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Investigation of Inter Fiber Cohesion in Yarns. I. Influence of Certain Spinning Parameters on the Cohesion in Cotton Yarns

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Abstract: This paper investigates the influence of raw material and process parameters in spinning that affect the inter fiber cohesion in yarns. An instrument has been developed for measuring the minimum twist of cohesion. With regard to the raw material parameters, the influence of different cotton fiber mixings for a given count of yarn is investigated. Also the effect of spinning to varying counts for a given cotton variety is studied. With regard to the process parameters, studies have been carried out to investigate the influence of noil extraction in comber, number of draw frame passages, draft pressure in ring frame and direction of twist. Cohesion improved with increase in the noil extraction percentage in the comber. Increase in the number of draw frame passages also improved the cohesion. Draft pressure in ring frame improved the fiber cohesion in yarn up to a pressure of 2.1 kg/cm^2. Direction of twist had no effect on the cohesion.

Keywords: Cohesion, Cotton, Draft, Mixing, Noil

Introduction

The minimum twist of cohesion (MTC) can be defined as the minimum number of turns or twist required to cause cohesion between the fibres so as to be held in the yarn structure. It is related to the yarn strength. It is the difference between the number of turns present per unit length in the yarn and the number of turns removed in breaking the yarn under a given load. The lesser the difference the better is the fiber cohesion. Barella was the first to carry out investigation on this cohesion phenomenon in cotton rovings and yarns [1]. He further extended his study to woolen and worsted yarns [2]. El Mogazhy *et al.*, whilst estimating staple fiber processing propensity, feel that surface cohesion of fibres provides a complete picture of processability [3]. They have also reported on the sliver cohesion of finisher draw frame sliver which is most important in fibre processing propensity [4]. Studies were carried out on ring and compact yarns and it was found that compact yarns gave better cohesion [5]. In another study, the influence of critical ring frame parameters such as twist, spindle speed and traveler size on the inter fiber cohesion has been studied and it was found that all these parameters affected the fiber cohesion [6]. As Barella had carried out only preliminary studies on the cohesion phenomena in cotton rovings and yarns, it was felt necessary to extend his study further by examining the influence of certain critical parameters in spinning such as type of raw material, count of yarn, noil%, etc., that could possibly influence the cohesion behavior of the fibers. The studies revealed interesting results that are discussed in this paper.

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Materials and Methods

For carrying out the study, 100 % cotton ring spun samples were used. Studies have been carried out in the following aspects:

- Variation in MTC between nose, middle and base regions of ring cop
- Effect of spinning varying counts of yarn on MTC
- Effect of different cotton mixings on MTC of yarn
- Effect of direction of twist
- Effect of noil extraction
- Effect of drafting pressure
- Effect of number of draw frame passages

An instrument has been developed for measuring the minimum twist of cohesion (Figure 1). The specimen to be tested is clamped to a top rotating jaw which is motor driven. An electrical connection is given from motor to a digital counter which monitors the number of rotations made by the rotating jaw. The scale attached to the instrument enables the gauge length of the specimen to be tested. Provision is made to accommodate gauge length upto 500 mm. The length of the yarn samples tested was 500 mm. While one end of the yarn sample is clamped to the top rotating jaw, the other end is suspended by a small weight to give some tension to the yarn sample. The yarn tension used in this test is 0.1 grams/tex. Thus a tension weight of 1.48 grams was used for the yarn sample of 40s Ne. A switch attached to the left side of the instrument enabled the choice of direction of jaw rotation through the motor. Thus the yarn sample is rotated in the reverse direction of its twist. In other words it is untwisted by switching on the motor. At a particular point the yarn breaks due to the suspended weight. At this point the reading on the digital counter is noted and the motor immediately

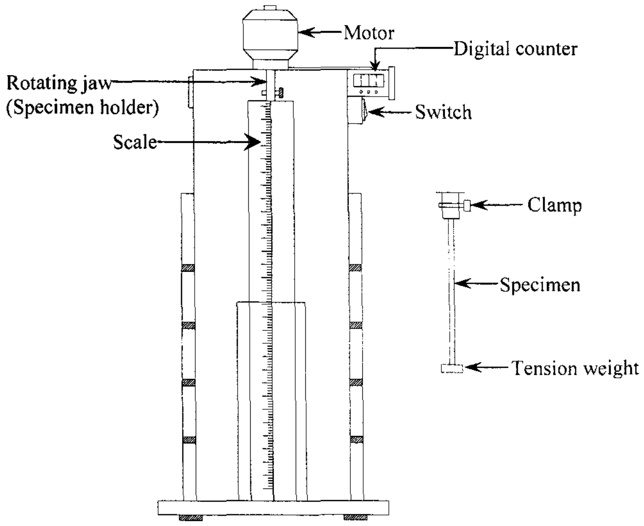

Figure 1. Instrument for measuring the minimum twist of cohesion of yarn.

switched off. Another sample of yarn is tested for twist per unit length on electronic twist tester and the value is converted to 500 mm. The difference between the number of turns measured in the yarn and the number of turns caused to break the yarn specimen under load gives the value of the minimum twist of cohesion.

Results and Discussion

Variation of MTC between Base, Middle and Nose of Ring Cop

The variation of the MTC of yarn between the base, middle and nose regions of the ring cop is shown in Table 1. As can be observed from Table 1, the MTC value at the base region of the cop was found to be the least, which means that the cohesion was higher in this region as compared to the middle and nose regions. This can be attributed to the higher spinning tension due to the greater balloon height at the base region, which results in better fiber migration and packing of fibers in this region of the yarn. Better migration of fibers results in greater interlocking of fibers in the yarns structure. This results in improved cohesion in the base region. On the other hand, the least cohesion is found to be in the nose region, which is due to the least spinning tension in this region.

Table 1. Variation of MTC of yarn between base, middle and nose regions of ring cop

No	Type of material	Linear density of yarn (tex)	MTC value*		
			Base	Middle	Nose
1	100 % cotton	37	79	82	85

*Mean of 20 readings.

Table 2. Effect of spinning varying yarn counts on MTC

No	Type of material	Yarn linear density (tex)	MTC value*
1	100 % cotton	60	76
2	100 % cotton	30	82
3	100 % cotton	20	86
4	100 % cotton	15	89
5	100 % cotton	12	92
6	100 % cotton	10	94

Table 3. Effect of different cotton mixings on the MTC value of yarn

No	Type of material	Type of mixing	Yarn linear density (tex)	MTC value*
1	100 % cotton	50 % J34 + 50 % comber waste	20	81
2	100 % cotton	Digvijay	20	74
3	100 % cotton	H4	20	66
4	100 % cotton	S6	20	60
5	100 % cotton	MCU5	20	55

Effect of Spinning Varying Yarn Count

The cohesion of fibers was found to increase with coarser counts, for a given fiber type. The reason for this is the increased number of fibers in the yarn cross section enhances more number of contact points in the yarn structure, which lead to better cohesion. On the contrary, spinning to finer counts with the same fiber type gives lower cohesion as is shown in Table 2.

Effect of Different Cotton Mixings

The influence of the type of mixing on the MTC of yarn is shown in Table 3. It has been found that the type of cotton mixing has an effect on the fiber cohesion. The superior variety of cotton gave better cohesion for a given yarn count, due to longer and finer fibres. Longer fibers will have more contact points and this results in better length exploitation. On the other hand finer fibers have more surface area, leading to better packing of the fibers in the yarn.

Effect of Direction of Twist

The influence of the twist direction on the MTC value is shown in Table 4. As can be seen from the Table the direction of twist has no significant influence on the fiber cohesion.

Table 4. Effect of direction of twist on MTC of yarn

No	Type of material	Yarn linear density (tex)	Direction of twist	MTC value*
1	100 % cotton	20	Z	92
2	100 % cotton	20	S	94

Table 5. Effect of varying noil extraction at comber, on MTC of yarn

No	Type of material	Yarn linear density (tex)	Noil extraction (%)	MTC value*
1	100 % cotton	15	8	102
2	100 % cotton	15	9	99
3	100 % cotton	15	10	97
4	100 % cotton	15	11	94
5	100 % cotton	15	12	92
6	100 % cotton	15	13	89
7	100 % cotton	15	14	85
8	100 % cotton	15	15	82
9	100 % cotton	15	16	80
10	100 % cotton	15	17	79
11	100 % cotton	15	18	79
12	100 % cotton	15	19	81
13	100 % cotton	15	20	84

Effect of Noil Extraction %

The influence of the percentage of noil extracted at the comber is shown in Table 5. It was found that between 8-11 % noil extraction, there was no significant change in the MTC value. Beyond 11 %, there was a marked increase in the cohesion up to 19 % after which the cohesion value remained unchanged. The reason for better cohesion above 11 % noil extraction was more removal of short fibers. At noil extraction level of above 19 %, there was no improvement in the fiber cohesion. This due to the fact that the proportion of short fibers was so less that it did not significantly affect the cohesion.

Effect of Drafting Pressure in Ring Frame

The influence of varying drafting pressures on the MTC of yarn is shown in Table 6. As can be seen from the Table, the cohesion improves up to drafting pressure of 2.1 kg per sq.cm. Higher pressure in the drafting zone increases tension of the fibers emerging from the front roller nip. The fibers thus emerging from the front roller are twisted in taut condition, which thus results in better packing of fibers in the yarn, leading to better cohesion. Also higher friction field is generated between fibers and fiber movement in drafting zone is more controlled. Hence there is less drafting irregularity. There is no change in the cohesion beyond drafting pressure of 2.1 kg per sq.cm.

Table 6. Effect of varying drafting pressures on the MTC of yarn

No	Type of material	Yarn linear density (tex)	Drafting pressure (kg/cm^2)	MTC value
1	100 % cotton	30	1.5	105
2	100 % cotton	30	1.6	101
3	100 % cotton	30	1.7	98
4	100 % cotton	30	1.8	95
5	100 % cotton	30	1.9	91
6	100 % cotton	30	2.0	89
7	100 % cotton	30	2.1	86
8	100 % cotton	30	2.2	85
9	100 % cotton	30	2.3	85
10	100 % cotton	30	2.4	85
11	100 % cotton	30	2.5	85

Table 7. Effect of number of draw frame passages

No	Type of material	Yarn linear density (tex)	Number of draw frame passages	MTC value
1	100 % cotton	30	1	93
2	100 % cotton	30	2	88
3	100 % cotton	30	3	85
4	100 % cotton	30	4	84

Effect of Draw Frame Passages

The influence of the number of draw frame passages is shown in Table 7. Increase in the number of draw frame passages results in more removal of fiber hooks and also straightening of the hooks. This also leads to better mean fibre extent in the yarn which in turn results in better fiber cohesion.

Conclusions

The above studies revealed the following results: The cohesion is greatest in the base region of ring cop, followed by the middle and nose regions. For a given variety of cotton fiber, the coarser counts give better fiber cohesion in comparison with the finer counts. Superior cotton mixings for a given count gave better cohesion. Direction of twist in yarn has no effect on the fiber cohesion. There is significant increase in the fiber cohesion between noil extraction levels of 11-19 %. Cohesion improves with increase in drafting pressure at ring frame, up to pressure of 2.1 kg/cm^2. Cohesion improves with increase in number of draw frame passages.

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