Manual Verses Electronic Spindle Ring Alignment and its effect on Ring and Compact Yarn Properties

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Abstract
For studying the effect of spindle ring alignment that is eccentricity of spindle, the spindles are set at different eccentric gauges. Starting from perfectly centred at the gauge of0 to the gauges of 3 and 6away from the centre, with the help of electronic spindle centring gauge. The effect of these eccentricities on the properties of ring and compact yarn of different counts have been observed. Similarly the comparative study between the manually centred spindle set by using mechanical gauge and spindle centred by using electronic gauge have been carried out.The unevenness (U%), imperfection index (IPI)are significantly affected by ring eccentricity and no effect on to the hairiness and CSP value of ring yarn. In case of compact yarn there in no effect of ring eccentricity on to the hairiness, U% and IPI of yarn. The results also state that the manual ring centring by skilled technician is similar to electronic ring centring.

Keywords
spindle alignment, eccentricity, ring yarn, compact yarn

1. Introduction

The eccentricity of spindle means alignment of spindle with respect to ringis one of the important settings in ring frame machine. The alignment of spindle is important from the point of view of end breakage rate and quality of yarn.[1].In yarn properties specially spindle to spindle variation of hairiness mainly caused due to disturbed spindle centering [2] .The large effect of spindle centering found in peak spinning tension[3]ofleads to the spindle and bobbin vibrations [4] which ultimately affect yarn quality. Proper ring-spindle geometry only can give excellent results in terms of qualityand production [5].The conventional method, for observing ring spindle geometryby using a disc. The disc is put on the spindle and the gauging is done only by visual judgment of the operator. Pressure, fatigue and position greatly affects the judgment and obviously, ultimate yarn quality. Currently, electronic devices are available to set the ring at centered position accurately up to a level better than 0.1mm. It is possible to measure the eccentricity with these devices more accurately.Therefore it is important to know the effect of spindleeccentricity on to the quality of yarn as well as the reliability of methods available for setting eccentricity of spindle.

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2. Materials and Methods

The 100% cotton yarn have been prepared with MCU5 and DCH32 varieties with staple length2.5% span length of 36mm and 50% span length of 18 mm for the count of 80s Ne compact, 94s Ne ring and 100s Ne compact yarn.The cotton fibres having fineness of 3.2 micronaire, strength 25 to 26 g/tex and 4% trash.

While preparing the yarn the following parameters have been set at ring frame LR6/S machineframe for each count as shown in table 2.1. The machine is having ring diameter of 36 mm and lift of 160 mm. The roving with 2.25 hank is used to produce all three different counts considered under the study. The total draft is maintained to 35.56, 44.44 for 80s and 100s compact yarn respectively with break draft of 1.14. While for non compact yarn produced by setting a total draft of 41.7 with break draft of 1.14.The traveller type ESR HF used for compact yarn and EL1UDR for non compact yarn with appropriate number as shown in table. According to the yarn count the spacer is selected, for finer counts of 100s and 94s spacer with 3mm thickness and for 80s with 3.2 mm.

Table 2.1 Ring frame parameters for 94s Ne ring and 80s &100s Ne compact yarn

Yarn count	80s Ne(LR6/S) Compact	94s Ne(LR6/S) Non-compact	100s Ne(LR6/S) Compact
Average Spindle speed(rpm)	18500	19000	19000
Twist multiplier	3.9	4.3	4.1
Twist per inch	34.8	41.6	41.0
Break draft	1.14	1.14	1.14
Total draft	35.56	41.7	44.44
Lift(mm)	160	160	160
Ring dia.(mm)	36	36	36
Traveller size	19/0 (ISO 11.2) ESR HF	19/0 (ISO 11.2)EL1UDR	20/0 (ISO 10)ESR HF
Spacer(mm)	3.2	3.0	3.0

The misalignments or setting of spindles at different level of eccentricities are carried out by electronic device and manually with the aid of centring gauge. The centering is done for 10 spindles from left hand side 1 to 10 for each machine. Then the samples were testedafter completion of full doff.

2.1 Spindle eccentricity centring and measurement

Electronic device for centring:Orion electronic spindle centring device as shown in Fig 2.1 and 2.2 has been used for measuring the eccentricities. Accuracy levels of better than 0.1 mm can be achieved, with this device. The heart of the device is the sensor probe which is tailor made as per the size of the sample ring . This probe sits on a master centre. The probe have to be calibrated at the beginning of every gauging session. The master centre is used for the calibration purpose only.

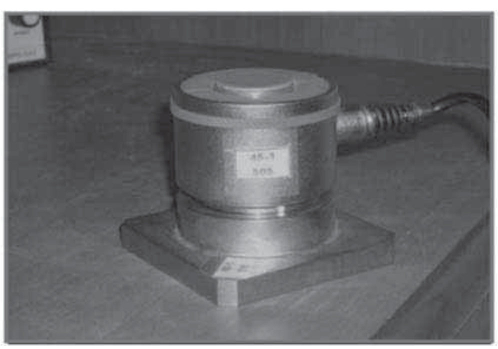

Figure 2.1: Electronic spindle centring gauge

Figure 2.2: Display of instrument showing alignment along x axis (top side) and y axis (left side)

The mechanical gauge is also used for ring centring, herethe centring is depends up on the potentiality of the worker and the skill and the lighting condition, therefore it takes more time for centring.For ring centring machine has to stop and the gauge need to be insert in to the spindle with the required diameter of ring and spindle.Then ring has been adjusted to the centre based on the gauze as shown in Fig 2.3a.

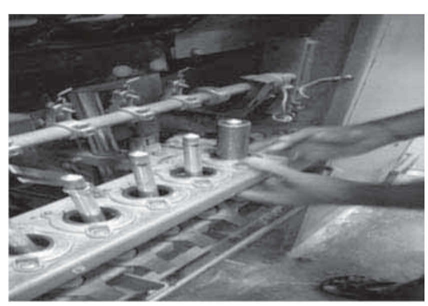

Figure 2.3 a) Gauge mounted on spindle manually

Figure 2.3 b) Gauge used for manual centring

The ring was centred against spindle with different misalignment combination by electronic centring device and manually as shown in table2.2.

Table 2.2 Different spindle misalignment (eccentricity) combination

Yarn Count and type	80s Ne Compact	94s Ne Ring	100s Ne Compact
Ring Eccentricity	0'	0'	0'
	3	3	3
	6	6	6
	0	0	0

Where,

0' eccentricity - manually centring is done nearest to zero

0 eccentricity- centre position at gauge 0 using electronic device

3 eccentricity - disturbed from centre at gauge 3 using electronic device

6 eccentricity- disturbed from centre at gauge 6 using electronic device

2.2 Testing of yarn samples

The yarn samples were tested for unevenness, imperfections and hairiness using uster tester-5 -5400 with test length of 400m at a speed of 400m/min for 10 specimensof each sample.The imperfection index (IPI) is considered as the sum of +200 neps, +50 Thick and -50 Thin Places.

The tensile properties were measured using cascade stretch (v 14.1) machine with test length of 120yards and CSP was calculated based on these results.

3. Results and discussion

The yarns samples of different count at different levels of eccentricity were tested for yarn quality parameters that are IPI (imperfection index), hairiness, U% (Unevenness) and strength in CSP (count strength product)as shown in table 3.1.

Table 3.1Effect of eccentricity on ring and compact yarn quality

Count	Eccentricity	Imperfections	Hairiness	U%	CSP
80s	0	143.4	2.38	11.05	3084
80s	3	154.8	2.37	11.18	3408
80s	6	165	2.37	11.19	3581
80s	0'	155.1	2.34	11.09	3470
94s	0	346	3.21	12.23	2822
94s	3	369.1	3.25	12.33	2845
94s	6	425.8	3.18	12.5	2855
94s	0'	370.6	3.28	12.4	2773
100s	0	275.1	2.2	12.07	3522
100s	3	283.6	2.22	11.98	3644
100s	6	289	2.24	12.03	3697
100s	0'	273.3	2.14	12.01	3570

3.1 Effect of eccentricity on U%

The graph has been plotted for different eccentricities values against U % value for different type of yarns as shown in figure 3.1. There is increasing trend has been observed for ring yarn and for compact yarn as such no difference have been seen for different values of U% at different eccentricities. As already in case of ring yarn there is more unevenness which is further may get increase with spindle misalignment but for compact the effect is not much as it is having more uniformity and control over floating fibres.

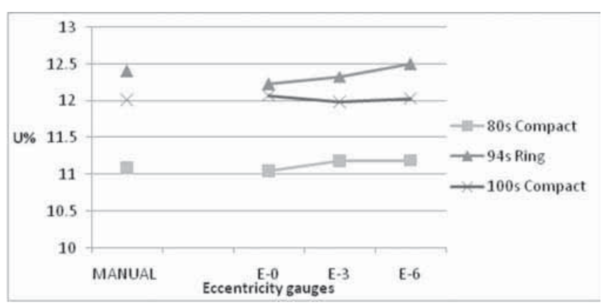

Figure 3.1 Effect of eccentricity on U% for ring and compact yarn

As per the results of ANOVA test for U% between different eccentricities value as shown in Table 3.2, there is no significant change U% for compact yarns with change in eccentricities of 80s and 100s count. But for ring yarn there is significant change in U% with change in eccentricity. This may be because of less control on unevenness of ring yarn which further get disturb with change in eccentricity.

produced by centring manually and by electronic device (at 0 eccentricity).As the manual centring is not very accurate, with manual centring still there will be a little eccentricity which will be in the range of 0to1. There is not much change is observer from ring yarn from eccentricity 0 to 3, which indicate that for little deviation of eccentricity there is having no effect on U%. Therefore there is no significant difference has

Table 3.2 Result of significance test (ANOVA) for U% between different eccentricities

Yarn Property	U %								
Count	80s			94s			100s		
Eccentricity	0	3	6	0	3	6	0	3	6
N (number of samples)	10	10	10	10	10	10	10	10	10
Variance	0.078	0.071	0.100	0.023	0.059	0.033	0.45188	0.4698	0.39835
F value (between 0,3, 6 eccentricities)	1.132			4.858			0.161		
F crit Value	3.354			3.354			3.354		
Result	No Significance difference			Significance difference			No Significance difference		

For comparing manual centring with electronically aligned centring and its effect on U%, the U% values of manufactured at eccentricity '0' set by electronic gauge and manual centring have been tested by significance test as shown in Table 3.3. It is found that there is no significant difference on U % between theyarn been seen between U % set by electronic gauge and by manually for ring yarn. In case of compact yarn, there is no significant difference even at eccentricity level of 0 to 6. Therefore it can be concluded that the yarn U% is not affected whether set by electronic gauge or by manually.

Table 3.3 Result of significance test (ANOVA) for U% between centring by electronic gauge (0) and manually

Yarn Property	U %					
Count	80s		94s		100s	
Eccentricity	0	Manual	0	Manual	0	Manual
N (number of samples)	10	10	10	10	10	10
Variance	0.078	0.136	0.023	0.077	0.452	0.501
F value (between 0 and manual eccentricities)	0.250		2.781		0.046	
F crit Value	4.414		4.414		4.414	
Result	No Significance difference		No Significance difference		No Significance difference	

3.2 Effect of eccentricity on Imperfections

The graph has been plotted for different eccentricities values against IPI value for different type of yarns as shown in figure 3.2. There is increasing trend has been observed for ring yarn as well as for compact yarn, but for compact yarn less difference have been seen for different values of IPI at different eccentricities. As the IPI value corresponds to the thick and thin places, in case of ring yarn there is more IPI which is further may get increase with spindle misalignment but for compact the effect is not much as it is having less IPI value, more uniformity and control over floating fibres.

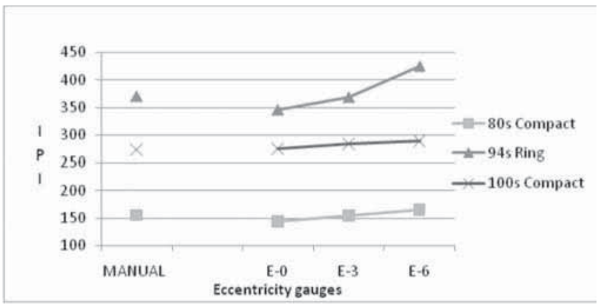

Figure 3.2 Effect of eccentricity on IPI for ring and compact yarn

As per the results of ANOVA test for IPI between different eccentricities value as shown in Table 3.4, there is no significant change IPI for compact yarns with change in eccentricities of 80s and 100s count. But for ring yarn there is significant change in IPI with change in eccentricity. This may be because of less control on fibres movement in ring yarn which further get disturb with change in eccentricity.

For comparing manual centring with electronically aligned centring and its effect on IPI, the IPI values of manufactured at eccentricity '0' set by electronic gauge and manual centring have been tested by significance test as shown in Table 3.5. It is found that there is no significant difference on IPI between the yarn produced by centring manually and by electronic device (at 0 eccentricity). As the manual centring is not very accurate, with manual centring still there will be a little eccentricity which will be in the range of 0to1. There is not much change is observer from ring yarn from eccentricity 0 to 3 as compare to 3 to 6, which indicate that for little deviation of eccentricity there is having no effect on U%. Therefore there is no significant difference has been seen between IPI value set by electronic gauge and by manually for ring yarn. For compact yarn there is no significant difference even from eccentricity 0 to 6. Therefore it can be concluded that the yarn IPI value of yarn is not affected whether set by electronic gauge or by manually.

Table 3.4 Result of significance test (ANOVA) for IPI between different eccentricities

Yarn Property	IPI								
Count	80s			94s			100s		
Eccentricity	0	3	6	0	3	6	0	3	6
N (number of samples)	10	10	10	10	10	10	10	10	10
Variance	732	678	1212	1099	2881	3307	7195	4198	6882
F value (between 0,3, 6 eccentricities)	1.416			6.937			0.125		
F crit Value	3.354			3.354			3.354		
Result	NoSignificance difference			Significance difference			No Significance difference		

Table 3.5 Result of significance test(ANOVA) for IPI between centring by electronic gauge (0) and manually

Yarn Property	IPI					
Count	80s		94s		100s	
Eccentricity	0	Manual	0	Manual	0	Manual
N (number of samples)	10	10	10	10	10	10
Variance	732	1161	1099	2361	7195	7464
F value (between 0 and manual eccentricities)	0.729		1.735		0.002	
F crit Value	4.414		4.414		4.414	
Result	No Significance difference		No Significance difference		No Significance difference	

3.3 Effect of eccentricity on Hairiness:

The graph has been plotted for different eccentricities values against hairiness value for different type of yarns as shown in figure 3.3. There is no specific trend has been observed for ring yarn as well as for compact yarn for different values of hairiness at different eccentricities.

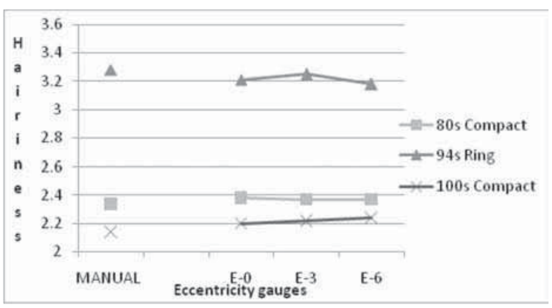

Figure 3.3 Effect of eccentricity on hairiness for ring and compact yarn

As per the results of ANOVA test for hairiness between different eccentricities value as shown in Table 3.6, there is no significant change hairiness for ring and compact yarns with change in eccentricities of 80s and 100s count. Hairiness which is caused due to uncontrolled floating fibres, obviously less in compact yarn due to reduction in floating fibre and by reducing spinning triangle even after changing eccentricity, as the protruding fibres at the surface which is going to form the hairiness already been reduced . For ring yarn also there is no effect of eccentricity on hairiness as spindle eccentricity not affecting the protruding fibres.

For comparing manual centring with electronically aligned centring and its effect on hairiness, the hairiness values of manufactured at eccentricity '0' set by electronic gauge and manual centring have been tested by significance test as shown in Table 3.7. It is found that there is no significant difference on hairiness between the yarn produced by centring manually and by electronic device (at 0 eccentricity). As the manual centring is not very accurate, with manual centring still there will be a little eccentricity which will be in the range of 0 to1. There is not much change is observed

Table 3.6 Result of significance test (ANOVA) for hairiness between different eccentricities

Yarn Property	Hairiness								
Count	80s			94s			100s		
Eccentricity	0	3	6	0	3	6	0	3	6
N (number of samples)	10	10	10	10	10	10	10	10	10
Variance	0.054	0.046	0.059	0.032	0.039	0.015	0.007	0.007	0.024
F value (between 0,3 and 6 eccentricities)	0.017			0.477			0.399		
F crit Value	3.354			3.354			3.354		
Result	No Significance difference			No Significance difference			No Significance difference		

in ring yarn and compact yarn even at eccentricity from0 to 6, Therefore there is no significant difference is seen between yarn hairiness of yarn set by electronic gauge and by manually for ring yarn and compact yarn.

3.4 Effect of eccentricity on CSP

The graph has been plotted for different eccentricities values against CSP value for different type of yarns as shown in figure 3.4. There is increasing trend has been observed for compact yarn and for ring yarn but as such not much difference have been seen for ring yarn at different values of CSP at different eccentricities.

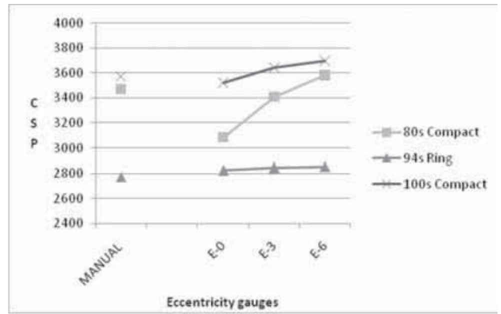

Figure 3.4 Effect of eccentricity on CSP for ring and compact yarn

Table 3.7Result of significance test (ANOVA) for hairiness between centring by electronic gauge (0) and manually

Yarn Property	Hairiness					
Count	80s		94s		100s	
Eccentricity	0	Manual	0	Manual	0	Manual
N (number of samples)	10	10	10	10	10	10
Variance	0.054	0.059	0.032	0.029	0.007	0.005
F value (between 0 and manual eccentricities)	0.150		0.644		3.213	
F crit Value	4.414		4.414		4.414	
Result	No Significance difference		No Significance difference		No Significance difference	

As per the results of ANOVA test for CSP of yarn between different eccentricities value as shown in Table 3.8, there is no significant change in CSP for ring yarns with change in eccentricities. For compact yarn there is significant change in CSP with change in eccentricity for 80s count and for finer yarn of 100s count there is no significant difference.

As per study, the migration of fibres is low in compact yarn and more in ring spun yarn due to elimination of spinning triangle, and more strength of compact yarn is mainly due to higher packing density and more fibre integration [6]. The significant change and increase in strength observed in case of compact yarn may be due to the further more fibre integration to the axis of yarn. For finer compact yarn of 100s count the strength is already high may be due to maximum alignment and integration of fibres. Therefore there is no chance of

Table 3.6Result of significance test (ANOVA) for hairiness between different eccentricities

Yarn Property	CSP								
Count	80s			94s			100s		
Eccentricity	0	3	6	0	3	6	0	3	6
N (number of samples)	10	10	10	10	10	10	10	10	10
Variance	207032	77940	22771	9882	15995	2717	26763	25941	24753
F value (between 0,3 and 6 eccentricities)	6.157			0.315			2.987		
F crit Value	3.354			3.354			3.354		
Result	No Significance difference			No Significance difference			No Significance difference		

further improvement with change in eccentricity and hence the no significance difference.

For comparing manual centring with electronically aligned centring and its effect on CSP, the CSP values of manufactured at eccentricity '0' set by electronic gauge and manual centring have been tested by significance test as shown in Table 3.9. It is found that there is no significant difference on CSP between the yarn produced by centring manually and by electronic device (at 0 eccentricity). As the manual centring is not very accurate, with manual centring still there will be a little eccentricity which will be in the range of 0 to1. There is not much change is observer from 80s compact from eccentricity 0 to 3 as compare to 3 to 6, which indicate that for little deviation of eccentricity there is having no effect on U%. Therefore there is no significant difference has been seen between CSP value set by electronic gauge and by manually for 80s compact yarn but for ring yarn and finer 100s compact yarn as there is no significant difference even from eccentricity 0 to 6. Therefore it can be concluded that the yarn CSP value of yarn is not affected whether set by electronic gauge or by manually

Table 3.9 Result of significance test (ANOVA) for CSP between centring by electronic gauge (0) and manually

Yarn Property	CSP					
Count	80s		94s		100s	
Eccentricity	0	Manual	0	Manual	0	Manual
N (number of samples)	10	10	10	10	10	10
Variance	207032	95825	9882	24444	26763	24640
F value (between 0 and manual eccentricities)	2.851		0.499		0.425	
F crit Value	4.414		4.414		4.414	
Result	No Significance difference		No Significance difference		No Significance difference	

4. Conclusion

The effect of spindle eccentricities on to the properties of spun yarn have been studied namely IPI (imperfection index), hairiness, unevenness (U%) and strength in terms of CSP (count strength product). The eccentricity of spindle having significant effect on the U% of the ring yarn while for compact yarn the effect is not significant. Further the U% of yarn is increases with increase in spindle eccentricities for ring yarn. The IPI of yarn is increases with increase in the eccentricity for both ring and compact yarn. However the eccentricity of spindle having significant effect on the imperfection index (IPI value) of the ring yarn only while for compact yarn the effect is not significant. Similarly the yarn strength is also increases with increase in eccentricity but there is no effect on strength of ring yarn. For compact yarn there is no effect of change in eccentricity on to the hairiness of yarns both for ring and compact yarn.

While comparing the results of spindle centring that is eccentricity at zero value set by electronic gauge and the manually cantered nearest to zero value, there is no significant difference have been observe on the properties of ring and compact yarn. So it can be concluded the use of electronic gauge is required for the ease of setting the eccentricity and there is no significance difference in the properties of yarn even if spindle is centred manually.

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