A Study on Properties of Modified Rotor Spun Yarn

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ABSTRACT

Fibers due to their large length-diameter ratio are the most effective materials in supporting tensile loads still. Many textile applications do introduce fiber compressions either in a simple form or under complex loading conditions. The majority of these compressive loadings are directed laterally across the fiber axis like compression of fibrous assembly during draftee. Compression occurring to fabric during calendaring and embossing treatments etc. A special pre-compression apparatus was fabricated and mounted before the entry of fibrous strand into opening roller of rotor spinning frame. Cotton Slivers were pre-compressed in this zone at varying loads and the effect of this pre-compression on the resultant yarn has been studied. The yarn properties considered for the study are the studies are U%, tenacity, elongation, hairiness and imperfections. The drawback with rotor spun yarns is lower tenacity and elongation which always need an improvement. Modified rotor spun yarns obtained as a result of pre-compression of slivers shows lesser U %, reduced thin, dick and naps, lower hairiness values and mainly improved tenacity, elongation and work of rupture which would be a vital point for the industry.

Keywords: Fiber, Neps, Tenacity, Spun Yarn

I. INTRODUCTION

Compressional properties of textile materials are important in some technological applications. The compressional properties of textile materials have direct relevance to bulk, handle of fiber masses, and structure of yarns and handle of fabrics. The compressional forces play an important role in the breakdown of pile fiber in the carpets. During drafting, fibers are compressed between a pair of rollers moving at a certain velocity and under a certain pressure. The fibers are compressed t higher twist factors in yarn. In knitting operation, the yarns are compressed to make them in the form of loop. The lateral compression property of yarn influences the material properties of fabrics to large extent. In weaving, the warp and weft yarns are compressed. The high performance fibers used in technical textiles like parachute fabrics, bullet proof vest etc., are also subjected to compressive forces during applications.

Thus in all stages of textile manufacture and also during applications, the textile materials are subjected to compressive stresses and strains. In the above context, it becomes crucial to study the compression properties of fibers, fiber assemblies, yarns and fabrics and the parameters used for representing them. In this work, an attempt has been made to design and fabricate a crushing apparatus to laterally compress the slivers before their entry into opening roller of rotor spinning frame. The modified rotor spun yarns thus produced were then studied for tensile properties, evenness, and hairiness. The results highlight the improvements in above tested parameters with increase in pre compression loads.

Objectives

➢ To design and fabricate a pre-compression set up to compress the slivers prior to their entry into rotor spinning system.
➢ To produce rotor spun yarns from pre-compressed slivers (henceforth referred to as Modified Rotor Spun Yarns).
➢ To study the yarn properties like tenacity, elongation, hairiness, U%, thin, thick and neps obtained from slivers pre-compressed with four different loads.

Chapter II
2.1 Material and Methods

The slivers are introduced in rotor spinning frame mounted with the pre-compression zone. Three different pre-compression loads were applied on the sliver samples before their entry into the feed roll of rotor frame. The complete processing parameters for cotton are shown in below. The yarn produced from these pre-compressed slivers were subjected to different testing methods to get the yarn quality results such as evenness%, thin and thick faults, hairiness , single yarn tenacity and elongation. Various yarn testing instruments used are Uster tester 4, uster Tensojetansd Zweigle hairiness tester.

Cotton Fiber		
Mixing Details	Pneumafil waste	25%
	Mech II Grade	10%
	Cotton: Comber	40%
	Noil	25%
	Flat Strips	
Stable Length		20mm
Fineness		4.5

Table 1: Raw Material Parameters

2.2 Determination of Raw Material Parameters
2.2.1 Length

The fiber length is measured by using the Baer sorter technique.

2.2.2 Fineness

Microaire values are also measured by using airflow principle. Fiber fineness influences both the strength and irregularity of yarns. The micronaire measurement employs the theory of flow of air through a porous medium. When air under constant pressure is allowed to pass through fixed mass of fiber compressed in a cylinder of fixed dimensions, the rate of flow air is found to depend on the resistances offered by fibrous plug. Cotton fibers of around 10gms are weighted, the fibers are inserted into the testing chamber and the cover is pressed. The micronaire value is noted manually.

2.3 Process Flow Chart

To study the effect of sliver pre-compression on properties of rotor spun yarn, the sliver was passed through a pre-compression unit before its entry into opening roller rotor spinning frame.
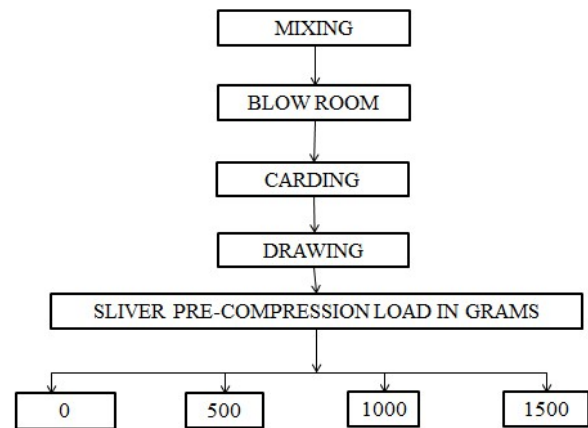

Figure 1: Process Flow chart for Modified Rotor Spun Production System

2.3 Process Parameters
2.3.1 Blow Room
- Lap feed used in line: MBO, Step cleaner, PO, Condenser, Three Bladed Beater, Kirschner Beater.
- Feed roller Beater setting = 8mm
- Grid Bar setting = Minimum
- Beater Speed = 750rpm

2.3.2 Draw Frame
- Model = LR DO/6
- Speed = 240rpm
- Fluted Roller Setting = 38/38 mm
- Total Draft = 6.5
- Break draft = 1.3
- No.of Doublings = 6
- Creel Tension Draft = 1.02
- Web Tension Draft = 1.02
- Delivery Hank = 0.13

2.3.3 Carding
- Model = LR C1/2
- Cylinder Speed = 350rpm
- Licker in Speed = 750rpm
- Flats Speed = 4inches/min
- Doffer Speed = 25 rpm
- Feed plate to Licker in = 25mm
- Flats Setting = 0.2/0.2/0.2
- Delivery Hank = 0.12

2.3.4 Rotor Frame
- Model =ElitexBD200SNSN
- Opening Roller speed = 8000rpm
- Rotor Speed = 60000rpm
- TM/TPI = 4.8/21
- Wire Type = OK 40
- Count = 20s Ne
- Total Draft = 154
- Rotor diameter = 43mm
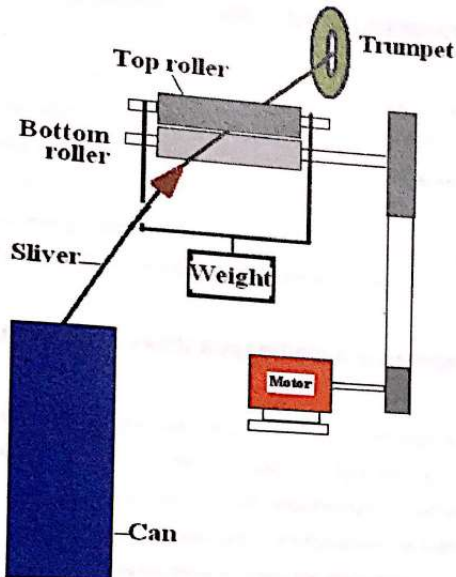
2.4 Description of Sliver Compression Apparatus

Figure 2: Schematic Diagram of Sliver Compression Apparatus

The sliver compression apparatus comprises of the following parts,

➢ AC gear motor,25HP,14Rpm
➢ Bottom roller diameter 27mm,3 inches width , Axially Fluted
➢ Synthetic covered top roller diameter 28mm, 3 inches width
➢ Motor pulley diameter 2inches
➢ Driven Pulley diameter 11.5 inches
➢ Weigh pan carry dead weights

The bottom fluted roller is driven by the motor via the motor and driven pulleys through belt drive. Parameters like motor type, speed, driver and driven pulley diameter were carefully chosen as to keep the surface speed of bottom fluted roller at around 8inchesxper minute, which is the normal rate at which the sliver is being fed in this rotor machine.

The apparatus mounted along the path of the sliver. Attention was given so as not to stretch the sliver by any means. The sliver is loaded by applying dead weight pan which is hooked to the top roller. Loads can be changed by directly changing the weight on the weight pan. The top roller is negatively driven due to the frictional contact with the bottom roller.

Figure 3: Sliver Compression Apparatus

2.5 Testing Procedure for Measurement of Yarn Properties

The yam produced from parent and pre-compressed roving's tested under standard testing atmosphere after conditioning as per ASTM standards. Uster tester 4 is used to test the unevenness and imperfections of the yarn. UsterTensojet 4 is used to test the single yarn tenacity and elongation. Zweigle hairiness tester is used to test the protruding hair count distribution of the yarn. The conditioning of samples in standard atmosphere has been maintained throughout the study.

2.6 Determination of Yarn Evenness and Imperfections by UT4

The yarn delivered from the rotor frame is passed through the measuring slot of evenness tester which works on the principle of capacitance. Finally the results arrived from the tester are unevenness% and imperfections. Generally thin (-50%), thick (+50%) and neps(+200%) are taken into consideration for rotor spun yarn. The testing speed is for 400mpm and testing time is 1 min for each test.

2.7 Determination of Yarn Hairiness by Zwigle Tester

The condition yarn under standard testing atmosphere is then passed through the Zwigle hairiness tester which works on the optical principle. The image of the protruding fibers from the surface of the yarn are captured and sensed by array of detectors. Then it is accounted in a corresponding segment to get the values with the range of 1 to 12mm. Generally S3 value (total number of protruding hairs above 3mm length) is taken into consideration for hairiness measurement.

2.8 Determination of Single Yarn Tenacity and Elongation

The conditioned yarn under standard testing atmosphere is then passed through two pairs of disc rotating in counter clockwise direction against each other. Here the principle involved is constant rate of elongation. Gauge length of 5oo mm and testing speed of 400mpm is maintained. Tenacity is cN/tex and elongation in % is obtained.

III. Results and Discussion

The results obtained for the modified rotor yarn which has shown improvement in many aspects with respect to increase in the pre compression loads.

3.1 Influence of Sliver Pre Compression on Evenness

Sliver Hank	Mean U% of Sliver I Passage	Mean U% of Sliver II Passage	Improvement in U%
0.13	6.6	6.5	1.5

Table 1: Mass Irregularity of Cotton Sliver Measured on UT4

3.2 Modified Rotor Yarn Evenness

Sliver hank	Pre- Compression Load (g)	Yarn U%	DR 1.5m
0.13	0	13.6	66.12
	500	13.01	54.93
	1000	13.15	56.84
	1500	12.57	55.72

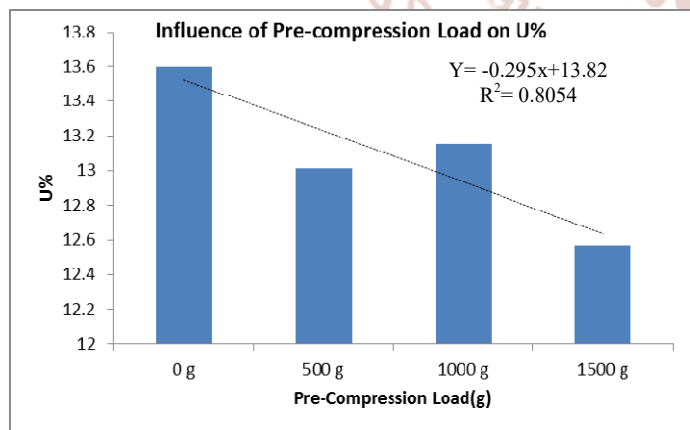Table 2: Effect of Pre-Compression Load on Yarn Evenness

Figure 4: Effect of Pre- Compression Load on Yarn U% in Cotton
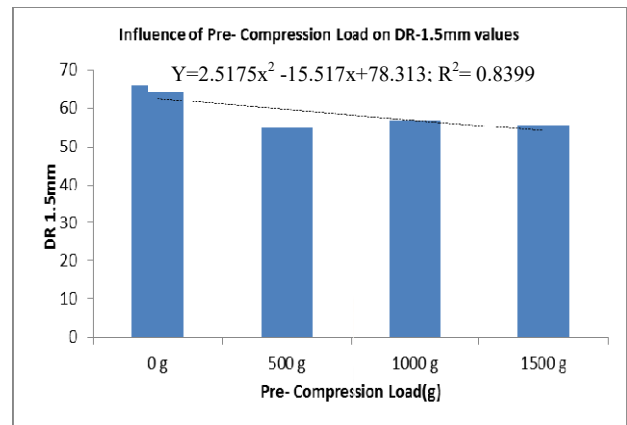

Figure 5: Effect of Pre-Compression Load on Yarn DR-1.5m in Cotton

3.3 Modified rotor Yarn Thin, Thick and Neps

Sliver Hank	Pre-Compression Load (g)	Thin(-50%) per KM	Thick (+50%) per KM	Neps (+280%) per Km
0.13	0	38	150	125
	500	25	173	105
	1000	20	105	63
	1500	28	65	53

Table 3: Effect of Pre-Compression Load on Yarn Thin Places
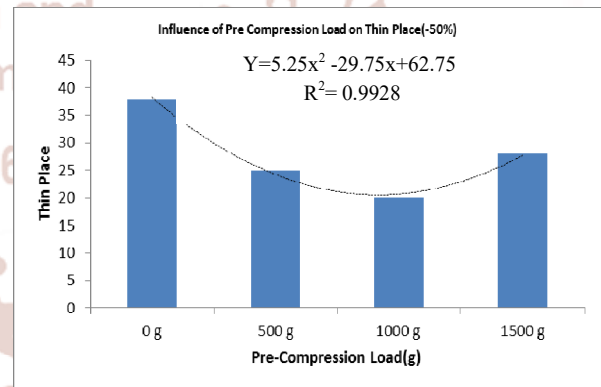

Figure 6: Effect of Pre-Compression Load on Yarn Thin Places
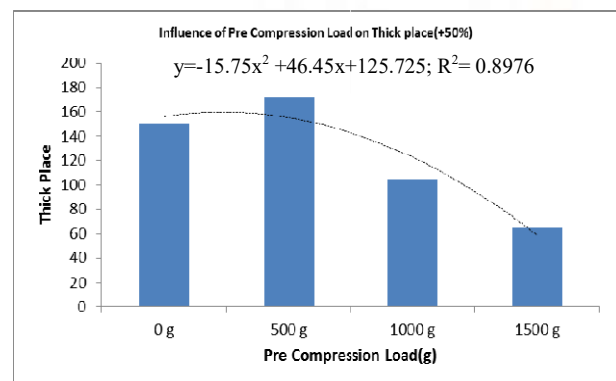

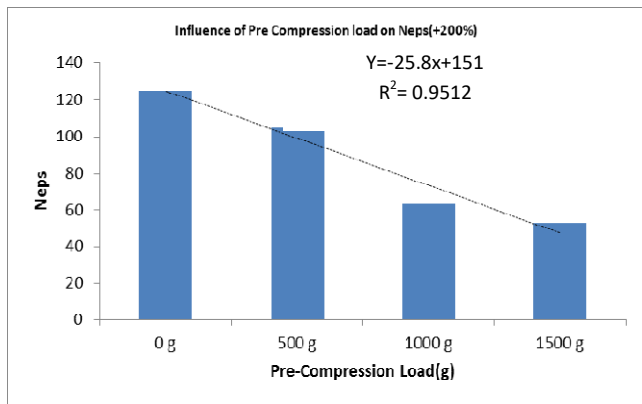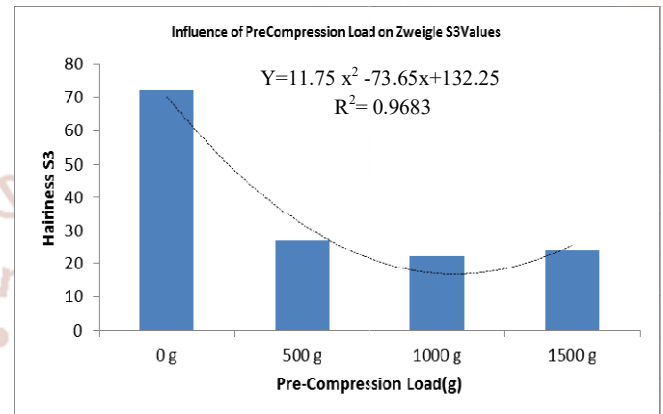Figure 7: Effect of Pre-compression Load on Yarn Thick Places

Figure 8: Effect of Pre-compression Load on Neps

3.4 Modified Rotor Yarn Tenacity, Elongation and Work of Rupture

Sliver Hank	Pre-Compression Load (g)	Single yarn tenacity in g/tex	Single yarn elongation %	Work Rupture gf cm
	0	9.51	5.68	455.3
	500	9.44	5.45	444.8
0.13	1000	9.82	6.07	501.3
	1500	10.25	6.14	531.1

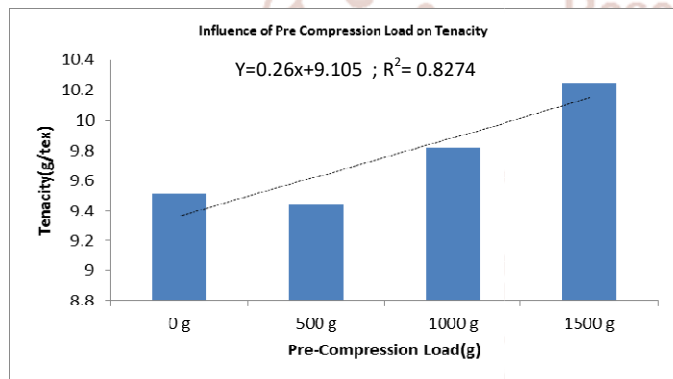Table 4: Effect of Pre-Compression Load on Tensile Properties

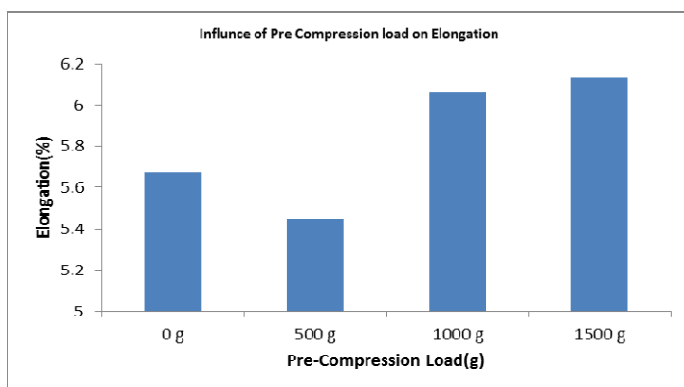Figure 9: Effect of Pre-Compression Load on Single Yarn Tenacity

Figure 10: Effect of Pre-Compression load on single Yarn Compression

3.5 Modified Rotor Yarn Hairiness

Sliver Hank	Pre-Compression load (g)	Yarn Hairiness S3 Value
	0	72
	500	27
0.13	1000	22
	1500	24

Table 5: Effect of Pre-Compression Load on Yarn Hairiness

Figure 11:E of Pre-compression Load on yarn Hairiness

3.6 Modified Rotor Yarn Quality Index

The yarn quality index takes into account the key quality parameters of yarn viz., tenacity, elongation and evenness. From the above discussions, it is obvious that the yarn tenacity, elongation and evenness improve whereas hairiness and imperfections decrease with increasing pre-compression loads. To have a consolidated effect of all three parameters on the quality of the yarn, the yarn quality index was developed by barilla et al.

$$\text{Yarn Quality Index (YQI)} = \frac{Yarn\ Tenacity\left(\frac{g}{tx}\right) \times Breaking Elongation(\%)}{Yarn\ Unevenness\ (CV\%)}$$

Pre – Compression Load(g)	YQI
0	3.18
500	3.16
1000	3.63
1500	4.01

Table 6: Effect of Opening Roller Speed on YQI

IV. Conclusion

➢ The U% of the modified rotor yarn reduces linearly around 8% with increase in pre-compression load.

➢ Imperfections per Km are the least when the pre-compression load is 1500grams.

- ➢ Tensile properties of modified rotor spun yarn namely tenacity, elongation and work of rupture increase by 8%, 7%, and 18% respectively with increase in pre-compression load.
- ➢ The hairiness value reduces drastically by 65% with application of pre-compression load.
- ➢ The yarn quality index improves by25% as the pre-Compression load is increased from 0-1500grams.

V. References

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