THE DEVELOPMENT OF A PASSIVE FALSE TWISTER MECHANISM IN HANDLING LOW STRENGTH COTTON SLIVERS ON HIGH DRAFT SPINNING MACHINE

S. Shaikhzadeh Najar, Ali. A. A. Jeddi and A. R. Hossainpour

Textile Engineering Department, Amirkabir University of Technology
Tehran, Iran, saeed@cic.aut.ac.ir

(Received: April 11, 2001 – Accepted in Revised Form: July 31, 2002)

Abstract A passive false twist unit (spiral) has been developed to assist with the handling low strength slivers on a high speed-spinning machine with a high-speed feed. In the first trial, a false twist simulator device was constructed to determine whether the passive false twist unit can be used on high speed feeding with different can distance from the feeding device. In the second trial, the effects of using one or two false-twist units on rotor spun yarn properties with different draft ratios were investigated. The experimental results show that the effect of double false-twist unit at 30° entry angle of sliver and two turns of sliver around the false-twist wire is significant on rotor spun yarn properties. It is also found that to obtain the optimum operating conditions, single or double passive false twister units are needed for different conditions including the can distance from feed part and different feed speeds.

Key Words Cotton, Sliver, Passive False Twist, Draft, Strength, Rotor Spinning Machine

چکیده یک واحد تاب مجازی غیر فعال (مارپیچ) برای کمک به انتقال فتیله های با مقاومت کم در یک ماشین ریسندگی با سرعت تولید و تغذیه بالا مورد استفاده قرار گرفته است . در اولین آزمایش ، یک دستگاه مدل تاب مجازی برای بکارگیری واحد تاب مجازی غیر فعال در شرایط سرعت تغذیه بالا و فاصله های مختلف بانکه تا واحد تغذیه ساخته شد . در دومین آزمایش ، تاثیرات استفاده از یک یا دو واحد تاب مجازی بر خواص فیزیکی نخهای ریسیده شده چرخانه ای مورد بررسی قرار گرفت. نتایج آزمایشها نشان می‌دهد که استفاده از یک واحد تاب مجازی مضاعف با دو دور چرخش فتیله حول مفتول تاب مجازی و زاویه ورود فتیله در مقدار ۳۰ درجه، برخواص فیزیکی نخ ریسیده شده چرخانه ای با اهمیت است. همچنین مشخص گردید که برای بدست آوردن وضعیت عملی بهینه، تحت شرایط مختلف فاصله بانکه تا قسمت تغذیه و نیز سرعتهای مختلف تغذیه، به یک تا دو مکانیزم تاب مجازی غیر فعال نیاز می‌باشد.

1. INTRODUCTION

The problem of processing of lightweight slivers (<3 Ktex) during some of the recent developments for cotton spinning in higher production speeds was considered in previous work [4]. It has been shown that false-twist can offer a potential technique for dealing with low strength and lightweight cotton slivers. The results from this technique appeared that such a device has little effect on drafting regularity.

It has been reported [3] that, in new spinning systems using sliver feed directly to the machine, the speed of sliver feed and the distance of sliver can from feed rollers are different. In Rotor system, the speed of sliver feed is high and the distance of sliver can from feed rollers is short, while for Ring-Can and Dref-Ring systems this distance is long and sliver feed speed is low. In the case of Air-jet system both of these factors are high. Based on this background, we decided to consider using of a passive false-twist device on a high speed and high draft spinning machine (Rotor spinning machine), to optimize the false twist factors and compare the regularity, strength, elongation and count of the produced yarns with those produced without this device.

2. REVIEW

Several workers have previously made theoretical and experimental study of the effect of twist [5] and the strength and rupture force of twistless slivers [1,2]. The characteristics of static and dynamic friction of fibers are significant criterion for adjusting drafting units in the roving and fine spinning processes. The influences of the preliminary draft factor and the speed of the drafting unit on these characteristics were focused by Troger et al. [7]. Research relating to high drafting [6] was particularly undertaken from the point of view of fine spinning frames offering a range of high delivery speeds. Thus, there is no conclusion to date as regards the effects of varying delivery speed on the drafting process within the drafting unit and hence on yarn quality.

3. METHODS AND EXPERIMENTS

The experiments of this investigation were carried out at two stages. First, based on previous research [4], we designed a simulator device to determine the effect of different factors such as the entry angle of sliver, the diameter of false -twist wire, the speed of silver feed, the can distances from feed part, using of one or two passive false twister mechanism, the sliver linear density and the number of sliver turns around the false-twist wire, on the changing of twist level before the straight part of the false-twist spiral unit. At the second stage, we considered the influence of this unit on Rotor spun yarn properties including drafting regularity, yarn strength, count and elongation.

4. FALSE-TWIST SIMULATOR DEVICE

The false-twist simulator device (Figure1) includes a false-twist spiral unit, and a pair of delivery rollers which are mounted on a table, a guide roller and a sliver can. As can be observed in Figure 1, there are three different zones along the sliver. Zone II is the false twisting device, zone I and III are the distances between the false twist unit and feed rollers and sliver can respectively. The length and position of the false-twist unit are adjustable and the speed of sliver feed can be changed by adjusting the delivery rollers speed. The twister unit initially generates opposite directions of twist in zone I and III. While the twist in zone I rapidly decays to zero, the twist in zone III rises to a fairly

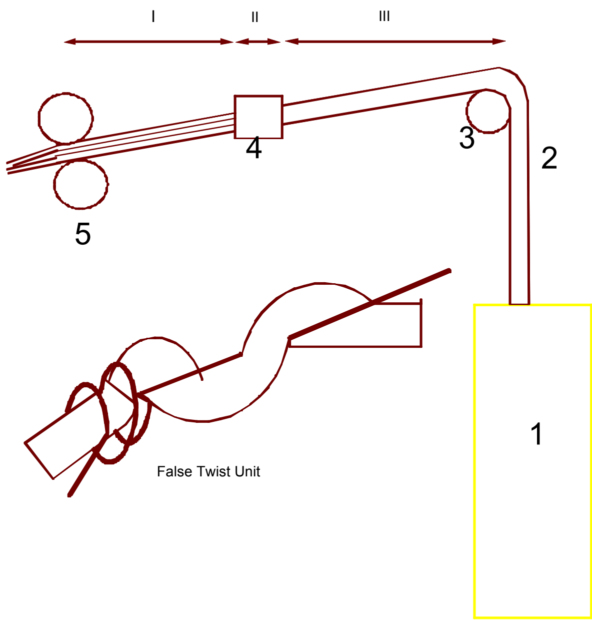

Figure 1. Schematic diagram of a passive false-twist simulator device with one false-twist unit.
Legends:
1.Can
2. Sliver
3. Guide roller
4. False twist unit
5. Feed roller
I: Feed roller distance from false-twist unit
II: False-twist unit length
III: Twist penetration length

constant value.

5. FACTORS INFLUENCING THE TWIST OF SLIVERS

In the first series of experiments, we chose the following factors to consider the number of twist insertion in the slivres; three false-twist wires with different diameters (2,4 and 6 mm.), five entery angles of sliver (10°, 20°, 30°, 40° and 50°), three different sliver feed speeds (2, 4 and 6 m/min), and one, two and three turns of sliver around the false-twist wire. Two different carded cotton slivers (finisher drawframe sliver) with linear densities of 2.5 and 3.8 Ktex were respectively used in this investigation.

The slivers were pulled through the false-twist unit under the above conditions so that the twist

TABLE 1. A Typical Result of Sliver Twist before the False-Twister Unit for Different Factors.

I = The distance between the false-twist guide and feed rollers nip.
II = The length of false-twist device.
III = The distance between false-twist unit and sliver can.
B = The number of twist before the false-twister unit.
C = The length of sliver is passed through twister when the twist level before the spiral guide to be constant.
D = The length of sliver is passed through the false-twister unit where the twist after which is decayed.
Entry Angle of Sliver = 30°. Sliver Weight = 2.5 Ktex.
Speed of Sliver Feeding = 4 m/min.

Turns of Sliver	1			2			3		
Wire Diameter (mm)	2	4	6	2	4	6	2	4	6
I (cm.)	26	27	29	26	32	33	32	35	37
II (cm.)	14	14	14	15	15	15	15	15	16
III (cm.)	150	155	173	155	169	175	165	181	190
B	6	7	9	7	8	10	9	11	12
C (cm)	188	200	208	210	212	220	217	230	228
D (cm)	215	224	232	220	228	239	240	248	262
Sliver Twist (T.P.M)	4.0	4.5	5.4	4.6	5.5	5.7	5.4	6.1	6.4

before the twister unit was steady or constant, whereas the twist after the false twister reached zero. The average of three assesments of turns per meter in slivers, the length of zones I, II and III, the number of twist before the false twister (B), the lengths of sliver are passed through the twister unit when the twist level before the spiral is fairly constant (C) and the twist after is decayed (D), were obtained for each changeable factors [3]. Table 1 shows a typical results of sliver twist for sliver of 2.5 Ktex at sliver entry angle of 30° and sliver feed speed of 4 m/min.

The total length of zones I, II and III is the distance of sliver can from feed part. This distance was found in first series of experiments between 167cm. to 250cm. The distance between sliver can and feed rollers in Air-Jet, Ring-Can and Dref-Ring systems have been reported to be 3,4 and 5 m. respectively [3]. Therefore, we used two false-twister units to insert twist in a longer length of sliver. The experimental set up used for the second series of experiments is shown in Figure 2. The same lengths of zones I, II and III for first series of experiments were applied for these experiments.

6. INVESTIGATION RELATING TO THE PROPERTIES OF YARNS PRODUCED WITH AND WITHOUT FALSE TWISTER

In the second stage of current work, a series of

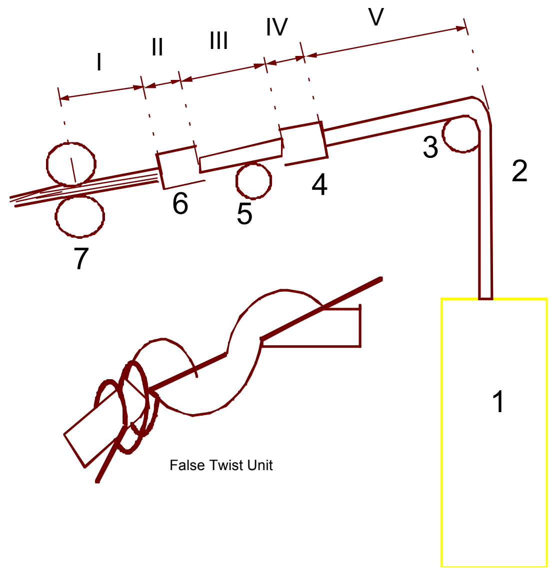

Figure 2. Schematic diagram of a passive false-twist simulator device with two false-twist units.
Legends:
1. Can
2. Sliver
3. Guide roller
4. False twist unit II
5. Guide roller
6. False twist unit I
7. Feed roller
I: Feed roller distance from false-twist unit I
II: The length of false-twist unit I
III: Twist penetration length between two false-twist units
IV: The length of false-twist unit II
V: Twist penetration length

yarns were produced to investigate the effects of using one or two false-twist units on Rotor spun yarn properties. We used a Suessen (WST Model) Rotor spinning machine with rotor diameter of 46 mm. and an opening roller type of OB20 running at 7000 rpm. The sliver feed speed and sliver linear density were kept constant at the values of 1 m/min and 2.5 Ktex respectively. Thus, three different yarns corresponding to three different draft ratios of 64, 80 and 90 were respectively produced. Other yarns and machine parameters are listed as follows:

Yarn counts: 15.3,19.3 and 21.3 N_e (38.6, 30.6 and 27.7 tex)
Yarn twist level: 688,800 and 840 T.P.M
Yarn delivery speed: 64,80 and 90 m/min.
Rotor speeds: 44080,64000 and 75600 r.p.m.

Therefore, under above mentioned conditions three different groups of yarns were processed in Rotor spinning machine using a single or double false-twist unit or without the false-twist mechanism. The entry angle of sliver and diameter of the twister wire were 30° and 2 mm respectively. The sliver was turned around the twister wire one or two times. The distances between the sliver can and spinning machine when using single and double false-twist units were nearly 200 cm. and 400 cm respectively. To compare the results with those of Rotor spun yarns, these distances were also chosen.

For each group of yarns, we made replicate tests of yarn regularity using an Uster evenness tester 3 (10 samples of hundred meters length), yarn count (30 samples), yarn strength and yarn elongation using an Uster Dynamat tester (30 samples). The average results were calculated and compared statistically with each other [3]. The first test for each yarn assessed the general data (G) at the steady running of trial, while the second test concentrated on the beginning of the trial, start-up data, (S) to see whether the variation of the residual twist level have any marked influences on yarn properties.

7. ANALYSIS OF RESULTS

From the data obtained in the first series of experiment at the first stage of the work, the

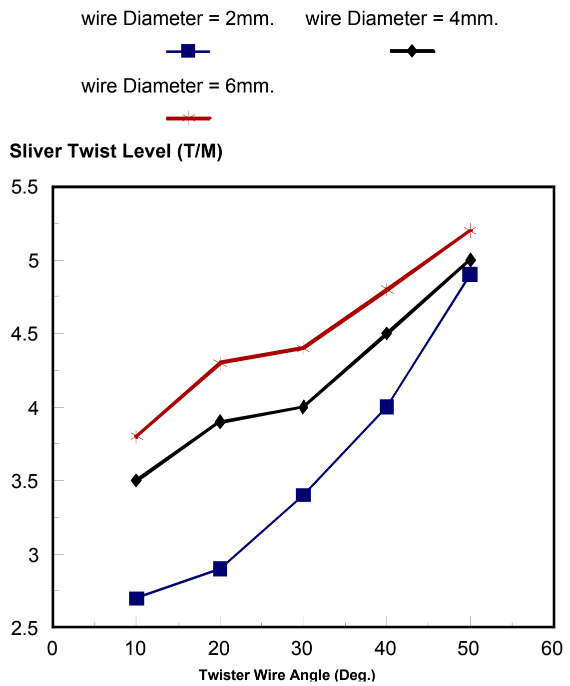

Figure 3. Effect of the twister wire diameter and angle on sliver twist level.No. of sliver turns around the twister wire = 1, Sliver count = 2.5 Ktex, sliver speed = 2 m/min.

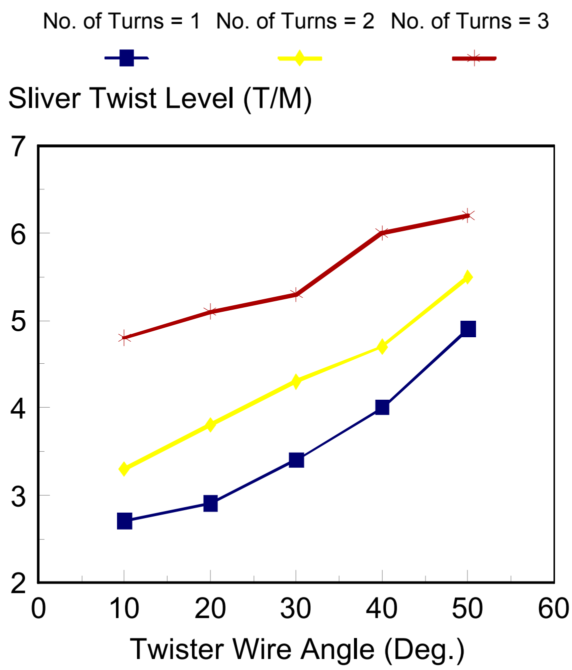

Figure 4. Effect of No. of turns of the sliver around the twister wire on sliver twist level. Sliver count = 2.5 Ktex, sliver speed = 2 m/min, twister wire diameter = 2 mm.

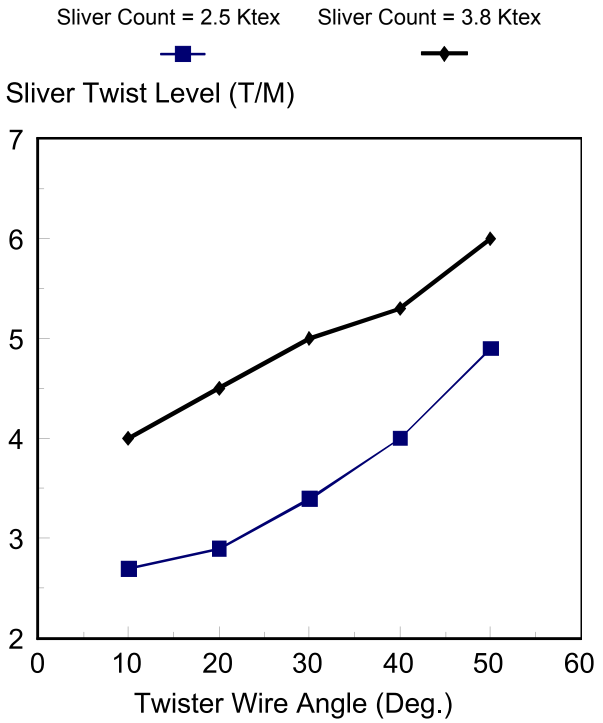

Figure 5. Effect of sliver count on sliver twist level. No. of sliver turns around the wire =1, sliver speed = 2 m/min and twister wire diameter = 2 mm.

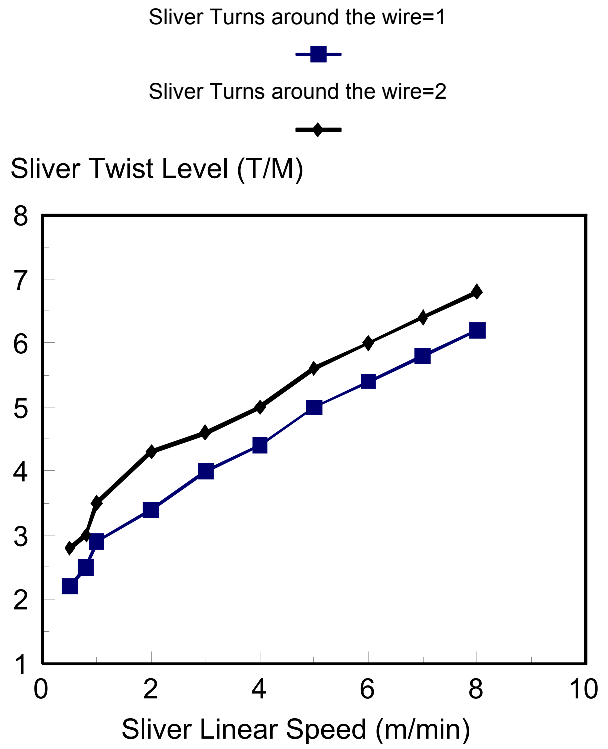

Figure 6. Effect of sliver speed on sliver twist. Wire diameter = 2mm, sliver count = 2.5 Ktex and wire angle = 30 (Deg.).

typical graphs in Figures 3, 4, 5 and 6 can be plotted to show the changing of the twist of sliver due to the entry angle of sliver, the diameter of false-twist wire, the number of turns of sliver around the false-twist wire and the weight and the transfer speed of sliver respectively. These Figures show that with the increase of each of these factors, the twist of sliver increases.

Figures 7, 8, 9 and 10 show the effect of the above factors on the distances between twister and feed rollers (zone I). The importance of this analysis is to determine the correct position of the false-twist unit for different weight and transfer speed of sliver.

Similar consideration was carried out for the length of false-twist unit (zone II). The typical graphs are shown in Figures 11,12 and 13. The results indicate that the diameter of false-twister wire and the transfer speed of sliver have no influence on the twister length, but with increasing the sliver weight the length of twister unit increases.

The experimental results also show [3] that the lengths (C) and (D) are increased due to the increase of sliver entry angle, sliver speed, sliver

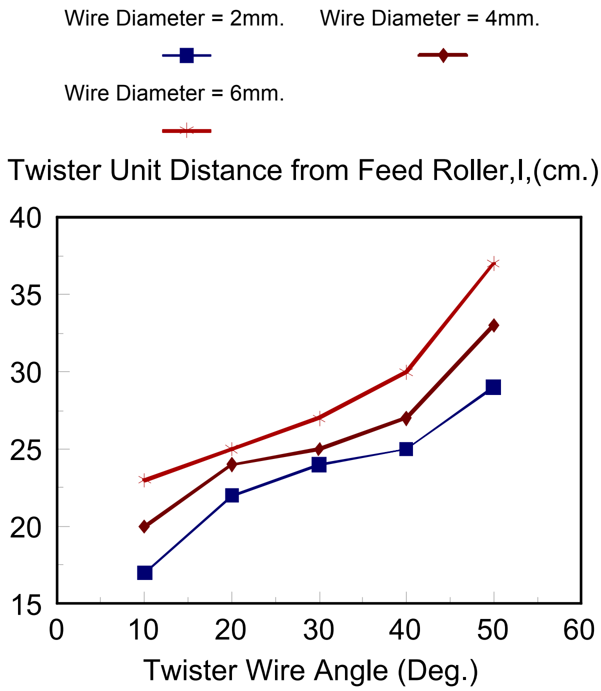

Figure 7. Effect of wire diameter and angle on twister unit distance (I) from feed roller. No. of sliver turns around the wire=1, sliver count=2.5Ktex, sliver speed=2m/min.

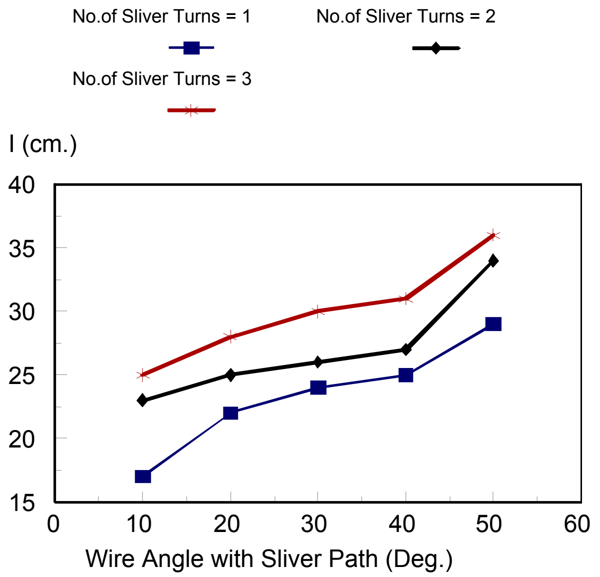

Figure 8. Effect of No. of Sliver Turns around the Twister Wire on Twister Unit Distance from Feed Roller (I). Sliver Count = 2.5 Ktex, Sliver Speed = 2m/min and Wire Diameter = 2 mm.

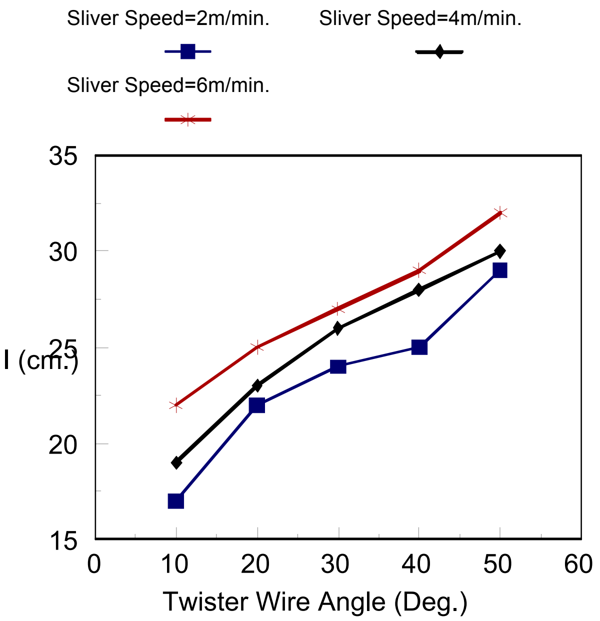

Figure 9. Effect of sliver speed on twister unit distance from feed roller (I). Wire diameter = 2 mm.,sliver count = 2.5 Ktex and No. of sliver turns around the twister wire = 1.

turns around twister wire, and the diameter of twister wire. However, in all cases, the length D is more than the length C which is in agreement with the results of Jeddi and Oxenham [4].

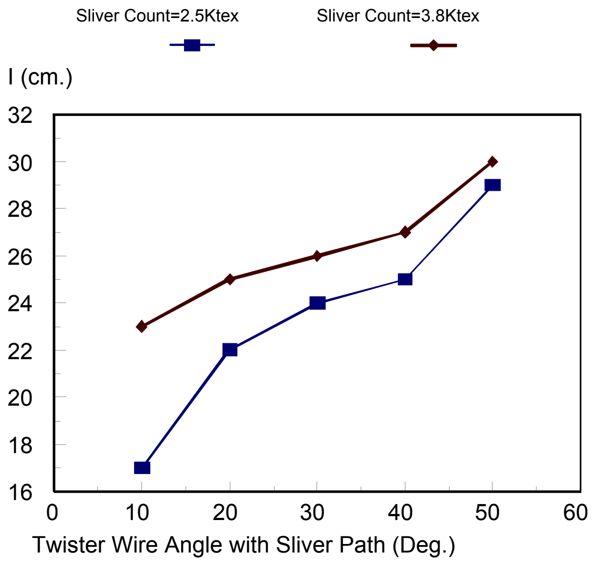

Figure 10. Effect of sliver count on twister unit distance from feed roller (I). Wire diameter = 2mm., sliver speed = 2m/min. and No. of sliver turns around the wire = 1.

The exprimental results for the second stage of the work are summerised in Table 2. Comparison between the yarns produced with and without false-twist device does show that only two turns of sliver around the false-twist wire in the cases of using double twister device and different draft ratios we have significant differences in yarn properties (with the 99% confidence limits), at the begining of the trial “Start up” (S) and the steady running conditions “General” (G). It seems likely that due to increase of frictional contacts, the sliver is subjected to some tension forces, which in turn results to a thinner yarn. It is reasonable to state that increasing the yarn count (N_e) will significantly change the yarn irregularity and elongation. The experimental results in Table 2 also demonstrates that the rotor spun yarn produced with a shorter can distance from feed part (corresponding to using a single false-twist unit) is significantly stronger than that of with a longer distance (corresponding to using a double false-twist unit). This result may be attributed to a higher sliver weight in a longer distance, which leads to a higher resistance force against running of sliver. It is postulated that the resistance force will change the fiber orientation in the sliver and thereby reducing the yarn strength. We see, however, there are no significant differences in yarn properties for other

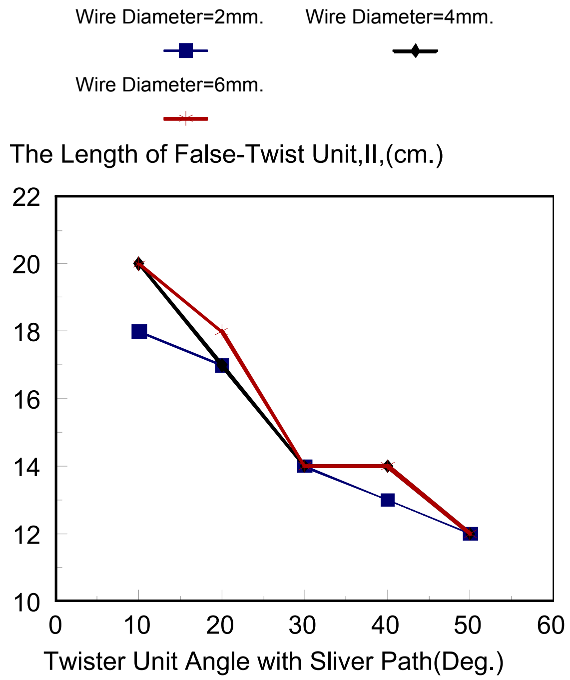

Figure 11. The effect of wire wiameter and twister unit angle with sliver path on false-twist length (II). Wire diameter = 2mm., sliver speed = 2 m/min. and No. of sliver turns around the wire = 1.

cases.

We also showed that [3] the yarns properties that are produced with single false twist device, up to 30° sliver entry angle and two turns of sliver around the false-twist wire have no distinct differences with the yarns produced without the false-twisting device. The wire diameter also has no effect on the yarn properties. Similar results obtained for double false-twist device excepted for the maximum turns of sliver around the wire that should be one turn.

8. CONCLUSIONS

This research indicates that the passive false-twist device can offer the potential for dealing with low strength and lightweight cotton slivers on the high speed spinning machine as a low cost device, the ease of retrofitting these units to existing machines, and the absence of any requirement for additional devices.

The experimental results in the case of the false-twist simulator device, suggest that for the distance from a supply can to the feed rollers up to

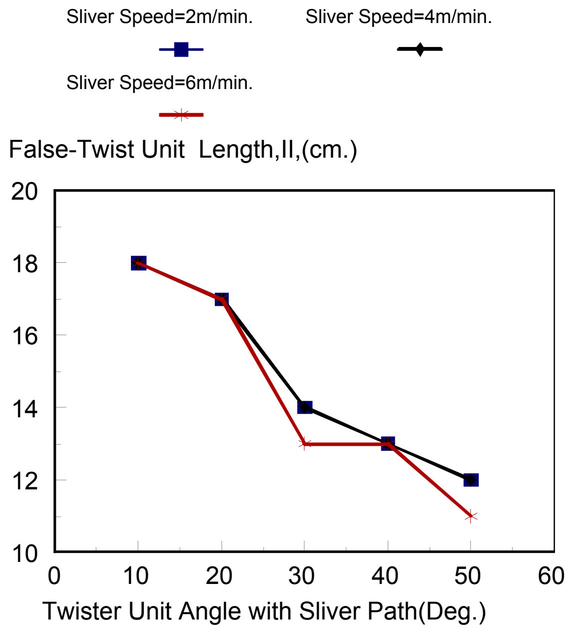

Figure 12. Effect of sliver speed on false-twist length (II).Wire diameter = 2mm., sliver speed = 2m/min. and No. of sliver turns around the wire = 1.

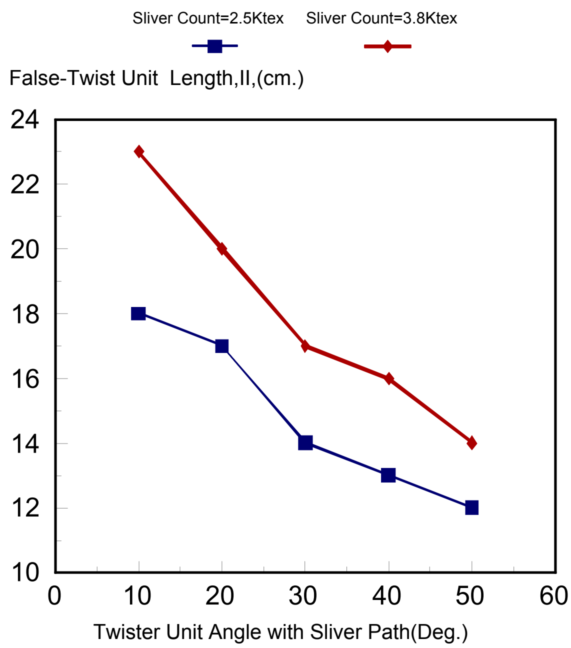

Figure 13. Effect of sliver count on false-twist length (II). Wire diameter = 2mm, sliver speed = 2m/min. and No. of sliver turns around the wire = 1.

250 cm., a single device is needed and for longer distance, two devices should be used. The increase of entry angle, sliver weight, transfer speed of

TABLE 2. Statistical Comparison between Yarn Properties Produced with and without False-Twist Device (S = Start up, G = General, W = Without Device, *: Significant at 1% Level). Entry Angle of Sliver = 30°, Sliver Weight = 2.5 Ktex, Wire Diameter = 2 mm., Speed of Sliver Feeding = 1 m/min.

Draft	No. of Devices	Turns of Sliver	Data	Regularity C.V%	Strength (cN/tex)	Elongation %	Yarn Count (Ne)
64	Single	1	S	15.58	15.29	11.42	16.12
			G	15.61	14.02	10.82	14.86
		2	S	15.69	13.91	10.54	15.2
			G	15.7	14.61	10.73	15.72
			W	15.01	14.25	10.83	15.2
	Double	1	S	16.02	12.96	7.82	15.8
			G	16.18	12.14	7.92	14.92
		2	S	18.4*	13.2*	5.6*	17.2*
			G	18.7*	13.4*	5.2*	17.4*
			W	16.21	12.74	7.84	15.43
80	Single	1	S	18.65	14.33	6.8	20.2
			G	18.67	14.04	6.48	19.71
		2	S	18.77	14	6.24	19.24
			G	18.81	14.01	7.13	19.17
			W	18.46	14.01	6.33	19.35
	Double	1	S	17.88	12.83	6.71	19.71
			G	18.01	12.72	6.42	19.8
		2	S	19.4*	12.59*	4.2*	22.7*
			G	19.6*	12.63*	3.96*	23.4*
			W	18.53	12.33	5.64	19.28
90	Single	1	S	19.42	15.35	6.8	22.51
			G	19.31	13.59	7.2	19.98
		2	S	19.03	13.97	6.34	20.14
			G	19.9	14.5	6.95	21.17
			W	19.3	14.6	6.4	21.36
	Double	1	S	21.07	13.64	4.8	22.08
			G	20.16	13.31	3.67	21.4
		2	S	22.7*	11.6*	3.4*	22.3*
			G	21.9*	12.05*	2.65*	22.82*
			W	20.4	13.29	4.1	21.74

sliver, and the number of twist turns of sliver around the wire of false-twist unit, and also the increase of the wire diameter, increased the twist level of sliver. Utilizing single and double false-twist units in sliver feed area of Rotor spinning machine revealed that at 30° entry angle of sliver only two turns of sliver around the fasle-twist wire in the cases of using double false-twist device and different draft ratios significantly changed the rotor spun yarns properties both at the start up and steady running conditions. It is also found that the rotor spun yarn produced with a shorter distance of sliver can from spinning machine is significantly stronger than that of with a longer distance. This research opens a new concept into the modern and high-speed spinning systems. The use of passive false-twist device in air-jet spinning warrants further investigation.

9. LITERATURE CITED

1 Grosberg, P., “The Strength of Twistless Slivers”, ***J. Textile Inst.***, 54, (1963), 223-233.

2 Grosberg, P. and Smith, P. A., “The Strength of Slivers of Relatively Low Twist”, ***J. Textile Inst.***, 56, (1965), 15-23.

3 Hossainpour, A. R., “The Development of False Twist Mechanism in Handling Low Strength Cotton Slivers on High Speed Feeding or High Draft”, M.Sc. Thesis (In Persian), Amirkabir University of Technology, (1997).

4 Jeddi, A. A. A. and Oxenham, W., “The Potential of False Twist to Assist in Handling Low Strength Cotton Slivers”, ***Textile Res. J.***, 65, (1995), 423-426.

5 Smith, P. A., “The Effect of Twist on a Worsted Roving”, ***J. Textile Inst.***, 53, (1962), 511-528.

6 Tröger, J., “Dissertation Technical University of Chemnitz”, Section Textil-Und Ledertechnik, (1990).

7 Tröger, J., Schlegl, E. and Schwabe, B., “Influence of the Preliminary Drafting factor and the Drafting Unit Speed on the Static and Dynamic Friction Characteristics of Slivers in High Drafting Units”, ***Melliand Textilber***, **74**, E3-E6, (1993).