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Study the Impact of Rove Strand Surface Contact on Flyer Top and Roving Spacer Size on Ring Yarn Properties

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Abstract

The project focuses on the study the impact of the roving strand surface contact on flyer top and the spacer size on yarn properties. For the study 100% cotton fiber which 0.7Ne roving and 23Ne yarn were used. The different flyer top (front flyer top, conventional back flyer top, and modified back flyer top) and the roving spacer sizes (spacer size 4mm, spacer size 5mm, and spacer size 6mm) were used to produce a rove (0.7Ne) that were processed in to yarn. The produced yarns are tested in Almeda Textile Company spinning laboratory for different parameters. The modification of the conventional back flyer top is achieved by equalizing the surface contact of the rove strand on the front and back flyer tops. From the analysis it is found that low surface contact of rove strand on flyer top (conventional back flyer top) and higher spacer size has a significant effect on rove evenness, yarn evenness, and yarn strength compared to the modified back flyer top and smaller spacer size. These yarn properties are improved by modifying the conventional back flyer top and by using the smaller spacer size. The modification of conventional back flyer top is not only used to improve the yarn property but also used to reduce the number of sensors (light barriers) which controls the rove ends down in the roving machine.

Keywords: Flyer top • Yarn property • Surface contact • Spacer size • Evenness • Sliver property

Introduction

Product produced through speed frame is called as "Rove", which is packaged on bobbin. Speed frame process is an intermediate process which normally comes after draw frame process. Speed frame process reduces the weight of sliver and inserts protective twist into it. It is difficult to fed draw frame sliver directly to the ring frame due to draft limitation, and feeding problem for draw frame sliver. Hence it is required to reduce in two steps so that good yarn quality can be produced [1]. Spinning performance gets drastically affected by the faulty roving preparations. Parameters adopted for roving has significant impact on spinning quality and production. Speed frame machine comprises of pairs flyers and spindles, each pair of which represents one roving unit. The rotation of flyer imparts twist to the fibrous strands [2-4]. The bobbins are not arranged individually or in a single row. Instead, they are arranged in the delivery section in two rows one behind the other, with the bobbins of one row offset relative to those of the other. This arrangement is extremely economical in terms of space, but has several disadvantages: the design is made more complicated; operation of the machine is made less convenient; and automation is hindered. The technological disadvantages are still more significant. The effect is produced by the difference in the unsupported lengths the lengths between the drafting arrangement and the flyer top to have different angle of approach of the rove strand to the flyer top for the two rows (Figures 1 and 2). This results differences in take-up of twist, spinning triangle and different degrees of integration of the fibers [5-7]. Modern roving frames no longer suffer this technological disadvantage. In fact, the flyers in the rear row are equipped with an extension, which eliminates the above-mentioned differences in angles [8,9].

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Impact of spacer: Spacers are found in drafting zone which used between top and bottom aprons to create space between them. Spacer size is coded by color means that the different spacer colors have different size [10,11]. Using of Minimum possible spacer size in roving machine gives better results for rove and yarn property [12]. Evenness and total imperfection could be improved by closing down the apron spacing. SKF recommends smallest possible spacer for all the counts. It's however, often necessary to use a wider spacer for a coarser count [13,14]. If there are undrafted places in the yarn when it leaves the front rollers, the break draft should be increased. Spacer should be increased only if the draft results remain unsatisfactory after the break draft has been increased. The optimum selection of spacer size not only improves the yarn strength and evenness, but also reduces long thin and thick faults in the yarn [10,15,16].

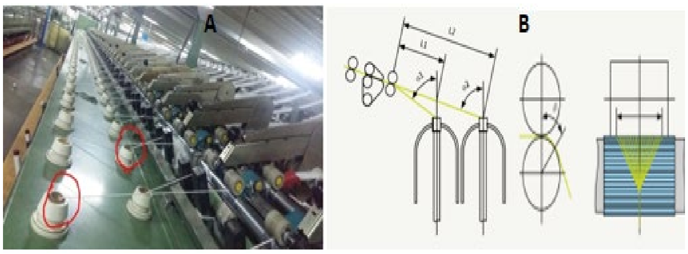

Figure 1. Roving machine thread (rove strand) path geometry at the delivery and flyer top (A taken from the working machine by the author and B taken from Bannot et al., book).

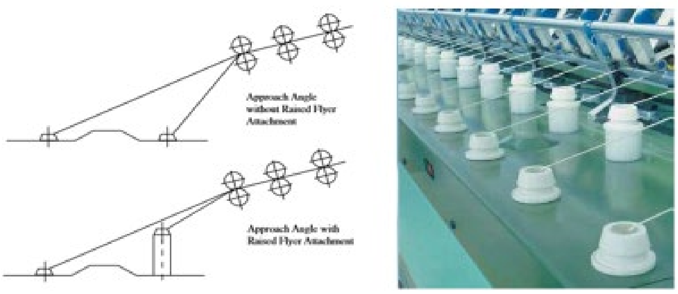

Figure 2. Roving frame machine flyer top development.

Materials and Methods

Materials

- Sliver – used as input material for roving machine
- Rove- used as input material for ring frame machine
- Yarn- used for checking the property
- Teflon - used to modify the back flyer top

Equipments

- Spacer (6mm, 5mm and 4mm) – to check the impact of spacer size on yarn property
- Lathe machine – to turn the Teflon to get the required shape
- Drill machine – to drill the Teflon
- Vernier caliper - used to measure thickness and length
- Power hack saw – used to cut the Teflon with required length
- Uster tester 3 – used to test evenness, thick and thin place, neps
- Uster tensorapid 3 – used to test strength of yarn

Methods

Rare/back flyer top modification and take measurement: First the variation in clearance between the two rove strands was measured and found to be 45mm (Figures 3-6).

Select Teflon diameter: After taking all the measurements Teflon with diameter of 70mm is used.

Turning and drilling of the Teflon: Two machines are used during the experiment (as shown in Fig 5). One is a lathe machine used to hold and turn the Teflon and the second one is a drilling machine for creating the desired diameter hole. Trying the modfied back flyer top on the machine for rove production and the surface contact of the rove strand on the back flyer top is increased as shown in Figure 6.

Rove production: Before the rove production the input material characteristics has been determined by the High-volume instrument (HVI) machine [17] and we have selected roving machine number 3. From this roving

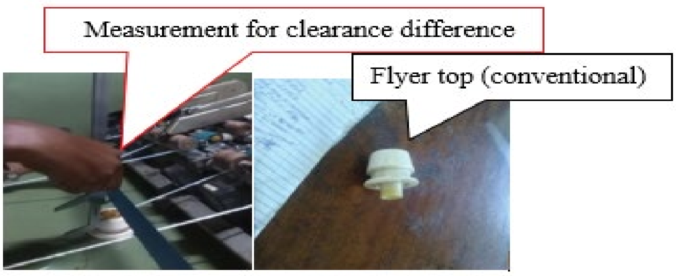

Figure 3. Rove strand clearance difference measurement flyer tops (photo taken by the author during modification).

Figure 4. Teflon measurement and cutting.

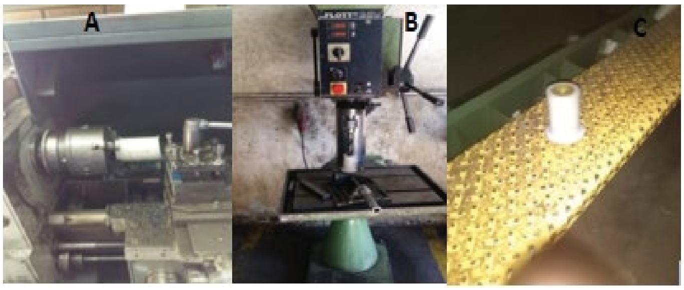

Figure 5. (A) Teflon turning, (B) Drilling and fitting and (C) The modified flyer top.

Figure 6. Modified flyer top on production (encircled by red).

machine two spindles (spindle number 117, 118) are used to produce five (5) rove strand samples each by using different spacer sizes (green color=6mm, black color=5mm, white color=4mm) sequentially with original flyer top. The same is done after modification of rare flyer top.

Testing the rove evenness: The rove produced after and before modification at different spacer sizes is tested its evenness using Uster tester 3, 10 times each sample.

Yarn production: Using of the rove produced in roving machine (spindles 117 and 118) with different conditions (spacer size and rare flyer top height) but similar rove count (0.7Ne) as an input is used to produce 23 Ne five (05) samples of yarn in ring spinning machine (no. 12) with spindle numbers of 553 and 554.

Testing the yarn properties: Evenness - of the yarn produced with different roving spacer size and before and after modification of flyer top is tested by using Uster tester- 3 evenness tester machine, 10 times each.

Yarn strength: The cotton yarn's produced with different spacer size and different back flyer top height are subjected for breaking strength test by Uster tensorapid -3, ten times each.

The study focuses on the impact of rove strand surface contact on flyer top and roving spacer size on yarn properties. Using of different spacer size on rove production and the variation in rove surface contact between the two rows back and front top flyer have an effect on yarn properties. The impact of rove strand surface contact on flyer top and spacer size yarn properties was studied and reported. The results of tests for selected yarn properties have been analyzed by taking USTER statistics norms [18] and the company set points

Results

Rove evenness test results: Experiments were conducted for 100% cotton rove strand produced from roving machine number 3 (F15 Marzoli) with rove count of 0.7 Ne produced by using of spacer sizes of 6, 5, and 4. Testing was performed in Uster evenness tester-3 by ISO 2649 method [19] and the results recorded were listed as follows (Tables 1-6 and Figures 7 and 8).

Yarn evenness test results: Testing was done according to ISO 2649 standard and system

Yarn strength test results: This testing was performed according to ASTM-1578 standards [20] and testing procedures

Table 1. Roving evenness test result for spacer sizes of 6 mm, 5 mm and 4 mm.

		Average test result of evenness (U %)					
Spacer size (mm)	**Flyer type**	**1**	**2**	**3**	**4**	**5**	**Mean**
6	Front flyer top	6.08	6.21	6.38	6.19	6.07	6.18
	Conventional back flyer top	6.32	6.49	6.46	6.79	6.92	6.59
	Modified back flyer top	6.01	6.16	6.13	6.02	6.21	6.11
5	Front flyer top	5.96	5.89	6.01	5.81	6.03	5.94
	Conventional back flyer top	6.35	6.16	6.38	6.48	6.09	6.3
	Modified back flyer top	5.42	5.45	5.58	5.52	5.47	5.49
4	Front flyer top	5.34	5.28	5.31	5.26	5.38	5.31
	Conventional back flyer top	5.74	5.87	5.68	5.91	5.97	5.83
	Modified back flyer top	5.21	5.26	5.3	5.28	5.32	5.27

Table 2. Statistically determined roving evenness results.

Flyer type	spacer size(mm)	Mean	SD	Cv%
Front	6	6.18	0.251	4.061
	5	5.94	0.184	3.098
	4	5.31	0.10	1.883
Conventional back	6	6.59	0.499	7.572
	5	6.3	0.324	5.143
	4	5.83	0.243	4.166
Modified back	6	6.11	0.176	2.88
	5	5.49	0.126	2.304

Table 3. Yarn evenness Test result for different spacer size.

Spacer size (mm)	Flyer top	Sample	Um%	Cvm (1m)(%)	Thin place (-50%)	Thick place (+50%)	Neps (+200%)
6	Front	1	13.25	17 .05	3	208	163
		2	13.07	16.8	5	178	160
		3	13.11	17.03	6	189	157
		4	14.01	16.77	2	176	113
		5	11.18	16.89	4	178	139
	Conventional Back	1	15.96	20.42	90	349	346
		2	11.87	14.99	0	152	141
		3	13.81	17.75	16	223	179
		4	14.71	18.67	21	271	193
		5	13.95	17.86	5	227	88
	Modified Back	1	12.61	16.85	0	89	69
		2	12.50	16.20	1	138	103
		3	12.60	16.26	1	136	93
		4	13.44	16.09	2	97	108
		5	13.86	16.20	1	120	98
5	Front	1	13.45	17.23	3	128	69
		2	11.95	15.23	0	90	52
		3	12.46	16.05	0	104	65
		4	12.05	16.36	2	129	105
		5	12.63	16.26	3	128	99
	Conventional Back	1	12.43	15.99	1	119	88
		2	14.48	10.66	16	246	184
		3	12.12	16.8	15	245	198
		4	14.34	18.34	22	210	164
		5	12.87	16.46	1	215	172
	Modified back	1	12.81	16.87	5	154	108
		2	13.65	17.5	8	132	71
		3	12.53	16.71	2	129	86
		4	12.62	16.84	3	124	92
		5	12.71	17.11	1	118	99

4	Front	1	12.25	16.23	2	108	79
		2	11.85	15.52	0	87	58
		3	12.26	16.32	1	94	55
		4	11.72	15.69	1	96	72
		5	11.92	16.23	2	98	81
	Conventional Back	1	13.31	17.33	2	177	131
		2	12.87	14.99	0	152	141
		3	12.15	16.87	5	165	138
		4	12.08	16.72	3	148	134
		5	13.02	16.49	4	167	142
	Modified back	1	12.13	15.45	1	95	57
		2	11.98	15.79	0	101	72
		3	12.23	15.60	0	81	67
		4	11.73	14.92	1	69	97
		5	11.52	14.73	0	95	99

Table 4. CV% of yarn evenness test results from table 3.

Flyer top	Spacer size(mm)	Mean	SD	CV%
Front	6	12.92	2.094	16.206
	5	12.51	1.256	10.006
	4	12.00	0.583	4.89
Conventional back	6	14.06	2.984	21.2
	5	13.25	2.19	16.525
	4	12.69	1.090	8.59
Modified back	6	13.00	1.216	9.36
	5	12.86	0.904	7.029
	4	11.92	0.488	4.065

Table 5. Yarn strength test result.

Spacer size (mm)	Flyer type	Average yarn strength test (cN/Tex)					
		1	2	3	4	5	Mean
6	Front	12.17	11.35	10.40	11.54	9.79	11.05
	Back	8.28	9.73	10.71	9.57	10.72	9.802
	Modified back	10.47	9.68	9.83	11.15	10.24	10.274
5	Front	10.56	11.60	11.22	10.44	12.31	11.23
	Back	9.71	9.40	10.08	11.65	9.11	9.99
	Modified back	12.05	11.43	12.01	13.23	12.11	12.17
4	Front	12.14	12.31	11.98	12.01	11.58	12.00
	Back	11.42	12.27	11.21	11.80	12.14	11.77
	Modified back	12.57	12.65	12.85	13.11	13.41	12.92

Table 6. Statistically determined CV% of yarn from table 5.

Flyer top	Spacer size(mm)	Mean	SD	Cv%
Front	6	11.05	1.896	17.16
	5	11.23	1.542	13.75
	4	12.00	0.541	4.5
Conventional back	6	9.802	2.010	20.5
	5	9.99	1.99	18.9
	4	11.77	0.908	7.72
Modified back	6	10.27	1.165	11.34
	5	12.17	1.31	10.76
	4	12.92	0.691	5.35

Discussion

Impact on rove evenness: As shown in the above table 1 and statistical analysis the test result for the roving sample produced from the roving frame machine number 3 with spindle number 117, 118 of 0.7Ne rove count, the Cv% for evenness of modified back flyer top is better than the conventional back flyer top. The Cv% of conventional back flyer top is (7.572%, 5.143%, 4.166%) but Cv% of modified back flyer top is (2.88%, 2.304%, 1.80%) Cv% with spacer size of 6, 5 and 4 respectively. As we can see form the result with the same spacer size the modified back flyer top has better result as well as in general decreases respectively with regards to spacer size decrement. This is because the surface contact of the roving strand on the modified back flyer top is higher than the conventional back flyer top which helps to get additional twist on the rove strand. Due to the additional twist insertion the spinning triangle of the modified back flyer top is narrow when we compare with the

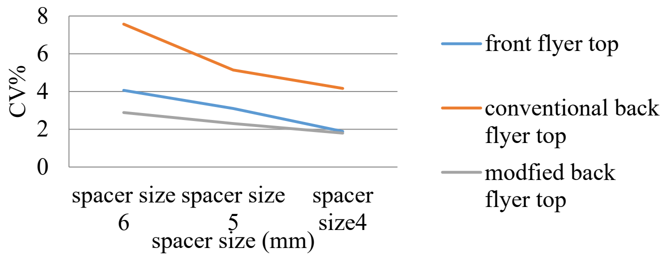

Figure 7. CV% of rove evenness with different roving spacer size.

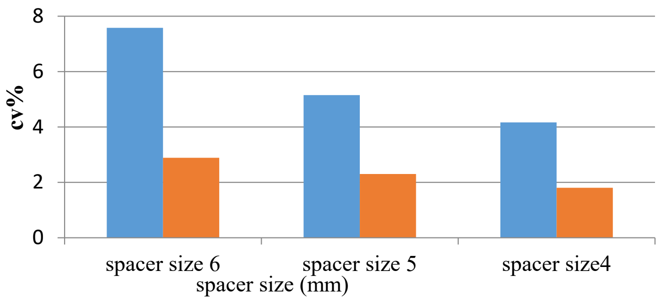

Figure 8. CV% of rove evenness difference of modified and conventional back flyer top.

conventional back flyer top spinning triangle. When the spinning triangle is narrow fibers will attach cohesively without any flying fiber which results for rove hairiness reduction. Using of different spacer size have effect on roving evenness as shown on the above statistical analysis. During producing of the rove different types of spacers were used (green 6mm, black 5mm and white 4mm). The Cv% for evenness of front flyer top (4.061%, 3.098%, 1.883%), conventional back flyer top (7.572%, 5.143%, 4.166%), modified back flyer top (2.88%, 2.304%, 1.80%) for spacer size of 6, 5 and 4 respectively for all. As the spacer size reduces the rove evenness gets better for all flyers and same is for Cv% to evenness. The spacer size determines the fiber volume and proper fiber guidance on the main drafting zone. As the spacer size reduces there will have proper fiber guidance to have parallel arrangement and proper handling for the rove strand formation with even strand surface. But if the spacer is too small there will negative impact on fiber damaging or count variation for not permitting to pass enough number of fibers through the strand.

Impact on yarn evenness: The 23Ne ring spun yarn sample produced from the ring spinning machine number 12 with spindle numbers 553 and 554 by using of the previous produced 0.7Ne rove. Based on the above statistical analysis Cv% of yarn evenness for rove produced using of conventional back flyer top is (21.2%, 16.525%, 8.59%) but Cv% of yarn produced from rove produced using of modified back flyer top is (9.36%, 7.029%, 4.89%) produced with spacer size of 6,5 and 4 respectively. As we have seen the test results for evenness on the rove strand produced from the modified back flyer top is better than the conventional back flyer top. The same result is coming to yarn because the evenness problem in rove strand pass to yarn. And also, as shown the above statistical analysis on table 4 the Cv% for spacer size 6, 5 and 4 the Cv% for yarn evenness of front flyer top (16.206%, 10.006%, 4.065%), conventional back flyer top (21.2%, 16.525%, 8.59%) and modified back flyer top (9.36%, 7.029%, 4.89). Additionally, the test results for modified back flyer top and front flyer is similar in all cases. This shows the surface contact for the rove strand for both gets similar.

Impact on thick, thin place and neps: The yarn produced from different rove strand were subjected for yarn thick (+50%), thin (-50%) and neps (+200%) during yarn evenness analysis. As you have seen the results on table 3 the yarn produced from rove strand of front flyer and modified back flyer top with a spacer size of 4 have better results for the three aspects. And as the spacer size increases the results get worse for the all yarns produced from different rove strands. Thick, thin and neps results from mass variation on the yarn strand. The reason for their presence on the yarn strand is due to fiber guidance problem during spinning. For higher spacer size you may have thin, thick or neps at a time. Rove strand produced with high spacer size there is a big problem on fiber guidance on the main drafting zone. The fibers have a chance to pass together without volume limit and causes thick and thin at a time. And for improper guidance we can face fiber paralleling problem which may snarl each other results for neps. With modified top flyer on back and front flyers we can have impact on fiber cohesiveness to form neps, thick and thin. If the surface contact of rove strand is low on the flyer top the fibers will fly or transfer to other portion of the strand which results mass variation on the total strand at different distance.

Impact on yarn strength: From the above statistical analysis, the Cv% of yarn strength for the modified flyer top is better than conventional back flyer top. The Cv% for yarn strength of conventional back flyer top (20.5%, 19.9%, 7.72%) but the modified back flyer top is (11.34, 10.76, 5.35. the strength of yarn depends on the contribution of each fiber on the strand. This relates how much the fibers are arranged parallel to each other toward the center axis of the yarn strand. And also, as shown on the above statistical analysis table 6 the Cv% of yarn strength for spacer size 6, 5, 4 is decrease respectively. The Cv% of front flyer top (17.16%, 13.75%, 4.5%), conventional back flyer top (20.5%, 18.9%, 7.72%), modified back flyer top (11.34%, 10.76%, 5.35). From the results yarns produced form modified back flyer top with smaller spacer size have better result. Because the smaller spacer size gives better fiber guidance by making parallel to each other. The same thing is true for modified back flyer top helps the rove strand to get additional twist for binding the fibers to the core of the rove strand i.e., there is no flying out fibers and all will be bind to the yarn central axis to increase the substance utilization of the fibers. Generally, the modified back flyer top was given better yarn properties than conventional back flyer top. Modified flyer top not only improve yarn property but also reduce the number of light barrier sensors by half on roving machine which control tension and ends down. The roving machine in Almeda each flyer top need to have individual light barrier because the angle of contact of front flyer top and back flyer top is different so it needs the front flyer top one light barrier and the back flyer top need another light barrier separately. But the modified back flyer top and the front flyer top only need one light barrier because the angle of contact for both is the same. And also, the spacer size 4mm have given better rove and yarn property. To improve the property of yarn the optimum spacer size is recommend.

Conclusion

Generally, roving strand surface contact on flyer top and spacer size have an impact on yarn properties such as strength and evenness of the yarn were studied in this project. The study shows that the impact of roving strands surface contact on flyer top and spacer size on yarn properties is high. As the surface of contact on the flyer top and rove strand increase the rove strand evenness, yarn strength, evenness and total imperfection gets better in all spacer sizes. But at spacer size of 4mm is good for all rove and yarn properties. Optimum selection of roving spacer size is an important one to improve roving evenness, yarn evenness and strength of the yarn. In order to improve the evenness and strength the size of the spacer size should be small. Therefore, it can be concluded that the modified back flyer top and small spacer size have given better strength and evenness of yarn.

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