

A Detailed Study on Effective Floating Fibre Control in Ring Frame and its Impact on Yarn Quality

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ABSTRACT: Drafting is the most important and fundamental operation in spinning and it gives a very important effect to the yarn quality. Today, the well-known 3-roller double-apron drafting systems of ring spinning frames permit to draft roving's up to a total draft of 80 folds and more under optimum conditions. The fibre strand in the main drafting field consists of only a few remaining fibres. There is hardly any friction field and fibre guidance provided by the rollers alone is inadequate. Special fibre guiding devices are therefore needed to carry out a satisfactory drafting operation. The mass irregularity introduced in ring frame drafting mainly depends upon the quality of the input material, parameters of the drafting system and mechanical faults. For studying the effect of floating fibres in drafting zone 3 spacers Active Cradle (AC) with flexible leading edge and an optimally arranged pin (P), 39mm cradle, The Ri-Q-Draft system with the Ri-Q-Bridge were used. The yarn of combed and carded variety with linear density of 40's and 60's were produced with compact spinning system and conventional spinning system using the above said 3 spacers. The yarns thus produced were tested for imperfection, unevenness and classimat faults. Statistical tools like chi square test, critical difference analysis were used to optimize the results,

KEY WORDS: Drafting zone, Spacer., Imperfection, Fibre control

I. INTRODUCTION

Spinning is the process of creating yarn from various raw fibre materials. In spinning, separate fibres are twisted together to bind them into a long, stronger yarn. Nip distance between front top roller to top and bottom apron nip nearly 12mm and this is the distance in which fibre less than 12mm float freely here and there and without control, which causes high unevenness and imperfections in yarn. To control less than 12mm fibre in front zone modified elements are used instead of normal spacer & cradle. Mass irregularity is the most important quality characteristic of yarn. Importance of irregularity arises from the following factors.

1. Mass Irregularity has a profound influence on appearance of yarn and fabric.
2. More regular the yarn, better will be the appearance and aesthetic value of the product.
3. Regularity contributes to a smoother feel.
4. Regular yarns will have fewer weak places. As yarn breaks at weakest place, more regular yarns will have a better strength.

BREAK-DRAFT

The purpose of the break-draft zone is to prepare the main draft. The fibres in the roving are stretched and extended up to a degree which allows them to shift in the main zone immediately after leaving the cradle clamping line. The

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basic correlation for each individual staple length between the setting of the break-draft zone and of the break-draft of a ring frame drafting system is shown in Fig.1

MAIN DRAFT

As a basic principle, each of the two pairs of rollers in a drafting zone produces a zone of fibre friction by pressure. The fibre condensation caused by this pressure does not only have a vertical effect, but spreads from both sides into the fibre strand (shown in fig). The two fields of friction should not overlap, nor should their spheres of activity be too far apart.(Fig. 2)

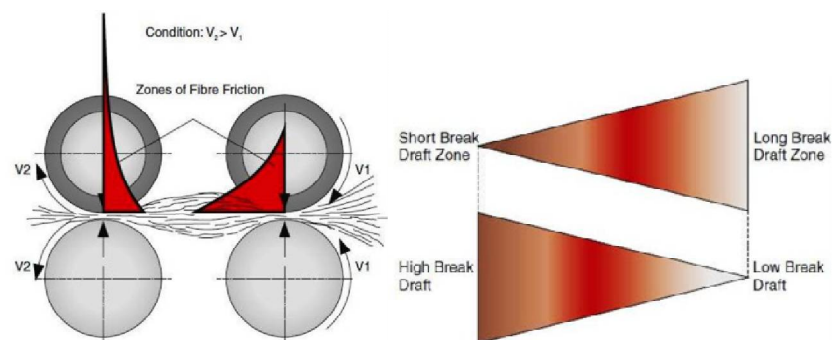


Figure 1 Friction field generation in Break draft zone Figure 2 Friction field generation in Main draft zone

DRAFTING FORCE

The high degree of parallelism of the fibres achieved by the preceding steps of drawing, doubling and imparting of twist on the roving frame has in turn the effect that the inter-fibre friction at the cradle clamping line is still high.

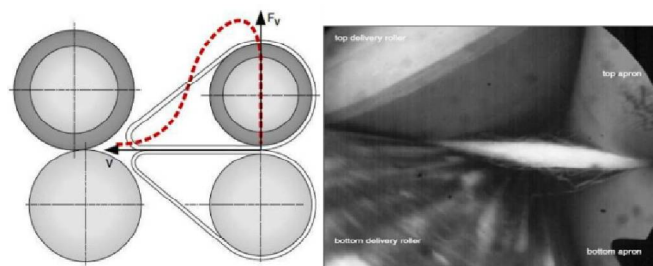


Figure 3a) Strength of inter-fibre friction, F_v – drafting force, V – Direction of draft b) High Speed Photography of Floating fibre zone

II. MATERIALS AND METHODS

MATERIALS

The studies were carried out in modern mills with state of art machines using the same mixing, which mills were using for their regular production. Floating fiber control elements are based on the principle of widening friction zones in horizontal way without friction zone overlapping. By shifting the front field of friction towards the cradle opening, the apron nip can be closer. For this reason, the correct cradle design is important for the interplay with the point of friction. Additional point of friction as illustrated in fig. can be obtained by

1. Active Cradle (AC) with flexible leading edge and an optimally arranged pin (P) is the new ACP Quality Package by SUESSEN, this was initially developed by Chinese.
2. 39mm cradle also being used for the same purpose instead of previous usage of 36mm cradle.
3. The Ri-Q-Draft system with the Ri-Q-Bridge has been developed by RIETER to enable the aprons to more precisely control the fibers and consequently enable higher drafts to be used without losing fiber control.

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METHODS

Yarn evenness parameters were compared in yarns from same bobbin and same spindle to enhance accuracy of results and comparison study is conducted in the following materials.

1. 100% Cotton, Carded knitting yarn; Count: 40s Nec
2. 100% Cotton, Combed knitting yarn; Count: 40s Nec
3. 100% Cotton, Combed weaving yarn; Count: 60s Nec& 100s Nec.
4. 100% Cotton, Compact yarn; Count: 40s Nec& 60s Nec.

Following are the raw material quality parameters obtained by testing finisher draw frame sliver using “Advanced Fibre Information System” (AFIS) as per ASTM - D - 5866 -95.

RAW MATERIAL PARAMETERS

Count (Nec)	40s Carded Knitting	40s Combed Knitting	60s Combed weaving	100s Combed weaving	40s combed compact	100s combed compact
Cotton Variety	Sankar 6	Sankar 6	MCU 5	DCH 32	Sankar 6	DCH 32
Mean length in mm (W)	23.1	25.8	28.2	30.8	25.6	28.3
Length (W) – CV%	41.5	34.7	32.8	30.8	34.9	31.2
Upper Quartile Length (W)	29.4	31.1	34	37.1	31.3	33.9
Short Fiber Content (W)	15.1	5.9	4.3	3	6.9	3.1
Mean length in mm (N)	18	22.2	24.4	26.9	21.8	25
Length (N) – CV%	53.5	40.5	39.7	38.3	41.6	36.4
Short Fiber Content (N)	34.5	14.7	12.1	9.3	16.7	8.5
5% Length (mm)	34.1	36.7	39.9	42.9	36.3	39.5
Fineness (mtex)	165	182	172	180	183	179
Immature Fiber Content %	7.6	5.5	5	4	5.3	4.7
Maturity Ratio	0.86	0.93	0.94	0.98	0.94	0.96
Nep size (Microns)	620	618	603	587	614	648
Neps / Gram	66	29	29	17	22	24
Seed Coat Nep Size (Microns)	930	600	792	525	808	783
SCN count / Gram	4	1	2	1	3	2

YARN TESTING METHODS

S.No	Parameters	Instruments used	Testing Method
1	Count & Count CV%	Wrap reel and balance	ASTM - D - 1907 -01
2	Lea Strength & CV %	Lea strength tester	ASTM - D - 1578 -93
3	Yarn evenness	Uster evenness tester 3	ASTM - D - 1425 -96
4	Imperfections / km	Uster evenness tester 3	ASTM - D - 1425 -96
5	Classimat faults	UsterClassimat 3	ASTM - D - 6197 - 99
6	Single yarn strength	UsterTensorapid 3	Uster standard method

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Statistical Methods

- 1.U% results can be compared using critical difference method; recommended critical difference for U% results is 4.95 when number of observations is 10.
- 2.Total imperfections can compared using “Critical Difference” method (CD); recommended critical difference for IPI results is 14.14 when number of observations is 10.
- 3.For comparing total Classimat faults, “Chi-Square” method can be used to statistically test the difference between two sets of results

$$K2 = (O-E)^2/E,$$

Where “O” is observed value, And “E” is expected value.

K2 Value at 95% confidence level is 2.71 for 1 degree of freedom

III. RESULTS AND DISCUSSIONS

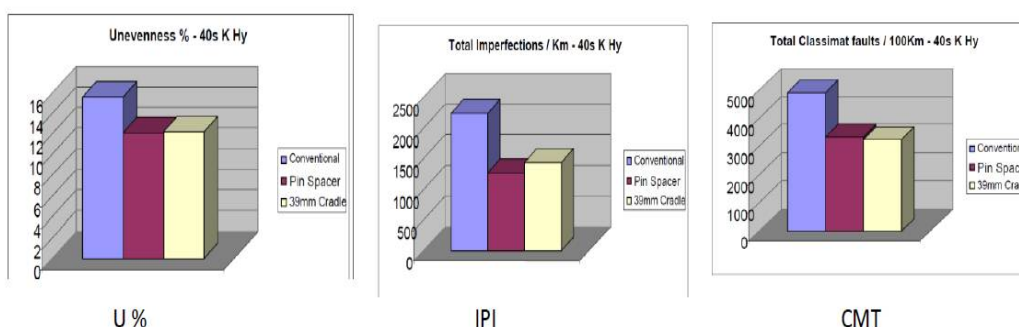
CARDED KNITTING YARN TEST RESULTS

COMPARATIVE TEST RESULTS OF 40S CARDED KNITTING YARN

STATISTICAL SIGNIFICANCE OF 40S CARDED KNITTING YARN TEST RESULTS

S.No.	Parameter	Conventional	Pin spacer	Statistical method	Calculated Result	Inference
1	U%	15.6	12.14	C D	22.2%	Differences are significant.
2	IPI	2240	1276	C D	43%	
3	CMT	4927	3346	Chi-square	5.01	
S.No.	Parameter	Conventional	39 mm Cradle	Statistical method	Calculations	Inference
1	U%	15.6	12.21	C D	21.7%	Differences are significant.
2	IPI	2240	1439	C D	35.7%	
3	CMT	4927	3259	Chi-square	5.64	

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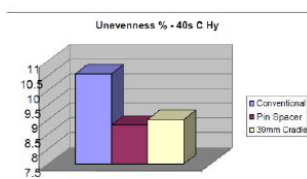
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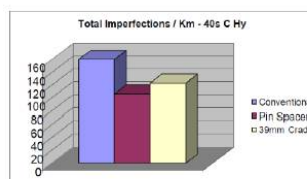
COMBED KNITTING YARN TEST RESULTS COMPARATIVE TEST RESULTS OF 40S COMBED KNITTING YARN

STATISTICAL SIGNIFICANCE OF 40S COMBED KNITTING YARN TEST RESULTS

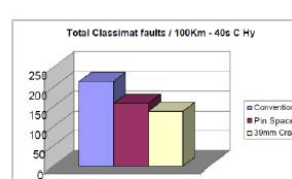
S.No.	Parameter	Conventional	Pin spacer	Statistical method	Calculations	Inference
1	U%	10.55	8.82	C D	16.4	Differences are significant.
2	IPI	160	106	C D	33.8	
3	CMT	215	159	Chi-square	14.6	
S.No.	Parameter	Conventional	39 mm Cradle	Statistical method	Calculations	Inference
1	U%	10.55	9.01	C D	14.6	Differences are significant.
2	IPI	160	123	C D	23.1	
3	CMT	215	149	Chi-square	20.2	



U %



IPI

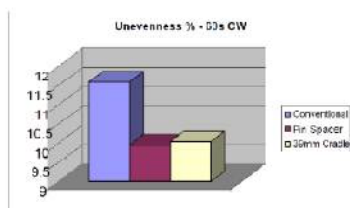


CMT

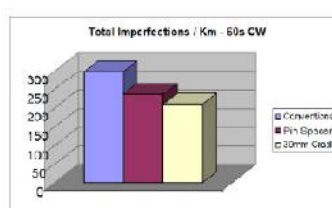
60S COMBED WEAVING YARN TEST RESULTS

COMPARATIVE TEST RESULTS OF 60S COMBED WEAVING YARN STATISTICAL SIGNIFICANCE OF 60S COMBED WEAVING YARN TEST RESULTS

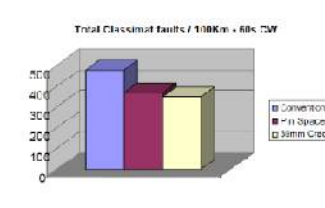
S.No.	Parameter	Conventional	Pin spacer	Statistical method	Calculated Result	Inference
1	U%	11.6	9.95	C D	14.2	Differences are significant.
2	IPI	298	237	C D	20.5	
3	CMT	478	368	Chi-square	25.3	
S.No.	Parameter	Conventional	39 mm Cradle	Statistical method	Calculations	Inference
1	U%	11.6	10.04	C D	13.5	Differences are significant.
2	IPI	298	212	C D	28.9	
3	CMT	478	349	Chi-square	34.8	



U %



IPI



CMT

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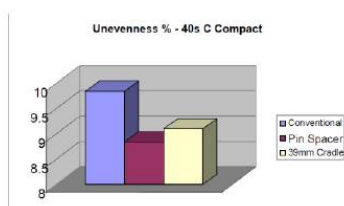
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40S COMBED COMPACT YARN TEST RESULTS

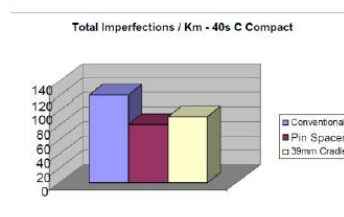
COMPARATIVE TEST RESULTS OF 40S COMBED WEAVING YARN

STATISTICAL SIGNIFICANCE OF 40S COMBED COMPACT WEAVING YARN TEST RESULTS

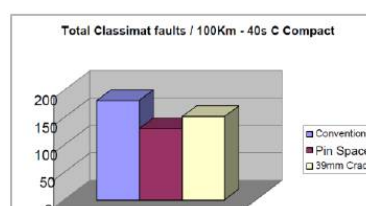
S.No.	Parameter	Conventional	Pin spacer	Statistical method	Calculations	Inference
1	U%	9.84	8.84	C D	10.16	Differences are significant.
2	IPI	121	81	C D	33.1	
3	CMT	180	129	Chi-square	14.5	
S.No.	Parameter	Conventional	39 mm Cradle	Statistical method	Calculations	Inference
1	U%	9.84	9.1	C D	7.5	Differences are significant.
2	IPI	121	92	C D	24	
3	CMT	180	151	Chi-square	4.7	



U %



IPI



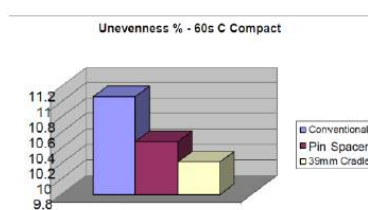
CMT

60S COMBED COMPACT YARN TEST RESULTS

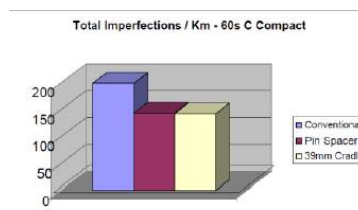
COMPARATIVE TEST RESULTS OF 60S COMBED WEAVING YARN

STATISTICAL SIGNIFICANCE OF 60S COMBED COMPACT WEAVING YARN TEST RESULTS

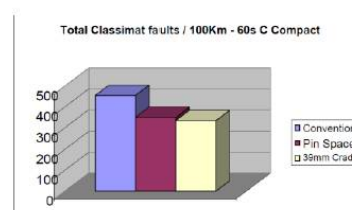
S.No.	Parameter	Conventional	Pin spacer	Statistical method	Calculations	Inference
1	U%	11.06	10.48	C D	5.2	Differences are significant.
2	IPI	199	143	C D	28	
3	CMT	456	351	Chi-square	24.2	
S.No.	Parameter	Conventional	39 mm Cradle	Statistical method	Calculations	Inference
1	U%	11.06	10.22	C D	7.6	Differences are significant.
2	IPI	199	142	C D	28.6	
3	CMT	456	336	Chi-square	31.6	



U %



IPI



CMT

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IV. CONCLUSION

In all trials, improvements in mass uniformity estimates such as U%, Imperfections and Classimat faults found significant. U% (Percentile Mean Deviation) of mass found giving statistically significant improvements in all trials confirming the additional guide provided by the modified pin spacer & 39mm cradle for passage of floating fibre in main drafting zone of ring frame. Reduction in Imperfections noticed up to 40% in coarser to medium counts. In finer counts, improvement in imperfections becomes marginal (up to 15%). Also reduction noticed in normal and higher sensitivity levels. Improvements in all channels of imperfections indicate that all short, floating fibres in main drafting zone of ring frame are aligned in a comparatively better way by the new elements. Classimat faults obtained with floating fibre control elements also show significant improvement while comparing conventional system. Reduction in objectionable faults emphasizes the possibility of clearer cuts reduction in cone winding process. Yarn mass uniformity improvements ultimately results in fabric appearance improvement, thus indicating the possible hike in yarn selling price. Reduction noticed in tensile strength co-efficient of variation (both in lea strength and single yarn strength) and also in elongation CV%. Even though this reduction in CV% is not statistically significant, marginal improvement noticed in all counts. Improvement is greater in carded counts than coarser counts (i.e) uniformity improvement is directly proportional to short fibre content of the strand. Remarkable potential application of these elements is that waste extraction at preparatory stage can be reduced by 1 to 2% to match the same level of imperfections at yarn stage. Addition of floating fibre control elements in drafting field makes the system highly sensitive to climatic changes. Also achieving the same level of productivity as conventional field depends on the optimization of process parameters & method of roving preparation. In some cases, it happened to reduce the spindle speed by 10% for maintaining same level of end breakage rate.

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