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Research Article

INVESTIGATION OF SHORT FIBERS FORMATION ON A CIRCULAR KNITTING MACHINE USING COTTON AS RAW MATERIAL

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ABSTRACT

When providing care, to protect a part of the human body against resins and plasters for certain time, it is necessary to use a circular knitted band in cotton as a raw material. The generating of Cotton fiber fly throughout the knitting process is due to interactions of frictional surfaces with the hairiness of ring spun yarn. During the manufacture, short fibers are formed in the machine device, this problem is more important with the use of cotton yarns. In this research paper, the short fibers formation on circular knitting machines from spun yarns such as cotton is investigated. The knitting conditions consist of; yarn tension, yarn feeding speed and the angle contact of the yarn with guides and needles. The results obtained illustrate the effect of yarn tension on the short fibers deposit caused by the combination of yarn friction with the knitting elements.

Keywords: cotton, knitting, tension, yarn.

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1. INTRODUCTION

What the research paper shows is the fact that the knitting industry did not know the fiber shedding. What made it relatively unknown was the way polyester filament was used in the knitted fabric production during its boom period some time before 1979 [1]. Yet, when the cotton knitwear was back in great demand in global fashion, then the manufactures were put into a great trouble due to the problem of fiber shedding [2]. Some investigations have been carried out on fiber shedding behavior of staple-spun yarn by considering fiber, yarn and knitting parameters along with finishing treatments on cotton spun yarn [3]. Most of these investigators deduced that fiber fly generation is caused by the fiber properties of the yarn in which the level of yarn hairiness is plays a major role [4].

The jersey bands used in the medical field are made of 100% cotton on circular knitting machines with a very high speed [5]. However, high speed production causes some problems, one of them is the formation of short fibers [6], an accumulation of loose fibers detached from the yarn body, especially from spun yarns in case of cotton. This presents many potential problems such as waste, working efficiency, environmental and costs.

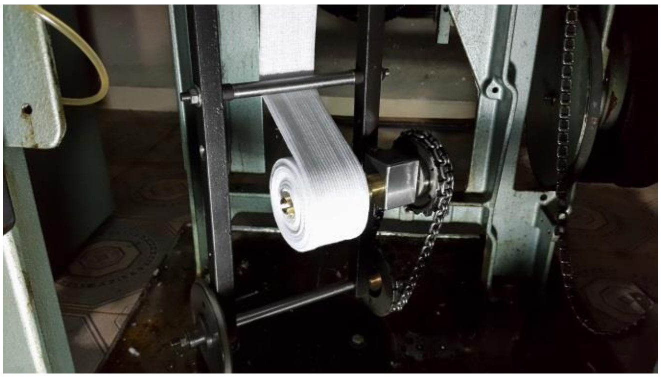

Fig.1. Circular knitting machine Bentley komet transformed to produce continues simple jersey fabric. Photo, Ali Bey H, Algiers

The main reason of this problem is the friction between yarns and knitting elements that occurs when the moving yarn passes over machine parts [7]. A part from considering the frictional résistance of yarn itself, yarn tension is created at the knitting points, which may at times be enough to break the yarn and produce loose fibers, and then faults in the fabric [8].Therefore, the knitting tension of the yarn should be low enough to produce a good quality fabric during the process. In order to maintain suitable tension during knitting, the friction between yarn and knitting elements should be low as well. Many studies suggest [9] that the coefficient of friction of the yarn should be low in order to produce good quality knitted fabrics and safe processing [10]. The purpose of this study is to investigate the relationship between the friction and the short fibers from a cotton yarn. The study is performed on a circular knitting machine Bentley komet 168 needles 4″ diameter (figure 1) adjusted to produce a single jersey knit continuously and on which it can be changed the yarn speed, the angle with the needle and the yarn tension. A ring spun cotton yarn with 50 Ne was produced for this study, and tests were repeated ten times for each in different testing condition [11].

2. MATERIALS AND METHODS

To determine the shedding of short fibers at the knitting needle, a knitted machine shown in (figure 2) is used. On this machine is installed a tension-measuring unit to determine the tension variation of a tested sample yarn. The yarn is threaded through the needle hook under tension. In order to monitor the input and output yarn tension, two tension measuring heads, which have 200 Hz maximum frequency, 0-50 cN measuring range, and two yarn guides on the measuring head, are also integrated into the yarn paths between the guide and the needle.

Fig.2. Short fibers in cotton deposited on circular knitting machine devices.

Photo, Ali Bey H, Algiers

The position P is adjustable to facilitate changes in the yarn wrap angle (A) in the needle hook as show in (figure 2). A control System under a pre-determined input tension and yarn speed is installed on this machine.

Variations in both tensions are monitored during the test, (figure 3) and the average tension of the input and output is calculated after the test. Yet, the former tension does not show a great deviation and the maximum input tension of the yarn is limited to 10 cN [12]. In general, the practical input yarn tension is adjusted to 3 cN in the circular knitting industry. However, in order to compare short fibers generation with tension variation during the test, we use three tensions (3, 5, and 10 cN).

Fig.3. Input and output tension of yarn during production.

Photo, Ali Bey H, Algiers

The short fibers shed on the needle hook are then collected onto a filter paper by creating a lower atmospheric pressure in the enclosed area with a suction unit [13]. Not only weighing the filter paper by a high accurate balance before and after the test determines the amount of short fibers shed during the manufacturing, but it also calculates the total fibers amount and the fibers amount from the collecting box:

Total fibers amount (T %)

$$T = \frac{W_0 - W_t}{W_t} 100 \ \ (\%) \qquad (1)$$

Fibers amount from the collecting box (F %)

$$F = \frac{N}{W_0} 100 \quad (\%) \qquad (2)$$

Where Wo = initial yarn weight, Wt = yarn weight after testing, and N = weight of the amount of fibers shed at the filter paper. The difference in the tension of the yarn can be calculated by:

$$T_2 = T_1 e^{\mu\alpha} \quad (3)$$

where

T_1 = input tension,

T_2 = output tension,

μ = coefficient of friction,

α = yarn wrap angle (radian).

3. RESULTS AND DISCUSSION

3.1 Yarn tension

Figure 4 shows the corresponding variations in output tension by changing pre-determined input tensions (3, 5, and 10 cN) and yarn feeing speed. The results show that output tension may not be influenced by the yarn feeding speed, since the output tension does not show any variation with increasing yarn speed in the test results. Thus, no significant variations in yarn tension which increases in yarn feed speed.

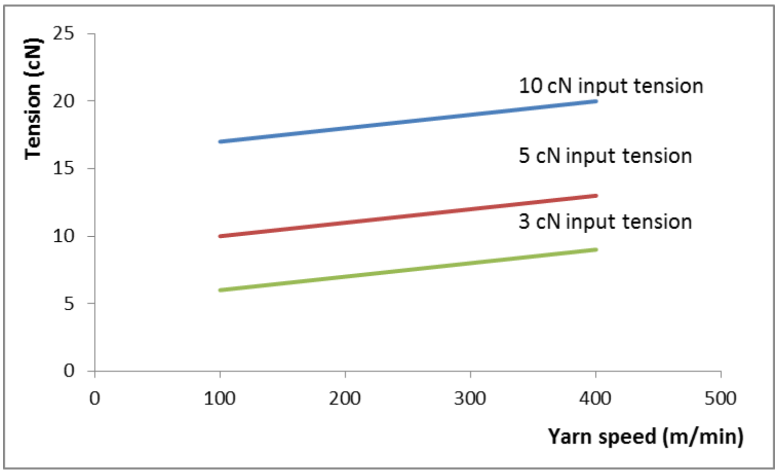

Fig.4. Variation of output tension with different input tension and speed (needle gauge 14, A = 3 radian)

However, what we know is the fact that there is a tension increase with high speed yarn feeding on the machine due to the load caused by the speed in the dynamic and complex machine structure. This means that the reason for this uniformity of results may be explained the way that only one stationary needle which is used in the test rig for simplicity. In reality, the knitting points of a circular knitting machine are dynamic and complex. We have also investigated the influence of the yarn wrap angle on the tension variation. Figure 5 shows a slight increase in the output tension when changing the yarn wrap angle and speed. This may be explained by a more acute yarn warp angle causing the yarn to come into contact with a wider surface area of the metallic needle hook. On this course, the result shows that the output tension of the yarn during knitting is much more likely to be influenced by the input tension and yarn feed angle, but yarn feeding speed does not have a great effect on output tension in this special testing condition.

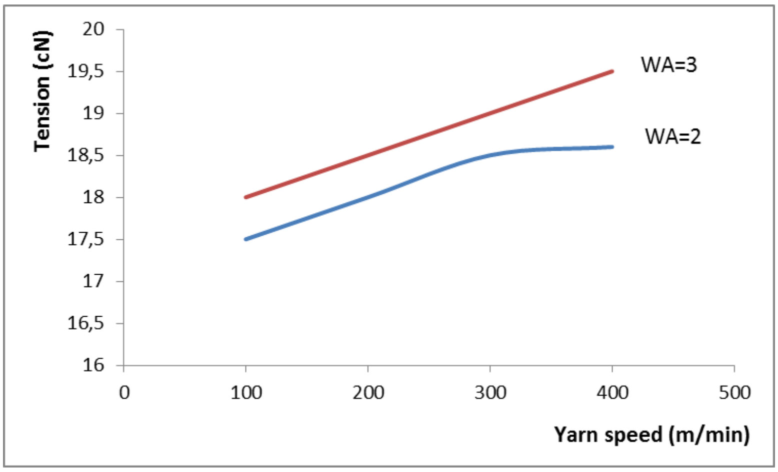

Fig.5. Variation of output tension at different yarn wrap angle

(input tension = 10 cN, needle gauge 14)

3.2. Yarn friction

Yarn friction mainly influences yarn tension in all textile processes, including knitting. This research paper shows that friction is also the main cause of short fibers separated from the yarn during knitting. Consequently, there is friction between the yarn and knitting elements like the needle or yarn guides. Hence, Surface friction damages the yarn structure, then component fibers of the yarn are easily shed from the yarn body.

Cotton yarns easily shed loose fibers because of their spun structure. And carded cotton yarn usually has a coefficient of friction of 0.20 to 0.26 in static conditions with metallic surfaces. During the treatment of knitting yarns to a μ value between 0.18-0.20 generally due to the use of the following results, which makes us able to compare the output tensions with different yarn surface condition.

To reduce friction of the yarn with the elements of the machines, such as needles, the yarn should be waxed, and μ 0.14 values are used. The output tension decreases with the increasing frequency of yarn waxing, implying that the yarn friction of the waxed yarn should be lower than that of unwaxed yarn as show in figure 6. From this result it is obvious that yarn friction with the needle during knitting should be minimized to produce a low yarn output tension and thus reduce the amount of short fibers loose from cotton yarns.

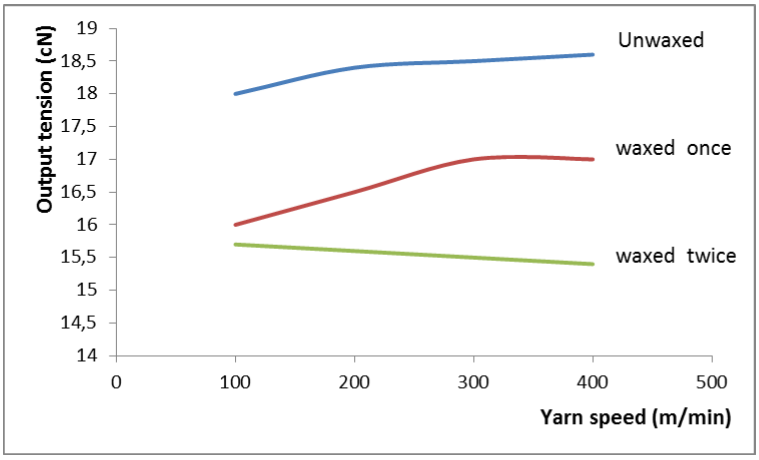

Fig.6. Variation of output tension with different yarn conditions

(input tension 10 cN, needle gauge 14, A 3 radian)

3.3. Quantity of short fibers

To investigate the relationship between yarn friction and the amount produced of short fibers, cotton yarn was used. The same parameters as before were changed, the input tension, yarn speed and yarn angle. The results are shown in figure 7.

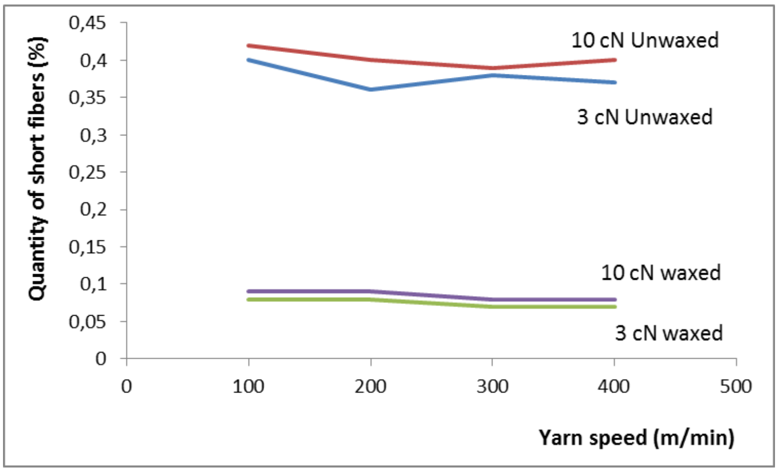

Fig.7. Amount of short fibers generated with different tensions, waxed and unwaxed yarns,

(needle gauge 14, A 3 radian)

The quantity of the short fibers from a cotton yarn with two different input tensions and different yarn speeds at a 3 radian wrap angle. The quantity of short cotton fibers from the collecting box shows a tiny difference between 3 and 10 cN tension at different yarn speeds. The total amount shows a small difference, it is slightly higher for 10 cN than for 3 cN.

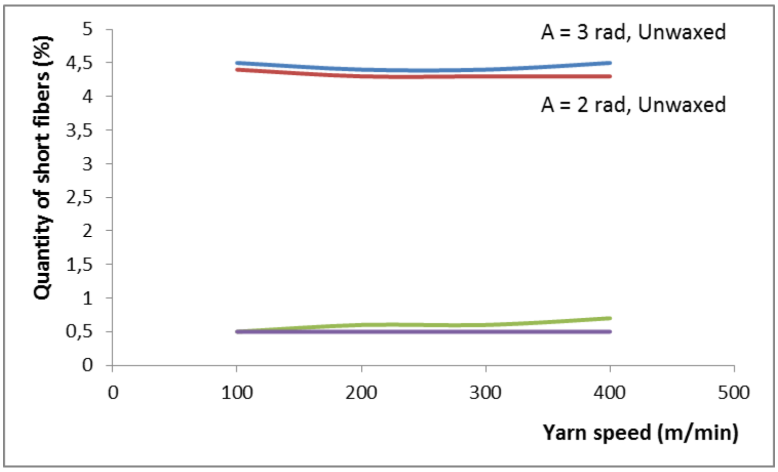

Fig.8. Quantity of short fibers at different angles, waxed and unwaxed yarns, (input tension 10 cN, needle gauge 14)

This shows that the difference in tension has an effect on short fibers because of the friction between yarn and needles ends with the yarn at a higher tension. The variation in the amount of short fibers at different yarn angles is shown in figure 8. There is a slight difference in the total amount of and the amount from the collecting box. In the previous test, yarn tension with a 3 (radian) wrap angle was slightly higher than with a 2 (radian) wrap angle.

K. Prabhat has proposed a Simple Method for Measuring the Friction Coefficient of Thin Fibers on 1991. This method is described for measuring the friction coefficient between a fiber, particularly thin fibers (with diameters down to a few micrometers), and a cylindrical substrate. The method allows for examination of the influences of the environment, temperature, and relative velocity between the fiber and the substrate [14].

4. CONCLUSION

Many potential parameters influence short fibers shedding during knitting in these machines. The main reason on the machine parts is friction. To investigate the relationship between friction and short fibers shedding, A circular knitting machine with 4'' diameter was used. During this study, as expected, the varied input tension influences the output tension linearly. Yarn speed does not affect the variation in output tension on the test rig significantly, because the input tension is kept constant for ail tested yarn speeds. An acute feed angle makes a more obtuse contact angle, and the results show that this slightly increases yarn frictional force and yarn output tension.

The angle does not significantly contribute to the amount of short fibers generated, so then a smaller needle gauge creates a higher output tension. Finer gauge needles have smaller diameter needle hooks. The use of finer gauge needles significantly increases the quantity of short fibers generated. Short fibers generation can be caused by yarn tension, which is again dependent on the friction between yarn and needle during knitting. Yarn tension can then be decreased to some extent by waxing the yarn.

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