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Research Article

Impact of Front and Back Roller Shore Hardness on The Quality of Cotton Carded Yarn in Ring Spinning Frame

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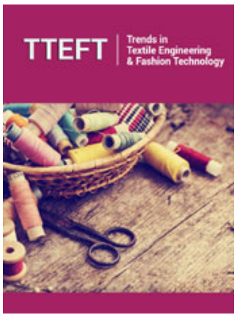

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Abstract

Roller hardness of drafting unit in ring spinning frame is very important for controlling the draft and quality of yarn. This research work deals with the impact of cot roller shore hardness on the quality of cotton carded yarn. The five samples were prepared by using the combination of three different cot roller shore hardness (65^0, 75^0 and 83^0) in ring frame. At first, yarn samples of 30Ne were produced by varying front roller cot hardness with constant back roller hardness. Secondly, yarn samples of 30Ne were produced by varying back roller cot hardness with constant front roller hardness. The test results of the samples were carried out. The trends of the obtained results were analyzed. The results showed that softer cots at front line significantly reduced mass variation and hairiness of yarn. On the other hand, harder cots at back line significantly reduced mass variation, imperfection level as well as yarn strength. Among these combinations, 65^0 at front line and 83^0 at back line were better for producing good quality yarn. This study will help the spinners of Bangladesh to select the appropriate cot roller with optimum shore hardness of front and back line at the drafting system in a ring spinning frame to get the required quality of the cotton carded yarn.

Keywords: Cot roller; Shore hardness; Durometer; Count Strength Product (CSP); Reiss kilometer (Rkm)

Introduction

Ring spinning technique has greatly influenced on the quality of yarn. There are some parameters which are greatly affected the quality of ring spun carded yarn such as drafting system, roller gauge, ring traveler, ring cup diameter, spindle speed, and material throughput rate etc. Drafting is the most important and fundamental operation in spinning, and it gives a very important effect to the yarn quality [1]. Drafting components have a significant influence on yarn quality and production costs in ring spinning (Especially spinning top roller covers i.e., cots and drafting aprons) [2]. These are the main components of the drafting mechanism and certainly it has more influence on the quality of the yarn produced Cots are used in draw frame, comber, speed frame and ring frame, whereas aprons are used only in speed frame and ring. The purpose of cots is to provide uniform pressure on the fibre strand to facilitate efficient drafting and use of aprons help to have better grip and control on fibres particularly floating fibres [3].The degree of the shore hardness is a main property of the top roller cot. Shore hardness is one of the main properties of top roller cot and varies for different types of fibre, application etc. Hardness may be defined as the resistance to indention under conditions that do not puncture the rubber. It is called elastic modulus of rubber compound [4]. Shore hardness of cot roller to provide uniform pressure on the fibre strand. This facilitates efficient drafting with the assistance of aprons, which results in a better grip and control of the fibers, particularly floating fibers which is advantageous for producing good quality yarn with minimum imperfection level [5]. Generally, Shore hardness of a rubber cot is measured by an instrument called 'Durometer' and the value is expressed in A scale. Cots are available in wide shore hardness ranging from 63° to 90° shore. A mathematical scale is used to convert the displacement data into hardness values within a range between 0 and 100 [6,7].

Now days, yarn quality is a prerequisite condition to the economic success of spinning sector. International competition and market requirements dictate the necessity to produce quality yarns at an acceptable price. There numerous attempts are taken to maintain the consistent quality level of yarn, including process modification, process control techniques and spinning parameters [8]. Among these, spinning parameters such as drafting systems specially spinning top roller shore hardness has great impact on the cotton yarn properties such as mass variation, imperfection level, CSP, Rkm and hairiness etc. Optimum shore hardness at front and back roller of drafting system not only provides good quality yarn but also its necessary for maintaining consistence quality level. It varies within different types of fibers and applications [9]. Although many studies have been conducted on cot roller hardness, but the investigation of combine variation of front and back roller shore hardness for finer count of 100% cotton fibre is still needed. Therefore, in this research work, it was observed that the variation of front and back roller cot shore hardness how much impact on the quality of ring spun carded cotton yarn and also tried to find out which combinations were better for producing good quality yarn.

Materials & Methods

Cameroon cotton fibre was selected as raw materials. The properties of fibre were given below Table 1.

Table 1: Fibre properties.

Parameters	Value
Fineness (Mic)	4.37
Maturity Ratio (Mat)	0.87
Upper Half Mean Length (UHML)	28.39mm
Uniformity Index (UI)	82.90%
Short Fiber (SFI)	8.90%
Bundle Strength (Str)	32.5gm/tex
Elongation (Elg)	4.90%

Table 2: Technical parameters.

Names	Parameters
Spindle speed	12000 rpm
Ring diameter	40mm
Pressure arm	18kg
Traveler No.	5/0
Cot roller hardness	65°,75°,83°

Table 3: Samples matrix.

Samples No	Parameters (F= Front roller & B= Back roller Hardness)
A	F-65°/B-65°
B	F-75°/B-65°
C	F-83°/B-65°
D	F-65°/B-75°
E	F-65°/B-83°

Working Procedure

1. The five samples were prepared by using the combination of three different cot roller shore hardness in ring frame (Rieter, G5/1). The process of sample preparation is given below with their respective things: Sample A was prepared by remaining same cot roller shore hardness at front- and back-line drafting zone of ring frame. Sample B (F-75°/B-65°) and Sample C (F-83°/B-65°) were produced by varying front roller shore hardness with constant back roller shore hardness whereas Sample D (F- 65°/B-75°) and Sample E (F-65°/B-83°) were prepared by varying back roller cot hardness with constant front roller cot hardness which was mention in the above Table 3. During these times of sample preparation, roller pressure (18kg) and the other parameters of ring frame machine were remained constant. During testing, the standard temperature (20±2 °C) and RH% (65±2%) were maintained in the testing lab.

2. Necessary tests were carried out for sample A, B, C, D and E respectively by using Uster Evenness Tester- 5, Wrap reel, Uster auto sorter 5 and Lea strength tester.

3. The test results were analyzed to observe the effect cot roller shore hardness of on the quality of produced yarn.

Results and Discussion

Impact of different roller hardness on mass variation (CV_m%) of yarn

Figure 1 (Graph-1) represents the mass variation of yarn against the variation of front roller and back roller cot hardness with remaining constant back roller hardness. From this bar chart it can be concluded that mass variation also increased with increasing front roller cot hardness. Yarn obtained from sample A (F-65⁰/B-65⁰) showed lower mass variation than sample B (F-75⁰/B-65⁰) and sample-C (F- 83⁰/B-65⁰). In case of sample-A, softer cots (F-65⁰) in front line gives additional guidance because only few fibers remain in the strand and these exhibits a tendency to slide apart. And it reduces the possibility of fiber breakage. As a result, it reduces the mass variation of the yarn. On the other hand, Figure 1 (Graph-2) indicates the mass variation of yarn against the variation of back roller cot hardness with remaining constant front roller hardness. From this graph, it can be explained the mass, variation decreased with increasing back roller cot hardness. Yarn obtained from sample-E (F-65⁰/B-83⁰) showed lower mass variation than sample-A (F-65⁰/B-65⁰). Harder cots at back line is suitable because it provides better gripping and also decrease the chance of producing floating fibres in the drafting zone that leads to reduce the mass variation of yarn.

Impact of different roller hardness on the IPI of yarn

Figure 2 (Graph-1) represents the IPI of yarns against the variation of front roller cot hardness with remaining constant back roller hardness. From this bar chart it can be concluded that IPI also increased with increasing front roller cot hardness. This indicate that softer cots in the front zone produce a lower imperfections level of yarn. Softer cots at front line attribute to the decrease in the uncontrolled length between the aprons and the nipping point of the front roller. This led to a more controlled flow of fibres [10]. In case of Figure-2 (Graph-2); it indicates the imperfections level decreased with increasing back roller cot hardness. Harder cots at back line improved the imperfection level of yarn because better gripping at back line decrease the possibility of producing drafting waves in drafting zone.

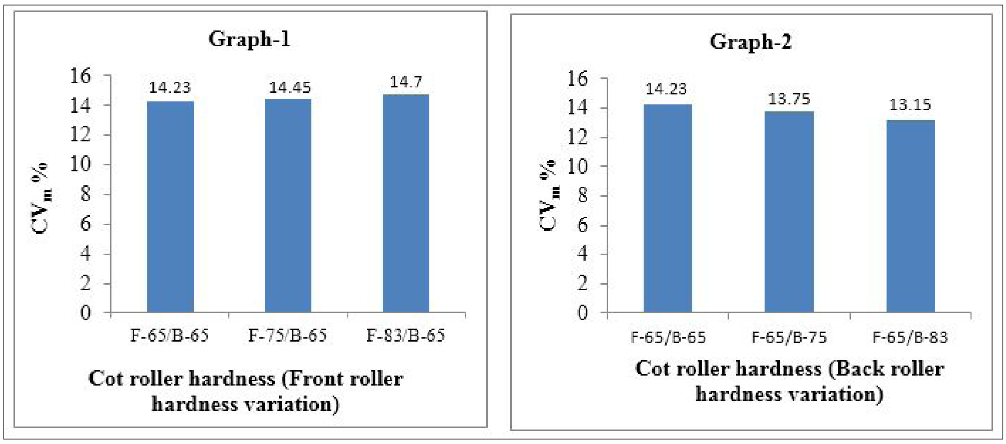

Figure 1: Impact of different roller hardness on the mass variation of yarn.

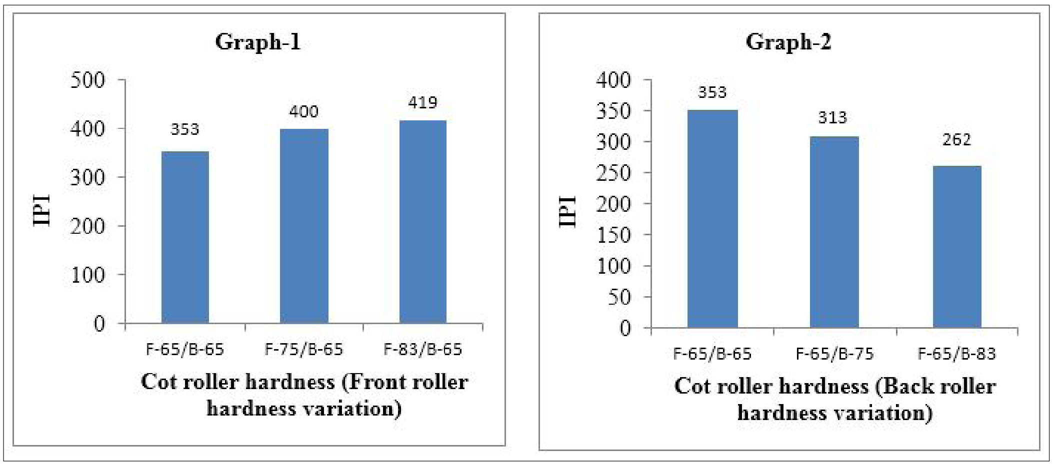

Figure 2: Impact of different roller hardness on imperfection index (IPI) of yarn

Impact of different roller hardness on the count strength product (CSP) of yarn

Figure-3 (Graph-1) represents the CSP of yarn against the variation of front roller cot hardness with remaining constant back roller hardness. From this bar chart it can be concluded that CSP also decreased with increasing front roller cot hardness. Harder cots at front increased imperfection level as a result; it produced more weak places in yarn. It creates disturbance in the twist insertion. Due to reason; it showed lower CSP. In case of figure-3 (Graph-2); it indicates the CSP increased with increasing back roller cot hardness. At back line with the harder cots produced lower imperfections of yarn resulting in it increased the strength of the yarn.

Impact of different roller hardness on the RKm Value of yarns

RKm stands for Reiss kilometer in German and Resistance Kilometrique in French. It is also known as 'free breaking length' or 'self-support length.' This is the theoretical length of a fiber, yarn or rope at which it breaks under its own weight when hanging freely in a vertical direction [11].Figure-4 (Graph-1) represents the RKm of yarn against the variation of front roller cot hardness with remaining constant back roller hardness. It can be concluded that RKm decreased with increasing front roller cot hardness. Harder cots at front line increase the possibility of fibre breakage. It increases the floating fibres in the spinning triangle that contributes to the imperfection level of yarn. In case of figure-4(Graph-2) it shows the RKm also increased with increasing back roller cot hardness with remaining constant front roller cot hardness. Sample-E showed higher Rkm value than sample-A because it produced by using cot roller shore hardness (F-65^0/B-83^0) at front and back line. Softer cots at font line and harder cots at back line reduce the imperfection level of yarn which shows better than other samples.

Impact of different roller hardness on the hairiness of yarn

In figure-5 (Graph-1) shows the Hairiness of yarn against the variation of front roller cot hardness with remaining constant back roller hardness. It can be explained that hairiness was also increased with increasing front roller cot hardness. Soft coverings at front line shift the nipping point of front rubbers rollers slightly forward, due to the increased of cross-sectional area. It reduces the spinning triangle, which causes the twist to be inserted in a better way. Better twist insertion reduces the hairiness of yarn. On the other hand, harder cots increased the fibre breakage which caused the higher value of hairiness. Figure-5 (Graph-2) it indicates the hairiness decreased with increasing back roller cot hardness. At back line with the harder cots, there is less chance of lap formation and breakage. The selvedge fibers almost fully integrate into the yarn thus resulting less hairiness in yarn [5].

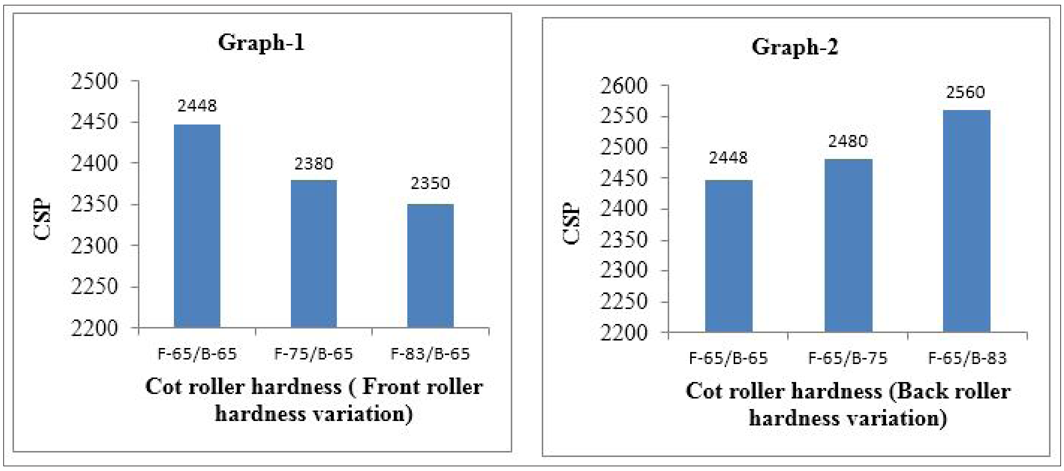

Figure 3: Impact of different roller hardness on CSP of yarn

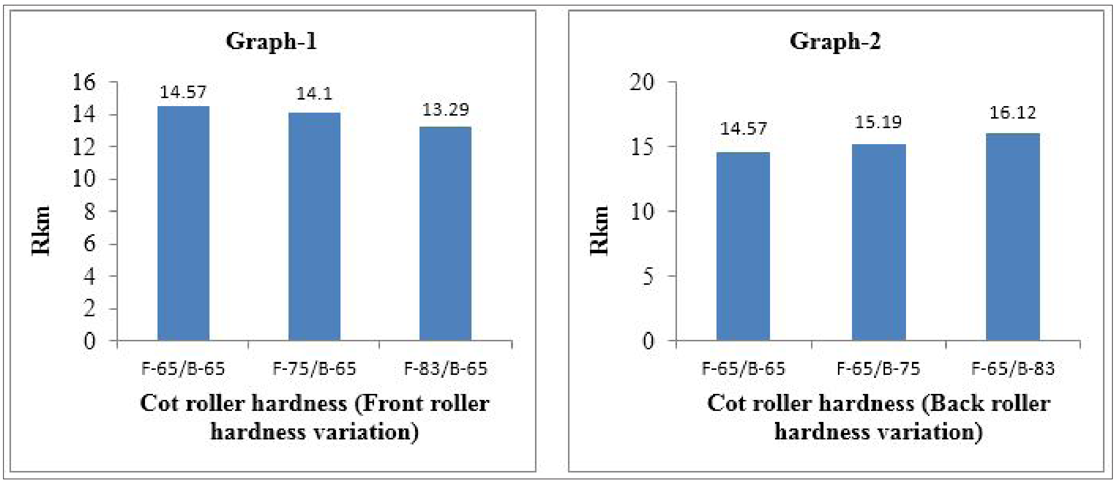

Figure 4: Impact of different roller hardness on Rkm of yarn

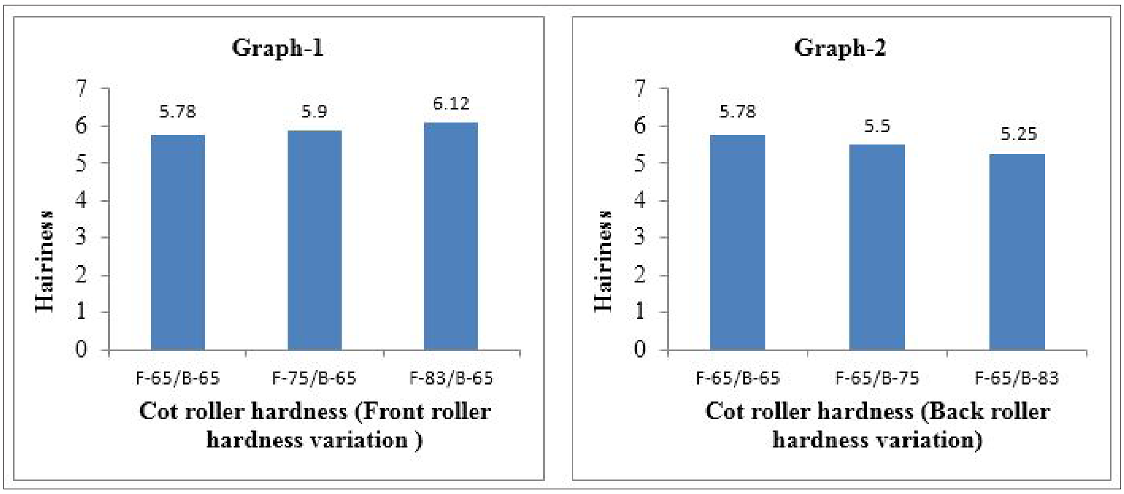

Figure 5: Impact of different roller hardness on Hairiness of yarn

Conclusion

By conducting this research work it can be concluded that softer cots at front line and hand, harder cots at back line of drafting zone influenced the mass variation, imperfections level, CSP and Rkm of the yarn. With the increment of shore hardness at front line, mass variation and hairiness of yarn also increased. On the other hand, with the decreasing of shore hardness at back line, imperfection level also decreased. Harder cots at back line gives lower imperfection level of yarn. Among these five combinations of cot roller shore hardness, front roller-65^0 and back roller 83^0 shore hardness showed better performance for producing good quality yarn with minimum irregularities and imperfections level.

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