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Improvement in Jute Yarn Quality Ratio by Incorporation of Draw Head System at Carding Stage

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Abstract

Jute as very unique natural bast and its industrial manufacturing started in India from around 1855. Till then jute processing machinery and the processing system progressed very slowly. Presently jute fibre/yarn used in several diversified products other than food grain packaging bag. To improve the quality of jute yarn a study has been carried out in a jute mill where the quality of jute yarn produced by usual finisher card (fitted with roll former) is compared with quality of yarn produced by the draw head fitted finisher card system. As two types of draw head systems are available presently, total three process are compared based on yarn quality produced by them.

It is found that draw head plays an important role on jute yarn quality in comparison to simple finisher card with roll former system. Specially the yarn produced by L make draw head system shows uniform controlled average sliver weight, lower sliver and yarn CV% better evenness and higher minimum yarn strength in yarn.

Traditional drawing frames are used for regular jute yarn, now-a-days by using draw heads in jute mills will improve the quality of the output sliver. This sliver is producing regular and fine jute yarn with higher tensile strength, work of rupture, breaking elongation and quality ratio and count variation percentage. The produced modified yarn was also more regular and uniform comparing to the traditional drawing frame.

Keywords: Draw-head • Quality ratio • Regular jute yarn • Roll former • Yarn evenness

Introduction

Jute is a natural lingo-cellulosic bust fibre. Due to its unique characteristics, it considered as a good technical textile fibre. At present jute industry is using modern rapier loom for production of B twill fabric. This process demands better even and strong jute to comply the standard loom efficiency. Jute fibre grows abundantly in India having average quality hence use of good quality fibre to improve the yarn strength is not cost effective. The alternate way to increase the yarn strength is needed to be identified.

James Mackie and sons introduced draw-head system earlier at jute finisher card stage to reduce a first drawing process and to make the jute yarn processing system more economic. They have introduced a push bar type draw-head in front of finisher card. The system was attached with delivery roller of the finisher card and no extra manpower was required for the system. Due to push bar type system, draw-head system failed to attain quality requirement.

Presently different new draw-head systems are again introduced in jute industry with different designs and specifications but the effects of those systems are not studied systematically. In the present study, the project team has given efforts to find out the effect of different draw-head system on yarn quality as well as compared the qualities with yarn quality of normal finisher card system (without draw-head) [1].

Materials and Methods

Three finisher cards withdraw head attachment are chosen for the study, one with roll former system and another two with two types of draw-head. These two draw heads are of different make. One is L make, another one is H make. Except the finisher cards other processing machineries are kept same for study. Same raw jute are processed through same machineries up to spinning and only finisher carding system was varied (Tables 1,2 and Figure 1).

The studies were decided to be performed for hessian 8.0 lb/ spindle yarn. The processes were performed at Ambica jute mills Pvt.

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The studies were decided to be performed for hessian 8.0 lb/ spindle yarn. The processes were performed at Ambica jute mills Pvt. Ltd, Howrah. Raw jute batch used for the experiments are given below:

Sl. no.	Jute quality	Weight % in the batch
1	Lower Assam	50%
2	Semi Northern	25%
3	Dessi	25%

Table 1. Quality of raw jute used during the project

Sl. no.	Name of the machine	Make	Specification	Draft applied	Doubling applied	Converted sliver Wt (at 16 % MR) at delivery
1	Spreader	Star India		10	NA	65 lb
2	Breaker	Madhabi engineering works Pvt. Ltd.	3 Pair	22.5	6:1	20 lb
3	Finisher card	Madhabi engineering works Pvt. Ltd.	3 and half pair	14	11:1	13.5 lb
4	Draw head, make-L	Lagan	Pin roller type	1.94	1:1	6.75 lb
5	Draw head, make-H	Hans	Drum type	2.02	1:1	6.75 lb
6	First drawing	Jutex industries Pvt. Ltd.	Screw gill	4	2:1 for roll former system and 4:1 for draw head system	6.75 lb
7	Second drawing	Mackie	Screw gill	6.1	4:1	4.42 lb
8	Inter drawing	Bhowmik	Screw gill	6.1	6:1	4.35 lb
9	Third drawing	Bhowmik	Screw gill	8.632	2:1	135 lb
10	Spinning	Bhowmik	Apron draft, 4 ¾" pitch	16.3	1:1	8.0 lb

Table 2. Details of machinery.

Both of the three process are same except the use of roll former system of finisher card and two types of draw head system between breaker card and 1st drawing machine [2].

Details of draw head (make-L)

Gearing of draw head system (make-L) and corresponding speed calculations rollers position and distances are given in Figure 2.

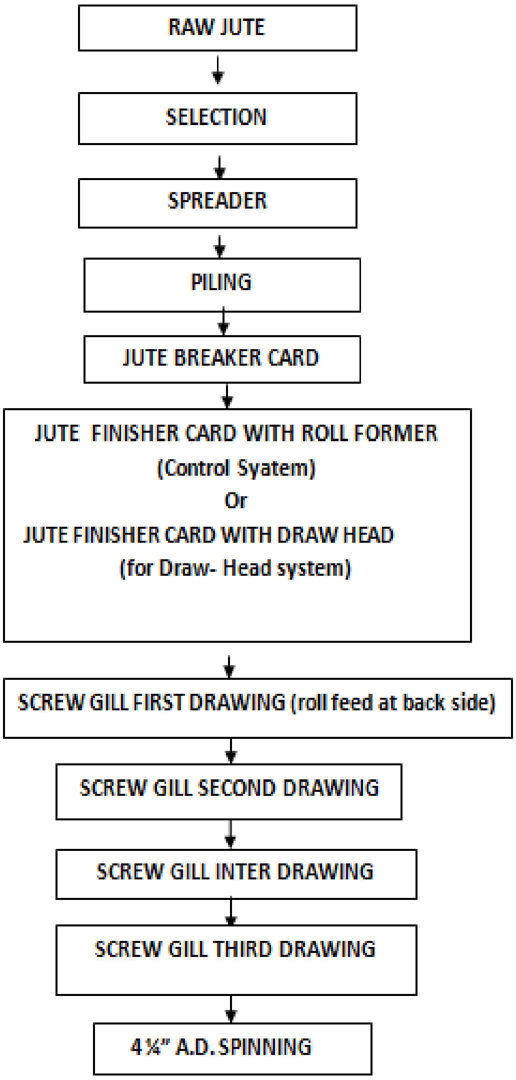

Figure 1. For finisher card with roll former system.

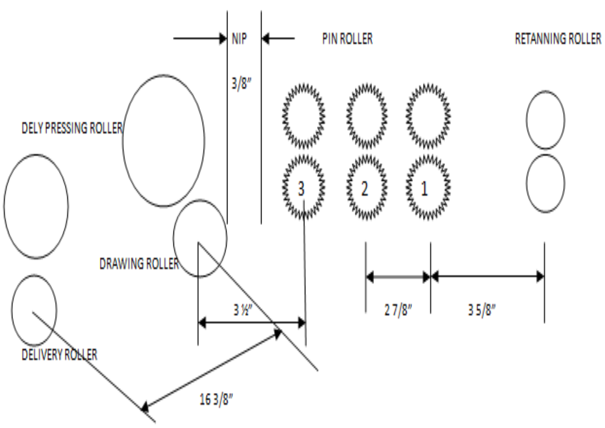

Figure 2: Roller position and distances of draw head system (make-L).

Roller diameters, distances

Details:

Diameter of delivery roller: 5"

Diameter of rubber pressing roller: 8 ½"

Diameter of drawing roller: 3 1/8"

Diameter of retaining roller: 2 ¾" (both front and back)

Diameter of retaining pressing rubber roller: 6 ¼"

Diameter of pin roller: 3.2"

Diameter of delivery roller: 5"

Centre distances between rollers:

Drawing roller to pin roller 3: 3.5"

Drawing roller to deliver roller: 16 3/8"

Drum no 3 to front retaining: 4 ¾"

Front retaining to pin roller 1: 3 5/8"

Length of drafting zone: 9 7/8"

Width of drafting zone: 7 3/8"

Delivery to drawing roller: 16 3/8"

Other details:

Delivery Speed of finisher card: 229.6 fpm (Tachometer speed)

Delivery speed of draw head: 398.10 fpm (Tachometer speed)

Draft of draw head: 1.94

Gearing calculations of draw head (make-L)

Surface speed of draw head retaining roller:

158.24 × (30/18) × (72/63) × (2.75/12) × 22/7=217.08 FPM

Surface speed of drawing roller:

158.24 × (30/18) × (72/40) × (3.125/12) × 22/7=388.54 FPM

Surface speed of delivery roller:

158.24 × (38/8) × (72/40) × (23/36) × (5/12) × 22/7=397.16 FPM

Draft constant:

(63/DP) × (23/36) × (5/2.75)=73.18 (DP-40T)

Draft:

DC/DP=73.18/40=1.83 (DP- 40T)

Gearing calculations of draw head (make-H)

Surface speed of front retaining roller:

168 × (25/20) × (21/21) × (68/34) × (34/34) × (2.0612/12) × 22/7=226.73 FPM

Surface speed of drawing roller:

168 × (25/20) × (21/21) × (48/24) × (46/40) × (28/20) × (2.5/12) × 22/7=442.75 FPM

Surface speed of delivery roller:

168 × (25/20) × (21/21) × (48/24) × (46/40) × (3.5/12) ×22/7=442.75 FPM

Draft constant:

(34/68) × (48/24) × (36/DP) × (3.5/2.031)=79.2

Draft:

DC/DP=79.2/40=1.98 (DP=40T)

Draw head (make H)

Gearing of draw head system (make-L) and corresponding speed calculations. Rollers position and distances are given below:

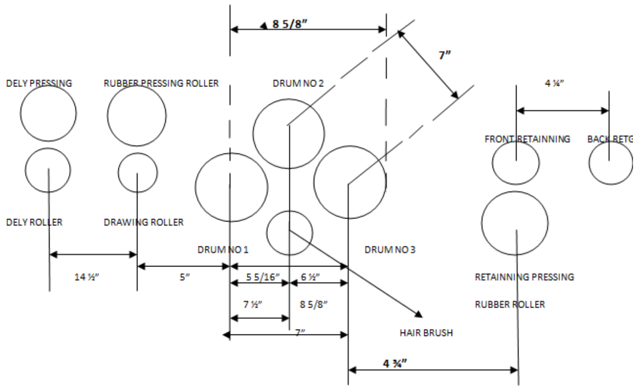

Figure 3. Roller position and gearing of draw head system (make-H).

Details:

Diameter of delivery roller: 3 ½"

Diameter of delivery pressing roller: 3 ½" Diameter

of rubber pressing roller: 8 ½"

Diameter of drawing roller: 2 ½"

Diameter of retainning roller: 2" (both front and back)

Diameter of retainning pressing rubber roller: 4 3/8"

Diameter of hair brush: 2 7/8"

Diameter of drum no 1: 6 1/8"

Diameter of drum no 2: 6 5/32"

Diameter of drum no 3: 6 3/16"

Centre distances between rollers:

Drawing roller to pin roller 3: 3.5"

Drawing roller to deliver roller: 16 3/8"

Drum no 3 to front retaining: 4 ¾"

Front retaining to pin roller 1: 3 5/8"

Length of drafting zone: 9 7/8"

Width of drafting zone: 6

Delivery to drawing roller: 16 3/8"

Other details:

Delivery speed of finisher card: 167.28 fpm (Tachometer speed)

Delivery speed of draw head: 440.65 fpm (Tachometer speed)

Draft of draw head: 2.02

Results and Discussion

Slivers and yarns of each stages are tested for each process and all data are tabulated below from Tables 3-7. Simultaneously several graphs are drawn to understand the comparison of test results obtained in the study (sliver and yarn parameters) for three identified process with and without draw head systems [3].

All sliver weight summary is given in Table 3 and yarn grist and weight summary is given in Table 4. Yarn evenness summary is given in Table 5.

A special draft-doubling relation tests were done during the study, to relate the extra doubling effect at draw head in sliver and yarn quality. The data of the said study are given in Table 6.

Stages	Parameters	Without draw head			With make-L draw head			With make-H draw head		
		Exp-1	Exp-2	Exp-3	Exp-1	Exp-2	Exp-3	Exp-1	Exp-2	Exp-3
Spreader (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	61.37	65.06	63.9	73.27	74.2	72.34	73.37	69.88	62.29
	Range	41.77-88.05	43.79-84.92	52.06-76.95	57.58-101.46	51.79-103.65	63.37-99.27	56.58-96.69	43.86-113.74	44.37-87.59
	CV%	25.71	20.77	14.64	21.28	26.79	15.76	17.31	31.71	22.06
	MR%	36.2	37.91	36.25	34.45	33.9	35	34.1	29	41.2
Breaker card (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	20.65	18.54	18.59	17.03	17.18	17.42	22.17	15.765	18.53
	Range	14.96-29.26	13.20-22.49	16.84-20.89	14.39-20.36	14.17-20.62	14.61-20.10	20.63-23.75	13.30-17.65	1820-20.03
	CV%	19.43	18.3	13.51	11.99	13.37	10.61	5.19	11.13	2.81
	MR%	29.83	33.83	34.67	28.85	28.8	28.9	28.5	27.6	33.58
Finisher card (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	14.148	12.4	13.21	Not applicable					

	Range of sliver Wt	12.80-15.17	11.91-13.42	12.68-14.27						
	CV%	6.91	4.97	3.95						
	MR%	25.2	32.6	27						
Draw head (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	Not applicable			6.36	6.41	6.33	7.49	6.15	7.14
	Range of sliver Wt				5.60-6.85	5.52-6.68	5.76-6.6	6.72-8.10	3.63-6.95	6.06-8.59
	CV%				5.35	5.53	4.98	5.29	19.3	14.46
	MR%				22.3	29.2	27.3	25.9	24.6	30.92
1st Drawing (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	6.87	5.36	6.84	6.24	6.31	6.31	7.83	6.89	6.29
	Range of sliver Wt	6.48-7.30	3.89-6.69	6.60-7.20	5.77-6.54	6.07-6.62	6.02-6.51	7.44-8.21	6.53-6.97	6.10-9.40
	CV%	5.22	20.47	3.36	3.81	3.19	3.1	3.54	3.44	1.91
	MR%	25.2	31.2	27.6	22.3	26	25.9	22.9	25.3	28.4
2nd Drawing (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	4.16	3.69	4.25	3.79	3.81	3.72	4.49	4.35	3.8
	Range of sliver Wt	3.73-4.54	3.55-3.96	3.95-4.41	3.46-4.09	3.63-4.08	3.52-4.02	4.15-4.78	3.93-4.58	3.36-4.01
	CV%	8.69	4.36	3.38	5.31	3.45	5.03	5.11	4.34	5.65
	MR%	22.6	30	25.1	22.9	24.5	23	23.1	422.9	25.8
Inter drawing (5 yds test length)	Average sliver weight in lb/100 yds at 16% MR	3.98	3.27	4	3.67	3.63	3.77	4.38	4.12	3.79
	Range of sliver Wt	3.71-4.20	2.15-3.69	3.95-4.07	3.51-3.84	3.49-3.79	3.6-3.99	3.85-4.79	4.04-4.26	3.66-3.9
	CV%	5.65	19.5	1	3.22	2.6	3.31	6.15	1.75	2.41
	MR%	22	28.2	24.4	21.8	24.5	22.7	20.4	21.6	24.4
Finisher drawing (30 yds test length)	Average sliver weight in lb/100 yds at 16% MR	136	116.27	139.77	127.67	125.71	128.11	151.41	137.408	130.26
	Range of sliver Wt	132.14-139.72	110.49-119.6	134.33-146.92	127.02-131.27	122.83-127.83	123-138.11	139.5-176.85	134.88-140.63	126.21-134.76
	CV%	2.22	3.36	2.62	1.84	1.19	3.86	6.94	1.69	2.09
	MR%	22.8	28.2	24.2	19.7	20.8	21.4	22.1	20.1	22.7

Table 3. Sliver weight summary.

From Table 3, it is observed that make L draw head system has better control over average sliver weights as well as on sliver weight variation and CV% which is prominent from 1st drawing stage to finisher drawing stage.

Parameters	Without draw head	Without draw head	Without draw head	Average, maximum, minimum and variations for with-out draw head system	With make-L draw head-1	With make-L draw head-2	With make-L draw head-3	Average, maximum, minimum and variations of With make-L draw head system	With make-H draw head	With make-H draw head	With make-H draw head	Average maximum, minimum and variations of with make-H draw head system
Yarn count average (in grist)	8.85	7.78	8.96	7.78-8.96	7.76	7.97	7.91	7.76-7.97	10.02	8.99	8.49	8.49-10.02

Yarn count CV%	4.63	7.65	3.49	3.49- 7.65	2.56	2.27	3.3	2.27-3.30	6.62	3.7	4.71	3.70 -6.62
Yarn count maximum (in grist)	9.41	8.35	9.39	9.41	8.24	8.23	8.4	8.4	11.3	9.54	9.49	11.3
Yarn count minimum (in grist)	8.05	6.16	8.46	6.16	7.52	7.74	7.58	7.52	9.2	8.52	8.12	8.12
Strength averagen (in lb)	6.54	6.42	7.07	6.68	6	6.1	6.18	6.09	7.96	7.31	6.83	7.37
Strength CV%	13.58	12.55	18.75	12.55-18.75	15.51	10.89	15.57	10.89-15.57	19.13	18.83	23.89	18.83-23.89
Strength maximm (in lb)	8.2	8.6	9.8	9.8	8.6	7.4	9	9	12.2	10.2	11.8	12.2
Strength minimum (in lb)	5	5.2	4.1	4.1	5	5	5	5	5	5	4	4
QR	73.9	82.58	78.91	80.36	77.32	76.54	78.13	77.33	79.44	81.31	80.45	80.36
Min QR (average of minimum 5 readings)				58.15				63.45				51.47

Table 4. Yarn parameters details (for 8 lb/ spyndle).

From Table 4, it is prominent that make L draw head system has better control on yarn count and CV% over other two systems. The minimum yarn strength and minimum quality ratio of make L draw head system is also improved than other two systems.

From Figures 4 and 5, it is observed that yarn count variation of L make draw head system is much controlled over other processes. This is a graphical representation of improvement of count variation in support of Table 4. The yarn grist variation is significant as per T test given in page no.

From Figure 5, it is observed that minimum quality ratio of L make draw head system much better than other processes. This is just a graphical representation of improvement of minimum quality ratio in support of Table 4.

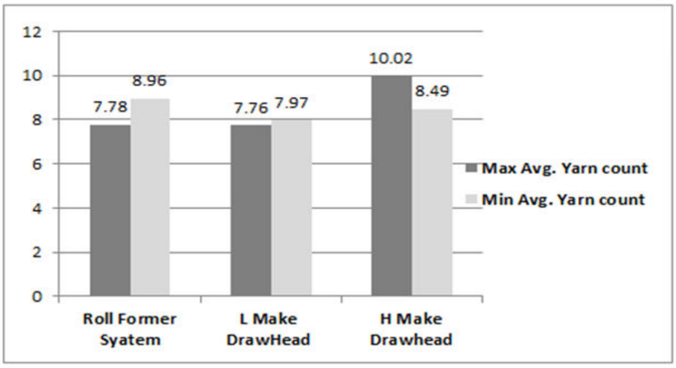

Figure 4. Range of average yarn count (grist) obtained during repetition of process for each of 3 different system.

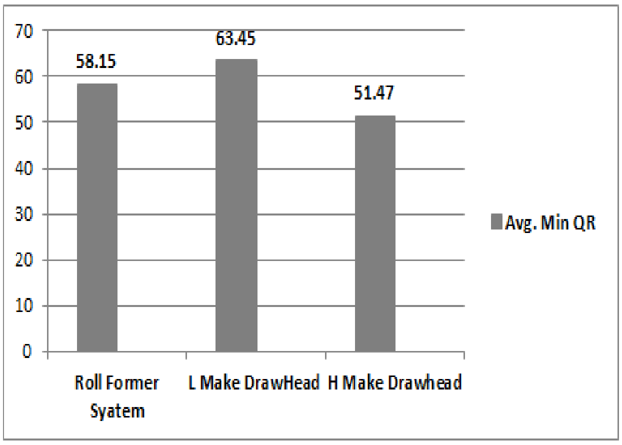

Figure 5. Average of 5 minimum yarn quality ratio obtained during repetition of process for each of 3 different system.

All yarn evenness and irregularity related data are tabulated for all the systems in Table 5. Make L data are better for maximum yarn evenness related parameters like Um%, CVm (1 m)%, CVm (3 m)%, number of -60% thin places, Thick places and neps/slubs. Spyndle is length of 14400 yards.

Sl no.	Parameters	Average values for role former system	Average values for make-L draw head	Average valuesfor make-H draw head
1	Um%	24.8	21.8	22.4
2	CVm%	33.8	28.3	29.6
3	CVm (1 m)%	15.6	11.7	13.3
4	CVm (3 m)%	11.5	8.3	9.8
5	Thin/km (-30)%	5550	5133.3	4843.3
6	(-40)%	3336.7	2920	2601.7
7	(-50)%	1580	1060	968.3
8	(-60)%	450	186.7	233.3
9	Thick/km (+35)%	2873.3	2473.3	2395
10	(+50)%	1540	1066.7	1256.7
11	(+70)%	640	423.3	516.7
12	(+100)%	236.7	103.3	131.7
13	Neps/km (+140)%	716.7	470	570
14	(+200)%	283.3	113.3	161.7
15	(+280)%	93.3	33.3	45
16	(+400)%	23.3	13.3	11.7

Table 5. 8 lb/spyndle* yarn evenness summary report.

From the two bar chart it is observed that CV% for 1 m and 3 m length is improved in L make draw head in comparison to the other two systems (Figures 6 and 7).

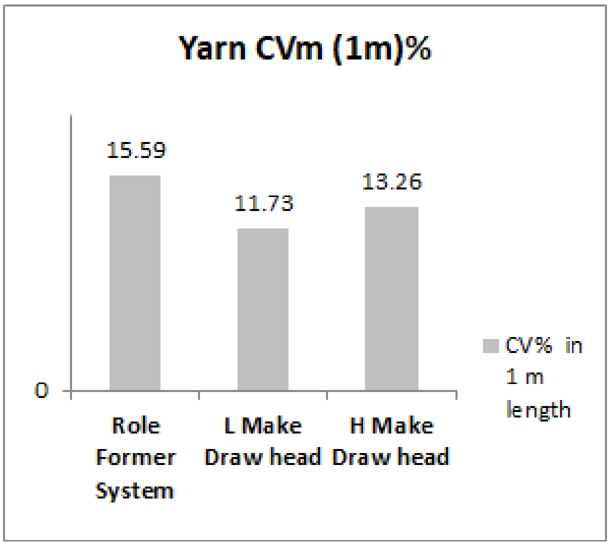

Figure 6. Yarn CV% of 1 m cut length of 3 different systems.

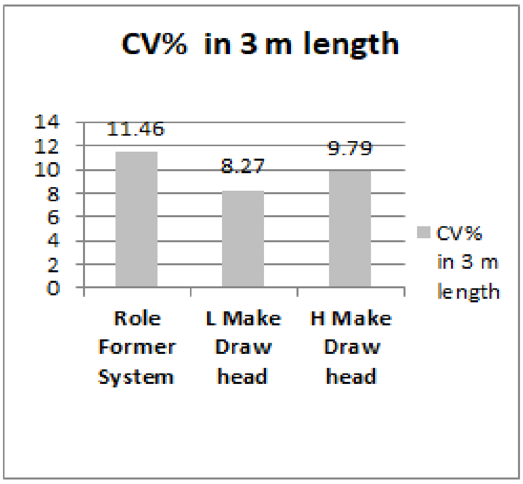

Figure 7. Yarn CV % of 3 m cut length cut length of 3 different systems.

From this bar chart of Figure 8, it is found that in L make draw head -60% Thin portion is much controlled. From the above two bar chart it is observed that, in case of number of 100% thick portion present in the yarn, L make draw head yarn is showing better result in comparison to the other two systems (Figure 9).

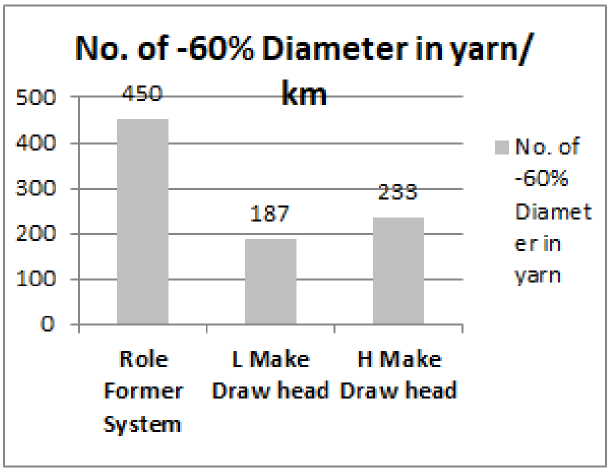

Figure 8. Average no. of -60% thin portion in the yarn processed by 3 different systems.

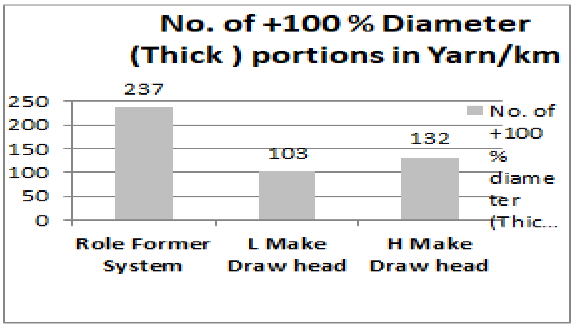

Figure 9. Average no. of +100% thick portions in the yarn processed by 3 different systems.

From the above bar chart of Figure 10, it is found number of slubs/ neps are improved in L make draw head system in comparison to the other two systems (Table 6) [4].

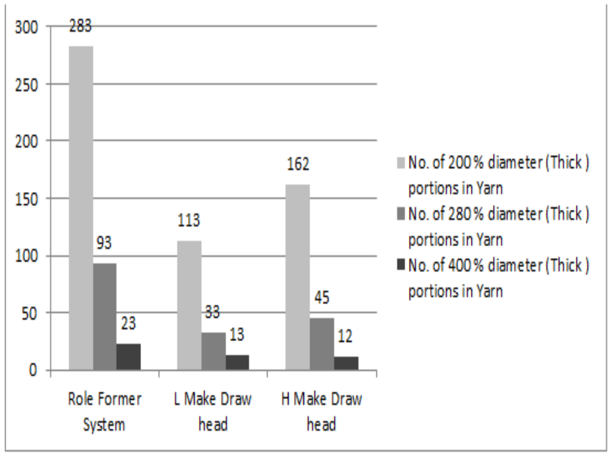

Figure 10. Average no. of +200%, +280% and +400% thick portions in the yarn processed by 3 different systems.

1 yds test length, For F/ Dwg-1yds	Without draw head				With make l draw head-exp				With make h draw head			
	Exp-1	Exp-2	Exp-3	Range of CV %	Exp-1	Exp-2	Exp-3	Range of CV %	Exp-1	Exp-2	Exp-3	Range of CV %
Finisher card average sliver weight of 1 yd test length (in lb/100 yds)	13.61	12.05	14.21		6.33	6.62	6.57		7.6	7.39	5.95	
Finisher card with roll former sliver weight cv % of 4 yd test length	11.17	6.15	5.66	5.66-11.17	8.52	9.68	7.24	7.24-8.52	5.59	9.5	19.21	5.59-19.21
1st Drawing draft	4				4				4			

1st Drawing doubling	2				4				4			
1st Drawing average sliver weight of 4 yd test length (in lb/100 yds)	6.92	5.33	6.77		6.28	6.26	6.29		7.96	7.14	6.56	
1st Drawing sliver weight cv % of 4 yd test length	7.09	19.51	3.23	3.23-19.51	5.06	2.13	1.84	1.84-5.06	3.46	5.62	3.31	3.31-5.62

Table 6. Draft doubling effects.

A special draft-doubling relation tests were done to relate the extra doubling effect at draw head in sliver and yarn quality. Here 1 yd samples are taken from finisher card roll/draw head delivery which is actually 1st drawing feed sliver.

As the first drawing doubling is 2:1 for roll former system and 4:1 for draw head systems with respect to 1st drawing draft 4 (for all systems) the sliver test length was taken as 4 yds for all system. 1 yds feed sliver of 1st drawing will be 4 yds in delivery as the 1st drawing draft is 4 [5,6].

As per theory, higher draft of machine increase CV% and higher doubling (total 19008 no. of doubling is applied on sliver at draw head processes instead of 9504 no. of doubling of roll former system) decrease the CV%.

As the draft is same for all three processes doubling effect is very prominent in Table 7. Due to the extra doubling at 1st drawing feed side the sliver CV% drastically reduced in draw head systems in comparison to roll former system (Figures 11 and 12) [7-10].

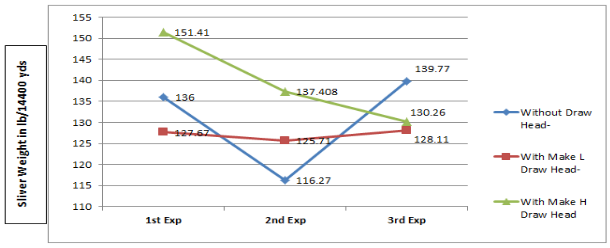

Figure 11. Average converted (at 16%mr) sliver weight of finisher drawing in lb/ 14000 yds.

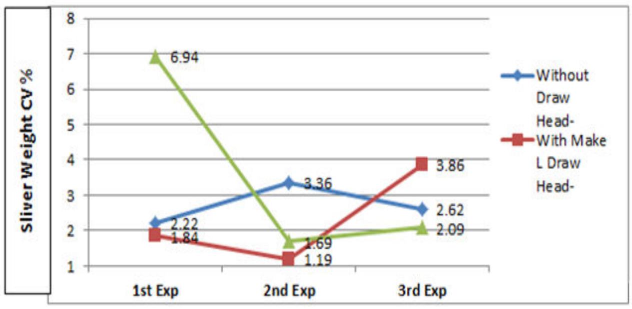

Figure 12. Converted (at 16% MR) finisher drawing sliver weight CV.

	Converted yarn weight (at 16% MR)					
	RF system	Drawhead-H	RF system	Drawhead-L	RF system	Drawhead-L
No of test	30	30	30	30	30	30
Mean	8.53	9.17	8.53	7.88	9.17	7.88
SD	0.7	0.8	0.7	0.23	0.8	0.23
	SE1	0.13	SE1	0.13	SE1	0.15
	SE2	0.15	SE2	0.04	SE2	0.04
	SE_{diff}	0.19	SE_{diff}	0.13	SE_{diff}	0.15
	t_{cal}	3.3	t_{cal}	4.9	t_{cal}	8.5

Table 7. Significance (T test) test for yarn grist variation.

There are significant difference in yarn weight both at 1% and 5%level of significance.

Null hypothesis: Difference between converted weight of yarn made from roll former and drawhead-H type is zero.

Alternate hypothesis: Difference in means of converted weight of yarn is different from zero.

Conclusion: Since 3.3 is greater than 2.75, the difference between the mean converted weight of yarn made from roll former and drawhead-H type is significant at 1% level of significance.

Null hypothesis: Difference between converted weight of yarn made from roll former and drawhead-L type is zero.

Alternate hypothesis: Difference in means of converted weight of yarn from roll former and drawhead-L type is different from zero [11].

Conclusion: Since 4.9 is greater than 2.75, the difference between the mean Converted weight of yarn made from roll former and drawhead-L type is significant at 1% level of significance.

Null hypothesis: Difference between converted weight of yarn made from drawhead-H and drawhead-L type is zero.

Alternate hypothesis: Difference between means of converted weight of yarn from drawhead-H and drawhead-L type is different from zero [12].

As per Table 3 and the above Line charts it is found that in L make draw head finisher drawing sliver weight is much controlled. As two different draw head systems are studied in the above study, the better system is found make-L [13,14]. The better results is obtained in make-L over make-H is due to the machine design and structure difference. Any free portion in the machine where sliver runs without support of roller/guide, pin or conductor make the fibre arrangement as well as sliver irregular and increase the irregularities. These distances are more in make H system. Additionally probably the 3 over 3 pin roller system of make L system has given a positive pressure impact on sliver with positive control which is missing in 1 over 3 pin drum system of make H draw head system [15].

Conclusion

From every aspects of the above results it is observed that the draw head systems (specially make L system) improves the jute sliver weight consistently. The make L process also reduce Jute yarn weight variation significantly at both 1% and % significance level. Eventually the evenness of sliver and yarn has improved. This is due to the extra doubling given in the 1st drawing system in draw hwad process and design of make L system, by introducing draw head system at finisher card machine, jute industry can achieve better sliver regularity without any extra effort.

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