International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.8, No.7, pp 191-197, 2015

Study on Properties of Ring Yarn and Compact Yarn Made With Custom Built Attachment

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Abstract: The concept behind the recent compact spinning technologies is that the strand of fibers delivered from the drafting system is condensed and this gives the yarn a more compact structure. Nowadays, the end use of compact yarn has become very much important due to its special characteristics. A custom-built front bottom roller attachment has been fabricated and fitted in the ring frame. The samples spun were 11.81 tex, 6.87 tex and 6.15 tex combed counts, with and without this attachment. The produced yarn samples were tested for all yarn characteristics and compared with Sussen EliTe compact yarn of respective counts. The material is subjected to longer length testing using classimat system. The test results are analyzed critically.
Key words: Classimat, compact yarn, custom built, ring yarn, seldom faults.

Introduction

The yarn faults which go into the woven or knitted fabric can be removed at very high costs or cannot be removed at all. Therefore the yarn processing industry demands a fault free yarn[1-3]. Classimat yarn faults have been one of the recent tools in optimizing winding parameters and market expectations and this system classifies the faults according to its length and magnitude[4]. Each yarn contains random places which deviate to quite a considerable extent from the normal yarn cross-section. These can be short thick places, long thin places, long thick places or even spinners doubles. Even though such events seldom occur, they represent a potential disturbance in the appearance of the fabric or can negatively influence subsequent processing of the yarn[3,13]. Depending upon the raw material, the machinery set up, production and process parameters, there are about 20 to 100 faults over a length of 100 km yarn which does not correspond to the desired appearance of the yarn. This means that the yarn exhibits a yarn fault every 1 to 5 km.

Seldom occurring faults are sub divided into three groups.

- Short Thick Places
- Long Thick Places
- Long Thin Places

Short thick places are those faults which are not longer than approximately 8 cm, but have a cross sectional size approximately twice that of the yarn. These faults are relatively frequent in all spun yarns. To an extent they are the result of the raw material such as vegetable matter and non-separated fibres. To a much longer extent, these faults are produced in the spinning section of the mill and are the result of spun in fly. Short thick places are identified easily in the yarn. In many cases, they cause disturbances in subsequent processing[5,7,8]. Long thick places are much more seldom-occurring than the short thick places and usually have a length longer than

40cms. In some cases, their length can even reach many meters. The cross sectional size is approximately + 40% to +100% and more with respect of the mean cross-section of the yarn. Long thick places will affect the fabric appearance. Faults like spinners doubles are difficult to determine in the yarn, with the naked eye. On the other hand, they can produce quite fatal results in the finished product[12].

A spinner double in the warp or in yarn for circular knitting can downgrade hundreds of meters of woven or knitted fabric[5-8].The difference between frequent yarn faults and seldom occurring yarn faults are mainly given by the mass of diameter deviation and size. These faults are monitored by Classimat[9]. Long thin places have lengths of approximately 8 cm and longer and cross-section of about -30% to -75% of an average yarn diameter. It is relatively seldom occurring in short-staple yarn and much frequently occurring in long staple yarns. Long thin places could result in serious cloth defects like streaks, variations in dye pick-up, etc., This type of faults is produced mainly in the process prior to spinning of yarn[10,11].

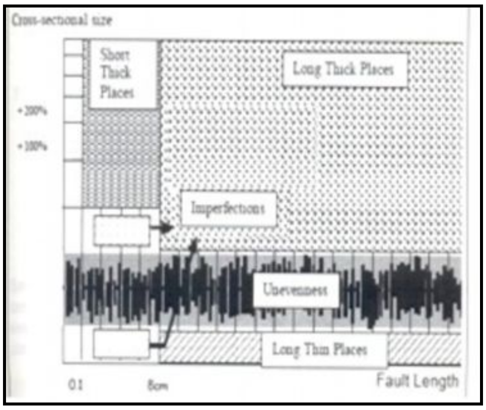

Figure 1. Types of Yarn Faults

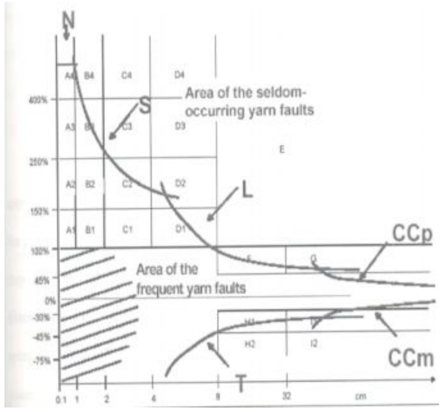

Figure 2. Seldom Occurring Faults

Materials and Methods

Fibre Properties and Mixing

The cotton fibre types with properties shown in Table 1 were used to spin the yarns used in this research work. Their mixing proportions for the respective yarn counts are depicted in Table 2.

Table 1. Fibre properties

Cotton Type	Fibre properties				
	2.5% span length (mm)	50% span length (mm)	Uniformity ratio %	Micronaire (micrograms / cm)	Tenacity (grams / tex)
Russian	34.16	16.67	48.79	1.6	30.04
MCU-5	32.58	16.20	49.72	1.41	23.86

Table 2. Mixing proportions

Count in Tex	11.81	6.87	6.15
Russian	---	70%	70%
MCU-5	100%	30%	30%

Sequence of machinery for processing

The process flow chart given below provides an outlook about the sequence of machines used in the spinning of yarn samples taken for this research work.

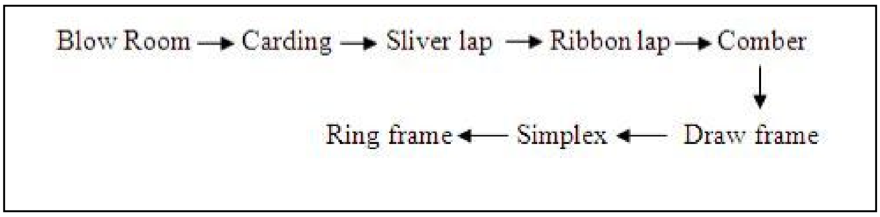

Figure 3. Process flow chart of machines used for yarn production

Process particulars

The process particulars of all the three yarn samples used in this study are given in Table 3.

Table 3. Process particulars

Process	Particulars	Linear density of yarns in Tex		
		11.81	**6.87**	**6.15**
Carding	Surface speed of Cylinder (mpm)	1794.5	1794.5	1794.5
	Surface speed of Lickerin (mpm)	682	682	682
	Surface speed of Doffer (mpm)	86.14	86.14	86.14
	Flat speed (cm / min)	22.86	22.86	22.86
	Hank	0.18	0.18	0.18
Draw frame	Hank	0.18	0.18	0.18
Simplex	Hank	1.6	2.3	2.3
	Surface speed of Front Roller (mpm)	194	197	196
	Spindle speed (rpm)	768	857	855
	Turns per metre (tpm)	46.85	57.48	57.48
Ring Frame	Front Roller Delivery (mpm)	595	451	457
	Spindle speed (rpm)	16800	16500	16700
	Turns per metre (tpm)	1112	1440	1440

Experimental procedure

The designed front bottom roller, shown in Figure 4, is fitted in LR DJ5 ring frame. For that, the threads are attached to both sides of the roller and it is fitted to the regular bottom roller. In the front bottom fluted roller, 1.5 mm diameter holes are drilled throughout the whole circumference in alternate manner. The inner diameter of 14 mm is drilled throughout the roller and suction is provided by connecting a connector and suction tube. A suction tube is given a uniform suction pressure of 30 mm water column.

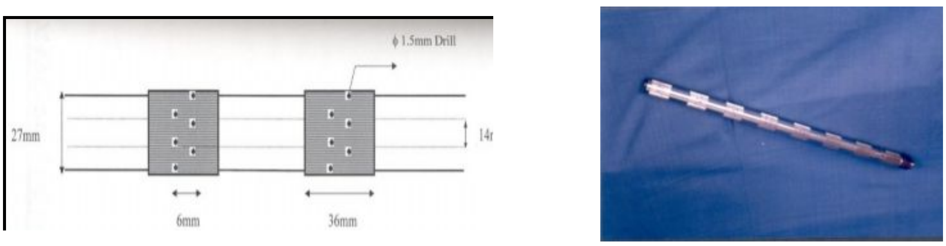

Figure 4. Modified flutted roller

Table 4. Quality parameters of yarn produced by Ring, Modified ring and Compact Spinning

Quality	Ring	M.Ring*	Comp#	Ring	M.Ring	Comp	Ring	M.Ring	Comp
Count in Tex	11.81	11.81	11.81	6.87	6.87	6.87	6.15	6.15	6.15
Breaking force	202.5	214.5	220.0	109.2	119.3	124.2	97.1	102.7	104.0
Breaking elongation%	4.91	5.04	5.20	3.77	4.78	4.90	4.00	4.62	4.82
Tenacity(RKM)	17.15	18.14	19.00	15.9	17.38	18.20	15.78	16.70	17.5
Unevenness%	11.12	11.48	10.80	14.31	14.41	14.00	15.21	14.91	14.50
CV%	14.14	14.61	14.00	18.28	18.16	17.88	19.29	19.03	17.00
Thin/km(-50%)	7	5	4	238	229	199	426	362	302
Thick/km(+50%)	126	98	85	403	399	299	479	472	402
Neps/km(+200%)	215	172	140	415	389	301	528	426	406
Total	348	275	229	1056	1070	799	1433	1260	1110
Hairiness index	4.13	4.07	3.98	3.42	3.18	3.08	3.05	3.02	3.00
Sh index	1.12	1.10	0.98	1.08	0.95	0.90	0.95	0.93	0.92
Short thick	702	701	600	2433	1421	1321	2691	2264	2064
Long thick	2266	1746	1600	4609	3561	2861	8711	8979	8070
Long thin	1974	1795	1694	9307	6063	5802	13053	10312	7312
Objectionable	33	29	22	62	41	32	76	56	35
Total faults	4976	4271	3916	16411	11089	10076	24532	21091	17481

M.Ring* = Modified ring yarn, Comp# = Compact yarn

Statistical analysis

The thick places/km, neps/km, long thick places are shown in the Table 4. It may be observed that the 6.15 tex has uniformly performed better in these parameters as well as in the rest of the parameters. Basic analysis on hairiness index, short thick places, long thick places, long thin places, objectionable faults and total faults have shown significant results favouring 6.15 rex.

The logistic regression analysis have been performed by keeping the objectionable faults as dependent variable as well by keeping the total faults as dependent variable by keeping the minimum of the total faults as '0' and the remaining as '1'. It has shown significant contributions on neps/km, total imperfections, hairiness, Sh index, short thick places and long thick places in the first stage. In the second stage, unevenness, CVM and thin places/km have shown significant contributions to the total faults.

Kolmogorov-Smirnov Test

(Mean & standard deviation known)

N	max D	p
Hairiness Index 7580	.305759	$p < .01$
Sh Index	.359975	$p < .01$
Short thick	.215845	$p < .01$
Long thick	.214150	$p < .01$
Long thin	.289405	$p < .01$
Objectionable faults	.203628	$p < .01$
Total faults	.159333	$p < .01$

The regression summary is given in the Table 5 for stage one parameters and Table 6 for stage two parameters.

Regression Summary for Dependent Variable: Total faults

$R = .997961$ $R^2 = .995927$ Adjusted $R^2 = .995924$

$F(6,7573) = 3086E2$ $p < 0.0000$ Std.Error of estimate:406.28

Table 5. Regression summary of first stage parameters

Intercept	Beta	St. Err.of Beta	B	St. Err. of B	t(7573)	p- level
Neps/km	-0.161	0.006	-10.4	0.373	-27.81	0.00
Total imperfections	0.643	0.007	12.5	0.131	95.509	0.00
Hairiness	0.305	0.004	5907.1	79.050	74.725	0.00
Sh index	-0.138	0.003	-12986.1	297.154	-43.701	0.00
Short thick places	0.746	0.002	7.3	0.024	297.858	0.00
Long thick places	-0.208	0.001	-1.5	0.008	-170.551	0.00

R= 0.997, R^2= 0.994, Adjusted R^2= 0.994
F(3,7576)=4446E2 p<0.0000 Std.Error of estimate:478.32

Table 6. Regression summary of second stage parameters

	Beta	St. Err. of Beta	B	St. Err. of B	t(7576)	p- level
Uneven	-0.642	0.002	-3513.91	13.978	-251.384	0.00
CVM	0.211	0.001	2.15	0.009	227.484	0.00
Thin place/km	1.587	0.003	82.68	0.134	617.250	0.00

In reporting logistic regression output it is important to provide enough information to gauge the substantive significance as well as the statistical significance. The percentage is useful in evaluating the odds ratios because doubling the odds of a percentage of 1% is different from doubling the odds of a percentage of 30%, for example. This table does not report the estimates for all predictors. The note at the bottom of the table indicates that several control variables were included in the estimation but these are not reported in the table. This approach simplifies the presentation of the table when there is no need to discuss the parameter estimates of the control variables**.**

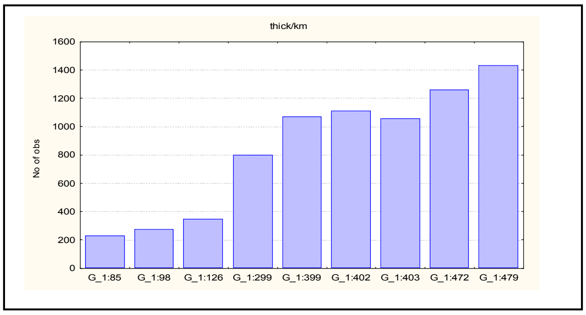

Figure 5. Comparison of thick places per km

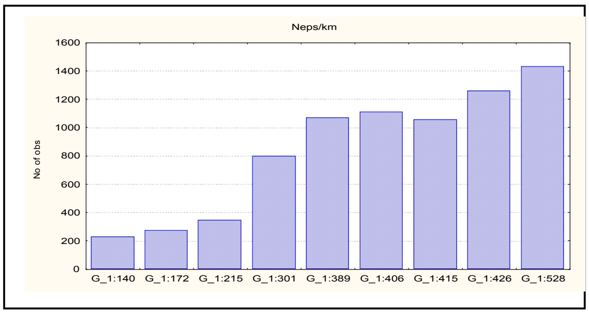

Figure 6. Comparison of neps per km

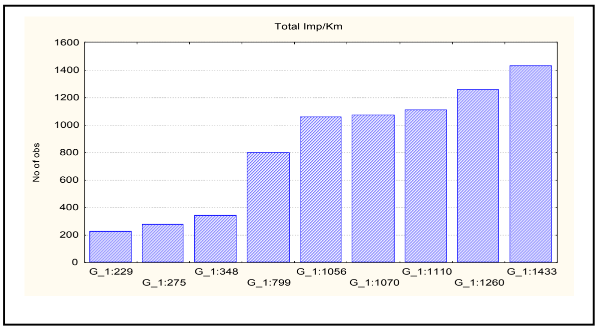

Figure 7. Comparison of total imperfections per km

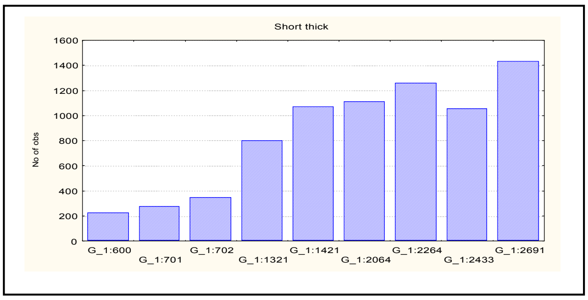

Figure 8. Comparison of short thick places

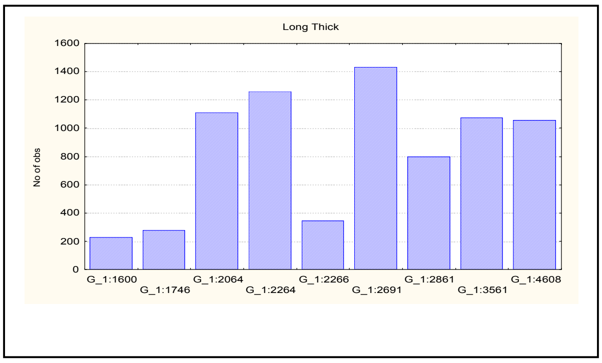

Figure 9. Comparison of long thick places

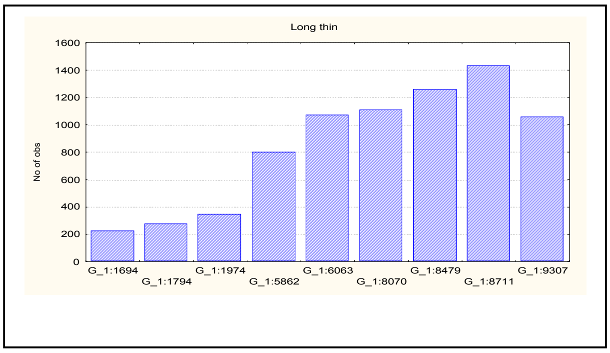

Figure 10. Comparison of long thin places

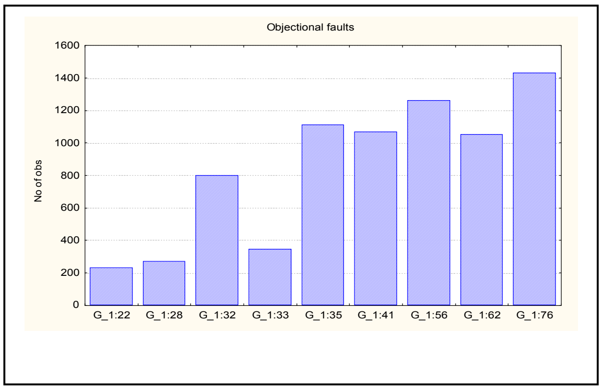

Figure 11. Comparison of objectionable faults

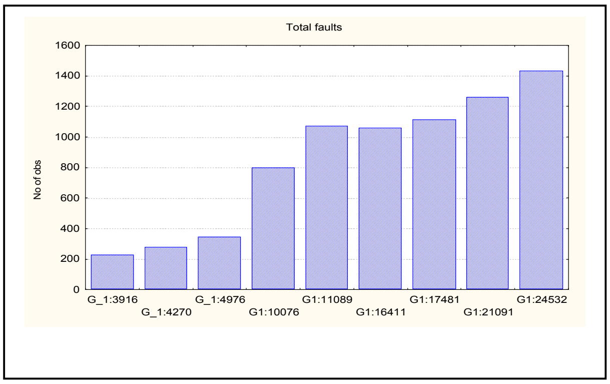

Figure 12. Comparison of total faults

The figures 5 to 12 depict the yarn fault analysis of three yarn counts namely 11.81 tex, 6.87 tex and 6.15 tex. The observations show more or less similar trend of yarn fault. The values of thick place per km, thin place per km and neps per km evaluated with the help of Uster Evenness Tester model UT 3 shows the faults were more pronounced in ring yarn followed by the modified ring yarn produced from custom built attachment and compact yarn.

The short thick place, the long thick and thin place were evaluated with the help of Uster Classimat also depicts the similar trend with more faults in ring yarn followed by the modified ring yarn produced from custom built attachment and compact yarn. The objectionable faults and the total faults also evaluated using Uster Classimat have shown the same trend.

It was evident all the three yarn counts showed similar trend which proves conditional logistic regression analysis by keeping the objectionable faults as independent variable and the total faults as dependent variable. By keeping the minimum of the total faults as '0' and the remaining as '1' the neps/km, total imperfections, short thick places, long thick places have significant contributions in the first stage. In the second stage thin places per km have shown significant contributions to the total faults.

Conclusions

The modified ring yarn produced by the custom built front bottom fluted roller has given a yarn with no adverse effects on quality parameters but an improvement on hairiness, single yarn strength, imperfections/km and Classimat faults is proved. The reason for reduction in hairiness is due to the chance of floating fibres being sucked in the front zone when it passes over the perforated bottom roller. Another supported reason for reduction of hairiness is that the material is drafted and twisted immediately after delivery and the formation of spinning triangle is also meager. This reduces higher strain in the fibre edges and ultimately more fibres flow at the centre. The result of the Classimat faults show a clear indication in overall reduction of faults and may be attributed to the uniformity of yarn produced. The objectionable faults are also reduced in all the counts tested and proved to have uniform drafting of the material with the new modification.

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