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A Study on Low Stress Mechanical Properties of Rotor Spun Compact Yarn.

J.Kannappan,
Kumaraguru College of Technology And
K.Ramachandralu,
P.S.G. College of Technolopgy

Introduction:

The aim of new yarn technologies is to incorporate the more desirable features in the yarns such as increase in strength, productivity and clearance in yarn hairiness. That the compact spinning technology has achieved these goals is a well-known fact. The extents to which tensile properties have improved have been demonstrated in a number of papers. While the attachment have been made in ring frames by various machinery manufacturers it was thought that the rotor spun yarns should benefit from the technology and consequently an attempt was made to incorporate the compacting device in rotor spinning. Rotor spun yarns are known for the low strength in comparison with ring spun yarn and if the performance can be improved with the aid of air-jet nozzle it will be welcome. It is therefore the purpose of this paper to report on the low stress mechanical properties of regular and compact rotor spun yarns as these affect such properties of fabrics as drape, handle and tailor ability. The work described in this paper is concerned with tensile, bending, compression and torque properties.

Materials and methods:

Materials:

Cotton mixing whose properties are given in Table 1 was selected for the study.

Table-1 - Properties of Fibres used for mixing.

S.No	Fibre parameters	Value
1	Cotton used	Shankar 4
2	50% span length	12.5
3	2.5% span length	24.2
4	Uniformity ratio	48.1
5	Strength	17.9
6	Elongation	5.9
7	Micronaire	3.95
8	Short fibre index	8.33

Yarn Production:

The air-jet nozzle which was optimized was used in Rotor Spinning. Yarns of 20s (29.50 Tex) were spun with and without the air-jet nozzle according to the experimental design indicated in Table 2

Table-2 - Details of yarn produced

Count /Tex	Rotor yarn	Rotor Compact
16/36.91	X	X
20/29.53	X	X
24/24.60	X	X

Yarn Testing:

Tensile and compression properties were measured using Kawabata tensile, shear and Kawabata compaction tester. The procedures followed were tested on those given on manuals. Parameters of tensile and compaction are given in Table 3.

Table 3 - Parameters of tensile and compaction.

Parameters	Description	Unit
Tensile	LT - Linearity of load extension curve WT - Tensile energy RT - Tensile resilience	- J/m2 %
Lateral compression	LC - Linearity of compression thickness curve WC – Compressional energy RC - Compressional resilience	- J/m2 %

Flexural rigidity:

This was tested by Carlene Method. The mean of 20 tests was taken to represent the flexural rigidity.

Twist liviliness:

This was determined by an instrument which was specially designed as per the design of instrument of Krishnakumar. The mean of 10 readings was considered.

Results and Discussions:

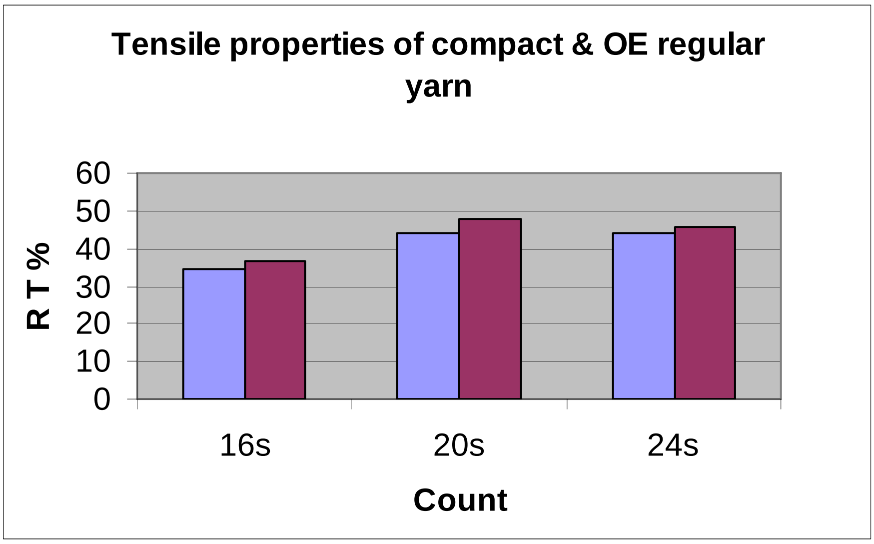
Tensile properties:

The tensile properties of regular and compact yarns produced on the Rotor Spinning are presented in Table 4.

Table-4 - Tensile properties of compact & OE regular yarn

COUNT		PARENT		COMPACT		
		VALUE	CV%	VALUE	CV%	%improve
16s	LT	**1.05**	2.66	**1.10**	3.76	4.55
	WT	**9.21**	5.38	**9.90**	2.47	6.97
	RT%	**34.54**	4.65	**36.42**	4.34	5.16
20s	LT	**0.98**	5.21	**1.08**	4.78	9.26
	WT	**8.08**	4.63	**8.61**	2.44	6.16
	RT%	**43.92**	8.56	**47.66**	2.04	7.85
24s	LT	**0.96**	3.15	**0.97**	3.81	1.03
	WT	**9.43**	5.80	**9.70**	2.26	2.78
	RT%	**43.81**	8.45	**45.49**	1.69	3.69

LT – linearity of load extension curve (-)
WT – Tensile energy (gf.cm / cm ^{2})
RT – Tensile resilience (%)



Examinations of the data shows that the values of LT(Linearity), WT(Tensile Energy) and RT(Linear Resilience) are highest for 16s and 20s Ne compact yarns. Higher values of tensile properties are desirable as the fabrics were from these yarns, will be endowed with better handle. It is also interesting to note that RT value of 16 Ne is considerably lower than those of 20Ne and 24 Ne yarns. WT represents yarn elongation while RT shows recovery; RT values are affected by thickness; Finer the yarns, the greater the tensile resilience. Yarn elongation is higher for 24 Ne, while the improvement noticed in RT% is significant in 20 Ne,it is marginal in 16 Ne and 20 Ne.

Compression:

Examination of the data given in Table 5 shows that compact yarns are similar to regular yarns in most of the cases. It is interesting to note that the compress ional resilience values are lower for 24Ne. WC values are higher for 24Ne yarns. Lower values of compress ional resilience indicate better performance. According to Morooka (2000) higher values of RC % are conducive for better handle and 24Ne yarns satisfy this criterion.

Table 5 - Compression values of compact & OE regular yarn

COUNT		PARENT		COMPACT		
		VALUE	CV%	VALUE	CV%	%improve
16s	LC	**0.42**	3.22	**0.41**	2.16	**-2.21**
	WC	**0.18**	3.21	**0.18**	3.98	**4.35**
	RC%	**36.85**	2.66	**36.37**	1.65	**-1.32**
20s	LC	**0.48**	1.20	**0.41**	1.62	**-8.18**
	WC	**0.18**	3.34	**0.19**	4.03	**2.14**
	RC%	**37.24**	1.93	**36.89**	2.07	**-0.95**
24s	LC	**0.38**	3.17	**0.36**	2.84	**-6.69**
	WC	**0.19**	3.08	**0.19**	1.95	**3.13**
	RC%	**22.87**	3.26	**22.15**	4.91	**-3.25**

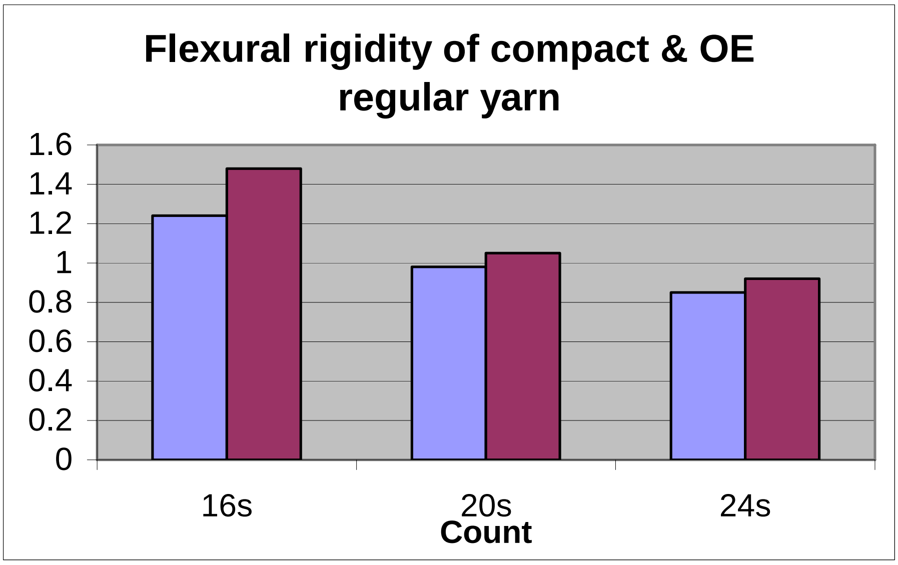
Lc - linearity of compression thickness curve (-)
Wc – compressional energy (gf.cm / cm ^{2})
Rc – compressional resilience (%)

Flexural Rigidity:

Values of Flexural Rigidity are given in Table-6. it is apparent that compact rotor spun yarn are characterized by higher values. The increase in Flexural Rigidity of Compact Rotor yarns range from 7.6% to 16.22%. This may be due to no freedom of motion of between fibres in compact yarn. Another reason is that the edge fibres are in by the swirling action of the nozzles yarn due to the air currents.

Table 6 - Flexural rigidity of compact & OE regular yarn

Count	Parent		Compact		% Increase	Specific flexural (mN.mm^2/tex)	
	Flexural rigidity g.cm^{2}x10^{-3}	CV%	Flexural rigidity g.cm^{2}x10^{-3}	CV%		Parent	Compact
16s	1.24	2.88	1.48	2.84	**16.22**	0.329	0.393
20s	0.98	1.28	1.05	2.08	**6.67**	0.325	0.349
24s	0.85	1.35	0.92	1.54	**7.61**	0.339	0.367



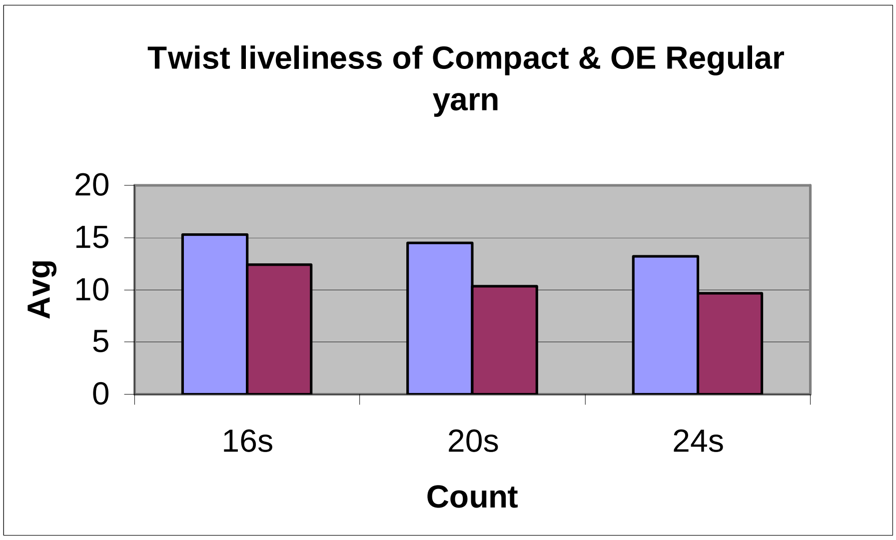
Twist liviliness:

Table 7 presents data on Twist Liveliness of Regular and Compact rotor yarns. It is apparent that the compact yarns have lower twist liveliness. This demonstrates that the residual torque in compact yarns is lower than that of regular yarn. This is due to the grouping of the edge fibres in the compact yarns.

Thus it has been demonstrated that the rotor compact yarns are quite different from the regular yarn in terms of low stress mechanical properties.

Table –7 - Twist liveliness of Compact & OE Regular yarn

Count	Parent		Compact	
	Twist Liveliness	CV%	Twist Liveliness	CV%
16s	15.28	2.56	12.44	2.71
20s	14.52	3.52	10.36	1.99
24s	13.22	2.62	9.68	2.11



Conclusions:

The Rotor compact yarns show higher Flexural Rigidity, better tensile properties and lower residual torque which are quite conducive for obtaining a fabric with better handle and Tailor ability.

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