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Effect of twist level and twist direction of core (double) yarn on dref-3 spun yarn

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In this study, an attempt has been made to understand the behaviour of friction spun yarn by introducing doubled yarns as core with diversity in twist level and direction. 'Z' twisted 15tex (40s Ne) parent yarn has been used for doubling purposes. To examine the effect of doubling, three twist levels are chosen, viz. 50, 60 and 70 % of the parent yarn twist for both the directions viz. S and Z. Thus, six samples of doubled yarns are prepared. These samples are tested for the count, twist, breaking force and elongation. These yarns are introduced as core into DREF-3 friction spinning system; keeping the sheath fibre constant viz. combed cotton sliver of 0.15 hank for all the samples. The twist direction of the doubled yarn used as core is found to be the influential factor for the breaking force and elongation of the friction spun yarn.

Keywords: Core yarn, Cotton yarn, Double yarn, DREF-3 yarn, Friction spinning, Twist direction, Twist level

1 Introduction

Core spinning is a technique used to produce core-sheath composite yarns for the purpose of taking advantage of the different properties of individual components in the same yarn. Core yarns have a structure consisting of two or more components. One of the components is the core of the yarn and the other is the outer covering (sheath). Conventionally, the staple fibre is used for the outer covering; the core could be continuous filament or staple fibre. The sheath of the yarn determines the staple fibre yarn's appearance and physical characteristics of the surface. The core of the yarn improves yarn tenacity and also permits the use of lower twist levels. The DREF-3000 friction spinning machine has two drafting units. The first drafting unit is for the fibres to reach the core of the yarn, whereas the second drafting unit locates wrapper fibres at right angles to the spinning drum. The sheath fibres are fed in sliver form and opened by a carding roller. The perforated spinning drums move in opposite directions in contact with the yarn surface. This creates torque, thus the sheath fibres are wrapped around the core and the core yarn structure is formed.

Generally, the friction spun yarns are weaker than the similar yarns produced by other spinning systems[1-3]. Lord *et al.*[4] found that the open-end friction spun yarn has only 60% of ring yarn strength and 90% of rotor spun yarn strength for similar yarns. For core type of yarns produced in DREF-3, Padmanabhan[5,6] found that the friction spun yarns were 25-30% deficient in strength compared to similar ring yarns. Louis *et al.*[7] also found that the DREF-3 friction spun core yarns using different cotton varieties were weaker compared to the similar ring and rotor yarns. So, in general when staple fibres are introduced as the core material, the friction spun yarns have lower strength. To eliminate this disadvantage staple fibre yarns can be used in specialized cases. The situation of using staple fibre yarns as core arises when the core is made out of coarse natural fibres. These kinds of fibres are easier to handle in the yarn form. In this study, an attempt has been made to understand the behavior of friction spinning process when the core material is a doubled yarn.

2 Materials and Methods

In this study, 40s single 'Z' twisted cotton yarn was used as the raw material to be used as core yarn. All tests were carried out following respective ASTM standards. The physical properties of the yarn is given below:

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Parameter		Value
Count	:	14.95 tex
Twist	:	25 tpi
Tenacity	:	18.72 g/tex
Breaking elongation	:	4.91 %

The parent yarn procured was doubled with the help of the doubling machine at a spindle speed of 2500 rpm; keeping the spindle speed constant and varying the twist level as well as the direction, i.e. three different twist levels (50, 60 and 70% of parent yarn twist) and two twist direction (S and Z). Table 1 represents the coding of the 6 samples prepared.

The doubled yarns thus produced were tested for the count, twist, breaking force and elongation according to ASTM standards. Six samples thus produced were fed as a core yarn through the DREF-3 machine. Material used for sheath was cotton combed sliver of 0.15 hank, and four such slivers were used for making the sheath of the final yarn. The friction spinning parameters were kept the same for all the samples so that the effect of twist c an be studied. The DREF-3 machine was introducing S twist in the core yarn.

The DREF-3 yarns thus produced were tested for the count, twist, breaking force and elongation. For the testing of twist of these yarn, the sheath was removed by hand (as in yarn clearer) and then the twist in the core yarn was tested.

Table 1—Sample coding

Code	Description (doubling)		
	Twist direction	Twist level % of parent yarn	TPI
Z/Z @ 50%	Z over Z	50	12.5
S/Z @ 50%	S over Z	50	12.5
Z/Z @ 60%	Z over Z	60	15
S/Z @ 60%	S over Z	60	15
Z/Z @ 70%	Z over Z	70	17.5
S/Z @ 70%	S over Z	70	17.5

3 Results and Discussion

Count, tenacity and breaking elongation of the doubled yarns are given in Table 2.

Table 2 shows that the count of each sample is nearly 30tex (nominal) which is obtained by the doubling of two 15tex single yarns. It is also noticed from the above table that the twist is maintained near nominal values, i.e. 12.5 tpi maintained for 50% twist level, 15 tpi maintained for 60% twist level and 17.5 tpi maintained for 70% twist level.

It is observed that for Z/Z type of yarns, with the increase in twist level the yarn tenacity increases. This is due to the doubling effect, so that the imperfections get nullified. In this case doubling twist level is also up to 70% of parent yarns, so fibre breakage is not there.

Further for S/Z type of yarn, there is not much change in the tenacity for 50% and 60% twist level but there is a slight drop for 70% twist level. The reason behind this kind of behavior might be that in the process of applying S twist over Z twisted yarn. The parent yarn's inherent twist is de-twisting as well as the two parent yarns are twisting. So the result is the combination of force loss by de-twisting and force gain by twisting. For 70% twist level the de-twisting of parent yarn occurs more than the twisting of the two almost parallel yarns.

Breaking elongation also follows the similar trend as that of tenacity. Here also with Z/Z twist the breaking elongation increases with twist and for S/Z twist, it reduces for 70% twist. Also in all the cases the elongation is lower for S/Z twisted yarn compared to Z/Z twisted yarn. Mechanical properties of DREF-3 friction spun yarns are shown in Table 3.

Table 3 shows that the count of each of the six sample is approximately 46tex. The approximate count of the doubled yarns are 30tex. So, it can be said that the DREF-3 yarn has almost 35% add-on by weight of sheath material. The twist readings of the

Table 2—Properties of the doubled yarns used as core materials in DREF

Code	Yarn count tex	Twist tpi	Tenacity gf/tex	CV% of tenacity	Breaking elongation %	CV% of breaking elongation
Z/Z @ 50%	30.76	12.7	17.79	5.12	7.82	10.18
Z/Z @ 60%	31.24	15.1	21.77	10.29	8.39	8.49
Z/Z @ 70%	32.09	17.5	26.12	13.46	10.42	10.12
S/Z @ 50%	29.53	12.7	15.82	5.76	6.53	8.17
S/Z @ 60%	29.53	14.8	15.91	8.54	6.92	7.04
S/Z @ 70%	29.82	17.4	12.50	11.21	6.56	4.09

Table 3—Mechanical properties of the DREF-3 friction spun yarn

Code	Yarn count tex	Yarn twist tpi	Tenacity gf/tex	CV% of tenacity	Breaking elongation %	CV% of breaking elongation
Z/Z @ 50%	45.78	17.0	11.93	11.32	11.39	9.28
Z/Z @ 60%	47.24	17.6	11.72	13.0	10.91	9.57
Z/Z @ 70%	47.62	21.4	10.85	17.1	12.74	9.39
S/Z @ 50%	45.42	8.6	12.81	6.11	9.19	5.65
S/Z @ 60%	45.08	9.2	12.80	7.74	9.55	12.1
S/Z @ 70%	45.42	13.8	13.00	10.85	8.95	8.46

DREF-3 core yarn are obtained by removing the sheath by hand. The twist readings are really intriguing (Table 3). The twist for the Z/Z type of core yarn increases and follows parent yarn pattern i.e. the twist in DREF yarn is higher for the core having higher twist. This may be due to the fact that the DREF-3 imposes S twist on the sheath, and on leaving the force imposed by the spinning drum the tendency of the core yarn is to get twisted in reverse direction. As a result, the Z/Z twisted core yarns add twist to the parent yarn twist. Thus, Z/Z type of core yarn shows more core twist. Similarly for S/Z type of core yarn there should be lesser twist in the core which can be observed from Table 3.

In all the cases, DREF-3 yarn having S/Z twisted yarns have higher strength compared to the DREF yarns having Z/Z twisted yarn as core with significance level of around 60%. Also it can be seen that for the friction spun yarns having Z/Z twist, the strength decreases with increase in core yarn twist, whereas the yarns having S/Z twisted core, the strength either remains same or increases. The statistical significance is found only at 50% confidence limit. The reason for this behavior may be attributed to the fact that when the Z/Z type of core yarn comes under the influence of the DREF-3, whose tendency is to impart sheath twist in S direction, at the entry to the friction zone de-twisting of the core yarn occurs and then the sheath accumulation occurs, thus producing some de-twisted zone in the final yarn. The increase in yarn CV% also indicates in this direction. Hence for 60%, more de-twisting and less sheath accumulation take place than for 50% and 70%. If we compare the tenacity of DREF yarn with the one obtained with doubled yarn, it can be seen that in Z/Z type of yarn the tenacity decreases as the twist level increases.

It may be seen that the tenacity behavior in the friction yarn with S/Z type of core is completely opposite than the parent yarns. The reason behind this kind of behavior might be that the DREF applies the reverse twist to that of the double yarn. Also, the S/Z type of yarn facilitates sheath accumulation.

It is observed that the elongation follows the exact reverse trend as that of tenacity which is significant at 85% confidence limit. It is further observed from Table 3 that for DREF-3 yarn the tenacity and breaking elongation are inversely proportional i.e. the higher tenacity with lower elongation and the lower tenacity with higher elongation, which is exactly opposite from doubled yarn.

4 Conclusion

In the current study, doubled yarns have been examined as core component in DREF-3 friction spinning system. From the results it can be concluded that the direction of twist is an important factor for using staple fibre yarn as core in friction spinning system. Significantly higher elongation is observed for friction spun yarns with Z/Z twisted core as compared to S/Z twisted core. The level of twist observed in core yarn after friction spinning, is less than that of the original yarn used as core. However, the strength of the final yarn is higher. It may be attributed to the fact of de-twisting effect of the core yarn which leaves more number of fibres aligned to the axis of the final yarn to exhibit higher strength. The sheath fibres, characteristics of a friction spun yarn, also add to the fact of enhanced tenacity of the final yarn.

References

1 Sinha S K & Chattopadhyay R, *Indian J Fibre Text Res*, 31(2006) 286.
2 Lord P R & Radhakrishnaiah P, *J Text Inst*, 78(1987) 140.
3 Oxenham W, Zhu R Y & Leaf G A V, *J Text Inst*, 83(1992) 621.
4 Lord P R, Joo C W & Ashizaki T, *J Text Inst*, 78(1987) 234.
5 Padmanabhan A R, *J Text Inst*, 80(1989) 555.
6 Padmanabhan A R, *Indian J Fibre Text Res*, 16(1991) 241.
7 Louis G L, Saluan H L & Kimmel L B, *Text Res J*, 55(1985) 344.