DESIGN AND DEVELOPMENT OF A NOVEL METHOD OF MECHANICAL COMPACTING SYSTEM

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

High performance 'compact yarn' in short staple spinning system, which has low hairiness and higher strength, has come into the existence to meet the needs of high productive weaving and knitting machines of today. In this project, an attempt is made to design and develop two different Mechanical Compacting Systems using Grooved Roller (MCS-GR) and Taper Roller (MCS-TR) for producing such compact yarn, and also to study and compare its quality performance in respect of yarn characteristics such as hairiness, strength and elongation, packing density, unevenness and imperfections with the normal spun yarn.

These systems are designed to be simple in construction and easy to be retrofitted in the existing ring frame at lower cost. The study reveals that there is an significant improvement of 54-69 % in Zweigle S3 value 62-90 % in Zweigle hairiness index and 5-15 % in Uster hairiness index for both the system. But, there is no significant change in strength due to lack of change in the packing density of yarn that could be derived for both the systems expect that there is an increase in imperfection in MCS-TR system. From the above results one can conclude that:

- Due to significant reduction in hairiness obtained in both system (MCS-GR and MCS-TR) it be employed gainfully in the production of yarn meant for knitted goods.
- Towards controlling the significant increase in imperfection in the case of MCS – TR, further studies are required by varying the taper angle of the attachment.

சாராம்சம்

இன்றைய உயர் உற்பத்தி நெசவு மற்றும் பின்னலாடை தொழில் நுட்பங்களுக்கு செயல்திறன் பொருந்திய நெருக்கமாக்கப்பட்ட நூல் தேவைப்படுகிறது, இந்த திட்டப்பணியில் இரு வெவ்வெறு முறைகளில் முறையே MCS – GR (Grooved Roller) மற்றும் MCS – TR (Taper Roller) நெருக்கப்பட்ட நுல் தயாரிக்கும் வழிகளை வடிவமைத்து அதன் முலம் தயாரிக்கப்பட்ட நெருக்கப்பட்ட நூல்களின் தரம் சார்ந்த பண்புகளான நூலின் மயிர்த்தன்மை ஆகியன சாதாரண தொழில் நுட்பத்தில் தயாரான நூல்களுடன் ஒப்பிட்டுப்பார்க்கப்பட்டுள்ளது,

இந்த புதிய வடிவமைப்புகள் குறைந்த செலவில் பழைய நூற்பு இயந்திரங்களில் நிறுவிக்கொள்வதற்கு வசதியாக ஏற்படுத்தப்பட்டுள்ளது, இத்திட்டத்தின் முலம் தயாரிக்கப்பட்ட நெருக்கப்பட்ட நூல்களில் ஏறக்குறைய 54 முதல் 69 விழுக்காடு நூலின் மயிர்த்தன்மை (Zweigle S3 value) குறைந்துள்ளது,

இதேபோல் மற்றுமொறு நூலின் மயிர்த்தன்மை அளவிடப்படும் முறையின் (Zweigle Hairiness Inder) கணக்கின் 62 முதல் 90 விழுக்காடு குறைந்துள்ளது,Uster; மயிர்த்தன்மை கண்டறியும் கருவியின் படி 5 முதல் 15% மயிர்த்தன்மை குறைந்துள்ளது, மேலும் புதிய முறையில் தயாரிக்கப்பட்ட நெருக்கப்பட்ட நூல்களின் இழை அடர்த்தியில் பெரிய மாற்றம் இல்லாததால் நூலின் வலிமையில் மிகுந்த வேறுபாடு இல்லை, ஆனால் MCS – TR நுட்பத்தில் நூலின் சரின்மைத்தன்மை (Imperfection) அதிகரித்துள்ளது, மேற்கூறிய ஆய்வுத்திட்ட முடிவுகளின் படி,

- இந்த புதிய முறைகளில் படிவமைத்து தயாரிக்கப்பட்ட நெருக்கப்பட்ட நூல்கள் மிகக் குறைந்த அளவிலான மயிர்த்தன்மையைக் கொண்டிருப்பதால் இந்நூல்களை பின்னலாடை தயாரிப்பில் பயன்படுத்திக்கொள்ளலாம்,

- மேலும் MCS – TR நுட்பத்தின் லம் தயாரிக்கப்பட்ட நூல்கள் அதிக சீரின்மைத்தன்மையுடன் இருப்பதால். அதைக் கட்டுப்படுத்த Taper உருளையின் சாய்வுக் கோணத்தை மாற்றியமைத்து புதிய முயற்சிகள் (Further studies) மேற்கொள்ளப்பட வேண்டும்,

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MCS- Mechanical Compacting System

MCS-GR - Mechanical Compacting System-Grooved Roller

MCS-TR - Mechanical Compacting System-Taper Roller

NR-Normal Ring Yarn

C- Combed

K-Carded

PCS-Pneumatic Compacting System

CHAPTER 1

INTRODUCTION

1.1 General

The technology development that has taken place in Weaving and Knitting processes during the past few decades to achieve higher and higher productivity demanded high tenacity and less hairy high performance yarn. These have necessitated the invention of compact yarn.

The structure of existing ring spun yarn is not ideal and perfect to meet the requirements. Many fibres of drafted strand is not getting integrated in to the yarn properly by the twisting process there by increasing the hairiness and reducing the yarn strength realization.

In order to overcome these shortcomings in ring spun yarn, an attempts have been made by the few manufactures to reduce the width of the stream of fibres emerging from the front roller. This is carried out by using Pneumatic and Mechanical system to condense/compact the drafted fiber stream in an extra zone created before it is twisted.

1.2 Necessary for an Alternate system for the Compact Yarn Production:

The Pneumatic/Mechanical Compacting system that are commercially available today are costing exorbitantly and it is not viable to Indian mills to venture on it. Further for certain downstream processes, such as knitting demand for reduction of hairiness is more predominant than for increased strength. All these have created necessity for an alternate system and made us to take up a research project to develop a simple suitable cost effective and retrofitable system, so as to obtain a gain in quality in respect of hairiness and strength.

In the innovative research work pursued by S.Ganesan,(2004) an attempt has been made to achieve condensation of drafted strand using non pneumatic mechanical system working on the positive, negative, semi-positive nip (Nip being the demarcation point between condensation and twisting of fibers) principles.

Our effort through this project is to explore new system and/or modify those systems, so as to produce better results that are cost effective.

CHAPTER 2

LITERATURE REVIEW

2.1 CONVENTIONAL RING SPINNING:

2.1.1 Reason for yarn Hairiness and Deterioration in Strength:

Chattopadhyay (2002) observed that when a roving strand is drafted for a given count, high draft has to be set at the ring frame. As the result of it the width of fiber flow becomes too large at the front roller creating a wider spinning triangle. Because of during twisting process all the fibers are not getting integrated properly into yarn, there by increasing the yarn hairiness and deterioration in strength.

2.1.2 Spinning Triangle:

The turns of twist in a yarn are generated at the traveler and it travel against the direction of movement to the drafting arrangement. Twist must run back as close as possible to the nip line the rollers, but it never penetrates completely to the nip because the drafted fiber strand is wide strand, after leaving the rollers, the fibers first have to move inwards and wrapped around each other. Accordingly at the exist point of front roller there is always a bundle of fibers in triangular shape without twist, which is called spinning triangle.

Klein(1987) in his observation stated that the size of the spinning triangle depends upon the roving hank, draft, spinning tension and the twist level in the yarn.

1. A short altitude of triangle represents a small weak points and hence fewer end breaks. But, the fibres on the edge must be strongly deflected to bond them in (angle of deflection is more). This is not possible with all fibres; it results in the fly or hairiness in the yarn surface.

2. Long altitudes of triangle imply a long weak point and hence more end breaks. However the edge fibres are better bound in to yarn due to the requirement and less defective.

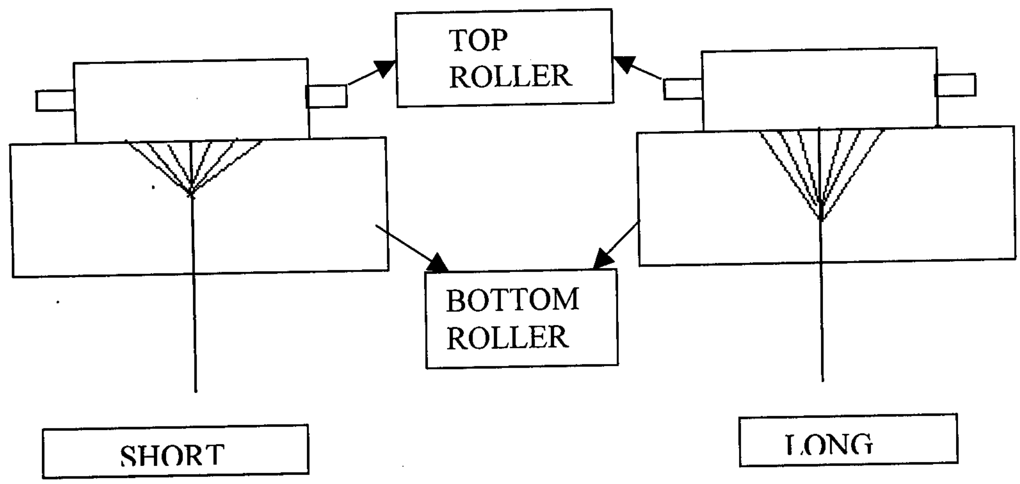


Fig.1. spinning triangle

2.2 DEVELOPMENT OF COMPACT SPINNING SYSTEM:

By bringing the width of the drafted strand from 3 to 4 mm to less than half a mm through a creation of additional zone for condensing through PCS/MCS means the angle of deflection of edge fiber required for binding is brought down to moderate, therefore increasing the efficiency of binding of fiber in to the yarn. The following sections explain the function of various systems based on pneumatic and mechanical (magnetic) principle that are available in the market.

In Pneumatic Principle

- Suessen- Elite spinning
- Rieter -Comfor spin
- Zinser -AirCom Tex 700

In Mechanical Principle

- Lakshmi RoCoS compact spinning

Chellamani, et.al (2002) and Ishtiaque, et.al (2003) has reviewed that compact systems and their observations are discussed in the following sections(features, advantages,disadvantages).

2.2.1 SUESSEN –ELITE spinning:

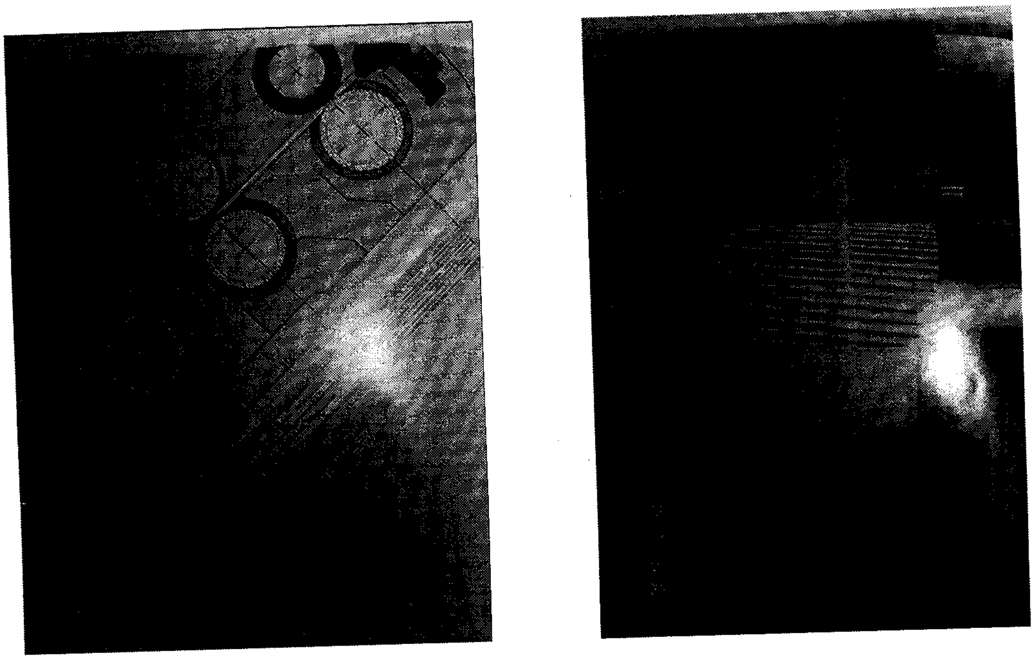


Fig.2 Suessen –Elite spinning

2.2.1.1 Design Concept and System of Functioning:

- A tubular profile subjected to negative pressure is closely embraced by a perforated lattice apron GM
- The delivery top roller LW fitted with rubber cots presses the lattice apron against the hollow profile and drives the apron, at the same time forming the delivery nipping line.
- The tubular profile has a small slot in the direction of fiber flow, which comments at the immediate vicinity of the front roller AW,nipping line and ends in the region of delivery nipping line as shown in fig.2
- This creates an air current through the lattice apron namely the slot towards the inside of the profile tube. These air current seizes the fibers after they leave the

front roller nipping line and condenses the fiber strand, which is conveyed by the lattice apron over a curved path and transported to the delivery line

- As the slot being under negative pressure reaches right upon to delivery nipping line, the fiber Assembly remains totally compacted.

2.2.1.2 Features:

- The diameter of the delivery top roller is slightly bigger than the diameter of front top roller, which creates a tension in longitudinal distance during the condensing process.
- The consequence of this tension causes the curved fiber to straighten end, therefore support the condensing effect of the negative pressure acting on the fiber band in the slot area of the profile tube.

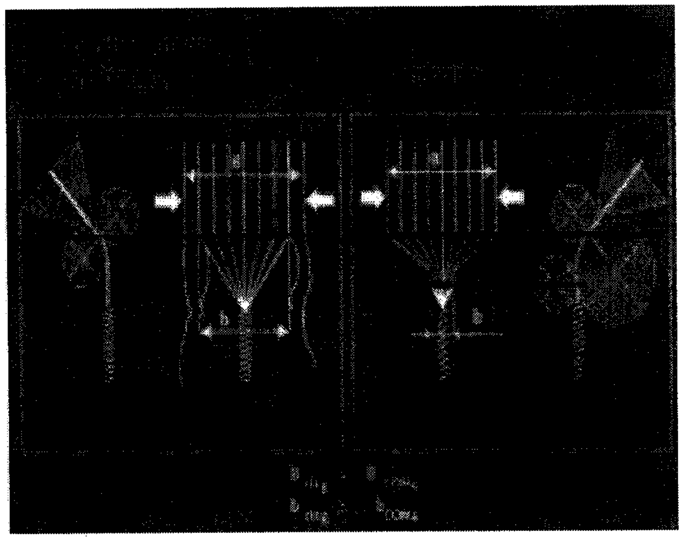
2.2.1.3 Advantages of Elite spinning:

- Carded Elite yarn match with conventional combed yarn in strength
- It needs less twist and therefore produces an excellent fabric handles.

2.2.1.4 Disadvantages:

- Maintenance cost per spindle is very high.
- As time passes the lattice apron tends to smoothen so that co-efficient of friction may change, leads to breakages
- Roving traverse is restricted to 3-5 mm which reduces the life of cots

2.2.2 RIETER-COMFOR spinning:



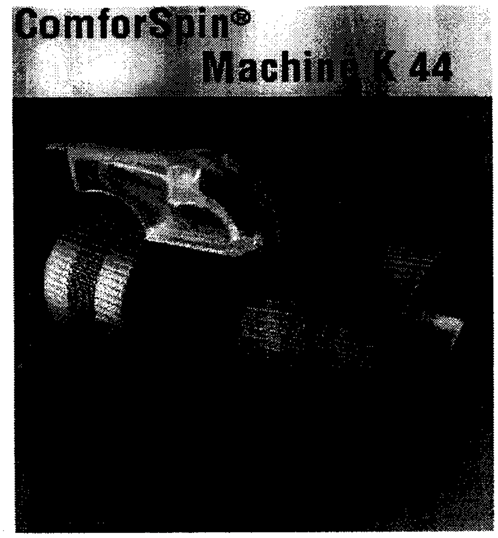


Fig. 3.Yarn Formations in Ring & compact spinning

The ComforSpin® technology allows aerodynamic parallelization and condensation of the fibres after the main draft. The spinning triangle is thus reduced to a minimum. The heart of the K 44 ComforSpin® machine is the compacting zone, consisting of the following elements:

- Perforated drum
- Suction inserts
- Air guide element

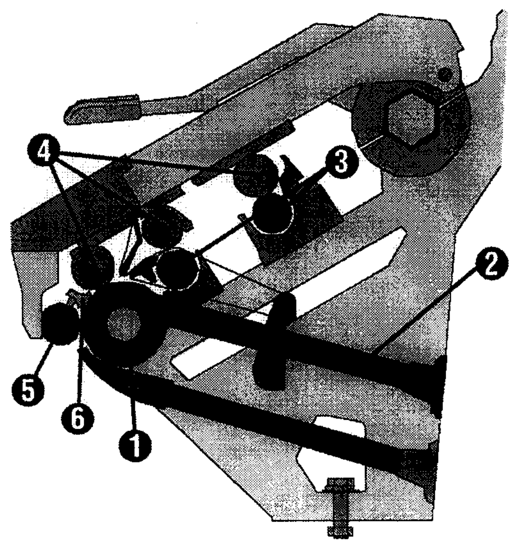


Fig 4: Rieter Comfor spinning

The directly driven perforated drum is hard wearing and resistant to fiber clinging. Inside each drum is an exchangeable stationary suction insert with a specially shaped lot. It is connected to the machine's suction system. The air current created by the vacuum generated in the perforated drum condenses the fibers after the main draft. The fibres are fully controlled all the way from the nipping line after the drafting zone to the spinning triangle.

An additional nip roller prevents the twist from being propagated into the condensing zone.

The compacting efficiency in the condensing zone is enhanced by a specially designed and patented air guide element. Optimal interaction of the compacting elements ensures complete condensation of all fibers.

2.2.2.1 Features:

- The fiber condensing zone immediately follows a 3 roller drafting system with double aprons.
- The delivery roller of drafting system is replaced by a perforated drum
- The fibers supplied from the delivery nip line of the drafting system and thus hold firmly on the surface of the perforated drum and move with the circumferential of the drum.

2.2.2.2 Advantages of Comfor spinning:

- Frequent cleaning is not required due to big hole size.
- Consistency of condensing, no clogging.

2.2.2.3 Disadvantages:

- Power consumption and cost is high.
- Restriction of roving frame.
- Fiber loss in suction due to big holes.

2.2.3 ZINSER AIR COM-TEX 700:

Chellamani, et.al (2002) and Ishtiaque, et.al (2003) observed on Zinser compact spinning machine the fiber bundling produced in the conventional 3 roller drafting system run from compact nip line directly on to the perforated rubber apron under suction the fibres are united by the means of air steam applied by the three dimensionally air laterally and compacted to the diameter determined by yarn count and number of fibres per cross section. Only tiny spinning triangle results for this. All the fiber are optimally align and twist insertion takes place very homogeneously with out any great difference between peripheral fibres and core.

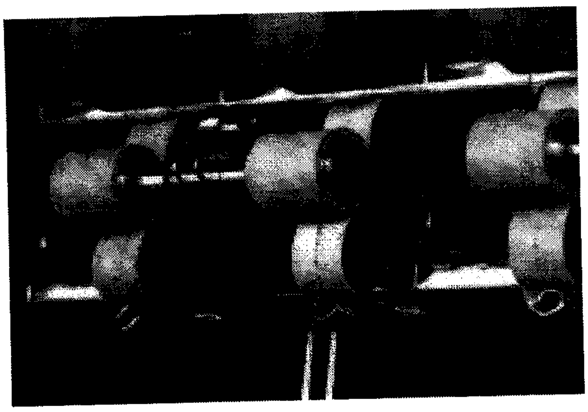


Fig.5.**Zinser air com-tex 700**

Fig.6. Fiber guide and air flow

The compacting zone is the CompACT3 spinning procedure is sub divided into

1. Compact element
2. Perforated apron
3. Pneumatic system

Pneumatic system is to provide the sub pressure .the compact element is used in addition to the conventional spinning element. Due to it geometry and shape this element is resistance to fly accumulation. The essential component is the compact apron.

On the compact apron compaction of yarn in corporation of vertical transport and air stream applied lateral to the perforation the fibers end which are to be strike out and or not use in subsequent process.

2.2.3.1 Advantages of Air Com Tex:

- Due to the favourable geometry and flexibility of the apron, a self cleaning is affected with each turn of the apron
- The condenser apron used is absolutely maintenance free and has a long life.

2.2.3.2 Disadvantages:

- Condensing is effective for small width which restricts the roving traverse to minimum level

2.2.4 LAKSHMI RoCoS:

2.2.4.1 The Principle

Rotor craft has developed a magnetic mechanical compacting system in the name of RoCos and LMW in collaboration with them has started marketing Lakshmi RoCos compact yarn spinning system recently . The schematic diagram is given below

Compact Yarn is produced by compacting the strand of fiber in a condensing zone - arranged after the drafting system - to such a degree so as not to allow the formation of a spinning triangle while twisting the strand of fibers into yarn. The undesirable yarn hairiness and the reduction of yarn strength resulting there from are thus avoided.

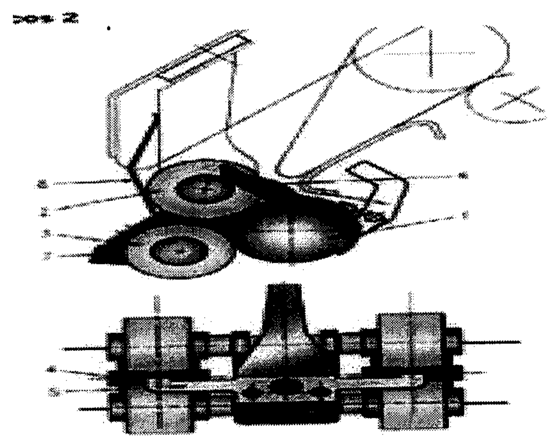


Fig. 7 Lakshmi RoCos

Until now, the condensing of the strand of fibers is brought about by air suction. The power required to produce this suction is substantial, the pneumatic compacting devices are expensive, and may require elaborate maintenance.

RoCoS, the Rotorcraft Compact Spinning System, works without air suction and uses magnetic mechanical principles only. The bottom roller 1 supports the front roller 2 and delivery roller 3. The condensing zone extends from clamping line A to clamping line B.

The very precise magnetic compactor 4 is pressed by permanent magnets without clearance against cylinder 1. It forms together with the bottom roller an overall enclosed compression chamber whose bottom contour, the generated surface of cylinder 1, moves synchronously with the strand of fibers and transports this safely through the compactor.

RoCoS 1 is suitable for cotton, pure and as blends with synthetic fibres, as well as for pure synthetics with a maximum staple length of 60 mm (2½").

On the other hand RoCoS 2 is suitable for wool, pure and as blends with synthetic fibres as well as for pure synthetics, having a minimum staple length of 50 mm (2").

In respect of yarn fineness and yarn twist, the standards usual in the industry are applicable. Compactors for coarse, medium and fine count yarns ensure ideal compacting.

The RoCoS device consists of cylinder 1, front roller 2, and delivery roller 3, the precision-ground and with Supra-Magnets equipped ceramic compactors 4, the supporting bridge 5, the yarn guides 6 and the top roller holders 7 with the weighting spring 8.

2.2.4.2 The Design:

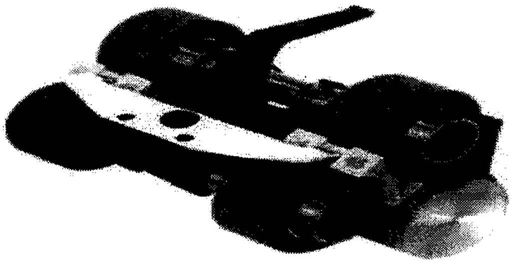


Fig.8.Rocos – Drafting Zone

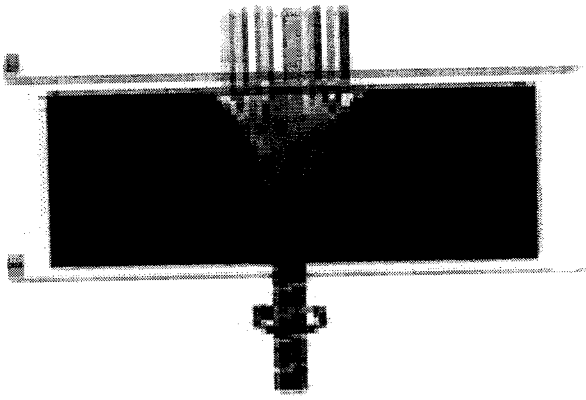


Fig.9.Magnetic compactor

Maintenance and operating instructions for high-drafting systems as common in the industry today is equally applicable for RoCoS. RoCoS does not require an investment in new spinning machines. The newly developed compact drafting system is available as a draft zone retrofit to most of today's ring spinning equipment.

2.2.4.3 Advantages of RoCoS Spinning:

- No air required
- No perforated aprons or drums required
- No increased energy costs
- No new machine required and retrofitting is easy.

2.2.4.4 Disadvantages:

- No roving traverse motion attached causing reduction on cot's life

2.3 ADVANTAGES OF COMPACT YARN

- Higher fiber utilization
- Higher tenacity with same twist factor, or
- Same tenacity with reduced twist factor for higher production
- Lowest hairiness (highest reduction in hairs longer than 3 mm)
- Fewer weak points
- Better imperfections (IPI) values
- Higher abrasion resistance
- Intensive dye penetration

2.4 FINDINGS FROM LITERATURE REVIEW:

The commercially above available systems are complex, costlier and only few are retrofittable (Elite and RoCos). Hence the Indian mills cannot afford for such system. The above system claims improvement in yarn hairiness and strength. For certain end product such as Knitting and Apparel fabric , requirement for reduction in hairiness is important than for strength. Hence there is a need to develop a simple and cost effective system to achieve the above two (gain in strength and hairiness) or any one of it objective. This has driven us to select a project on design and development of simple MCS cost effective and retrofittable to satisfy the above requirement.

CHAPTER 3

AIM AND SCOPE:

- To design and develop two different Mechanical Compacting System (MCS), that is simple and cost effective.
- To install the above MCS as retrofit in a lab model Ring Frame and study its performance in the production of Carded and Combed Compact yarn (20^{s}K, 30^{s}K and 40^{s}C) in relation to regular ring spun yarn.

CHAPTER 4

MATERIALS AND METHODS:

4.1 GENERAL:

Design and development of MCS has been first taken up and subsequently its performance is assessed in production of cotton yarn in relation to normal ring yarn.

4.1.1 Design and development: Mechanical Compact System (MCS)

The following MCS as attachment has been designed and fabricated for this project

- MCS-GR (Negative Nip principle by using Metal Grooved Roller)
- MCS-NR(Negative Nip principle by using Taper Roller)

- The design of the above two MCS has to be kept in such way to be retrofittable in the existing ring frame

4.1.2 Design concepts:

4.1.2.1 MCS – GR(Negative Nip principle by using Metal Grooved Roller):

In this system as per the sketch shown in the figure.11 a metal grooved roller has been introduced touching the yarn path and giving a rotation to it through the frictional contact with front top roller. This action reduces the tension slightly in the fiber strand and there by moves downward the converging point of yarn formation creating long spinning triangle, so as to facilitate better binding of fibers in to the yarn (reason explained in section 2.1.2). The frictional contact with top roller enables the grooved roller to rotate in the twist flow direction

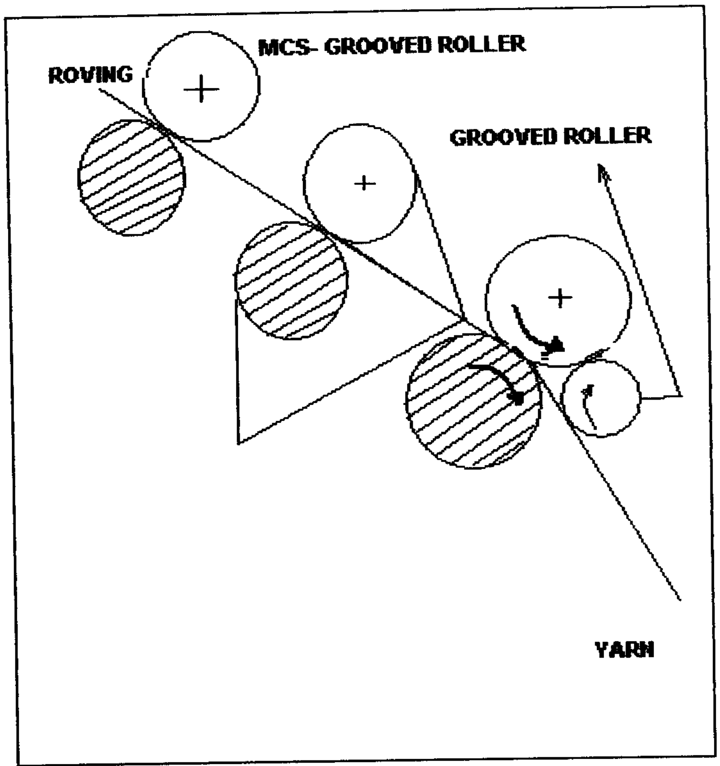


Fig.10. MCS- Grooved Roller Compacting

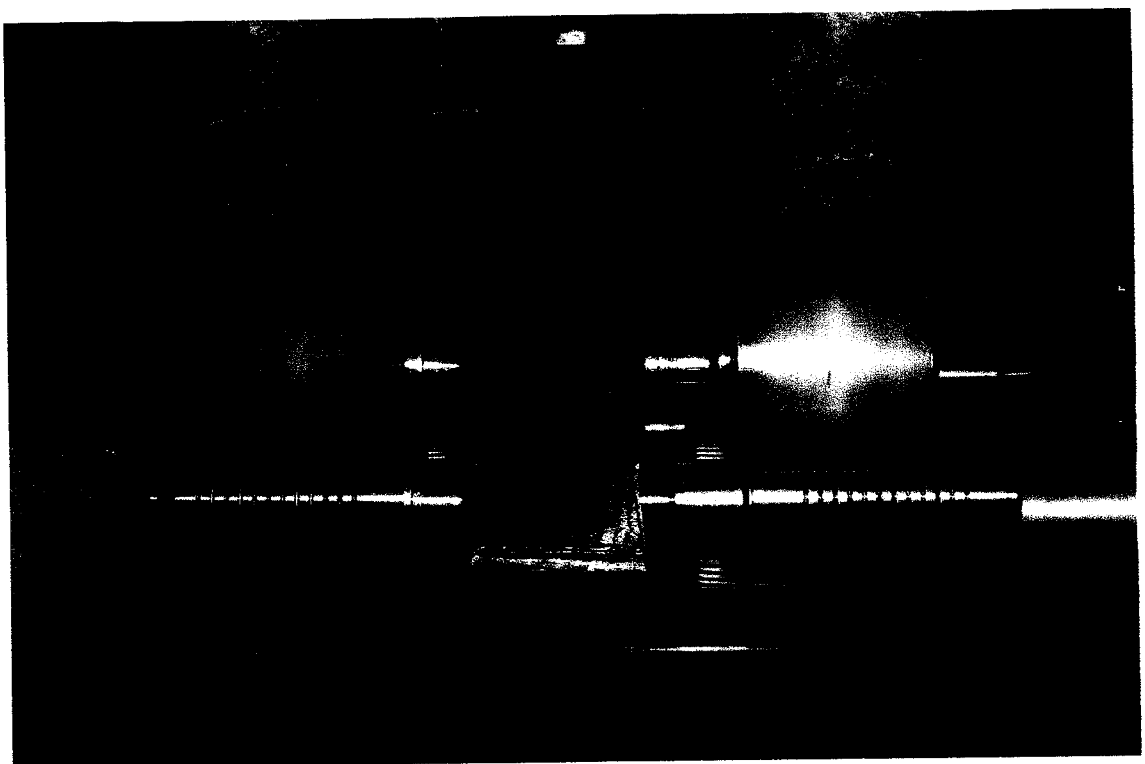


Fig.11.MCS- Grooved Roller Compacting

4.1.2.2 MCS-TR(Negative Nip principle by using Taper Roller):

In this system, as per the sketch shown in the figure 13. a taper rubber roller has been introduced touching the yarn path getting friction drive through front bottom roller. This makes the twisted yarn to roll over better, there by binding all protrnding fibers. To certain extent these actions expected to facilitate compactness of yarn.

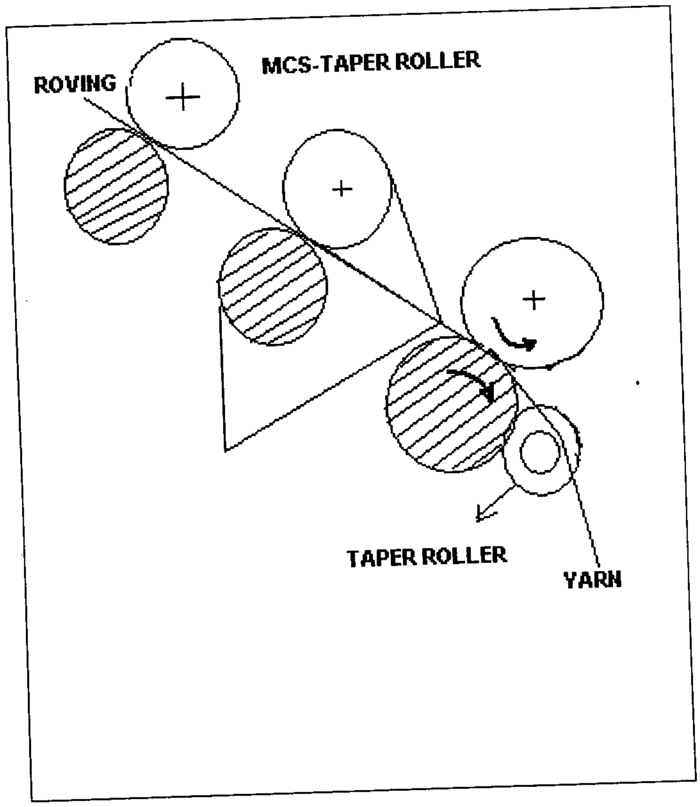


Fig.12. MCS- Taper Roller Compacting System

Fig.13. MCS- Taper Roller Compacting System

4.2 MATERIALS USED:

For assessing the performance of these systems three 100% cotton counts namely, 20s carded warp, 30s carded warp and 40s combed warp were selected. Rovings required for the production of above counts are procured from standard mills.

4.2.1 Properties of materials used for 20s, 30s, Carded and 40s combed:

The properties of cotton mixing used to produce 20s, 30s, and 40s are given in the Table 1, 2, 3 respectively.

Table.1 Materials used for 20s Ne Carded

Varieties	% of Mixing	2.5% Span Length (mm)	50% Span Length (mm)	Bundle Strength (g/tex)	Mic. Value	U %
Sankar-6	100	28.98	13.93	21.76	3.86	48.06

Table.2 Materials used for 30s Ne Carded

Varieties	% of Mixing	2.5% Span Length (mm)	50% Span Length (mm)	Bundle Strength (g/tex)	Mic. Value	U %
NHH44	100	26.3	13.5	18.5	4.1	**51.3**

Table.3 Materials used for 40s Ne Combed

Varieties	% of Mixing	2.5% Span (mm)	50% Span Length (mm)	Bundle Strength (g/tex)	Mic. Value	U %
Sankar4	32	27.6	13.9	20	3.8	50.36
Sankar6	17	29.5	14.8	21.5	3.9	50.16
Brama Ponni	33		15.4	21.9	3.8	50.99
Brama Ponni (Premier)	13	30.5	15.6	22.2	4.3	51.1
H4	5	28.5	14.3	20.7	3.5	50.17
Average		29.2	14.8	21.2	3.86	**50.6**

4.3 MACHINE DETAILS

The MCS-GR, MCS-TR are fitted in the lab model ring frame and their performance is assessed in the production of cotton carded (20s and 30s) and cotton combed (40s). The details of ring frame process parameters are given in Table.4. Identical process parameters are maintained for the production of normal ring and compact yarn

Table.4 Machine Details

Parameters	100% Cotton Yarn Counts		
	20s Ne (Carded)	**30s Ne (Carded)**	**40s Ne (Combed)**
Spindle Speed (rpm)	13500	15000	16000
Twist Multiplier (TM)	4.7	4.4	4.2
Hank Feed	1.3	1.2	1.4
Ring Traveler No	2/0 (Half round Elliptical)	5/0 (Half round Elliptical)	7/0 (Half round Elliptical)
Break Draft	1.14	1.15	1.15

4.4 TESTING

4.4.1 YARN TESTING

This section deals with testing methods and sample size used in this research work

4.4.1.1 Yarn Characteristic Test

The characteristic of yarn studied are evenness, imperfection, Uster hairiness index and Zweigle hairiness frequency and its index, tenacity, breaking elongation and overall yarn density. Systems was investigated by using the image analysis method the details of which are in the table 5, which furnishes the details on yarn characteristic test carried out, test method followed along with instrument used, sample size and number of test carried out.

4.4.1.2 Hairiness Testing of Yarn

The two leading manufacturer of yarn testing equipment namely, Uster and Zweigle provides data on hairiness of yarn. The Uster gives the total length of protruding fibres in cm per cm of yarn. The zweigle provides length wise frequency of hairs and overall Index. As the long hairs are only creating problems in the downstream process, there is a need to measure frequency of hair having 3mm or more length, which is designated as S3 values by Zweigle. The hairiness tester of Zweigle, measure and provide lengthwise distribution of hairs and overall hairiness Index. Susessen through their information bulletin explained the importance of having complete distribution of the different lengths of hairs.

Table 5-Details on Yarn Characteristic Test

Sr. No	Yarn characteristic tested	Instrument used	Test Method /Procedure	Sample Size	Number of Test carried out
1	Yarn Evenness, Imperfection and Hairiness Index – H(cm/cm)	Uster- UT3	ASTM D 1425-96 (at 400m/min for 1min)	10 Cops	1test/cop Total Test = 10
2	Single Thread Tenacity & breaking elongation	Uster- Tenso- rapid 3	Uster Standard Method – CRE- at 5m/min	10 Cops	20 test/cop, Total Test =200
3	Hairiness Frequency and Index (Zweigle)	Zweigle - G566	ASTM D 5647-01 (at 100 m/min 1min)	10 Cops	1test/cop Total Test = 10
4	Yarn Diameter & Overall Density	Uster- UT4- OM Module	Uster Std Method (at 400m/min for 1min)	10 cops	1Test/Cop Total= 10 Cops

(Note:- All the yarn testing were done at standard atmospheric conditions - 27° C± 2 and 65 % RH ± 2)

CHAPTER 5

RESULTS AND DISCUSSIONS

The yarn characteristics test results of 20s carded, 30s carded and 40s combed Mechanical Compacting System Grooved Roller and Taper Roller are given along with the normal ring spun yarn in the following tables 6 to 14. The results are discussed characteristics wise in following sections using chart

Table 6-Yarn Evenness Test Results-Ne 20 Carded

S.No.	Characteristics	N.Ring	MCS-GR	MCS-TR
1	**Irregularity C.V.m%**			
	Mean (#)	16.1	16.5 (-2.7)	16.4 (-2.3)
	CV_b%	2.2	2.83	1.8
	T_{Act}(table $T_{95\%}$=2.101)		1.64	0.054
2	**Thin (-50%)/km**			
	Mean (#)	20.0	27.9 (-39.5)	16.5 (17.5)
	CV_b%	57.7	40.6	36.6
	T_{Act} (table $T_{95\%}$=2. 101)		1.54	0.85
3	**Thick (+50%)/km**			
	Mean (#)	356.8	455.0 (-27.5)	418.8 (-17.4)
	CV_b%	16.1	21.9	9.02
	T_{Act} (table $T_{95\%}$=2. 101)		1.93	1.88
4	**Neps (+200%)/km**			
	Mean (#)	366.3	430.8 (-20.2)	374.8 (-4.9)
	CV_b%	11.7	13.5	12.1
	T_{Act} (table $T_{95\%}$=2. 101)		1.73	0.431
5	**Total Imperfections/km**	743.1	913.2 (-22.8)	810.1 (-9.1)

Code Used:- N.Ring=Normal Ring; MCS-GR=Mech.compacting system-Grooved roller
MCS-TS=Mech.compacting system-Taper roller

Note:-T Act=Calculated 't' value for the actual values of Mean and S.D found from the study
T 95%=t- table value at 95% confidence level
*-indicates statistical significant difference at 95% confidence level when TAct >T95%
Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 7 -Yarn Evenness Test Results-Ne 30 Carded

S.No.	Characteristics	N.Ring	MCS-GR	MCS-TR
1	**Irregularity C.V.m%**			
	Mean (#)	18.28	18.38 (-0.55)	20.17 (-10.3)
	CV_b%	1.6	2.2	2.2
	T_{Act} (table $T_{95\%}$=2. 101)		0.64	11.27*
2	**Thin (-50%)/km**			
	Mean (#)	72.8	91.1 (-25.5)	239.0 (-228.3)
	CV_b%	22.4	13.52	23.9
	T_{Act} (table $T_{95\%}$=2. 101)		2.84*	8.85*
3	**Thick (+50%)/km**			
	Mean (#)	639.3	692.8 (-8.4)	1167.0 (-82.5)
	CV_b%	8.2	17.2	9.9
	T_{Act} (table $T_{95\%}$=2. 101)		1.30	13.15*
4	**Neps(+200%)/km**			
	Mean (#)	466.8	554.8 (-18.9)	647.3 (-38.7)
	CV_b%	7.3	14.3	9.8
	T_{Act} (table $T_{95\%}$=2. 101)		3.22*	7.93*
5	**Total Imperfections/km**	1178.9	1338.74 (-13.5)	2053.3 (-74.2)

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compacting system-Grooved roller

MCS-TS=Mech.compacting system-Taper roller

Note:- T Act=Calculated 't' value for the actual values of Mean and S.D found from the study

T 95%=t- table value at 95% confidence level

***-indicates statistical significant difference at 95% confidence level when TAct >T95%**

 # Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table.8 -Yarn Evenness Test Results-Ne 40 Combed

S.No.	Characteristics	N.Ring	MCS-GR	MCS-TR
1	**Irregularity C.V.m%**			
	Mean (#)	15.0	15.7 (-4.7)	16.5 (-10.3)
	CV_b%	1.5	1.5	0.6
	T_{Act} (table $T_{95\%}$=2. 101)		6.89*	19.81*
2	**Thin (-50%)/km**			
	Mean (#)	18.5	32.6 (-76.1)	68.7 (-271.1)
	CV_b%	37.8	19.86	12.89
	T_{Act} (table $T_{95\%}$=2. 101)		4.67*	14.06*
3	**Thick (+50%)/km**			
	Mean (#)	144.5	181.3 (-25.5)	304.3 (-110.6)
	CV_b%	18.2	20.76	6.5
	T_{Act} (table $T_{95\%}$=2. 101)		2.53*	15.36*
4	**Neps(+200%)/km**			
	Mean (#)	79.3	104.12 (-30.7)	129.68 (-62.9)
	CV_b%	15.1	10.34	18.55
	T_{Act} (table $T_{95\%}$=2. 101)		4.87*	5.93*
5	**Total Imperfections/km**	242.30	317.99 (-31.2)	502.64 (-107.4)

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compacting system-Grooved roller

MCS-TS=Mech.compacting system-Taper roller

Note:- T Act=Calculated 't' value for the actual values of Mean and S.D found from the study

T 95%=t- table value at 95% confidence level

***-indicates statistical significant difference at 95% confidence level when TAct >T95%**

 # Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 9-Uster & Zweigle Hairiness Test Results-Ne 20 Carded

S. No.	Characteristics	N.Ring	MCS-GR	MCS-TR
	Zweigle Hairiness Test			
1	**Hairiness Frequency-1mm(per 100m)**			
	Mean (#)	16326.1	15772.4 (3.4)	15357.4 (5.9)
	CV_b%	13.74	11.06	15.51
	T_{Act} (table $T_{95\%}$=2. 101)		0.616	0.936
2	**Hairiness Frequency-2mm(per 100m)**			
	Mean (#)	928.3	422.5 (54.5)	352.28 (62.1)
	CV_b%	3.72	13.20	16.28
	T_{Act} (table $T_{95\%}$=2. 101)		24.38*	27.20*
3	**Hairiness Frequency-S3(per 100m)**			
	Mean (#)	2429	990.7 (59.2)	888.8 (63.4)
	CV_b%	47.6	23.15	52.4
	T_{Act} (table $T_{95\%}$=2. 101)		3.86*	3.91*
4	**Zweigle Hairiness Index**			
	Mean (#)	198.75	58.7 (70.5)	55.4 (72.1)
	CV_b%	52.56	23.19	50.35
	T_{Act} (table $T_{95\%}$=2. 101)		4.20*	4.19*
5	**Hairiness Index(H) cm/cm**			
	Mean (#)	6.86	5.81 (15.3)	6.15 (10.4)
	CV_b%	2.7	5.1	5.35
	T_{Act} (table $T_{95\%}$=2. 101)		9.53*	5.96*

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compacting system-Grooved roller
MCS-TS=Mech.compacting system-Taper roller

Note:- T Act=Calculated 't' value for the actual values of Mean and S.D found from the study

T 95%=t- table value at 95% confidence level

*-indicates statistical significant difference at 95% confidence level when TAct >T95%

Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 10-Uster & Zweigle Hairiness Test Results-Ne 30 Carded

S. No.	Characteristics	N.Ring	MCS-GR	MCS-TR
	Zweigle Hairiness Test			
1	**Hairiness Frequency-1mm(per 100m)**			
	Mean (#)	11142.9	10169.2(8.7)	11848.6(-6.3)
	CV_b%	6.62	16.48	11.74
	T_{Act} (table $T_{95\%}$=2. 101)		1.68	1.47
2	**Hairiness Frequency-2mm(per 100m)**			
	Mean (#)	948.7	428.7 (54.8)	495.5 (47.7)
	CV_b%	7.40	8.68	14.71
	T_{Act} (table $T_{95\%}$=2. 101)		20.70*	14.16*
3	**Hairiness Frequency-S3(per 100m)**			
	Mean (#)	1405.2	642.7(54.3)	546.6(61.1)
	CV_b%	18.02	45.94	29.64
	T_{Act} (table $T_{95\%}$=2. 101)		6.20*	9.03*
4	**Zweigle Hairiness Index**			
	Mean (#)	171.70	49.16 (71.4)	16.6 (90.3)
	CV_b%	37.67	72.09	55.31
	T_{Act} (table $T_{95\%}$=2. 101)		5.25*	7.51*
5	**Hairiness Index(H)cm/cm**			
	Mean (#)	5.44	4.72 (13.2)	5.19 (4.6)
	CV_b%	2.2	5.78	4.06
	T_{Act} (table $T_{95\%}$=2. 101)		7.64*	3.26*

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compactimg system-Grooved roller

MCS-TS=Mech.compacting system-Taper roller

Note:- T Act=Calculated 't' value for the actual values of Mean and S.D found from the study

T 95%=t- table value at 95% confidence level

*-indicates statistical significant difference at 95% confidence level when TAct >T95%

Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 11 -Uster & Zweigle Hairiness Test Results-Ne 40 Combed

S. No.	Characteristics	N.Ring	MCS-GR	MCS-TR
	Zweigle Hairiness Test			
1	**Hairiness Frequency-1mm(per 100m)**			
	Mean (#)	10071.4	5655.8 (43.8)	6365.0 (36.8)
	CV_b%	3.32	7.36	13.42
	T_{Act} (table $T_{95\%}$=2. 101)		26.15*	12.78*
2	**Hairiness Frequency-2mm(per 100m)**			
	Mean (#)	813.8	239.2 (70.6)	275.2 (66.2)
	CV_b%	9.70	4.34	13.69
	T_{Act} (table $T_{95\%}$=2. 101)		22.82*	19.47*
3	**Hairiness Frequency-S3(per 100m)**			
	Mean (#)	900.1	275.4 (69.4)	290.3 (67.8)
	CV_b%	15.48	17.36	46.73
	T_{Act} (table $T_{95\%}$=2. 101)		13.40*	9.91*
4	**Zweigle Hairiness Index**			
	Mean (#)	77.66	29.6 (61.9)	15.4 (80.2)
	CV_b%	56.24	61.46	96.58
	T_{Act} (table $T_{95\%}$=2. 101)		3.21*	4.27*
5	**Hairiness Index(H) cm/cm**			
	Mean (#)	4.34	3.93 (9.5)	4.06 (6.5)
	CV_b%	0.7	7.41	3.95
	T_{Act} (table $T_{95\%}$=2. 101)		4.43*	5.44*

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compacting system-Grooved roller

MCS-TS=Mech.compacting system-Taper roller

Note:- T Act=Calculated 't' value for the actual values of Mean and S.D found from the study

T 95%=t- table value at 95% confidence level

*-indicates statistical significant difference at 95% confidence level when TAct >T95%

Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 12 -Yarn Tensile and Yarn Density Results-Ne 20 carded

S. No.	Characteristics	N.Ring	MCS-GR	MCS-TR
1	**Single Thread Tenacity-Rkm(gf/tex)**			
	Mean (#)	16.34	15.14 (7.3)	16.12 (1.4)
	CV_b%	8.79	9.62	9.61
	T_{Act} (table $T_{95\%}$=1.96)		2.05	1.47
2	**Breaking Elongation %**			
	Mean (#)	6.36	6.17 (3.0)	6.55 (-3.0)
	CV_b%	6.35	9.55	8.06
	T_{Act} (table $T_{95\%}$=1.96)		3.8*	4.05*
3	**Yarn Diameter-(UT4-OM) mm**			
	Mean (#)	0.303	0.296 (2.3)	0.296 (2.3)
4	**Overall Yarn Density-(g/cm3)**			
	Mean (#)	0.41	0.43 (4.9)	0.43 (4.9)
	CV_b%	1.2	3.6	1.9
	T_{Act} (table $T_{95\%}$=2.101)		3.89*	6.63*

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compacting system-Grooved roller
MCS-TS=Mech.compacting system-Taper roller

Note:-T Act=Calculated 't' value for the actual values of Mean and S.D found from the study
T 95%=t- table value at 95% confidence level
*-indicates statistical significant difference at 95% confidence level when TAct >T95%
Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 13 -Yarn Tensile and Yarn Density Results -Ne 30 Carded

S. No.	Characteristics	N.Ring	MCS-GR	MCS-TR
1	**Single Thread Tenacity-Rkm(gf/tex).**			
	Mean (#)	14.31	14.98 (-4.7)	14.38 (-0.48)
	CV_b%	11.81	10.80	12.30
	T_{Act} (table $T_{95\%}$=1.96)		4.05*	0.40
2	**Breaking Elongation %**			
	Mean (#)	5.23	5.34 (-2.1)	5.13 (1.9)
	CV_b%	8.47	7.86	9.07
	T_{Act} (table $T_{95\%}$=1.96)		1.39	2.20*
3	**Yarn Diameter-(UT4-OM) mm**			
	Mean (#)	0.227	0.224 (1.32)	0.230 (-1.32)
4	**Overall Yarn Density-(g/cm3)**			
	Mean (#)	0.49	0.50 (2.04)	0.48 (2.04)
	CV_b%	2.80	1.30	1.58
	T_{Act} (table $T_{95\%}$=2.306)		2.08	2.02

Code Used:- N.Ring= Normal Ring; MCS-GR=Mech.compacting system-Grooved roller

MCS-TS=Mech.compacting system-Taper roller

Note: T Act=Calculated 't' value for the actual values of Mean and S.D found from the study

T 95%=t- table value at 95% confidence level

*-indicates statistical significant difference at 95% confidence level when TAct >T95%

Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

Table 14-Yarn Tensile and Yarn Density Results -Ne 40 Combed

S. No.	Characteristics	N.Ring	MCS-GR	MCS-TR
1	**Single Thread Tenacity-Rkm(gf/tex)**			
	Mean (#)	17.62	16.82 (4.54)	16.85 (4.37)
	CV_b%	11.55	10.44	9.26
	T_{Act} (table $T_{95\%}$=1.96)		4.21*	4.24*
2	**Breaking Elongation %**			
	Mean (#)	5.36	5.09 (5.04)	5.14 (4.1)
	CV_b%	12.68	8.73	7.71
	T_{Act} (table $T_{95\%}$=1.96)		4.7*	3.96*
3	**Yarn Diameter-(UT4-OM) mm**			
	Mean (#)	0.194	0.194 (--)	0.196 (-1.02)
4	**Overall Yarn Density-(g/cm3)**			
	Mean (#)	0.50	0.50	0.49 (2.0)
	CV_b%	1.7	1.3	3.8
	T_{Act} (table $T_{95\%}$=2.306)		---	1.55

Code Used:- N.Ring=Normal Ring; MCS-GR=Mech.compacting system-Grooved roller
MCS-TS=Mech.compacting system-Taper roller

Note: T Act=Calculated 't' value for the actual values of Mean and S.D found from the study
T 95%=t- table value at 95% confidence level
*-indicates statistical significant difference at 95% confidence level when TAct >T95%
Figures in the bracket indicate the relative change in the % of mean relation to ring yarn

5.1 EFFECT OF MCS ON EVENNESS AND IMPERFECTION:

The figures 14 to19 shows the comparative mean values (MCS-GR,MCS-TR versus NR) of irregularity(C.V.m %), total imperfection(per km) of 20sK, 30sK,40sC cotton yarn and their relative change in terms of percentage with normal ring yarn.

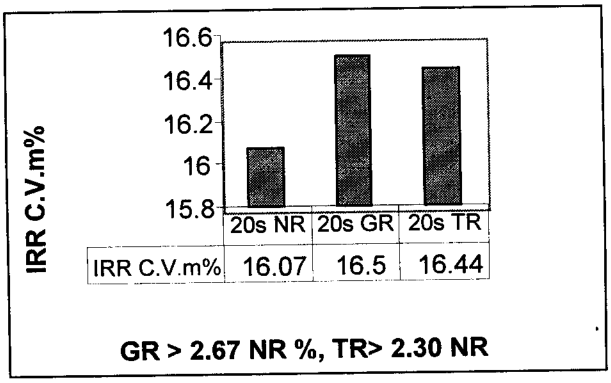
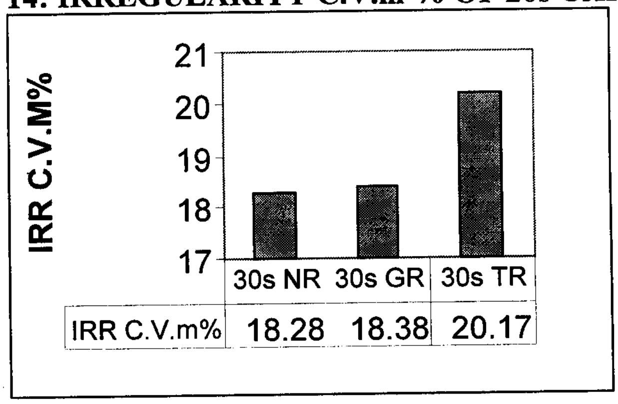


FIG 14: IRREGULARITY C.V.m % OF 20s CARDED



GR > 0.5% NR, TR >10.34 NR

FIG 15: IRREGULARITY C.V.m% OF 30s CARDED

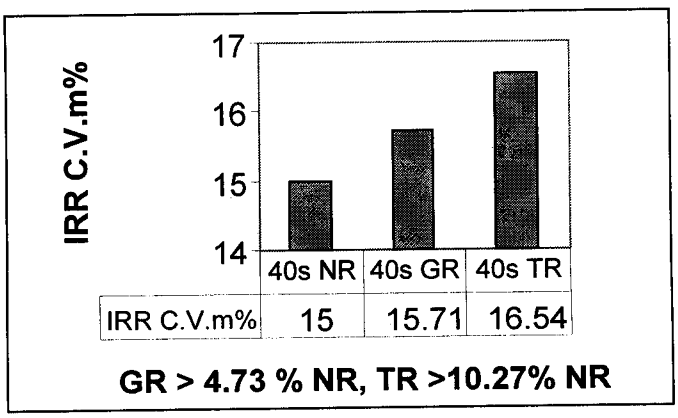


FIG 16: IRREGULARITY C.V.m% OF 40s COMBED

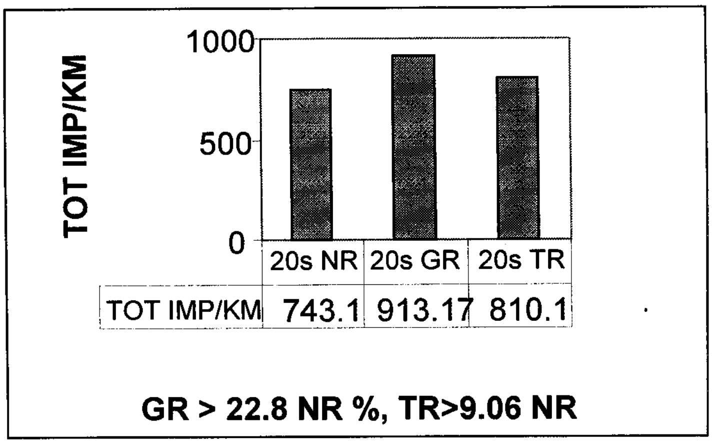


FIG 17: TOTAL IMPERFECTION /KM OF 20s CARDED

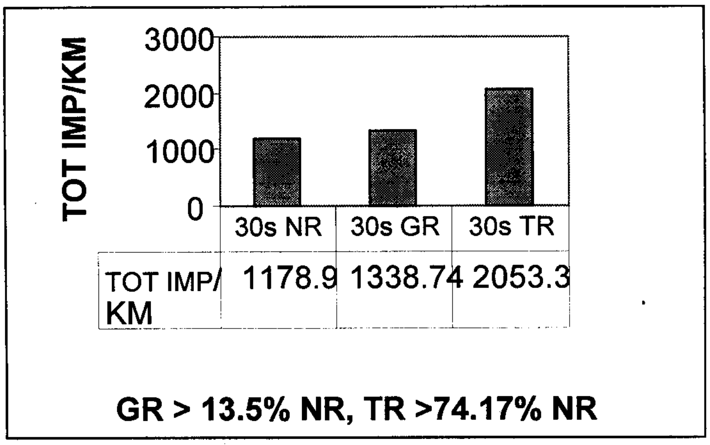


FIG 18: TOTAL IMPERFECTION /KM OF 30s CARDED

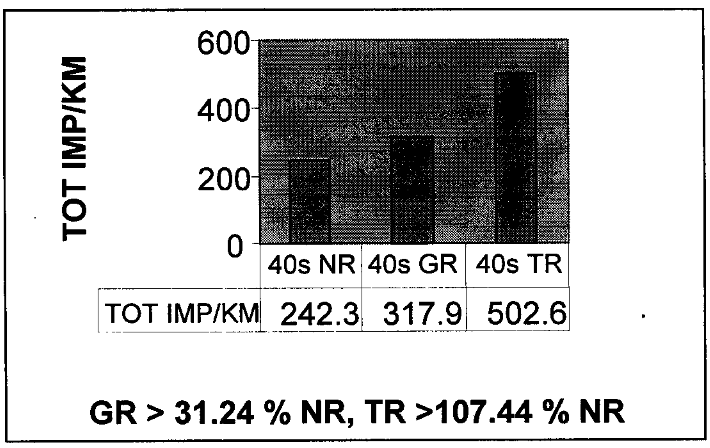


FIG 19: TOTAL IMPERFECTION /KM OF 40s COMBED

From the above figures one can note that there is a marginal increase in unevenness 2.7% for 20sK, 0.5% for 30sK, 4.7% for 40sC in case of MCS-GR, but it is not significant.

However there is a significant increase of unevenness 2.3% for 20s K, 10.3% for 30sK and 10.3% for 40sC in case of MCS-TR

With respect to total imperfection, there is significant increase of. 22.8 % for 20sK, 13.5% for 30sK, 31.2% for 40sC in case of MCS-GR.

Also there is significant increase of total imperfection 9% for 20s K,. 74.7% for 30sK, 107% for 40sC in case of MCS-TR

The reason for the above is explained below:

- The Grooved roller that has been used for MCS-GR system is a readymade top roller that was without cots. The surface condition of grooved roller used was not smooth. By appropriately improving the conditions of the surface of the groove, one can expect to eliminate the minor deterioration increase the imperfection.

- However in the case of MCS-Taper roller compacting as the increase in imperfection is significant for 20° taper angle used for the trial. Hence further studies using variation in the taper angle are to be explored to reduce the impact of it.

5.2 EFFECT OF MCS ON ZWEIGLE HAIRINESS FREQUENCY:

The figures 20 to 28 show the data for Zweigle Hairiness mean frequency (1mm, 2mm & S3) for MCS-GR, MCS-TR and N.R yarns.

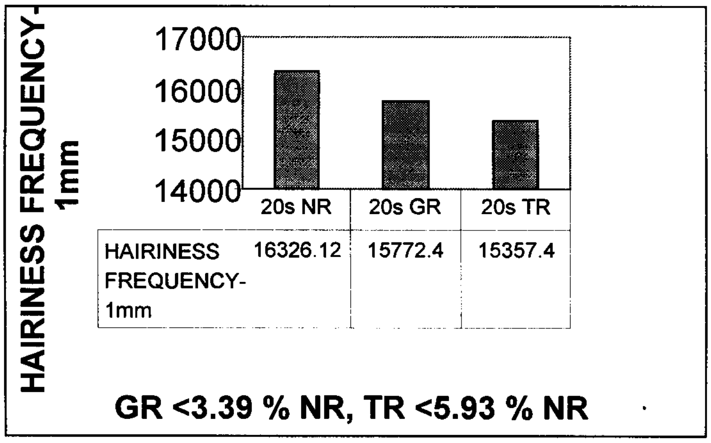


FIG 20: HAIRINESS FREQUENCY-1mm OF 20s CARDED

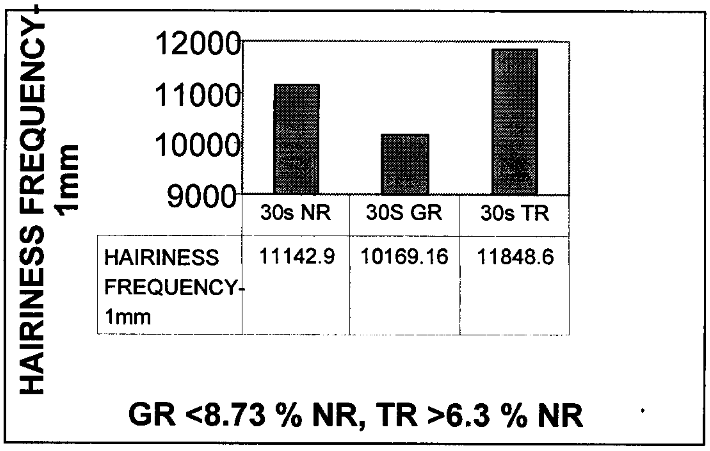


FIG 21: HAIRINESS FREQUENCY-1mm OF 30s CARDED

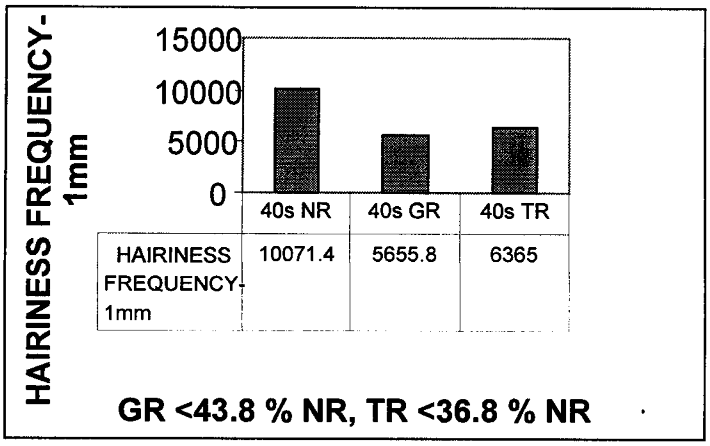


FIG 22: HAIRINESS FREQUENCY-1mm OF 40s COMBED

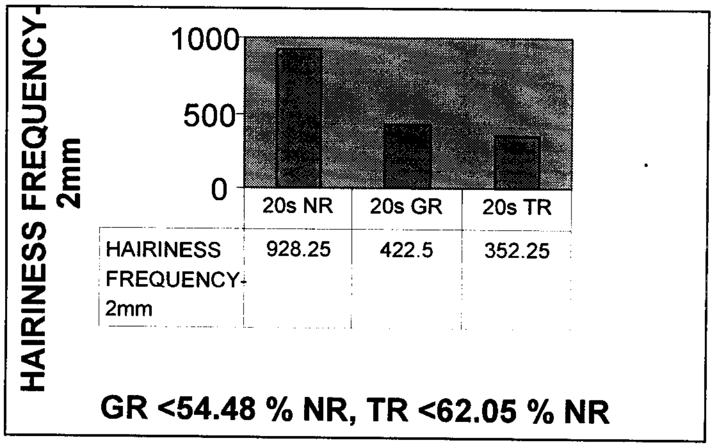


FIG 23: HAIRINESS FREQUENCY-2mm OF 20s CARDED

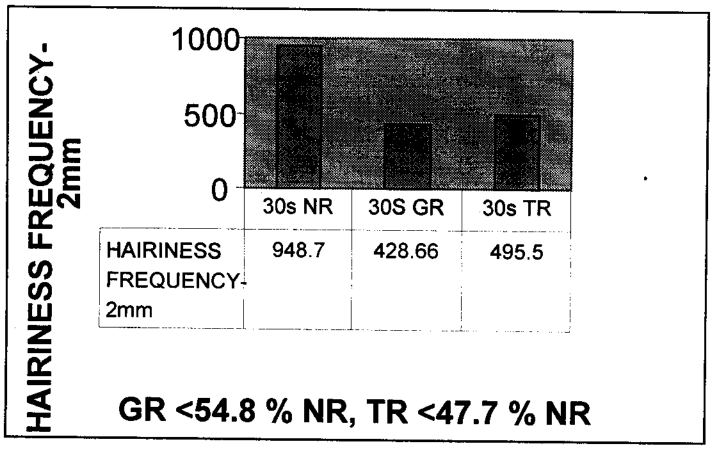


FIG 24: HAIRINESS FREQUENCY-2mm OF 30s CARDED

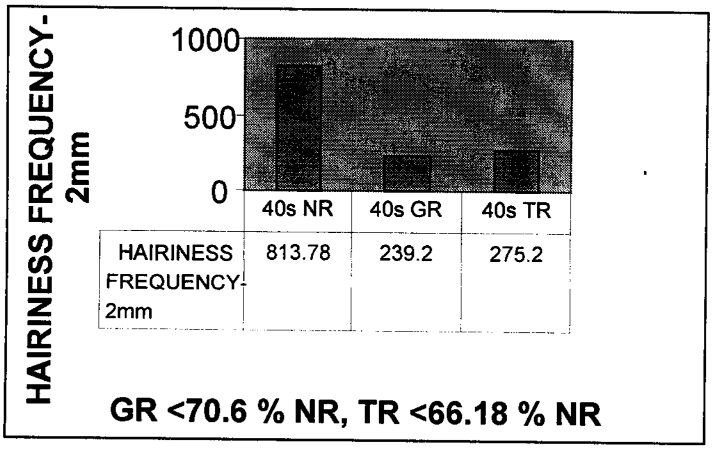
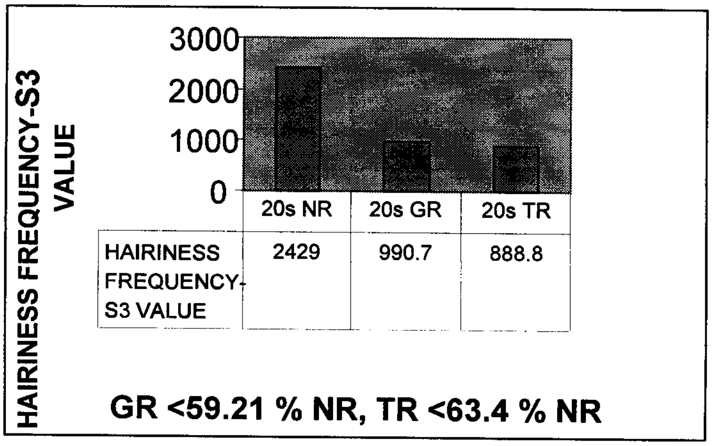
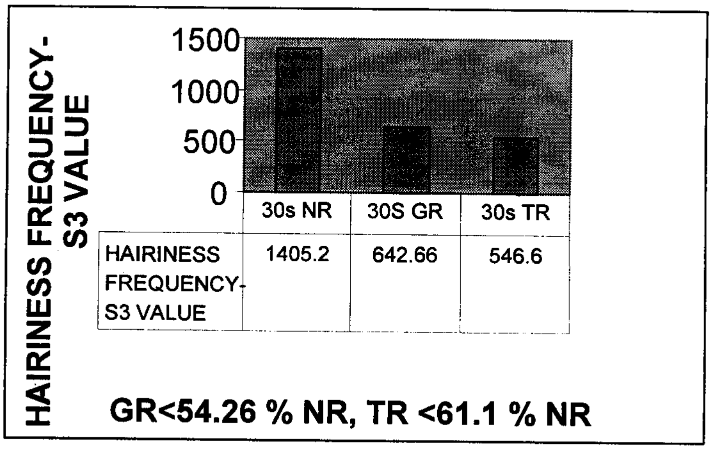


FIG 25: HAIRINESS FREQUENCY-2mm OF 40s COMBED



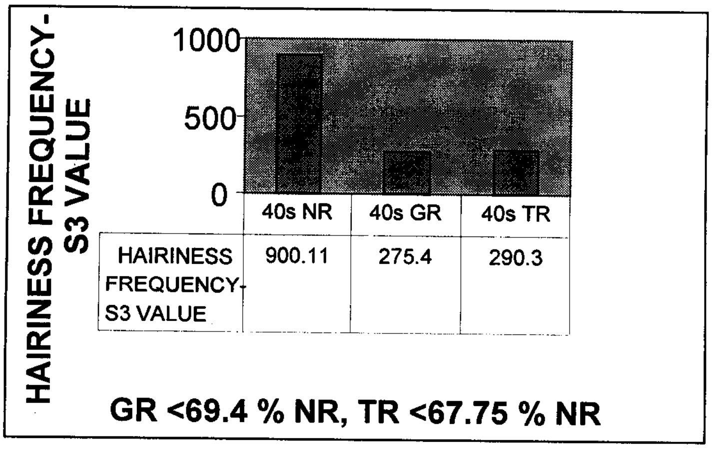
	20s NR	20s GR	20s TR
HAIRINESS FREQUENCY-S3 VALUE	2429	990.7	888.8

FIG 26: HAIRINESS FREQUENCY-S3 VALUE OF 20s CARDED



	30s NR	30S GR	30s TR
HAIRINESS FREQUENCY-S3 VALUE	1405.2	642.66	546.6

FIG 27: HAIRINESS FREQUENCY-S3 VALUE OF 30s CARDED



	40s NR	40s GR	40s TR
HAIRINESS FREQUENCY-S3 VALUE	900.11	275.4	290.3

FIG 28: HAIRINESS FREQUENCY-S3 VALUE OF 40s COMBED

The above figure shows for both MCS there is no significant reduction in Zweigle hairiness frequency for 1mm for carded count(20s and 30s) and some significant change for combed count 40s (43.8%-GR, 36.8%-TR).

The figure on Zweigle hairiness mean frequency (2mm) shows that in the case of MCS-GR yarn, there is significant reduction of 54.5%, 54.8%, and 70.6% for 20sK, 30sK and 40sC respectively in comparison with NR yarn.. Similarly for MCS-GR yarn's with Zweigle hairiness frequency (S3 value), there is significant reduction to the tune of 59.2%, 54.2%, and 69.4% for 20sK, 30sK and40sC respectively.

The figure on Zweigle hairiness mean frequency (2mm) shows that in case of MCS-TR, there is significant reduction of 62.0%, 47.7%, and 66.2% for 20sK, 30sK and 40sC respectively in comparison with NR yarn . Similarly for MCS-TR yarn's with Zweigle hairiness frequency (S3 value), there is significant reduction to the tune of 63.4%, 61.1%, and 67.1% for 20sK, 30sK and 40sC respectively.

5.3 EFFECT OF MCS ON ZWEIGLE HAIRINESS INDEX AND USTER HAIRINESS INDEX:

The figures 29 to 34 show the data for Zweigle hairiness index and Uster hairiness index for MCS-TR, MCS-GR and N.R yarns.

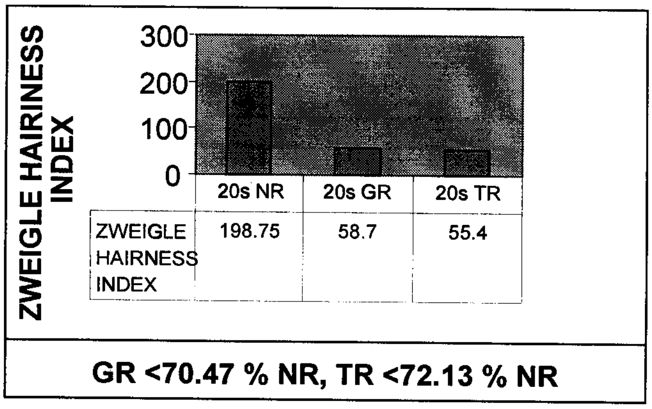


FIG 29: ZWEIGLE HAIRINESS INDEX OF 20s CARDED

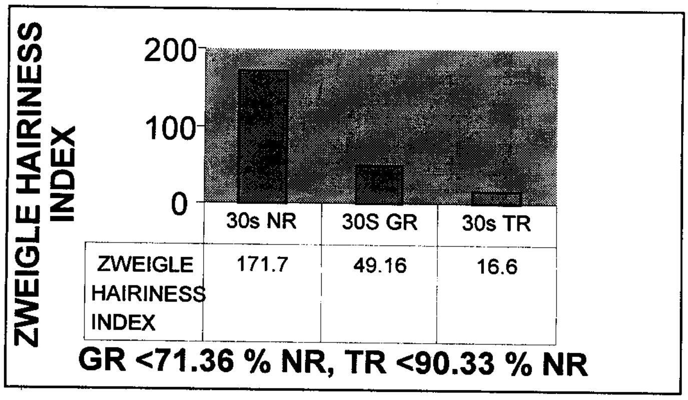


FIG 30: ZWEIGLE HAIRINESS INDEX OF 30s CARDED

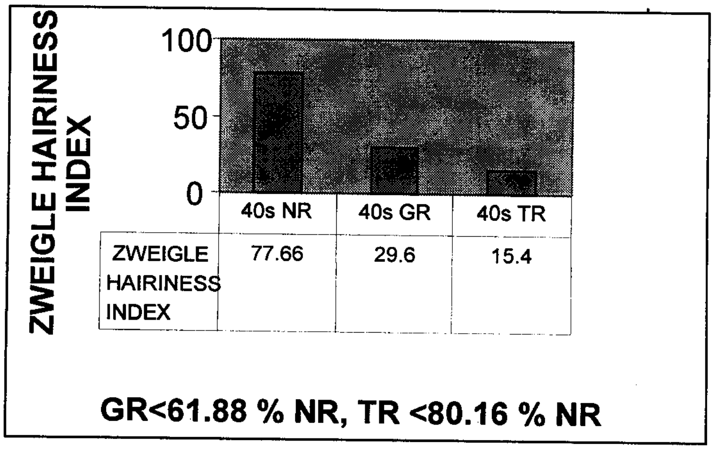


FIG 31: ZWEIGLE HAIRINESS INDEX OF 40s COMBED

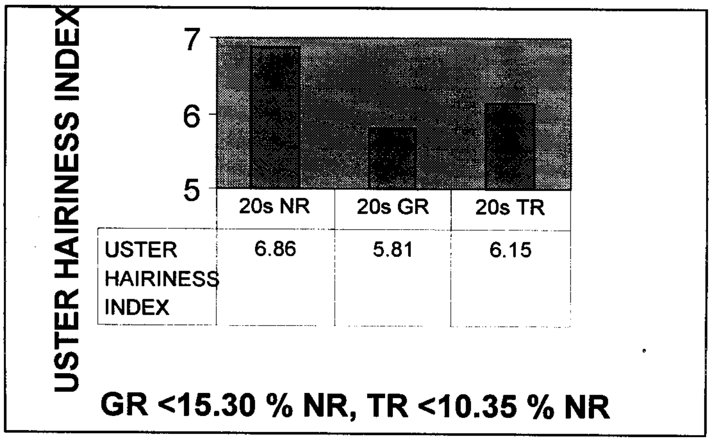


FIG 32: USTER HAIRINESS INDEX OF 20s CARDED

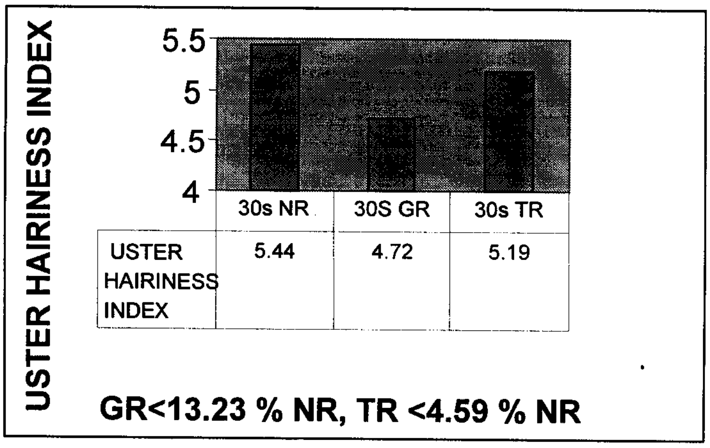


FIG 33: USTER HAIRINESS INDEX OF 30s CARDED

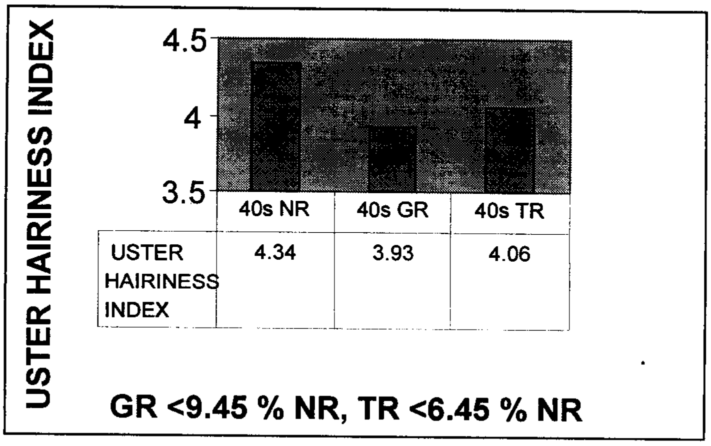
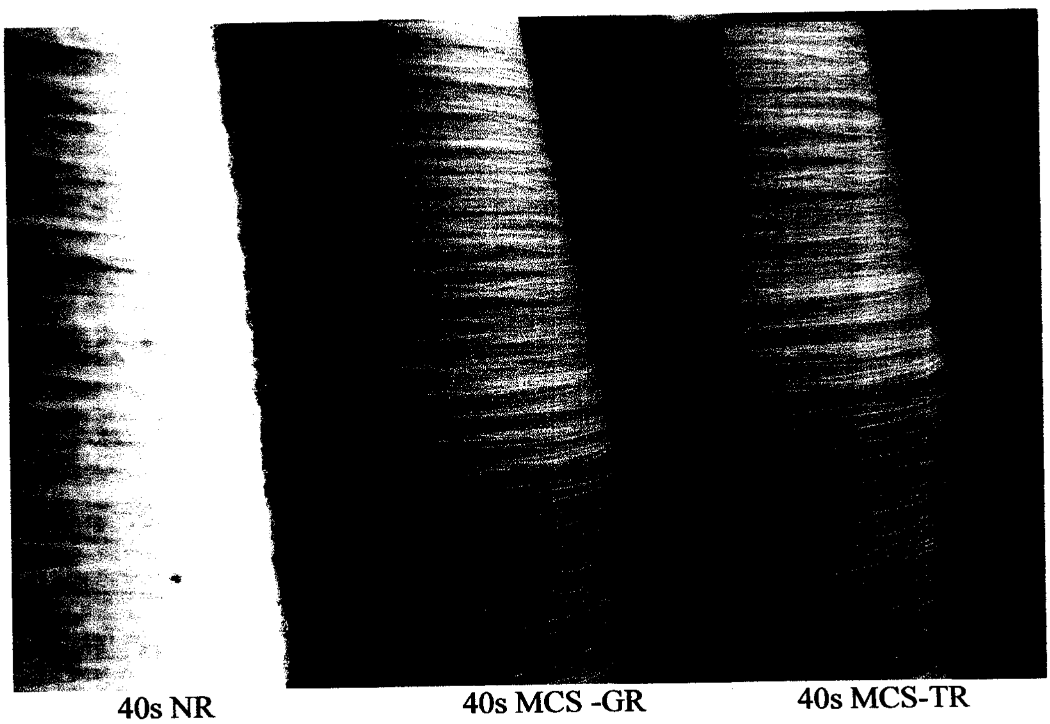


FIG 34: USTER HAIRINESS INDEX OF 40s COMBED

The figure on Zweigle hairiness index mean shows that in the case of MCS-GR, there is significant reduction of 70.5%, 71.4%, and 61.9% for 20sK, 30sK and 40sC respectively and in Uster hairiness index 15.3%, 13.2% and 9.5% for 20sK, 30sK and 40sC respectively in comparison with NR yarn.

The figure on Zweigle hairiness index mean shows that in the case of MCS-TR, there is significant reduction of 72.1% ,90.3%,and 80.2% for 20sK, 30sKand 40sC respectively and in Uster hairiness index 10.4% , 4.6% and 6.5% for 20sK, 30sK and 40sC respectively in comparison with NR yarn.

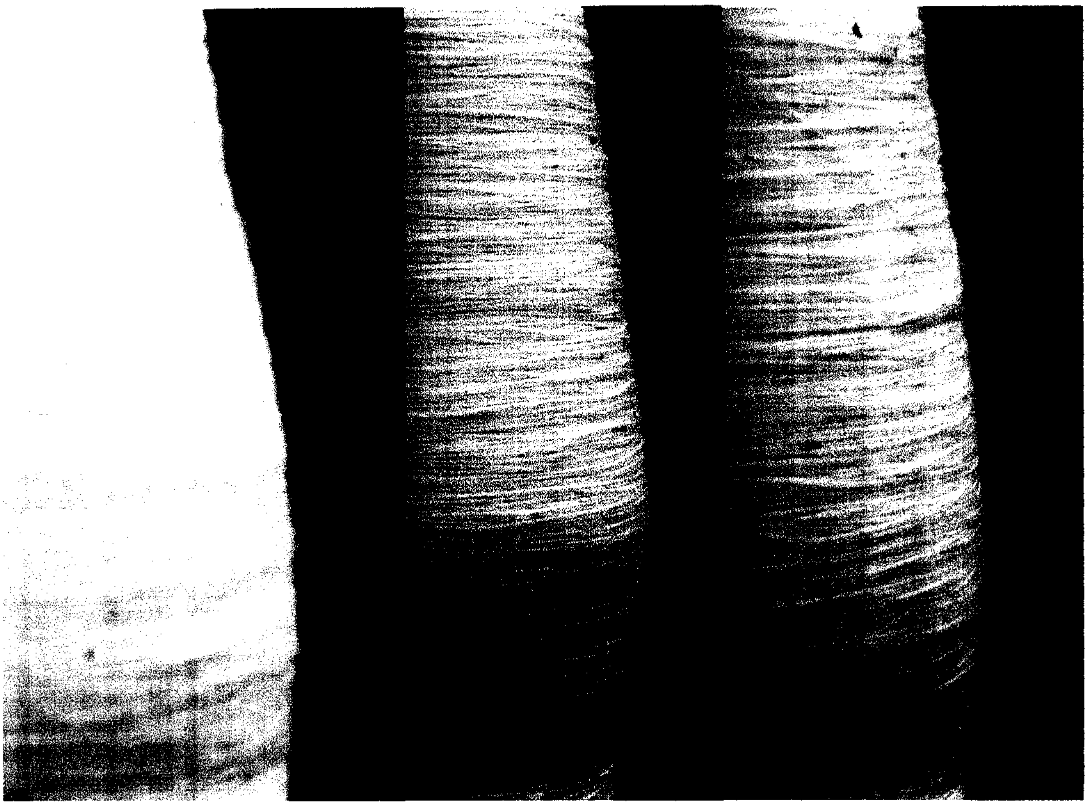
The photograph in Fig.35 Shows the appearance of hairiness for 40s combed count in comparison of the MCS-GR, MCS-TR with the NR yarn cop.



40s NR   40s MCS -GR   40s MCS-TR

Fig.35 Comparison of Hairiness (40s Combed)

The photograph in Fig.37 Shows the appearance of hairiness for 20s carded count in comparison of the MCS-GR, MCS-TR with the NR yarn cop.



20s NR 20s MCS-GR 20s MCS-TR

Fig.36 Comparison of Hairiness (20s Ne Carded)

The Reason for the reduction of hairiness is explained below:

The significant reduction in hairiness is made possible due to the effect of the mechanism attached in integrating all the fibers of drafted strand properly. The functioning of the MCS has been explained in the section 4.1.2 deals with design concept.

5.4 EFFECT OF MCS ON YARN TENSILE STRENGTH AND YARN DENSITY:

The figures 37 to 42 shows the comparative values of single thread tenacity, breaking elongation, yarn diameter, yarn density and their relative change in percentage.

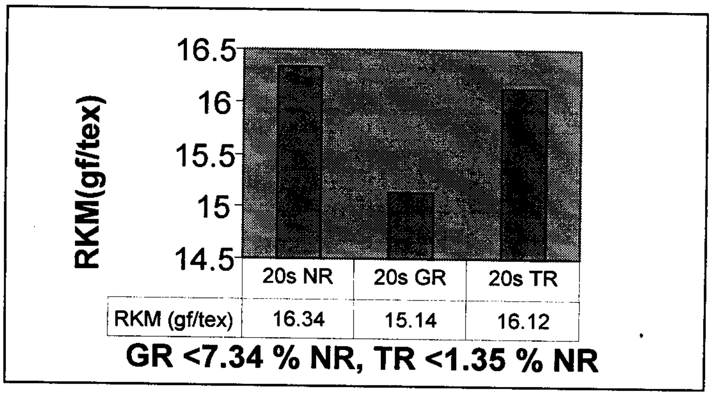


FIG 37: SINGLE THREAD TENACITY OF 20s CARDED

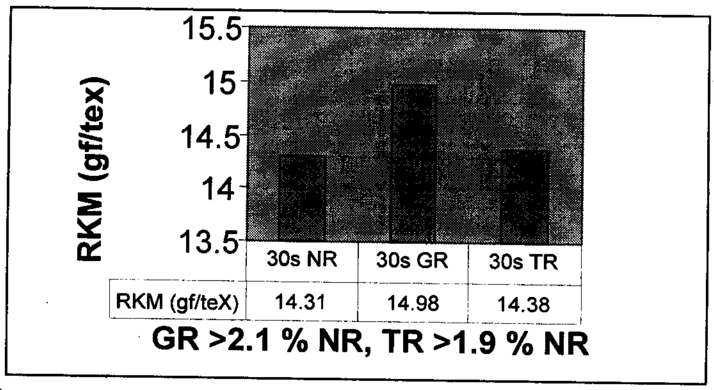


FIG 38: SINGLE THREAD TENACITY OF 30s CARDED

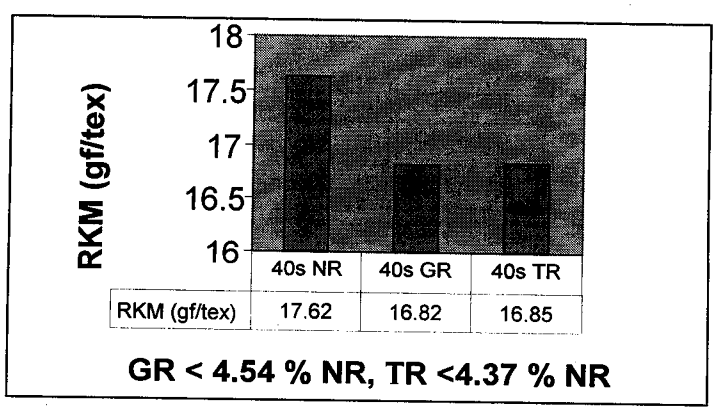


FIG 39: SINGLE THREAD TENACITY OF 40s COMBED

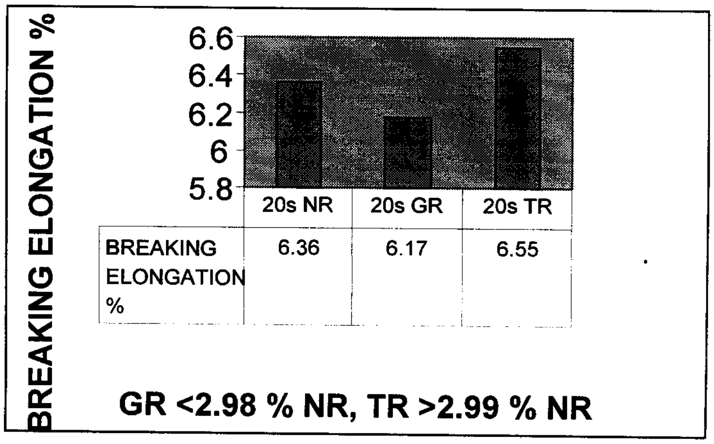


FIG 40: BREANG ELONGATION % OF 20s CARDED

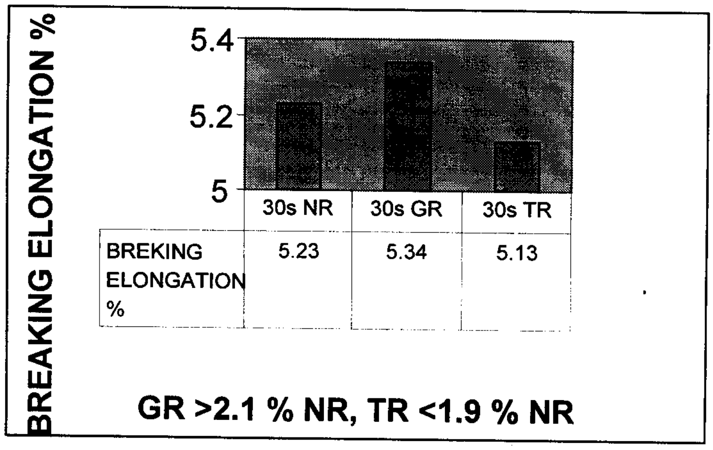


FIG 41: BREAING ELONGATION % OF 30s CARDED

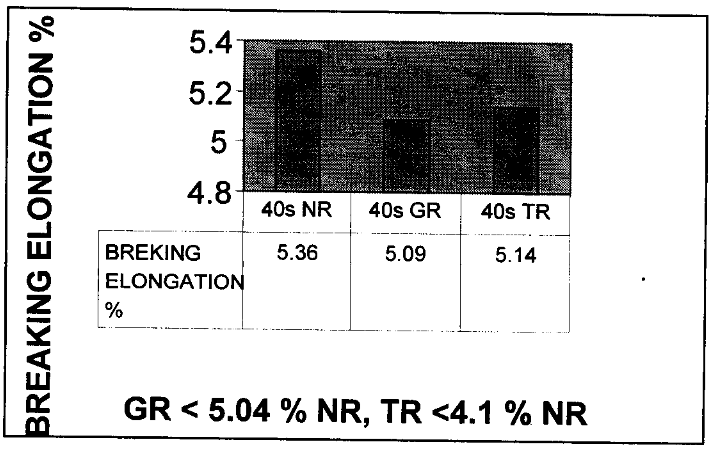


FIG 42: BREAING ELONGATION % OF 40s COMBED

The above figure shows that there is marginal change in the yarn strength (upto ± 4.5%) and elongation (1.9% to5.0 %) and in most of the cases it is not significant. As the overall packing density results does not show any significant increase in density and no appreciable gain in strength is expected. Hence it could be inferred that two MCS system are not contributing to significant increase in strength

CHAPTER 6

CONCLUSION

The following are the conclusion drawn from the foregone results and discussions:

1) There is a significant reduction in Zweigle S3 value (54.3%-69.4%), Zweigle hairiness index (61.9%-90.3%) and Uster hairiness index (4.6%-15.3%) of MCS yarn compared to NR yarn due to the favorable conditions created by the both retrofit (MCS-GR & MCS-TR) in properly integrating all fibers of drafted strand in to yarn body.

2) Towards controlling the significant increase in imperfection in the case of MCS-TR yarn further studies are required by varying the taper angle of attachment

3) Both the system (MCS-TR & MCS-GR) studied does not facilitate the compaction of drafted strand to any significant level, hence no increase in strength is derived..

4) From the above results one can conclude that MCS-TR & MCS-GR shall be used gainfully in the production of yarn meant for knitted goods where reduction in hairiness is more important but not strength.

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