THE APPARENT LOSS OF TWIST IN OPEN-END COTTON/POLYESTER BLENDED YARNS.

By

I. Rakha* and R. El-Bealy **

الفقد الظاهري للبرمات في خيوط الغزل ذات الطرف المفتوح
الناتجة من مخاليط القطن بألياف البولي استر

الخلاصة :

من الظواهر الهامة أثناء تكوين خيوط الغزل ذات الطرف المفتوح حدوث فقد في البرمات المعطاة للخيط ويرجع ذلك الى حدوث انزلاق بين الشعيرات وجدار التوربينة والى رد الفعل لعزم البرم أثناء اعطاء البرمات.

والبحث الحالي يهدف الى دراسة تأثير بعض العوامل مثل معامل البرم ونمر الخيوط ونسبة خلط الشعيرات المكونة للخيوط، ومتوسط طول الشعيرات ودقتها في مخاليط القطن بألياف البولي استر على كفاءة اكتساب البرمات في خيوط الغزل ذات الطرف المفتوح. وقد أجريت التجارب بتغيير عاملين عند عدة مستويات مختلفة وكذلك بتغيير ثلاث عوامل باستخدام طريقة تصميم التجارب ($٣^{٣}$). وتشير نتائج البحث الى ان متغيرات الخيوط المخلوطة مثل معامل البرم ومكونات الخلطة ونمر الخيوط تؤثر معنويا على كفاءة اكتساب البرمات. وبالاضافة للعوامل السابقة يتأثر معدل الفقد في البرمات بتفاعلات العوامل مع بعضها كما في حالة نسبة الخلط مع معامل البرم، وأيضا نسبة الخلط مع نمر الخيوط المنتجة. كما أمكن تحديد معامل الارتباط بين الفقد الظاهري في البرمات وخواص الشعيرات المخلوطة.

ABSTRACT The phenomenon of twist loss in open-end staple spun yarns has been explained by the slippage between Fiber ring and rotor wall and the reaction to turning moment during twist insertion. In the present study some variables such as: blend composition, twist multiplier, yarn count, staple length and fineness of fibers were chosen to explore the twist efficiency of rotor cotton/polyester blended yarns. The experiments were carried out by varying two variables at different levels and three variables 3^3 factorial design technique. The results declared that twist efficiency was found to be influenced significantly by O.E C/P yarn parameters. In addition to the above parameters, the two factor interaction such as Blend composition with twist multiplier and blend composition with yarn count affect significantly the twist efficiency. Also, it has been shown that there is a strong correlation between twist loss and fiber blend parameters.

I. INTRODUCTION:

In rotor spinning m/c, the loss in twist inserted in the yarn has been variably attributed to:
- The unique core-sheath bipartite structure of the rotor yarns.
- The leakage of twist through the tail of the fiber band and,
- The slippage between the fiber and the rotor wall. ..

From the work of other research workers, we can draw some information on the twist efficiency and an explanation for the phenomenon of twist loss in terms of the following parameters:

(i) Open-end yarn formation: in one such study (I) it was stated that some fibers slip particularly the surface fibers as they leave the collecting surface resulting in twist loss. It was thought that the core fibers do not slip much. Sultan and

---

* Lecturer ** Assoc. Prof. in Textile Dept. Faculty of Eng. Mansoura University.

El-Hawary (2) visualized slippage between the condensed fiber strand and collecting surface of the rotor.

(ii) Effect of some open-end m/c parameters, such as: rotor type, extractive nozzle and combing roller speed. It has been shown that the use of grooved doffing tube increases the wrapper fibers due to an increased false twist action resulting in an elongated peripheral twist extent (3). Also, it has been stated (4) that the use of grooved doffing tube results in a decreased twist efficiency. Manich et.al (5) Studies the effect of extractive nozzle and rotor type as a qualtitative factors on the apparent loss of twist in open-end spun yarns. Both rotor and nozzle type exert a significant influence on residual twist, which tends to increase when the nozzle produces a rising false twist effect and to dimish when friction of the yarn against rotor increases. The effect of combing roller speed on twist efficiency and the percentage of sheath fibers has been studied (6). As the combing roller speed increases, there is a gradual reduction the percentage of sheath fibers, i.e reduces the possibility of some fibers becoming wrapper fibers. Also, they results the twist efficiency goes up as the combing roller speed is increased.

(iii) Effect of fiber and yarn parameters:
In relation to the type of fiber. it has been shown that, compared to cotton fibers, the viscose rayon staple fibers show a highly percentage of sheath (7) and a lower twist efficiency (8). Viscose rayon fibers of different lengthes with the same linear density affect significantly on twist efficiency. Dyson (9) who also agreed that there is twist loss attributed this to the torsional rigidity of the fibers in the untwisted ribbon resulting in a reaction to the turnning moment which inhibits the process of twisting from being 100% efficient. In relation to O.E yarn parameters, a decrease in twist multiplier leads to a reduction in the sheath fibers and an increase in the twist efficiency (6). Also, residual twist increases significantly in a linear manner with yarn linear density.

Thus, the present work tends to study the influence of some variables on the apparent loss of twist in open-end C/P blended yarns. The experiments carried out to investigate the following:

- The effect of Blend composition, twist multiplier and yarn count on twist loss. Statistical analysis were made on the three variables factorials on the basis of three level for each.
- The effect of the type of fiber component, Mean fiber length in blends, and fiber finenss as a function of no of fibers/ cross-section on twist efficiency.

2. EXPERIMENTAL WORK:

2.1 Material Used:

Misr polyester staple fiber of 38 mm effective length, 1.4 denier and 5.9 gram/denier, and Egyptian cotton fibers "Giza 75" with staple length 28 mm, 4.5 μg/in and pressely index = 9.8 were used in the present study.

2.2 Open-End C/P blended yarn production:

The machine sequence was adapted for the individual components and blends. Seperate lines for polyester and cotton were used for opening, cleaning and carding. The two components were blended at drawing frame and blend levels were achieved by varying the relative number of cotton and polyester sliver fedon the drawing frame.

The blended slivers were fed to rotor spining using opening roller 65 mm in diameter, its speed was 7300 t. min^{-1} and 8000 t. min^{-1}. while the rotor diameter 45 mm and worked at constant speed 45000. t. min^{-1}.

Three spining variables : twist multiplier, yarn count and blend composition were changed while the other machine parameters were kept constant as shown in table (1).

Table (1)

Yarn Count	Twist Multiplier (αe)	Cotton/Polyester blend level					Designation
		100_c	75_c 25_p	50_c 50_p	35_c 65_p	100_p	
Ci	3.6	x	x	x	x	x	I (1 - 5)
	4.0	x	x	x	x	x	II (1 - 5)
	4.7	x	x	x	x	x	III (1 - 5)
	5.5	x	x	x	x	x	IV (1 - 5)
	5.8	x	x	x	x	x	V (1 - 5)

C : Cotton fibers (Giza 75) ; P : polyester staple fibers

C_i Yarn count "or yarn linear density" ; i = 1, 2, 3

C_1 = 18 Ne (33 tex), C_2 = 22 Ne (27 tex) and C_3 = 28 Ne (21 tex)

2.3 Measurements:

The apparent loss of twist was determined by means of the untwist-twist method . This method works through medium of twist contraction; sufficient reverse twist is inserted to restore the original length under a stated tension and it is assumed that one half the algebraic difference in twist is the amount originally contained in the sample. The difference between machine twist and yarn twist is known as apparent loss of twist and expressed as a percentage

$$T_r = (T_m - T_y) / T_m \cdot 100 \qquad (1)$$

where T_r : residual twist or the apparent loss of twist, T_m : machine twist and T_y : yarn twist

while the ratio between yarn twist and machine twist is known as twist efficiency. (η)

In addition, yarns were examined for yarn counton Autosorter, yarn strength on Tensomat strength tester and irregularity on uster evennens tester.

2.4 Statistical Analysis:

The experimental design technique 3^3 factarial design applied for the apparent loss of twist in open-end c/p blended yarns, as shown in table (2), to examine the main effect of three variables:

Twist multiplier : (-1) 3.6α_e, (0) 4.7 α_e, (+ 1) 5.8α_e

Yarn count : (-1) 18 N_e, (0) 22 N_e, (+) 28 N_e

Blend composition(-1) 100_c, (0) $50_c/50_p$, (+) 100_p

Also, it was decided to investigate all combinations of three levels of each of three variables.

Table (2). Values of Residual twist (T_r %)

Level of Twist. Factor. (α_i)	Level of O. E yarn Count (C_i)								
	C_1			C_2			C_3		
	Level of blend ratio (B_i)			Level of Blend ratio (B_i)			Level of Blend ratio (B_i)		
	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3
α_1	Tr_1	Tr_2	..	Tr_{10}	..	..	Tr_{19}	..	..
α_2	..	..	..	..	Tr_i	..	..	...	..
α_3	..	..	Tr_9	..	..	..	..	..	Tr_{27}

3. Results and Discussion:

3.1 Effect of twist multiplier, yarn count and blend composition on twist loss.

Fig (1) shows the effect of twist multiplier on twist loss in c/p blended yarns. It is seen that, as the twist increased from α_e 3.6 to α_e 5.8 there is almost a continuous increase in residual twist (T_r %) i.e the twisting efficiency decreases. This trend has been observed for all yarns.

The experimental results, are given in figures (2) and (1), indicate that the influence of yarn count "or Linear density" on O.E yarn residual twist, It is clear that, residual twist decreases Linearly when yarn Linear density decreases from 33 tex to 21 tex. The variation is very closer in case of cotton yarn while a substational differences exist in case of blends and 100% polyester yarns.

The curves, as shown in Figures (3) and (4), explore the relationship between fiber blend composition and twist loss in rotor spining yarns. It is seen that, the higher polyester content in blend, the lower twist efficiency. While a higher twist efficiency has been found for 100% cotton yarn.

Statistical analysis of results are shown in tables (3) and (4) in terms of the main effects and two-factor interactions. It can be noticed that from the variance analysis, the Linear main effect of blend composition is highly significant at the level 1%. Also, the Linear and quadratic effect of yarn count are statistically Significant at 1% and 5% respectively. In the same time the Linear effect of twist multiplier is significant at 5%.

The two-way table (4) indicate the interaction between two parameters. From the blend composition with yarn count (BxC) interaction, it is seen that a higher rate of twist loss at both higher percentage of polyester in blends and coarse yarn count. while a lower rate has been observed for lower yarn linear density and 100% cotton yarns. The linear effect of (B x C) is significant at 1% level and (B_L x C_Q) : The linear effect of blend composition with quadratic effect of yarn count (C_Q) affect significantly on the apparent loss of twist in open End blended yarns at 5% level.

From the two-way table (α x B): the blend composition (B) has the same trend whatever the condition of other factors" twist multiplier and yarn linear density (tex)". The Linear effect of (αx B) is significant at 10% level. Also, a rise of twist loss has been observed at twist multiplier changes from α_e 3.6 to 5.8 for blend ($50_c/50_p$) comparing to 100% open-end cotton-spun yarns.

Source of Variation		Mean Squares (ms)	Variance Ratio
(i) Main Effect :			
Blend Composition (B),	L	14134.41	1028.70 §
	Q	19.20	1.39
Yarn Count (C),	L	2123.35	154.54 §
	Q	149.67	10.89 **
Twist multiplier (α),	L	88.88	6.47**
	Q	1.19	0.09
(ii) TWo-Factor Interactions :			
Blend composition and yarn count	($B_L \times C_L$)	870.40	63.35§
	($B_Q \times C_L$)	1.60	0.12
	($B_L \times C_Q$	121.73	8.86**
	($B_Q \times C_Q$	10.21	0.74
Twist factor and blend composition	($\alpha_L \times B_L$	64.87	4.72*
	($\alpha_Q \times B_L$)	6.17	0.45
	($\alpha_L \times B_Q$	18.35	1.34
	($\alpha_Q \times B_Q$	14.59	1.06
Twist factor and yarn count	($\alpha_L \times C_L$)	7.21	0.53
	($\alpha_Q \times C_L$)	9.71	0.71
	($\alpha_L \times C_Q$)	0.51	0.04
	($\alpha_Q \times C_Q$)	8.39	0.61

- Significant levels : (§) at 1%, (**) at 5% and (*) at 10%
- L: is the linear effect and Q : is the quadratic effect of the variables

Table (4) The Two-way tables

(B x C)

	C_1	C_2	C_3	Sum
B_1	34.6	29.4	21.8	85.8
B_2	113.6	113.6	70.3	321.9
B_3	242.8	219.6	127.8	590.2
Sum.	415.4	362.6	219.9	997.9

(B x α)

	B_1	B_2	B_3	Sum
α_1	19.0	93.7	198.6	311.3
α_2	24.8	112.6	197.9	335.3
α_3	42.0	115.6	193.7	351.3
Sum	85.8	321.9	590.2	997.9

(α x C)

	C_1	C_2	C_3	Sum
α_1	132.6	112.8	65.9	311.3
α_2	140.8	125.1	69.4	335.3
α_3	142.0	124.7	84.6	351.3
Sum	415.4	362.7	219.9	997.9

while the change in twist factor for 100% polyester yarns shows a slight variation in twist loss.

From the two-way table (α x C) there is a noticable decrease in twist loss to changes in the level of yarn count. The best results obtained at low twist multiplier and lower yarn linear density.

It is clear from the above results, the coarser the yarn or the higher the twist or the higher the percentage polyester in the blend the higher apparent loss of twist. This may be explained by fiber slippage during yarn formation within the rotor. These parameters causing an increase in the amount of fiber slippage and consequently increases the radial twist gradient which represented by the difference between the surface twist and machine twist(10).

3.2 Effect of staple length and fineness of C/P fiber blends on the apparent loss of twist:

In terms of the type of fibre blend components, it has been shown that, compared to cotton fibers, the Open-end yarns produced from 100% polyester fibers and C/P blends show a higher apparent loss of twist (Tr %), as explained in the earlier section.

In the present investigation, yarns spun from cotton/polyester blends has five different length. The experimental results indicate that the fiber length affect significantly on twist efficiency as shown in Figs. (6) and (7). As the staple length increased it caused a drop in the twist efficiency. This may be explained by the increase in fiber length causing an increase in the sheath fibers and consequently affect on twist level(6).

The statistical results shows a strong relationship between the fiber length and twist efficiency. The values of correlation coefficient between the two are very high ranging between $r = -0.825$ and -0.938 for yarn count Ne 18 and Ne 28 respectively.

In terms of fiber fineness, the relationship between twist loss and number of fibers/cross-section is plotted graphically as shown in Fig. (8) for different blend composition. A substantial reduction in twist loss with increasing number of fiber/cross section and varying cotton/polyester blend level. The effect is particularly prominent for 50c/50p, 35c/65p and 100% polyester yarns, while a slight variation occured for 25p/75c and 100% cotton yarns. Statistically, the correlation coefficient "r" between twist efficiency and the no of fiber/ cross-section is (-0.588) for 100% cotton, (-0.839) for $50_c/50_p$ and (-0.94) for 100% polyester yarns.

The combined effect of fiber length in blends (L_b), number of fibers/cross section (n_f) and fiber coefficient of friction (μ) expressed by the term ($S = L_b\, n_f\, \mu$) and plotted against twist efficiency as shown in Fig (9). Within the range studied for each variables, increase of ($L_b \cdot n_f \cdot \mu$) leads to a reduction in twist efficiency ($r \simeq -0.97$).

It is clear that from the above discussion, the fiber length, coefficient of friction and fineness play a significant part in determining the apparent loss of twist. This proof the hypothesis given by lord and Grady(10). They have investigated the twist structure of Open-End yarns as follows:

$$\tan \phi = \Delta T / (f_\Delta + \mu_1 F)\, r = 2\pi r \tau \quad \ldots (2)$$

where τ is the twist/inch and r : is the radios in inch the equation suggests that the twist structure wible be determined by : fiber denier (which will affect "f_Δ" the forces developed in yarn formation zone), finish (which will affect "μ". coefficient of friction between the fiber and surface over which it is being dragged), rotor speed and size (which will affect the centrifugal force "F" acting on those parts of the fiber in contact with the surface), yarn count (which will affect "r" yarn radius) and false twist level which will affect "ΔT" torque reaction).

4. CONCLUSIONS:

The present study permits the following conclusions to be drawn:

1) The results indicate that, the Open-end yarn parameters: blend composition, twist multiplier and yarn linear density affect significantly the apparent loss of twist as following:-

   i) An increase in the polyester percentage in blends leads to a decrease in the twist efficiency and there is a slight change in twist loss associated with 100% cotton and cotton/polyester blended yarns containing higher %age of cotton fibers.

   ii) A decrease in the twist multiplier resulted in an increase in the twist efficiency.

   iii) Residual twist influences significantly as linear density of yarn (tex.) changes. The apparent loss of twist increase as yarn linear density increases.

2. The application of experimental design technique $(3)^3$. clearly shows the following:

   i) The linear effect of the three variables on twist loss is highly significant, at 1% level for blend composition and yarn count, while at 5% level for twist multiplier

   ii) The two-factor interaction such as (Bxc) : blend composition with yarn count; and ($B \times \alpha$): blend composition with twist multiplier affect significantly the apparent loss of twist.

3. The variation between machine twist and yarn twist, which is known as apparent loss of twist, resulted-in more fiber entanglement in the strand during yarn formation and provide a higher strength.

4. The existing correlation between the apparent loss of twist and fiber blend parameters is highly significant and increases:

   - As the Mean fiber length in blend increases (r:varies between - 0.83 and - 0.94)
   - when the number of fibers/cross-section increases. The influence is particularly prominent for 100% polyester (r = - 0.94) while a little change obtained for 100% cotton yarns (r = - 0.588).

   - Also, the combined effect of mean ~~fiber~~ length, number of fibers/ cross-section and fiber friction coefficient : $L_b \cdot n_f \cdot \mu$ on twist loss is highly significant (r = - 0.965).

REFERENCES:

1. Lord. p., Textile Res J. 41, 778-784, 1971

2. Sultan, M.P and El-Hawari, I.A. J. Textile, Inst. 65, 194-199, 1974.

3. Grosberg. P and HO. K.H. J. Appl. Polym. Sci., Appli. Polym. Symp. 31, 83-89, 1977.

4. Smith P.A. Text. Inst. Ind. 12, 343-345, 1974

5. Manich A.M. et.al. Textile Res. J. 338-343, April 1988, Textile Res. J. 207-211, March 1986.

6. Salhotra. K.R.. Textile Res. J. 710-714, Nov. 1981

7. Radhakrishniab P. ph.D thesis, Indian Institute of Tech., Delhi 1980. (Through T. Res. J Nov. 1981).

8. Gupta R.K., M. Tech. Thesis, Indian Institute of Tech., Delhi 1980, (Through T. Res. J. Nov. 1981).

9. Dyson. E., J. Textile. Inst., 65, 632-638, 1974

10. LORD, P.R. and GRADY, P.L. Textile Res. J., P. 123, Feb. 1976.

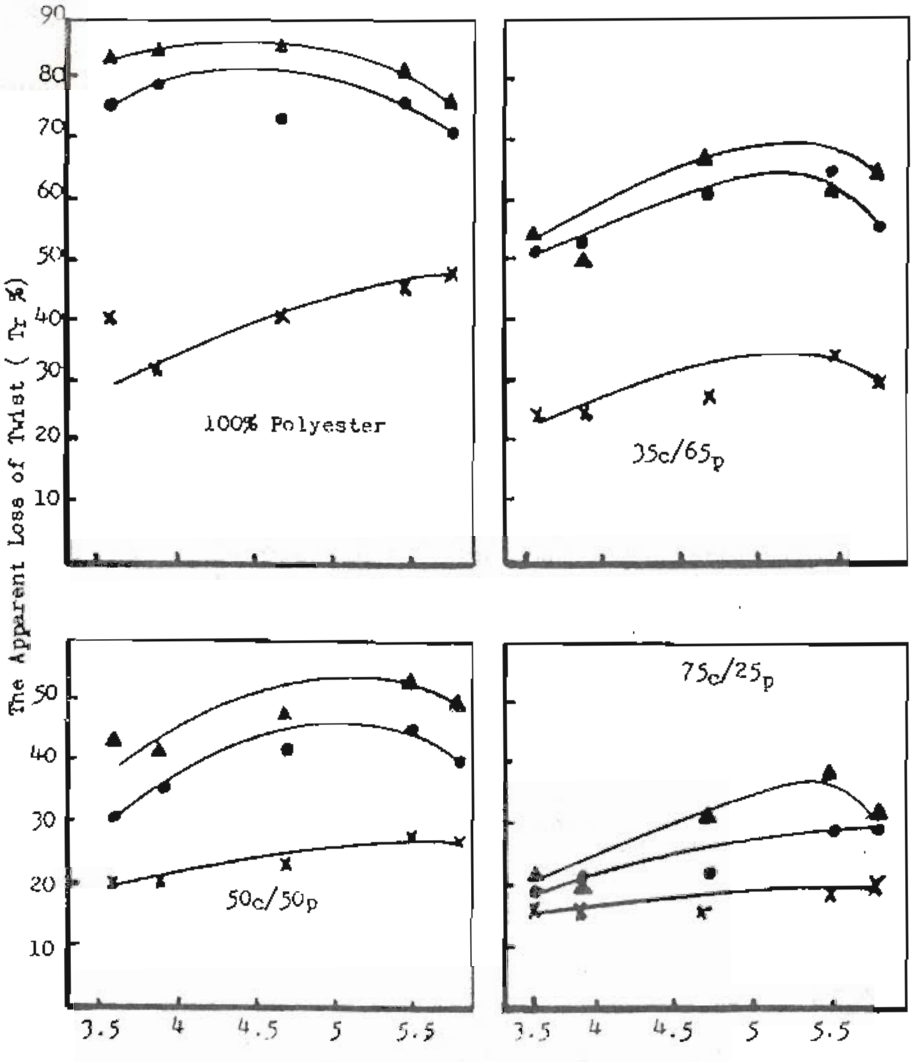

Fig.(1) Effect of Twist Multiplier on The Apparent Loss of Twist (T_r%) in Open-End Cotton/polyester Blended Yarns. (▲) $18N_e$; (●) $22N_e$; (x) $28N_e$

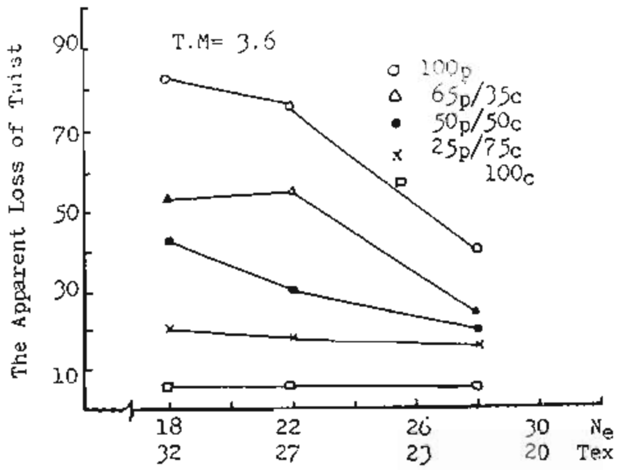

Fig.(2) Effect of Yarn Linear Density on The Apparent Loss of Twist in O.E Yarn

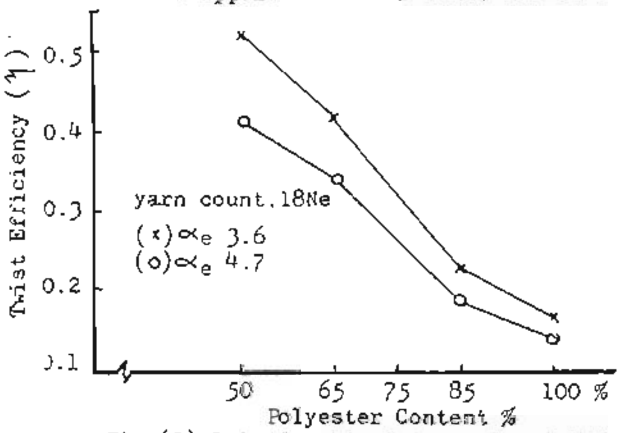

Fig.(3) Relationship Between Twist Efficiency (η) and Blend Composition

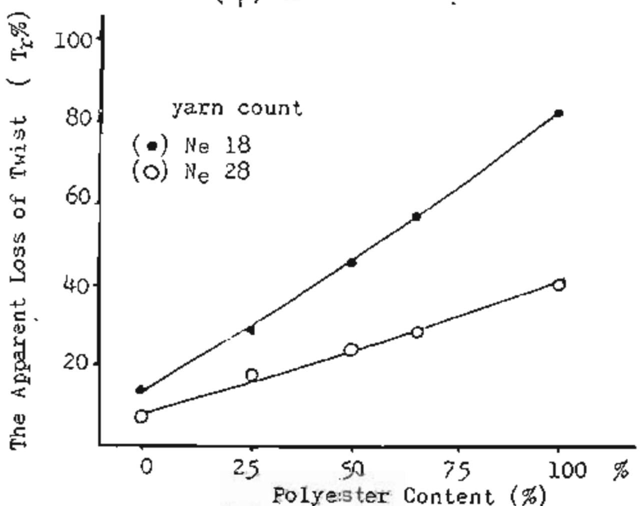

Fig.(4) Effect of Blend Composition on The Apparent Loss of Twist in O.E Yarns.

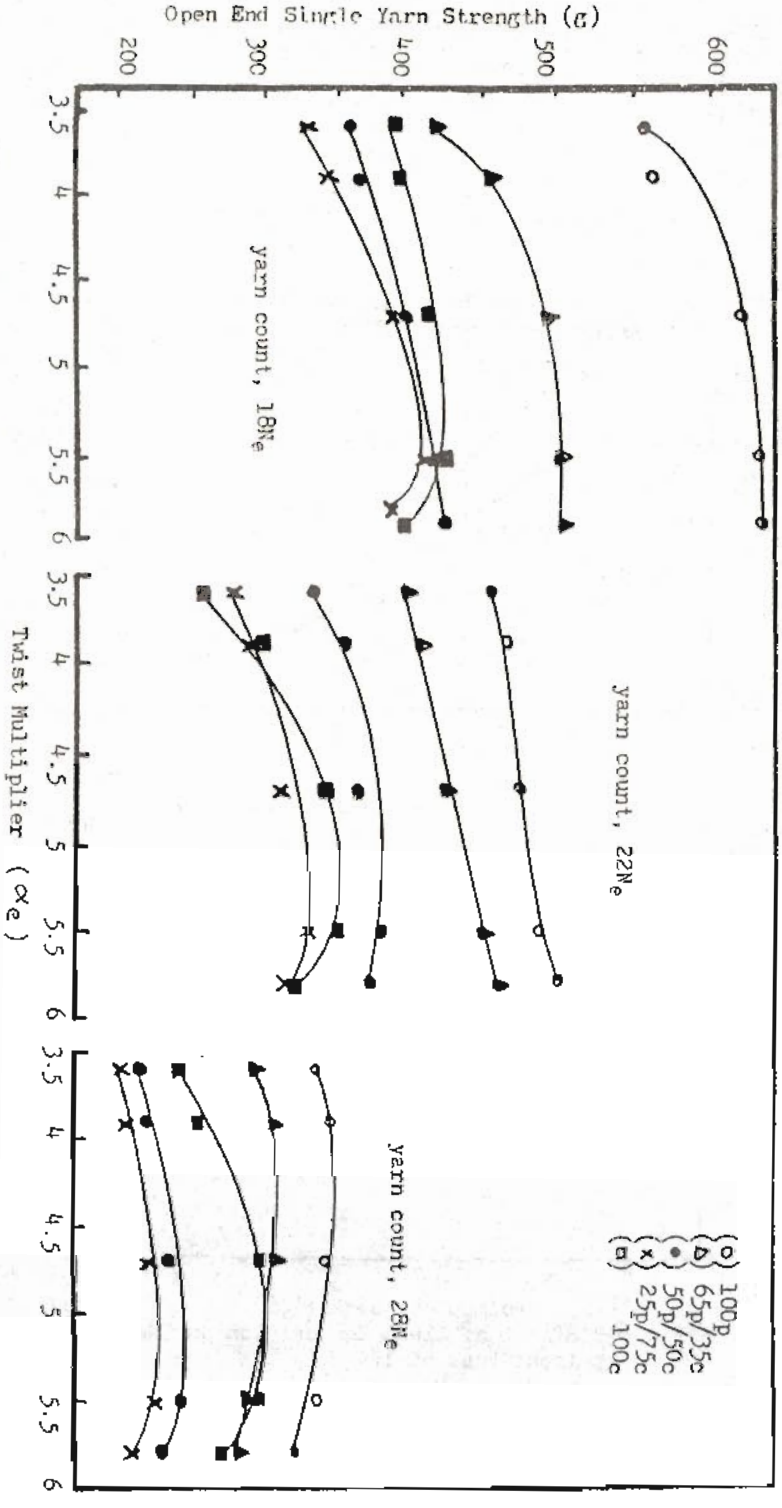

Fig. (5) Effect of Twist Multiplier, Blend Composition and Yarn Linear Density on O.E Yarn Strength

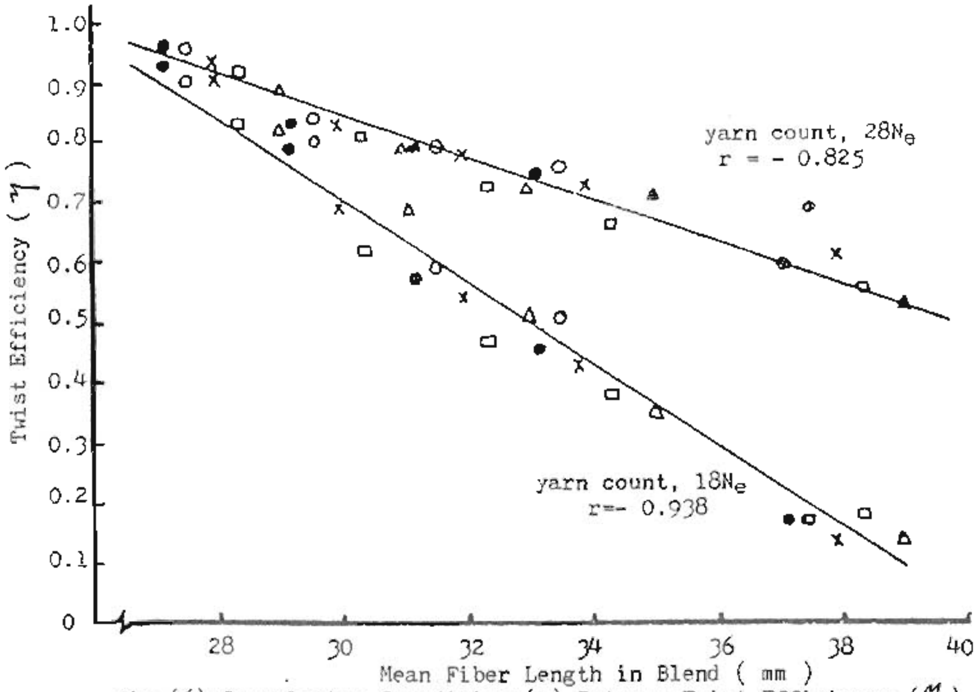

Fig.(6) Correlation Coefficient(r) Between Twist Efficiency (η) and Fiber Length in Cotton/Polyester Blends.

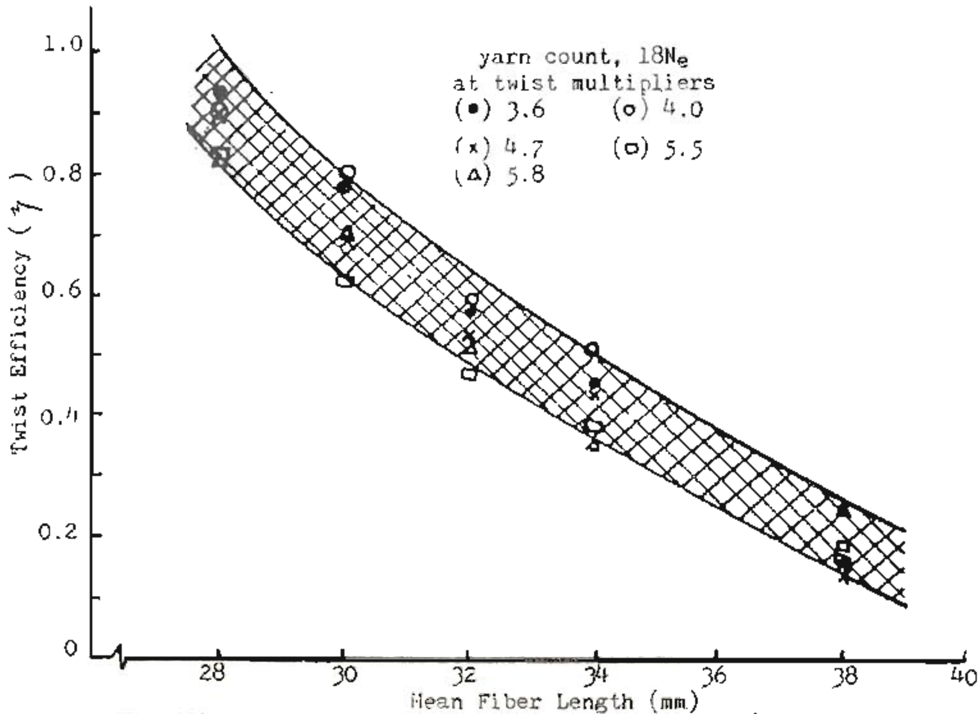

Fig.(7) Relationship Between Twist Efficiency (η) and Mean Fiber Length in Cotton/Polyester Blends at Various Twist Factors.

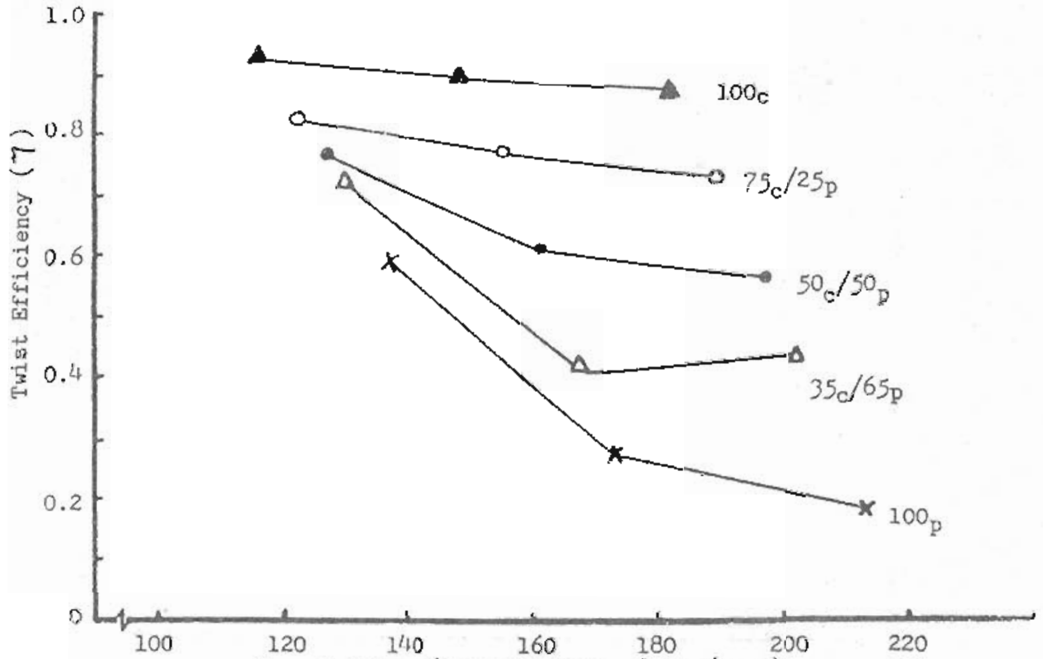

Fig.(8) Relationship Between Twist Efficiency (η) and NO. of Fibers/ Cross Section at Various Blend Levels.

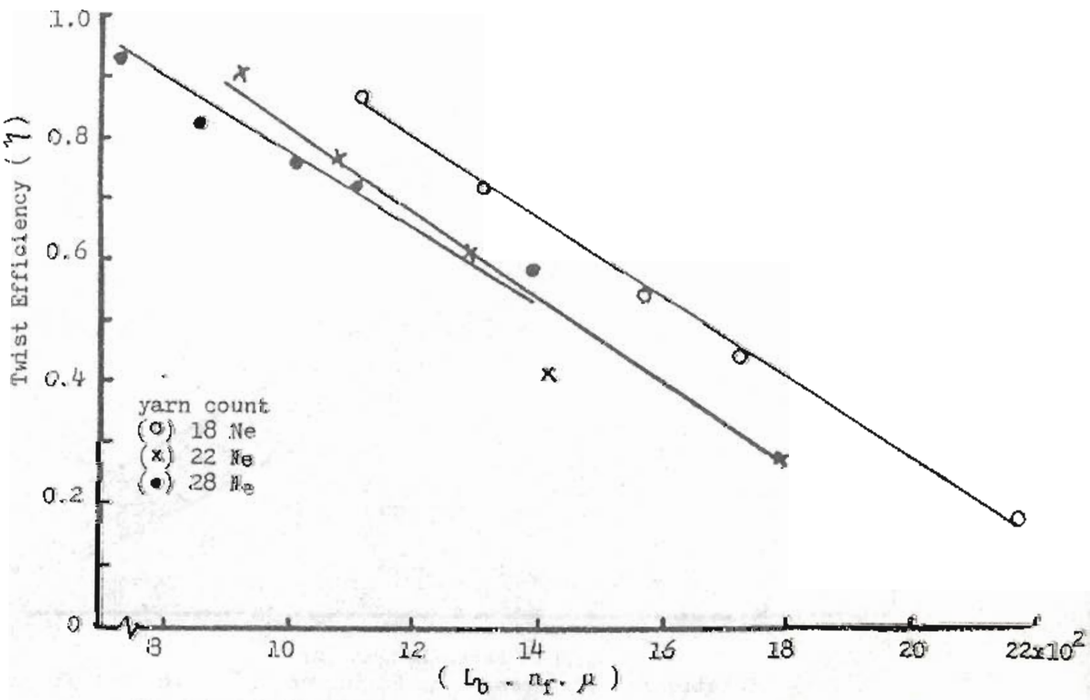

Fig.(9) The Combined Effect of Mean Fiber Length and No. of Fibers/ Cross Section on Twist Efficiency in O.E Blended Yarns.