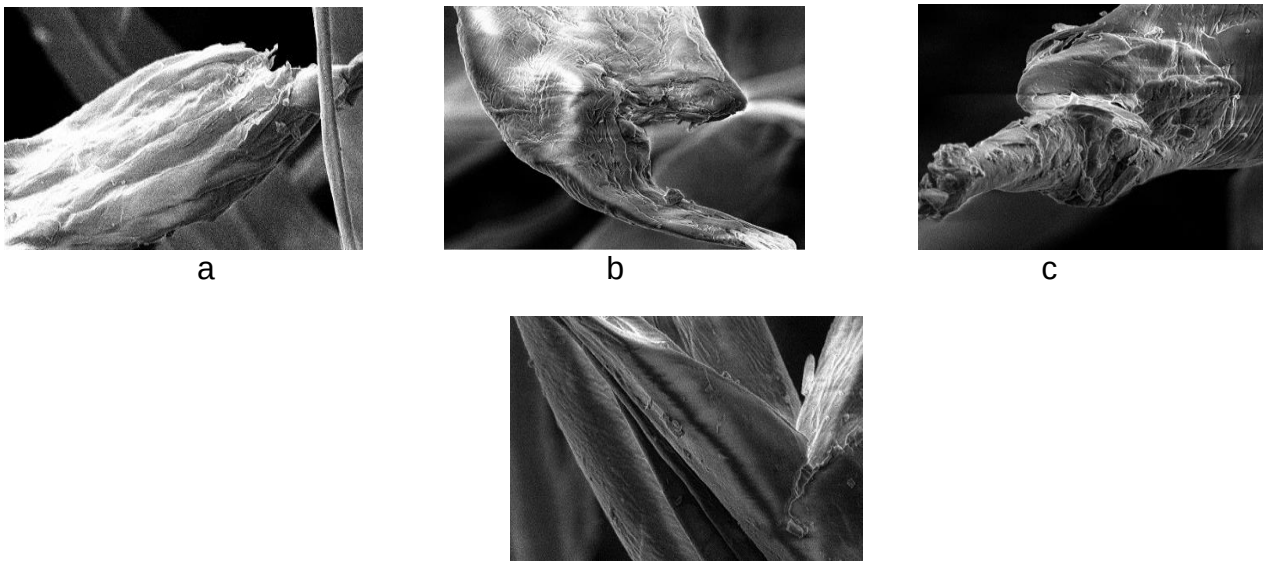

Figure 5: a. Scanning electron microscopic view of fibre fly from different zone of knitting a. fibril failure b. torn c catastrophic failure d. tear

4. Conclusion

The present study revealed that the fibre characteristics obtained from the parent cotton fibres and fibre fly show a good correlation between them. This indicates that some specific fibre properties are directly or indirectly contributing to shed fibre fly in the knitting process.

The study on specific hair lengths of cone package and fibre fly shows a good correlation. This fact indicates that the fibre shedding from cotton yarn is influenced directly or indirectly by the hairiness of the yarn.
The specific hair angles from the yarn surface of cop, cone and knitted fabric are measured. It indicates that the protruding fibres from the yarn surface are interacting with the various parts of the knitting machine with

the angles in the range of 45^0 to 47^0. As results, hairs may be bend sharply and broken from its weakest points depending on the magnitude of the stress develops within the fibres.

The investigation of the surface characteristics of cotton fibres by the scanning electron microscope (SEM) reveals that the fibres are badly damaged due to mechanical interactions in spinning. These damaged fibres are broken from their weakest points due to tensile pulling in cone unwinding zone, bending stress and strong abrasion in guide and knitting zones.

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