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THE EFFECT OF TRAVELLER SPEED ON THE QUALITY OF RINGSPUN YARNS AT LOW SPEEDS

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ABSTRACT

Ring spinning is the most common method for spinning yarn. Various parameters of the ring spinning machine affect the quality of yarn during the spinning process. The effect of ring traveller weight and spindle speed on yarn quality was investigated in this research. Yarn was prepared by using two spinning speeds, 6500 rpm and 9500 rpm. Three different travellers were then used at each of the two spinning speeds to produce 42Tex yarn. The yarn hairiness, twist levels and tensile strength were used to evaluate the quality of the produced yarn. Results showed that there was a decrease in the yarn hairiness as the spindle speed and traveller weight were increased while there was no observed trend in twist level. In relation to the tensile strength there was higher strength when yarn was spun at 6500 rpm and higher strength was observed when the F5 traveller was used at both speeds.

Keywords: tensile strength, traveller weight, twist, spindle speed, ring spinning, hairiness, yarn

1.0 INTRODUCTION

The aim of the ring frame is to produce the desired yarn and this is achieved firstly by drafting the roving to the desired count, inserting twist in to the yarn and building a package for transporting the yarn to the winding department. The ring spinning machine has been in use for decades if not the last century and has remained the preferred choice of machine for the production of yarn. The reason for the continued success has been the superior quality of yarn produced by the ring spinning machine to that produced by the rotor or air jet machine. The yarns produced, when compared, are stronger than rotor or air jet produced yarns, are less hairy hence they are preferred for skin contact fabrics (Das and Ishtiaque, 2004). Although air jets and friction spinning produce at superior speeds than ring spinning, ring spinning is widely used for textile applications as it produces yarns with highest quality compared to the other methods of production.

The ring frame normally has maximum speed of 25000rpm whereas the rotor can run at speeds of up to 120000 rpm (Khona, 1999). This paper aims to investigate the interaction between traveller weight and spindle speed.

1.1 Spinning tension

Spinning tension can be detrimental or beneficial to the - production of yarns (Rengasamy et al., 2003). The effect depends on the magnitude of the tension which is proportional to the friction coefficient between ring and traveller, the traveller mass and the square of the traveller speed which is related to the spindle speed(Khona, 1999).

Tension ~ friction x speed of traveller^2 x traveller mass …………Equation 1

On the other hand the spinning tension is inversely proportional to the ring diameter and the angle between the connecting line from the traveller-spinning axis to the piece of yarn between the traveller and cob.

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Spinning tension determines hairiness of the yarn both positively and negatively depending on the tension magnitude-count ratio with lower tension resulting in greater hairiness values than with higher tensions for a given count. This is the reason why heavier travellers result in low yarn tensions but if the traveller is too heavy, the yarn hairiness will also increase. Spinning tension also affects the strength of the yarn with higher tension producing stronger yarns than with lower tensions. Increases in tension may lead to increased end breakages per 1000 spindles (Su et al., 2013).

1.2 Spindle speed and yarn properties

Speed of the spindle in an important part in spinning process (Md. Osman Ghani Miazi et al., 2009). Studies on the effect of speed have shown that the increase in speed does, generally, result in the decrease in hairiness for a certain range of spindle speeds (between 10000rpm and 14000 rpm) before increasing above a certain speed (about 15000 rpm).

Sengupta (Sengupta and Kapoor, 1973) revealed that for polyester an increase in the spinning speed resulted in an increase in the Uster (U_m%) value while for the viscose fibres there was a decrease in the Uster value. According to Sengupta, the extensibility of viscose is lower than that of polyester and as such regularity improved or increased due to the increase in the ration of dynamic to static friction. The increase in the ration meant that cluster fibres were not dependent on one another but behaved independently. Using a double apron system Sengupta and Kapoor observed a decrease in yarn irregularity with increases in spindle speed. Govindarajulu et al. (Govindarjulu et al., 1973) observed that for 40s, while at speeds between 10000 rpm and 13000 there was an increase in the number of thin and thick places. However the neps were not affected by the speeds and no trend was observed for thick and thin places. However the neps were not affected by the speeds and no trend was observed for thick places due to speed variation.Yagvu and Koruda found that acrylic yarns showed a reduction in thick

places as the speeds were increased but beyond 15000 rpm.

Yarn hairiness is defined as the protrusion of fibres from the core of the yarn structure (I Usta and Canoglu, 2002, Xungai Wang and Lingli Chang, 2003). The effect of yarn is felt in the latter stages of production that is in weaving, knitting and winding where it may hinder the smooth processing of the products and also during the use of the garment (Lang et al., 2006). During wear, yarn hairiness affects fabric appearance, handle and thermal insulation, pilling propensity and yarn strength. Generally hairiness is affected by the spindle speed and traveller weight. Conclusions on the effect of the parameters have been drawn with most authors concluding that higher spindle speeds result in higher levels of hairiness of the yarn (Wang and Miao, 1997). Other factors to influence yarn hairiness include humidity, balloon control rings, separator plates and forward eccentricity.

1.3 Traveller weight and yarn properties

A number of authors have found that with the increase in traveller weight there is an reduction in the hairiness of the yarn (I Usta and Canoglu, 2002, Pillay, 1964). The reduction thought is thought to be up to a certain weight before it begins to increase again. The ring has an influence on the spinning process hence it may have an effect on the hairiness. Hairiness in turn has an effect on the energy consumption and drag hence it may affect the tension of the yarn in the spinning process (Tang et al., 2006).

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2.0 Materials and Methods

2.1 Raw material

The raw material used was 100% cotton obtained locally in Zimbabwe. The input sliver was 718Tex produced using the Reiter Speed frame.

Table 1 Raw Material counts in Tex

MATERIAL	AVERAGE COUNT (TEX)	STANDARD DEVIATION	CV%
Sliver from card	6255	15.68	6.54%
Sliver from draw frame	5189.00	21.25	4.05
Roving	718.38	16.88	2.39

2.2 Sample preparation

The effect of varying engine speeds while using different travellers of different masses was investigated. The study was carried out using setting for spinning 42 Tex yarns. Three traveller weights were used and two different spindle speeds used to produce the samples, all possible combinations between the travellers and spindle speeds were used to give different treatment combinations as shown in the table

Table 2 Sampling combinations

COMBINATION	TRAVELLER TYPE	SPEED (RPM)
Combination 1	F3	6500
Combination 2	F5	6500
Combination 3	F7	6500
Combination 4	F3	9000
Combination 5	F5	9000
Combination 6	F7	9000

2.3 Travellers

The travellers used in the study were of the flat type made from steel, hardened and tempered to give the necessary strength to prolong the life of the traveller.

Table 3 Traveller types used in the study

TRAVELLER TYPE	AVERAGE MASS (g)	TRAVELLER TYPE
Lakshmire M1 Flat 3 Saphire	0.079	F3
Lakshmire M1 Flat 5 Saphire	0.095	F5
Lakshmire M1 Flat 7 Saphire	0.113	F7

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2.4 Spinning machine

The Reiter G5/1 was used to produce the yarn. The speed of the machine was checked and verified using the Movistrob® Stroboscope.

2.5 Twist

The standard ASTM D1423 standard was used. The twist which is given in turns per meter was obtained using the Uster twist tester which measured or counts the turns on 25 centimetre samples. The twist measurement principle used by the twisting machine is the twist –untwist method. In simple terms the machine untwists 25 cm of the samples and retwists in the Z direction back to the original length.

2.6 Tensile strength

The standard ASTM D2256 was used for the tensile tests. The tensile strength was determined using the Tensometer Micro 500. The testing speed was 200 mm/min.

2.7 Hairiness

The standard ASTM D5647 was used for the test. The hairiness was measured using the SDL Hairiness tester. The machine measures the number of hairs per metre by analysing a 50 meter sample at a speed of 60 m/min.

3.0 RESULTS AND DISCUSSIONS

3.1 Twist

Table 4 shows values - for turns per meter of all the samples in the study. Overall, the difference in the mean values for each of the treatment combinations is 56 turns /per meter while the difference in the maximum values is 60 and 17 for the minimum values. The results do not show a specific trend on the effect traveller weight or speed on twist variation. F3 traveller used at a speed of 6500 had the lowest average and the minimum value for the twist values while the F7 produced the highest minimum values when compared to the other combination. The F7 produced yarns with the highest maximum reading. No specific pattern can be described by the results and hence it can be said that the traveller is found to be significant as is the effect of the spindle speed while there is no interaction between the spindle speed and the traveller.

Table 4 Twist values for yarns

Traveller/ speed	Mean	Minimum	Maximum	Range	Standard deviation	Coefficient of Variation
F3/6500	678.40	590	734	144	17.90	5.28
F5/6500	696.44	620	718	98	19.21	5.52
F7/6500	687.94	648	778	130	22.17	6.28
F3/9000	663.20	552	750	198	18.19	5.44
F5/9000	674.76	620	736	116	19.05	5.65
F7/9000	668.90	592	730	138	22.74	6.86

3.2 Hairiness

The results show that with the F7 there is better control in the system than when using lighter travellers as shown by the range (3), coefficient of variation (4.34) and the standard deviation (1.32). The control of the yarn during spinning was evident as the F7 traveller was the traveller to produce a steady balloon while with the other travellers the balloon would expand and loose shape during the spinning process. The results show that there is a general decrease in the average hairs per meter as the speed is increased. The trend is similar to that found by Ratnam et al. (Ratnam and Manivelu) at low speed (below 10000 rpm). The minimum hairiness decreased as the speed increased as shown by the decrease in the cluster of the smaller figures in the higher spindle speed range. The results show that the spindle speed has an effect on the hairiness of the yarn because as the speed was increased the hairiness per meter was decreased. On the effect of the traveller weight, considering the speed of 6500 rpm, as well as the 95000 rpm, there is a decrease in the average number of hairs of the yarn samples. This is in agreement with a number of studies that had the same observation in relation to hairiness and traveller weight (I Usta and Canoglu, 2002). The heavier traveller provides a higher spinning torque during the spinning proves which results in the fibres being given a greater twisting force into the yarn thus there are shorter protruding fibres.

Table 5 Hairiness results (Hairiness index)

Traveller/Speed	Mean (HI)	Minimum (HI)	Maximum (HI)	Range (HI)	Standard Deviation	Coefficient Of Variation
F3/6500	41.40	34.00	54.00	20.00	9.97	24.10
F5/6500	39.00	33.00	50.00	17.00	6.50	16.67
F7/6500	30.40	28.00	31.00	3.00	1.32	4.34
F3/9000	33.00	20.00	43.00	23.00	8.99	27.22
F5/9000	29.50	22.00	34.00	12.00	4.96	16.84
F7/9000	28.80	22.00	45.00	22.00	9.40	32.60

*HI=Hairiness index

3.4 Tensile strength

There were no significant differences in the strength of the samples although higher results were seen in the 6500 rpm spindle speed range. At 6500 rpm spindle speed the drafting speed is low compared to that at 9000 rpm. The resulting pulling of the fibres due to tension is therefore lower at the 6500 rpm spindle speed than at 9500 rpm. The consequence is that there is less strain on the drafted sliver and hence a more compact structure is produced by the machine at 6500 rpm. At higher speeds there is a tendency to pull the fibres from the main structure resulting in the reduction of fibre cohesion leading to lower results when the tests are carried out. The other result of increasing the spindle speed is that the traveller speed is increased hence the friction between the ring and the traveller is increased leading to increased tension in the spinning system. The increase in the tension applied to the yarn is therefore the result of the increased spindle speed and the friction on the traveller where the friction between the traveller and yarn results in the straining of the yarn.

Table 6 Tensile test results

Traveller/Speed	Mean(N)	Minimum(N)	Maximum(N)	Standard Deviation	Coefficient Of Variation
F3/6500	0.63	0.53	0.74	0.05	8.22
F5/6500	0.66	0.52	0.72	0.07	10.38
F7/6500	0.64	0.56	0.74	0.07	8.74
F3/9000	0.59	0.51	0.70	0.05	8.92
F5/9000	0.60	0.52	0.84	0.09	15.31
F7/9000	0.59	0.50	0.71	0.06	10.64

4.0 CONCLUSION

The investigation shows that there are more advantages to using higher speeds with a lower hairiness Index (below 30) and higher strength (0.59 kgf) reading obtained at 9500 rpm than at 6500rpm. Apart from the irregularity, the hairiness showed a decrease when a higher speed was used while the spindle speed showed an insignificant difference. Generally in the spinning of fibres, higher spindle speeds also have, apart from better yarn quality, the advantage of higher production rates. The traveller with the higher weight of the three travellers used produced yarn with lower hairiness at both speeds

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