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SPINNING PERFORMANCE OF EGYPTAIN COTTON/ POLYESTER BLENDS

BY

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ABSTRACT:

Two types of Egyptian cotton, Giza 69 and Ashmouni, were blended with polyester staple fibre, Tetoron, at different blend ratios to produce yarn counts 30, 50 and Ne 60 at five levels of twist multiplier. An experimental investigation was undertaken to display the blending characteristics of Egyptian cotton/polyester blends. The effect of blend levels on optimum twist multiplier, strength characteristics, critical blend proportion and the other qualities of these yarns is analyzed.

I. INTRODUCTION:

The use of blended yarn has significantly increased during the last two decades. Blending of two or more types of fibers is used to produce yarns with qualities, that can not be obtained by using one type of fiber alone. Many Textile mills in Egypt become intersted to process and produce yarns from cotton/polyester blends especially the blend had to contain at least 65% polyester. In the present work, the selection of fiber components, the blending ratios and the technological processes to be carried out are taken carefully to investigate and discuss the effects of various Egyptian cotton/polyester blend levels on the yarn quality. The study was carried out on a carded and combed cotton to show hos cotton of different properties perform in blends with polyester fibre.

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2. MATERIAL AND FIBRE MEASUREMENTS:

2.1. Material Used:

Two types of Egyptian cotton, Giza 69 and Ashmouni have to be blended with polyester staple fibres (Tetoron):

i) Giza 69 with Tetoron.

ii) Ashmouni (combed 20% noil) with Tetoron.

2.2. Fibre Measurements:

The main fibre property of the individual components and different blends were measured according to the procedure stated in A.S.T.M. Standard.

Fibre length distribution was evaluted by using the sutter webb and Digital Fibrograph tester, Fibre Fineness in terms of μg/inch by shiffeld micronaire and Fibre Strength measurements are determined by the stelometer tester (1/8 inch gauge) expressed in terms of g/Tex and on the pressely tester at zero gauge expressed in terms of strength weight ratio. Also, fibre elongation measurements were obtained from the stelometer at 1/8 inch gauge. The main fibre property of components and blends are given in Table (1).

3. YARN PRODUCTION AND PROCESSING:

3.1. Method:

Spinning the different blending Varites of Giza 69/ Tetoron and Ashmouni/Tetoron blends into three yarn counts Ne 30, 50 and Ne 60 with five different level of twist multipliers α_e 2.8 to α_e 5.

3.2. Blend Levels:

In this experiment cotton slivers "carded Giza 69 and combed 20% Ashmouni" were blended with polyester slivers (Tetoron) at the first Drawing Frame and the required Blend

Table (I): Fibre Properties in Blends.

Fibre property	Giza 69/Tetoron Blend 100_c	65_c 35_p	50_c 50_p	35_c 65_p	100_p	Ashmouni/Tetoron Blend 35_c 65_p	50_c 50_p	65_c 35_p	100 c
Fibre Length:									
U.Q.L. mm.	32.33	35.30	35.70	35.50	36.30	36.20	36.20	35.90	29.80
Mean length mm.	25.73	28.02	28.53	30.03	32.56	30.81	30.97	30.27	24.13
C.V%	34.19	32.85	32.36	27.15	17.35	24.89	23.99	25.37	33.72
Short Fibre ½ inch %	9.32	8.39	8.04	5.48	1.19	3.70	3.31	3.66	10.41
Fibre Fineness:									
ug/inch	3.71	4.46	4.60	4.78	5.86	5.38	5.38	4.98	4.61
Fibre strength (g/Tex)	32.10	36.00	43.00	44.80	56.00	41.90	38.70	32.00	27.10
Elongation %	6.40	11.60	15.40	16.20	17.40	17.00	16.40	13.30	7.20

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ratio was achieved by altering the sliver weight. Blends were 100C, $65_c/35_p$, $50_c/50_p$, $35_c/65_p$ and 100% p. and to determine the blend composition using a chemical method based on solving one or mere of the blend composition.

3.3. Machine Specifications:

All different types of yarns produced under industrial conditions from cotton, polyester staple fibre and cotton/polyester blends with different blending Ratio. Cotton and polyester were processed seperatly through opening, cleaning and carding and all blending of cotton/polyester was done at drawing frame. All details of processing are given below.

I. Blow Room:

"For Cotton"

i) Type of m/c and Make: Hergeth blowing Room (Germany)

ii) Sequence : For Cotton (Ashmouni)

3 Blending Bale Openers-Automixer-Vertical opener-Stepcleaner-porcupine beater-Hopper Feeder-Two bladed beater-Kirshner beater.

For Cotton (Giza 69)

3 Blending Bale Opener-Automixer-Stepcleaner-Porcupine beater-Hopper Feeder-Two bladed beater. Kirshner beater.

iii) Lap weight/m. (g) : 340 g/m. (Nm = 0.0023)

"For polyester staple fibre (Tetoron)"

i) Sequence : 3 Blending Bale opener-Step Cleaner-Purcopine beater-scutcher lap m/c.

ii) Lap weight g/m: 320 g/m. (Nm = 0.0031).

II. CARDING:

"For Egyption Cotton"

i) Type of m/c : TOYODA, 1976, (Metalic high production card)

ii) Doffer Speed, r.p.m. 30 r.p.m.

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iii) Hank of sliver, Ne: 0.136 (Nm 0.229) for Ashmouni
0.145 (Nm 0.245) for Giza 69

iv) Total card waste,%: 3.5-4% For Ashmouni
4.6% For Giza 69.

For Tetoron

i) Type of card : Platt m/c.
ii) Doffer speed, r.p.m: 13 r.p.m.
iii) Hank of Sliver, Ne: 0.1619 (Nm 0.2736)
iv) Total card Waste,%: 1%

III. Comber Lap Preparation:

Cotton (Ashmouni)

i) Sequence : Textima drawing and sliver Lap m/c.
ii) Doublings in drawing: 8
iii) Doublings in sliver Lap m/c : 20
iv) Lap weight/yd, grains: 758.2 (Nm 0.0186).

IV. Comber:

Cotton (Ashmouni)

i) Type and make : Textima type No. 1531
ii) Noil, % : 20%
iii) Hank of comber: 0.18, 0.160 and 0.145 Ne

V. Drawing:

Cotton and Tetoron

i) Type and make : Inglostadt
ii) Number of passages: 100% cotton and 100% Tetoron. Two passages, blend Material one passage of preblend drawing and two passages of post-blend drawing.
iii) Break draft : 1.8
iv) Number of doublings : 8
v) Hank of sliver, Ne: 0.154 (Nm 0.2603).

vi) Roller Setting:

	100% Ashm.	100%G.69	100%PE-F	Blend
Front zone	30	37	41	42
Middle zone	50	50	50	50
Back zone	41	41	45	45

For Spinning Yarns of Ne 50 and Ne 60

i) Type of M/c : Ingolstadt.

ii) Number of doubling : 4

iii) Hank of sliver, Ne: 0.35 (Nm 0.59).

iv) Roller Setting, mm: Front zone 35, Middle zone 50 and Back zone : 48

VI. Speed Frame:

For Spinning Yarn number of Ne 30

i) Type and Make: Ingolstadt Roving m/c, 24 Spindles.

ii) Drafting System: 3 over 4

iii) Hank of Roving : 1.25

iv) Twist multiplier, α_e: 100% polyester 0.65, Blend material 0.85 - 0.95 and for 100% cotton $_e$ = 1

v) Roller setting, mm:

	100%PE-F	100%Blend	100%G.69	100% Ashm.
Front zone	47	40	37	34
Middle zone	65	65	65	65
Back zone	53	43	41	38

For spinning yarn number Ne 50 and Ne 60

i) Type and Make : Rieter, 28 spindles

ii) Drafting system: 3 over 4

iii) Hank of Roving : 3

iv) Twist multiplier, α_e: 0.93

v) Roller setting, mm: Front zone 32, Middle 50 and Back zone 34.

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VII. Ring Frame:

For Spinning yarn number 30 Ne

i) Type and make: Ingolstadt, 32 spindles
ii) Drafting system: 3 over 3
iii) Break draft : 1.2 for cotton, 1.4 for blend material and 1.6 for 100% Tetoron
iv) Twist factor, α_e: Five different levels between 2.8 to 5 α_e
v) Ring diameter, mm: 53
vi) Traveller type: 1/0
vii) Roller setting, mm,

	Blend	100% PE-F
Front zone	46	53
Back zone	51	59

For spinning yarn count Ne 50, Ne 60

i) Type and make : Rieter, 32 spindles.
ii) Drafting system: 3 over 3
iii) Break draft : 1.4
iv) Doubling : 2
v) Twist factor, $_e$: 3.2 to 4.4
vi) Ring diameter, mm: 38
vii) Traveller type : 3/0 and 5/0
viii) Roller setting, mm: Front zone 51 and Back zone 51.

3.4. Yarn Measurements:

All yarns produced from Raw material and cotton/polyester blends were examined for:
Yarn count and count Variation by uster Autosorter, The twist per inch in the yarn is measured by indirect method. Measurements of yarn strength, extension at break, and strength variability. The uster Tensomatt tester was used and 200 test per yarn were performed. Also, A pendulum type tester was used for testing skein strength of yarns. The yarn irregularity were measured by using uster evennens tester and

imperfections (Thin, thick places and nips per 1000 meter) were measured at the same time. The yarn appearance is determined by comparing the tested yarn with ASTM cotton yarn grades.

4. RESULTS AND DISCUSSION:

Yarn Strength:

i) Optimum Twist Factor, for the strength of various blends: From Figures (1, 2 and 3) the curves indicate the nature variation of yarn strength made from different blends. As the twist multiplier increased yarn strength increased up to a certain limit (maximum strength) beyond which, the yarn strength was decreased with increasing twist multiplier, this was true for all blends. The optimum twist multiplier shown in Table (2) was determined from peak of yarn strength for each variety in twist multiplier end breakage curves.

As it was concluded from previous work/1/the optimum twist multiplier for different yarn size produced from the same material would have a constant value. In the present work, the optimum twist for three yarn counts (Ne 30, 50 and 60) produced from the same blend level, it varies in but lie close to each other.

The optimum twist multiplier values for peak yarn strength were taken and plotted against the blend proportion as shown in Figure (4). The optimum twist varies from α_e 4.6 for 100% cotton to α_e 3.3 for 100% polyester, i.e., with increasing of polyester proportion in blend the optimum T.M decreased.

ii) Strength characteristics of Egyptian cotton/polyester Blends: The relations between blending proportion and single end strength for Ne 30 produced from cotton/polyester blends at optimum and constant twist multiplier are shown in Figs.(5&6).

Table (2): Relation Between Blending Ratio and Optimum Twist Multiplier.

Polyester	Ne 30		Ne 50		Ne 60		Mean
%	O.T.M.	C.S.P.	O.T.M.	C.S.P.	O.T.M.	C.S.P	Optim Twist Multipleer
			For Giza 69/Tetoron Blend				
0	4.62	369	-	-	-	-	4.62
35	4.10	365	4.0	309	4.26	305	4.12
50	3.44	400	3.4	332	3.65	331	3.50
65	3.36	413	3.58	371	3.60	330	3.51
100	3.30	564	-	-	-	-	3.30
			For Ashmouni/Tetoron Blend				
0	4.60	333	-	-	-	-	4.60
35	3.88	347	3.79	329	3.90	307	3.86
50	3.84	389	3.86	336	3.84	318	3.84
65	3.60	417	3.68	394	3.82	365	3.69
100	3.30	564	-	-	-	-	3.30

It is evidently that the blended yarn strength is lower than weighing average of the compenent strength and by all blending ratios, the blended yarn strength is lower than the higher component strength 100% polyester 564 gram . Also, the ratio of $65_c/35_p$ does not show a great varation in yarn strength than the lower component strength "100% cotton-369 gram Giza 69, 330 gram Ashm." and yarn strength tends to increase as the polyester percent increased in blend.

Figure (7) shows the relation between blending ratio and maximum skein-count strength product, where the twist multiplier for maximum strength and been estimated from T.M-end breakage. Also, shows "HAMBURGER" theoretical prediction of yarn strength for various blend ratios based on the yarn strength of 100% of the two component and the main fibre properties /2/. It seems that, skein-count strength product increased with each increment of polyester in the blend. Also, the values of blended yarn strength that calculated from theoretical relations fall always below the experimental results.

From Figures (5, 6, 7 and 9). It is noted that, by all blending ratio the strength of Giza 69/Tetoron is higher than the strength of Ashmouni/Tetoron blends. The reason for this, At low percentage polyester, yarn strength is dependent of fibre properties (higher tencity and longer fibre). At higher percentage polyester (Such as $35_c/65_p$) aslight difference of yarn strength is dependent of the percentage of high tenacity fibre in the yarn.

iii) Critical blend proportion in relation to yarn tenacity:

The relations between blending ratio and variation of tenacity of blended yarn at different twist multiplier are given in Fig.(8). It is clear that from previous work /3/ the experimental results followos the predication of Hamburger, when both cottons and polyester were blended together the tenacity of blended yarn gradually decreased as the proportion of cotton decreased than that of 100% cotton and then increases again at critical blend level. The critical blend proportion in relation to yarn tenacity $50_c/50_p$ (where minimum strargth), and in relation to fibre bundle Tenacity it is found $54_c/46_p$ for Ashm/Tetoron and $52_c/48_p$ for Giza 69/ Tetoron blend as shown in Fig.(α). Also, the results show that as twist increases, the value this critical blend level is decreased as shown in Fig.(8).

Yarn Elongation:

The relations between yarn breaking extension and twist multiplier for different yarn number produced from different blend ratios are given in Figures (10 and 11). Generally, the yarn breaking extension is directly proportional to twist factor and the relation is very closely to be linear. Also, the slopes of regression line between breaking extension and twist maltiplier appears to be the same for yarn number at different blending ratios.

The Relation between blending ratio and breaking elongation of yarn count Ne 30 at different twist levels are given in Figures (13 and 14). The general trend here agreement with results predicted in the previous work. /4/, /2/. The experimental results shows somewhat a slight change in yarn breaking elongation with low percentage of polyester and sudden increase at mid range of percent polyester. As the percentage of high elongation fibre (polyester) increases, the yarn elongation will increase until it reaches the elongation of that component. It varies from 6.3% for Giza 69, 6.8% for Ashmouni to 12% for polyester i.e. for both cotton/polyester blends, elongation was lowest for 100% cotton and hgiher for 65, 50 than 35% polyester. Also, it is concluded that, at low percentage polyester, yarn elongation is independent of the blend ratio.

For both cotton/polyester blends as given in Figures (12, 11, 10), elongation was lowest for Giza 69/Tetoron than that of Ashmouni/Tetoron blend, at the same time the finer the yarn, the lower is the extension. Also, the Variation in yarn elongation with twist at different blending ratio is independent of the blend ratio, where yarn elongation is mainly due to fiber slippage rather than fibre extension.

Also, in the present work a trial to closer fitting for the relation between yarn extension and blending propertion as shown in Figs. (15 and 16). The experimental results were used to derive this relation. The assumed relation between elongation and blend proportion is

$$y = \frac{a\,x^c}{b + x^c}\text{, and}$$

The transformation formula:

$$Y = A + B\,x^{-c}$$

By graphical representation of data and algebraic mathematics, the values of A, B for different value of c valied to give the best fitting curve.

Hence the functional relation may be expressed in the form:

$$E_y = E_o \pm \frac{a/B_{pi} - B_{po}/^c}{b + /B_{pi} - B_{po}/^c}$$

where: E_y = blended yarn elongation (%)

E_o,B_{po}: elongation and Blend proportion at the inflection point.

B_{pi} = Blend proportion (polyester %).

Thus, for Ashmouni/Tetoron blend, the relation between yarn extension and blend proportion is follow S-shape curve between the higher and lower component extenstion as following:

$$E_y = 9.15 \pm \frac{/3.35/B_{pi} - 0.576/^{1.2}}{0.064 + /B_{pi} - 0.576/^{1.2}}$$

Yarn Irregularity:

The relations between the uster C.V% of blended sliver, Roving, yarn and blend level are shown in Figures (17, 18 and 19). Generally, as the polyester percentage increases the uster C.V% of blends decreases. The reason for this due to the better uniformity of fibre length and fineness of polyester staple fibre. Also, the values of yarn irregularity of Giza 69/Tetoron appears to be higher than that of Ashmouni/ Tetoron blends especially at high level of polyester percentage. The yarn imperfection per 1000 meter decreases as the polyester percent increased in blends.

Yarn Appearance:

The yarn grade improved with increasing the percentage of polyester in blend as shown in Table (4), i.e., Yarn appearance generally was better for blends than for 100% cotton yarn. Yarn appearance for different yarn count apparently a small differences were noted with each yarn number for Giza 69/Tetoron and Ashmouni/Tetoron blend, generally grades for finer yarn were lower than coorses, these results correspond to finding on yarn imperfection.

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Table (3): Uster evenness (C.V%) of Blended Sliver, Roving and Yarns at optimum Twist multiplier.

Polyester %	Uster evenness C.V%					
	Sliver	Roving		Yarn count "Ne"		
	0.15	1.25	3	30	50	60
	For Giza 69/Tetoron Blend					
100	4.50	5.30	-	18.0	-	-
65	4.34	9.08	12.28	19.37	22.3	25.0
50	4.66	9.25	16.95	19.90	23.8	25.2
35	4.40	7.00	11.70	20.90	27.8	26.9
0	8.00	9.80	-	22.7	-	-
	For Ashmouni/Tetoron Blend					
100	4.5	5.3	-	18.0	-	-
65	5.6	7.5	9.4	17.95	19.6	20.69
50	6.18	6.5	8.5	18.9	20.2	21.80
35	4.88	8.07	12.2	18.95	20.9	22.00
0	6.00	7.86	-	19.40	-	-

Giza 69 (Carded)

Ashmouni (Combed 20%).

Table (4): Grades of Blended yarns.

Blend %	Yarn grades					
	Giza 69/Tetoron blend Yarn count			Ashmouni/Tetoron Blend Yarn count		
	30	50	60	30	50	60
100_c	B^-	-	-	B	-	-
$65_c/35_p$	B^-	B^+	B	B^+	B	B
$50_c/50_p$	B	B	B	B^+	B^+	B^+
$35_c/65_p$	B^+	A^-	B^+	A^-	A^-	B^+
100_p	A	-	-	A	-	-

5. CONCULSION:

The optimum twist multiplier decrease as the proportion of polyester increased in blends (from 4.6 α_e for 100% cotton to 3.3 for 100% polyester). Also, optimum T.M for different yarn count are generally found within aclose range.

The blended yarn Tenacity decreases as the percentage of high tenacity fibre (polyester) is increased and then increases again at a critical blend level. The critical blend level with reference to fibre bundle tenacity is lower than that of blended yarn tenacity. Also, the results show that as twist increases, The value of this critical blend level is decreased.

The yarn elongation is increased by increasing polyester percent in blend. Also, at low percentage of polyester, yarn elongation is independent of the blend ratio. The variation of blended yarn elongation higher than that of 100% cotton and 100% polyester.
The theoretical relation between blending ratio and yarn elongation has been taken an S-shape curve and has been ver fied experimentaly.

In second drawing sliver, roving and yarns, the greater the proportion of polyester in blend, the lower is the uster C.V%. Also, yarn imperfection decreases as percent of polyester fibre increases in blend.

By increasing polyester content, the blended yarn grade will be slightly better, from grade B^- for 100% cotton to grade A for 100% polyester.

For Egyptian cotton/polyester blends, yarn properties were best for blends containing combed cotton. Thus, for the yarn count and different blend levels produced, fibre properties are important criteria for selection of cotton for blending with polyester.

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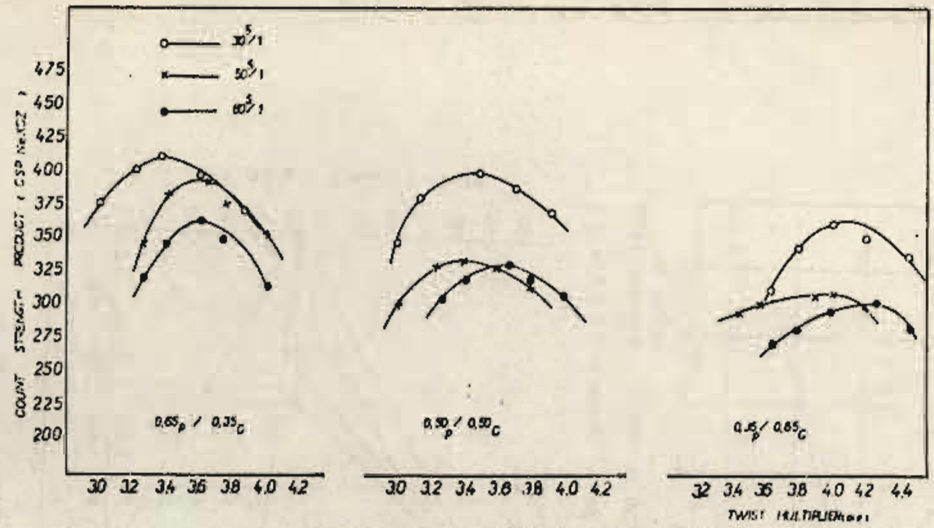
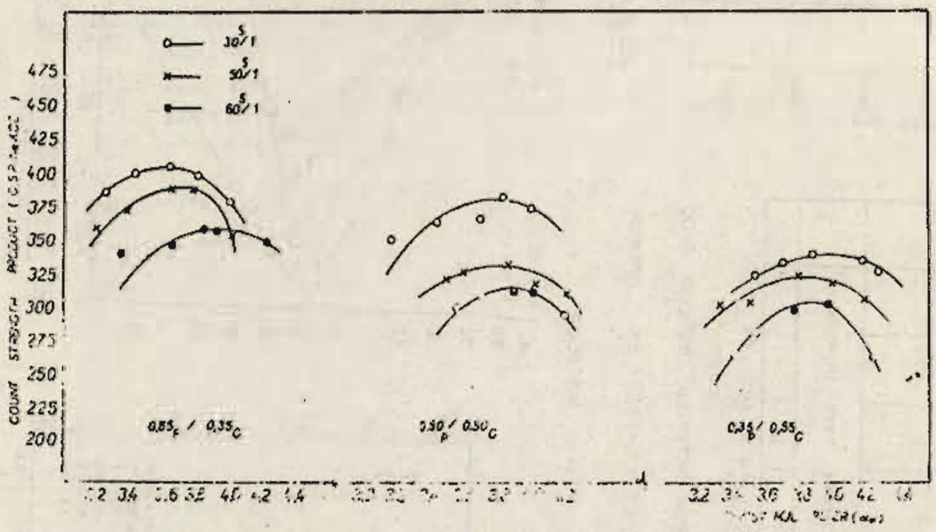
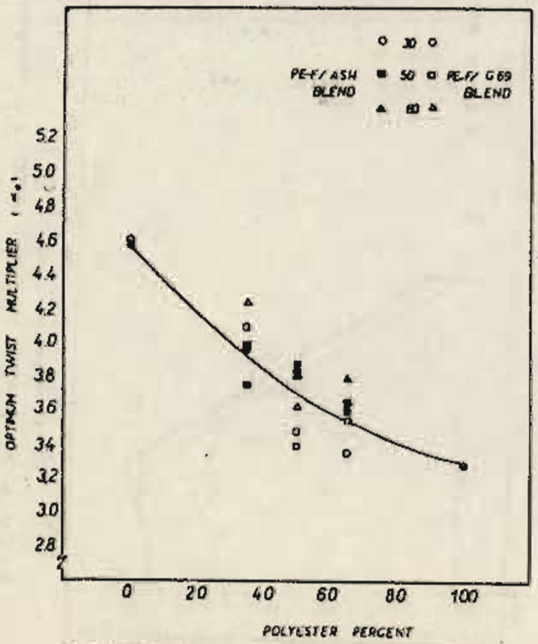


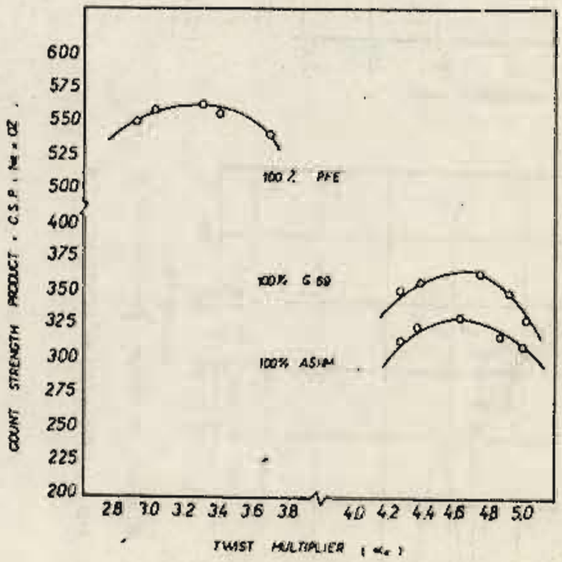
FIG(1) RELATION BETWEEN TWIST MULTIPLIER AND COUNT-STRENGTH PRODUCT FOR POLYESTER / GIZA 69 BLENDED YARNS.



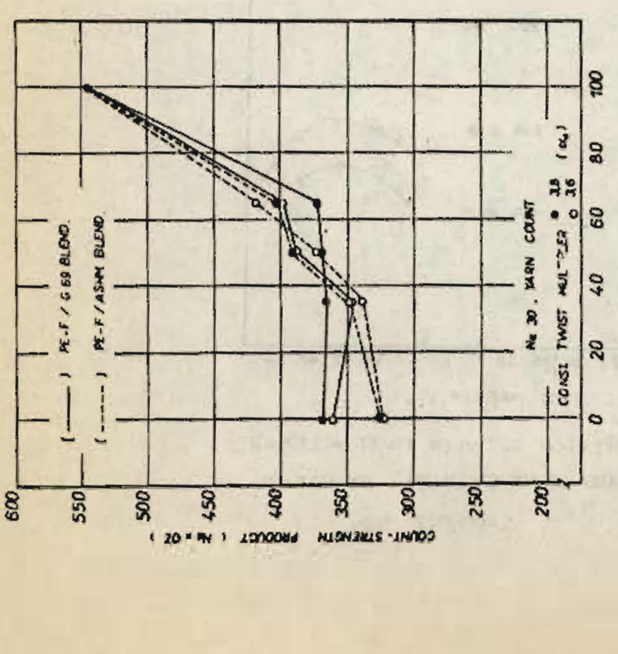
FIG(2) RELATION BETWEEN TWIST MULTIPLIER AND COUNT-STRENGTH PRODUCT FOR POLYESTER / ASHMOUNI BLENDED YARNS.



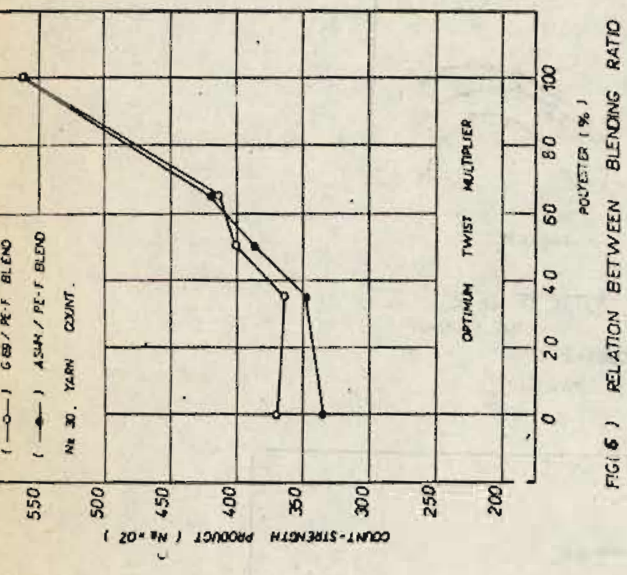
FIG(4) RELATION BETWEEN BLENDING RATIO AND OPTIMUM T.M.



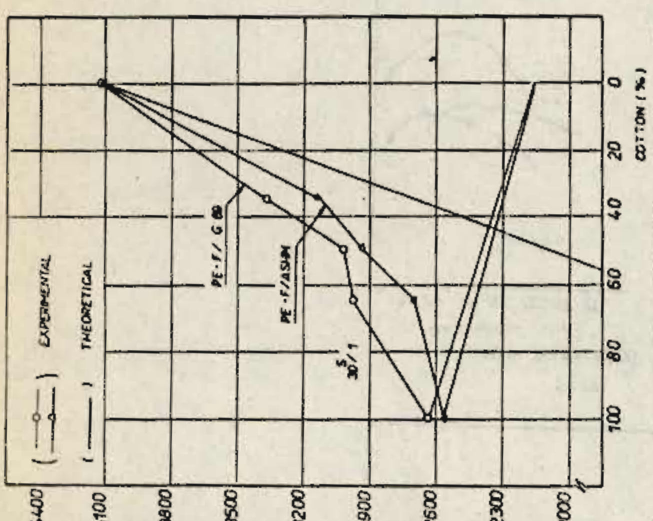
FIG(3) RELATION BETWEEN TWIST MULTIPLIER AND COUNT STRENGTH PRODUCT FOR COMPONENT YARN.



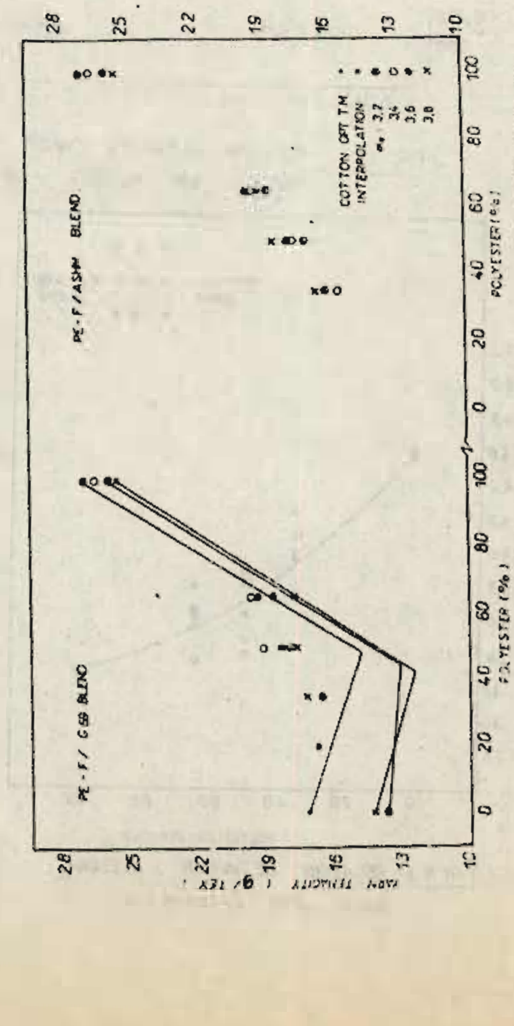
FIG(5) RELATION BETWEEN BLENDING RATIO AND C.S.P(NeXOZ) BY CONSTANT T.M.



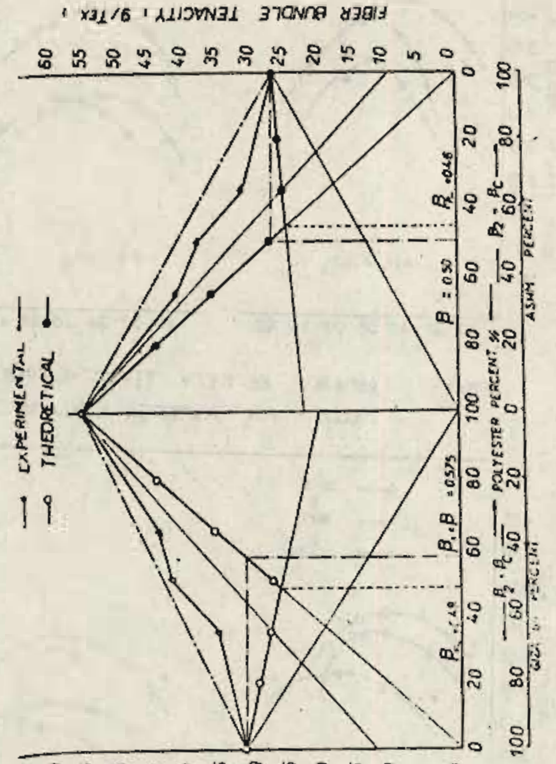
FIG(6) RELATION BETWEEN BLENDING RATIO AND C.S.P(NeXOZ) BY OPTIMUM TWIST MULTIPLIER.



FIG(7) RELATION BETWEEN BLENDING RATIO AND SKEIN STRENGTH (C.S.P. Ne x lb)



FIG(8) RELATION BETWEEN BLENDING RATIO AND BLENDING YARN TENACITY.



FIG(9) EXPERIMENTAL AND THEORETICAL VALUES OF FIBER BUNDLE TENACITY OF BLENDS.

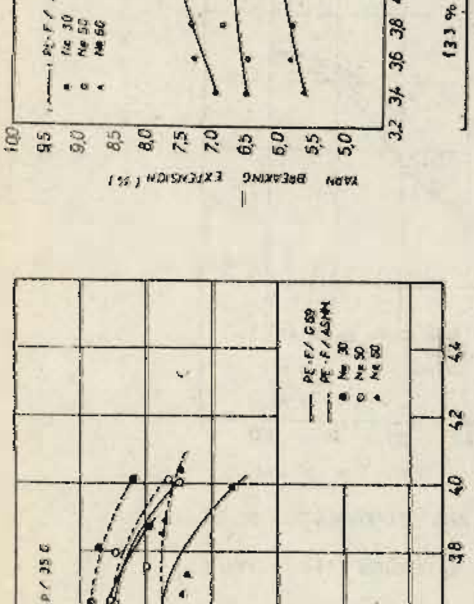
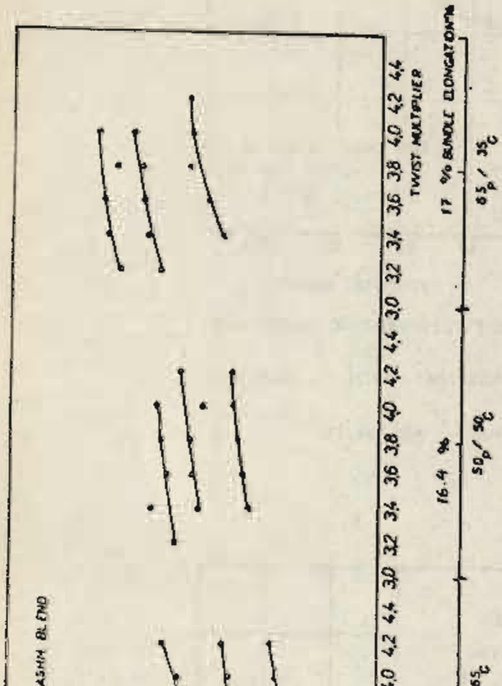
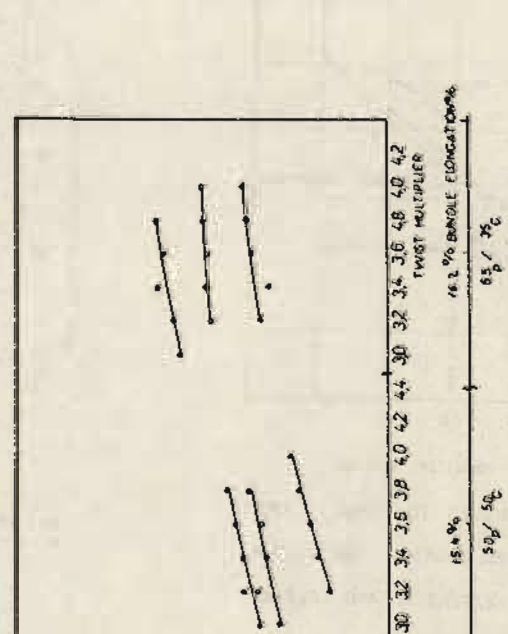


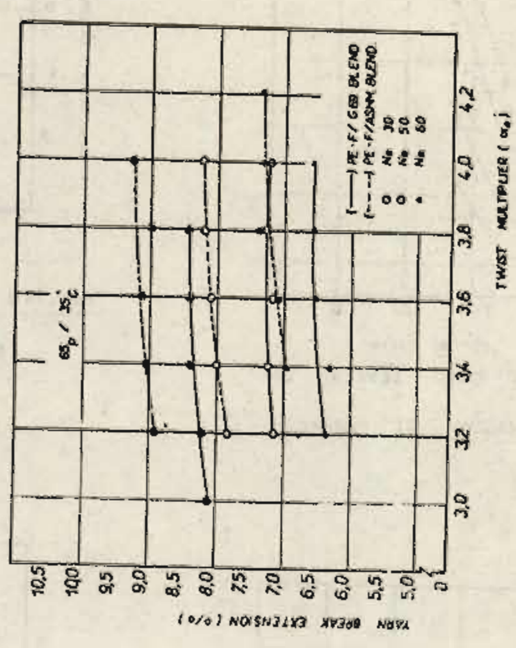
FIG.(9) EFFECT OF TWIST MULTIPLIER OF COTTON-POLYESTER BLEND ($65_p/35_c$) ON YARN TENACITY.



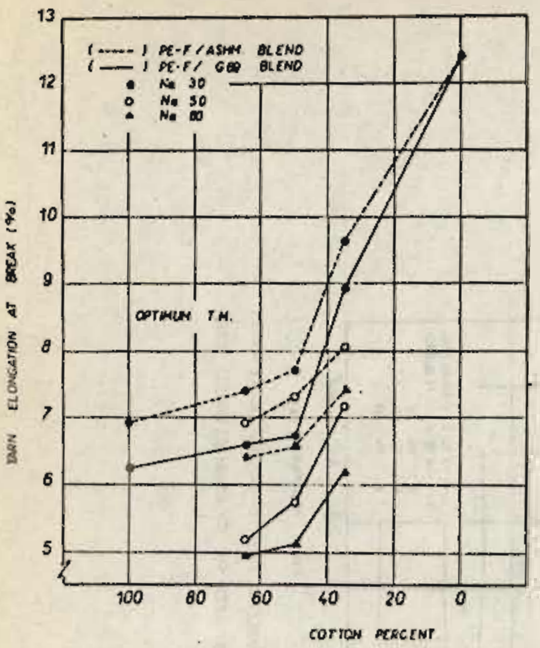
FIG(10) RELATION BETWEEN TWIST MULTIPLIER, FIBER ELONGATION AND BREAKING EXTENSION(%) OF BLEND



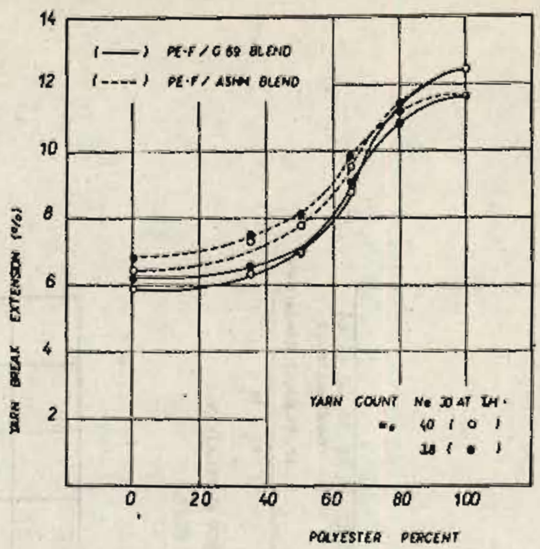
FIG(11) RELATION BETWEEN TWIST MULTIPLIER, FIBER ELONGATION AND BREAKING EXTENSION (%) OF BLEND



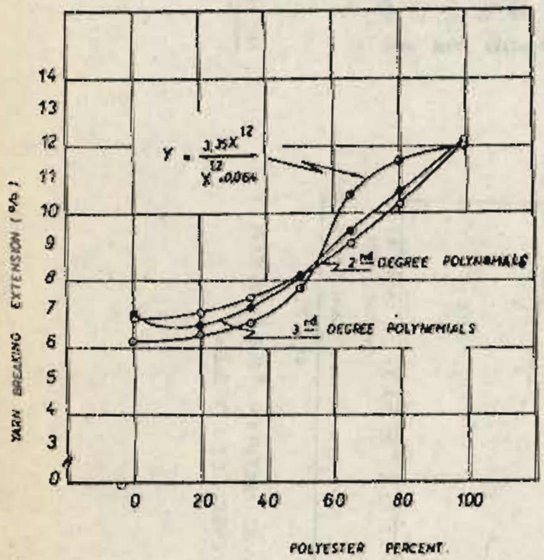
FIG(12) COMPARISON BETWEEN THE BREAKING EXTENSION OF PE-F/ G 69 AND PE-F/ ASHM. BLENDED YARN.



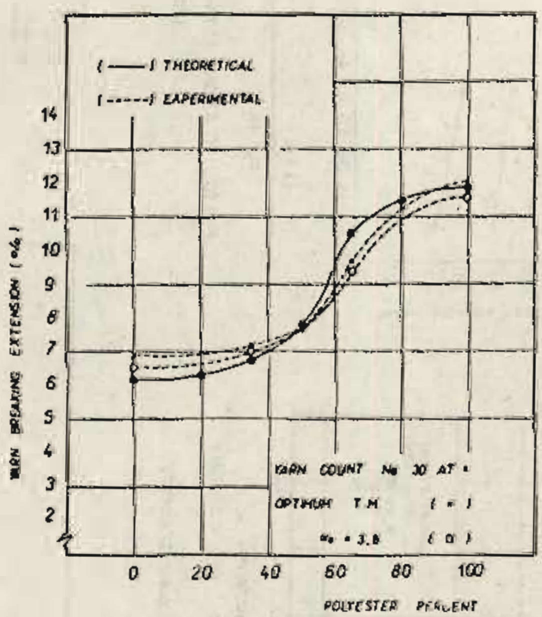
FIG(13) EFFECT OF BLEND LEVELS ON YARN EXTENSION AT BREAK.



FIG(14) RELATION BETWEEN BLNDING RATIO AND BREAKING EXTENSION (%) WITH CONSTANT TWIST MULTIPLIER



FIG(15) NON-LINER CURVES TO CHECK THE THEORETICAL RELATIONS BETWEEN YARN BREAKING EXTENSION AND BLEND LEVELS.



FIG(16) THEORETICAL AND EXPERIMENTAL VALUES OF BREAKING EXTENSION (%) WITH BLEND PROPORTION