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Optimization of Spacer Size and Degree of Shore Hardness on Yarn Quality in Ring Frame Machine

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Abstract

This study was mainly focused on the optimization of spacer size and degree of shore hardness in ring frame drafting systems to improve yarn quality parameters. The 100% cotton fiber carded yarn samples of 35.5Nm were produced to analyze the effect of spacer size and degree of shore hardness with different combinations. The spacers were 4.2 and 4.5 mm and the shore hardness was 70 back & 62 front and 70 back & 65 front. All yarn samples of the same count were produced on the same spinning positions by changing the spacer's size and degree of shore hardness by keeping all other parameters constant. The produced samples were tested according to standard testing methods and instruments. After testing, the tested results were compared to analyze the influence of spacer size and shore hardness on yarn quality in a ring spinning frame. The technologist needs to understand this and act on it to optimize the yarn production. The specific size of the spacer with specific shore hardness should be used for a particular count of yarn. The results showed that yarn quality i.e. U%, Cvm, Neps +200%/km, Thick +50%/km, Thin -50%/km, TIPI are considerably influenced by the spacer size with different shore hardness. So it is concluded that the best result has been obtained in the case of using a pink color spacer (4.2mm) with 70 degrees back and 65 front degree front top rollers.

Keywords: Spacer size; Shore hardness; Ring frame; Yarn quality

Introduction

Spinning is a part of the textile manufacturing process where the fibers are converted into yarn by passing through certain processes like Blow room, Carding, Drawing, Roving, Ring Frame, and finally winding into yarns. In the blow room, the raw material will be open and clean the impurities on the surface by bland of mat machine and passes into carding machine in the form of the chute. Carding is the heart of the spinning process. This is where the flock from bales was open into an individual fiber. Thus, it is ease to remove the excess impurities from the fiber surface. At this point, short fiber will be eliminated and form a carded sliver. The carded sliver is fed into breaker draw frame and finisher draw frame to parallelized, straitening, to improve yarn irregularity by doubling, drafting, and drawing. Ring spinning is one of the most common effective spinning techniques in yarn manufacturing process. It provides excellent yarn properties compared to other spinning systems. However, it is limited by relatively low traveler speed, high balloon tension, low spindle speed, and high spinning triangle size. These limitations are responsible for lower production rates than the rotor, air-jet, and friction spinning systems. Despite low production, ring spinning provides a yarn structure that yields excellent mechanical properties. Yarn quality is the main goal of the company to achieve the expected aim. But there are some parameters that affect yarn quality. These are yarn unevenness, total imperfection (nep, thin and thick place), and coefficient of mass variation. The distance between the lower edge of the top cradle and bottom apron nose bar determines the distance between the bottom and top apron. This in turn determines the intensity of pressure applied to the fibers to under control. This distance which is introduced by means of a special device is called a spinning spacer. The purpose of the introduction of apron drafting is to have adequate short fiber control during the drafting process. These short fibers are to be carried with full control along with the surface speed of the second roller as close as possible to the nip and pass forward. Until the fiber is gripped at the front nip, it is expected to be under the full control of the apron during its forward movement. Thus a positive apron control is governed by shore hardness. Any deviation of the apron control from the optimum values will lead to a distorted drafting process; were revolving in the proper selection of shore hardness, is also detrimental to yarn. The operation of the ring-spinning system can be divided into drafting, twisting, and winding steps. The drafting step plays an important role in the quality of yarn. Various studies were conducted regarding the drafting parameters of spinning systems to improve the yarn quality. In the ring frame drafting system, the spacer is the element that decides the distance between the top apron and the bottom apron at which the short fibers are mainly to be controlled.

Literature Review

The drafting parameters of ring spinning that affect the quality of yarn are drafting angle, drafting roller setting (front and back zone gauge), top rubber-coated roller hardness, cradle length, top roller pressure, aprons hardness, and spacer size. Each mentioned parameter contributes to the quality of spun yarn. The quality of the yarn is measured in terms of yarn evenness, yarn imperfections (thick, thin, and nep) [1]. According to Bhaveshkumar K et al., in their research, study the effect of spacer size on the yarn quality due to the apron slippage. The distance between the top and bottom apron is

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Table 1: Cotton fiber property.

Fiber property	Micronaire	Stable (mm) 50%	Short fiber (%)	Trash content	Color	Sticky point
Aver	4.56	28.95	25	6.89	Light spotted	36.35

Table 2: Description of spacer size and degree of shore hardness used in the study.

Spacer color	Spacer size	Shore hardness
White	4.5mm	70b & 62f
Pink	4.2mm	70b & 62f
White	4.5mm	70b & 65f
Pink	4.2mm	70b & 65f

larger than the optimum value the yarn U%, neps, thick place increases due to the ineffective short fiber control and if it is too less than also U% and thin place are higher due to higher percentage of long fiber damage. The ring frame spacer size is to be decided according to the yarn count to be spun because the yarn count decides the bulk of fibers material present in between the two aprons during drafting. There are two types of apron yarn guidance, which are a single apron and a double apron. Double aprons are the most effective for yarn guidance [2]. Drafting roller and apron has greater importance in determining process efficiency and yarn quality. The influence of the top roller cots material on the final yarn quality has been established as this direct content with the fibers. Many researchers have studied this important subject. Broome investigated the influence of the cots material on the yarn prosperities and concluded that among the properties surveyed, the coating hardness had the greater effect on yarn evenness and coat usually soft rubber [3]. There have been many studies conducted regard to the assessment of machinery parts attached to the results of the spinning process. But as it seems, and the writer's observation until now, there has not been a clear standard for rubber rollers above conditions (top roller) in ring spinning. In the same cases there is a standard rubber cot diameter, but this condition for special fiber processing only [4]. Starting from this fact, the writer ventured to try to conduct a study of the relationship between the quality and condition of the rubber roller on the results of unevenness (U%) yarn, thick, thin place, and nep. The flatness of a rubber roller in drafting system affects the quality of its yarns. Rubber rollers are any obvious defects that will result in conditions that are less yarn perfectly. In the event of the stretch, then for rubber rollers that are too loud or too soft, it will generate the conditions position the fibers in the yarn is uneven. Roller rubber hardness degrees is too low to process a particular fiber material, can produce floating fibers, and this happens because the stretch is not perfect (slip fibers). Looking for rubber rollers condition that the degree of hardness is too high (hard) can result in broken fibers, as if stretching occurs when the force's exerted [5,6].

Materials and Methods

Material

1. 100% Cotton was used to produce 35.5 Nm ring spun yarn. The cotton was tested under standard atmospheric conditions (20±2°C and 65% RH) (Table 1).

Equipments

The following machines are used to measures the above Cotton properties:

- Stingy (Cotton thermo detector) - sticky point detector,
- Trash analyzer-to determine trash content,
- Wire-to sea Micron ire value,
- Uster tester -to test, count, thin place, thick place and
- Spector dolt meter-test cotton color.

2. Carded sliver count 0.17Nm and roving count 1.1Nm.

3. Ring frame machine Shala forest Zinsser model 351.

4. Spacer and front top roller.

Experimental methods

In order to do this project, we followed different tests in the physical laboratory by changing process parameters (top front drafting roller shore hardness and spacer type for the same count of yarn). Measurements of yarn irregularity, coefficient of mass variation, and total imperfection point on 35.5Nm ring-spun yarn were conducted in order to assess the quality of yarn using experimental work. The samples were coded as the sample one sample 2 sample 3 and sample 4 based on the spacer and shore hardness combination as follows; sample one 1 by changing the spacer size 4.5mm with 70-degree shore hardness back and 62-degree shore hardness front top roller

Table 3: Uster 50% standard of carded ring spun yarn parameter 2013.

Count	U%	CVM	Nep +200%/km	Thick +50%/km	Thin -50%/km	TIPI
35.5Nm	12.16	15.2	162	120	7	289

Table 4: Experiment result of sample one conduct by using white (4.5mm) spacer with 70-degree shore hardness back and 62 degree of shore hardness front roller.

Number	U%	Cvm	Neps +200%/km	Thick +50%/km	Thin -50%/km	TIPI
1	14.36	18.25	190	498	102	790
2	12.27	15.61	164	253	6	423
3	13.72	17.42	221	403	58	682
4	13.02	16.68	180	373	14	547
5	13.52	17.22	193	447	25	665
Mean	13.38	17.02	189.6	394.8	41	625.4

sample 2 by changing the spacer size 4.2mm with 70-degree shore hardness back and 62-degree shore hardness front top roller, sample 3 by changing white spacer with 70-degree shore hardness back and 65-degree shore hardness front top roller and sample 4 by changing pink spacer with 70-degree shore hardness back and 65-degree shore hardness front top roller (Table 2).

Result and Discussion

As the experiment shown above, five samples (ring spinning cops) were tested and the mean value was calculated. This test is the primary evaluation of yarn unevenness, thin, thick place, nep and coefficient mass variation by changing spacer size and front top drafting roller. The above table has shown the variation of yarn unevenness (U%), coefficient of mass variation (Cvm%), thin, thick place, and nep on uster-tester results. These yarn faults are above the standard value. To improve those yarn quality parameters, we were used a different combination of spacer size and degree of shore hardness as shown in the tables above the data presented. So we tested the quality of yarn by using (4.5 and 4.2 mm) spacer size with 70 degrees of shore hardness back and 62 degrees of shore hardness front top roller and (4.5 and 4.2 mm) spacer size with 70 degrees of shore hardness back and 65 degrees of shore hardness front top roller (Table 3-9).

Comparison of experimental result with USTER standard in case of yarn unevenness: The effect of spacer size and degree of shore hardness on the yarn unevenness is plotted in (Figure 1). The spacer of 4.2mm with 62 degrees of shore hardness gives the best even yarn with a low u% of 35.5Nm. In the case of smaller spacer sizes there is better control of short fibers. Evenness is improved by closing down the apron spacing.

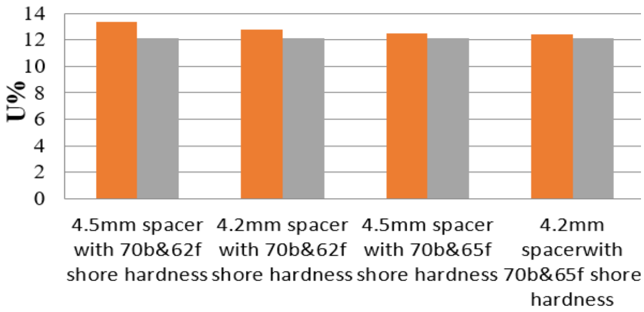

Figure 1: Effect of 4.5 & 4.2 mm spacer size with 62 & 65 degree of shore hardness front top roller on yarn unevenness.

Comparison of experimental result with USTER standard in case of yarn CVM: The effect of spacer size and degree of shore hardness on yarn coefficient is plotted in (Figure 2). The best result was obtained in the case of 4.2mm with 62 degrees of shore hardness. This is due to lower shore hardness higher will be contact area with

Table 5: Experiment result of Sample two conducted by using white (4.2mm) spacer with 70-degree shore hardness back and 62 degree of shore hardness front top roller.

Number	U%	Cvm	Neps +200%/km	Thick +50%/km	Thin -50%/km	TIPI
1	11.97	15.22	158	210	7	375
2	12.95	16.47	174	302	7	483
3	13.4	17	204	323	36	563
4	11.9	15.1	133	221	6	360
5	13.73	17.46	198	469	52	719
Mean	12.79	16.26	173.4	305	21.6	505.4

Table 6: Experiment result of sample three conducted by using white (4.5mm) spacer with 70-degree shore hardness back and 65 degree of shore hardness front top roller.

Number	U%	Cvm	Neps +200%/km	Thick +50%/km	Thin -50%/km	Tipi
1	12.46	15.86	155	278	12	445
2	12.56	15.99	166	297	14	477
3	12.39	15.76	189	264	14	467
4	13.02	16.6	161	331	27	519
5	12.2	15.5	155	176	15	346
Mean	12.53	15.94	165.2	269.2	16.4	450.8

Table 7: Experiment result of sample four conducted by using pink (4.2mm) spacer with 70-degree shore hardness back and 65 degree of shore hardness front top roller.

Number	U%	Cvm	Neps +200%/km	Thick +50%/km	Thin -50%/km	Tipi
1	12.24	15.58	185	251	9	457
2	12.96	16.56	201	296	21	518
3	12.31	15.65	162	196	13	371
4	12.19	15.52	170	255	7	432
5	12.38	15.74	181	224	12	417
Mean	12.42	15.81	179.8	244.4	12.4	436.6

Table 8: Summarized Mean value for yarn quality parameters for each samples.

Parameters	Sample 1	Sample 2	Sample 3	Sample 4
U%	13.38	12.79	12.53	12.42
CVM	17.02	16.26	15.94	15.81
Nep	189.6	173.4	165.2	179.8
Thick	394.8	305	269.2	244.4
Thin	41	21.6	16.4	12.4
TIPI	625.4	505.4	450.8	436.6

Table 9: Summary of percentage improvement in yarn parameters.

Spacer color	Spacer size	Shore hardness	U%	CVM%	TIPI%
White	4.5mm	70b & 62f	3.95	4.22	32.62
Pink	4.2mm	70b & 62f	8.2	8.5	38.27
White	4.5mm	70b & 65f	10	10.3	44.9
Pink	4.2mm	70b & 65f	10.84	11	46.7

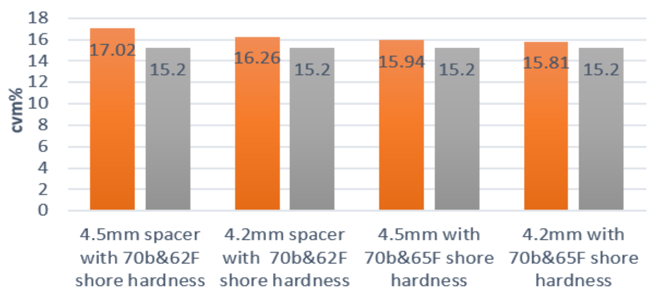

Figure 2: Effect of 4.5 & 4.2 mm spacer size with 62 & 65 degree of shore hardness front top roller on yarn coefficient.

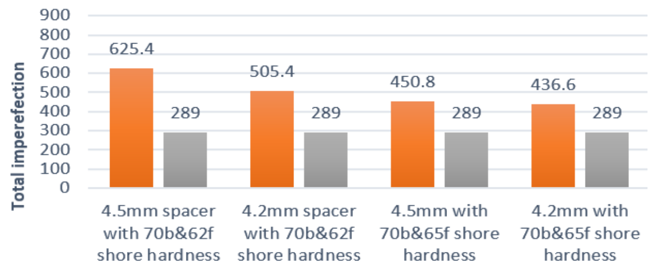

Figure 3: The effect of 4.5 & 4.2 mm spacer size combination with 62 & 65 degree of shore hardness front top roller.

steel bottom roller better so there will be positive control on fiber's strand producing the yarn with better mass uniformity.

Comparison of experimental result with USTER standard in case of yarn imperfection: The effect of spacer and degree of shore hardness on yarn total imperfection is plotted in (Figure 3). On the combination of 4.2mm spacer size with 62 degrees of shore hardness lesser imperfection level could be recorded. This is due to at a lower shore hardness higher will be contact area with steel bottom roller and closing down apron spacing a better control of short fibers.

Conclusion

As the experiment has been done, the quality of the yarn is improved by changing the spacer size and the degree of shore hardness of the top roller. In general, it is found that increasing the spacer size decreases the yarn quality parameters on 35.5Nm spun yarn. Instead of increasing the spacer size break draft is slightly increased. From the test carried out on the carded yarn 35.5Nm, it is found that the spacer size 4.2mm with 70 degrees and 65 degrees of shore hardness is found to have more impact on yarn quality parameters. So it is concluded that the best result has been obtained in the case of using a pink color spacer (4.2mm) with 70 degrees back and 65-degree front top roller. This is happen due to the perfect distance between the top apron and bottom apron in draft setting which causes more suitable pressure on the fiber strand at the front drafting zone. As a result, there is better control of fiber in this drafting arrangement zone and as a result the quality of the yarn being produced were highly improved. So for 35.5Nm 4.2mm spacer size with 70 degrees of shore hardness back and 65 degree of shore hardness is better in order to get better yarn quality. It is found that minimum spinning spacer with a medium degree of shore hardness will give relatively good yarn quality.

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