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USING POLYESTER WASTE WITH COTTON WASTE ON OPEN — END SPINNING MACHINE

by

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غزل شعيرات مخلوطة من عوادم القطن والبولى استر على ماكينة الغزل ذات الطرف المفتوح

خلاصة البحث :

يهدف هذا البحث الـ ـ ـ ـى دراسه قابليه غزل شعيرات من عوادم القطن والبولى استر بعد خلطها على ماكينات الطرف المفتوح. وتشمل العوادم مايلى: عوادم تمشيط وعوادم الفلاتس وعوادم الغزل المستخلصه من شعيرات قطن جيزه (٧٥) وعوادم الشابوة من شعيرات البولى استر اثناء التسريح. وقد تم اختيار التشغيل المناسب وكذلك ماكينه الطرف المفتوح لانتاج خيوط بنمر تتراوح من ٩٨ الى ٧ر٢٢ تكس هذه العوادم بعد خلطها بنسب مختلفه . وقد اوضحت النتائج ان خلط عوادم البولى استر مع عوادم القطن يزيد من الطول الفعال للشعيرات ويحسن متانة الخيوط المنتجه منها ويعطى امكانيه غزل خيوط طرف مفتوح بالنمر السابقه. وقد وجد ان خواص الخيوط المنتجسه تعتبر مقبوله حتى نمره ٢٩ تكس بأس برم ٢ر٥ انجليزى وبنسبه خلط تتراوح من ٥٠/٥٠ الى ١٠٠ بولى استر وتتلخص خواص هذه الخيوط فى ان متانتها واستطالتها جيده وانتظاميتها متوسطه كما ان دليل الجوده لها يصل الى ٧ ر١٢ .

Abstract:

The present work intended to study the spinning performance of mixed "cotton/polyester" waste fibers from existing mills on open-end spinning machine. cotton waste fibers "comber noils, card strips and penumafil" were extracted from cotton fiber Giza 75 and polyester card strips were used. The blends and preliminary processing equipment are selected correctly and rotor machine is set correctly. The mixed waste fibers are spun mainly into yarn ranging from 98 tex to 22.7 tex at maximum properties. The results indicate that the blend of polyester waste fibres with cotton waste composition resulted in increasing the effective fibre length of the mix, improving the yarn strength and enables the production of the above range of yarn counts.

The produced yarn properties were satisfactory for yarn count up to 29 tex, twist multiplier up to αe 5.2 and fibre composition 50/50 up to 100 PEF, good yarn strength, extension, average yarn regularity and yarn quality index up to 12.7 were obtaind.

1. Introduction :

The importance of waste as a raw material is attributed to : unlimited quati-

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ties are available, levels of supply consistent and price relatively stable. Waste produced during the preparation and processing of fibers, in the blowroom, carding, drawing, combing and also during spinning, winding, weaving and knitting. Fabric waste produced by cutting during garment make-up and finally the worn out and disposed of garments and fabrics which can be reprocessed in rag form.

Cotton waste can be placed in four categories, each of which requires a different approach for preparation.

(i) Dirty soft waste : Gin motes, blowroom droppings, scutch waste, under card waste, filter waste, flat strips from low quality cottons, floor sweepings.

(ii) Clean fiber waste such as : comber noils, flat strips from good medium cottons with up to 10% trash, penumafil waste draw frame sliver, card web wastes.

(iii) Soft waste such as roving waste

(iv) Hard twist waste : Such as cop ends , winding waste, kintted and woven fabric clips and selected rag waste have been used for conversion into yarns,non woven etc. The waste spinner has the greatest flexibility in his choice. he use a wide range of waste fibers, the quantity of each in his blend being determined by price, availability and final end product requirements.

The production of yarns from waste has been carried out by condenser spinning and Rieter spinning. Several articles deals with the use of waste on rotor spinning (2-8 13) and various textile mills are spinning cotton waste fibers. Comber noils and others on rotor machines (2,3,4,5). comber noils and card strips waste material can processed successfuly[13] and can be spun into commercial acceptable counts[6,7] for use in furnishing fabrics and blankets. Also yarns produced from blends incoroprating different waste composition have relatively good regularity and poor strength and abrasion resistance.

Artzt[9] Studied the importance of the proper selection of waste components and the non lint content of the material for production of high quality rotor spun yarns. The cleanness (trash and dust content) of the material is very important for roter spinning as are fiber strength, finenes, length characteristics, rigidity, crimp, elasticity and fiber friction.

A japanese firm [10] with a very large production of rotor-spun yarns has given the break-down of the end uses of their yarns according to fiber type and yarn linear density. cotton fiber can be spun into counts $6\text{-}22^{s}$ for end products such as denim, suede, casual wear, velveteen, towels, sheet, print cloths and industrial uses. while cotton/polyester blends can be spun into yarns with $10\text{-}22^{s}$ count for end product such as work wear training pants and base for clothes. Also, Munch[11] presents tables for rotor yarns to illustrate the acceptability of yarns in various field. Rotor spun yarns can not be used where exceptionally high strength are required in certain types of industrial fabrics (12). A large proportion of rotor yarns are cotton and are used for denims, towelling, sheeting and fabrics intended for printing and coating (12).

2. Experimental Work :

2.1 Material Used

Three types of cotton waste " comber noils, penumafil and card strips" were extracted from Egyptian cotton fiber (Giza 75) were used. polyester "flat strips" with the quality data was used fer blending with Mixed cotton waste fibers and the fiber parameters are givenin tables (1) and (2).

2.2 Yarn production :

Blow room " pre-cleaning" line was used for cotton waste component without passing through double cattoina machines as shown in Fig (1). Blends of cotton waste was prepared using the proportions 50% flat strips, 35% comber noils and 15% penuma fil as shown in Table (3).

Both Bales of the two component "Mixed cotton Waste" and polyester card strips, were processed through short blowroom "Composed of Bale Opener GBC 1000, K.F.O beater, R.V beater, Chute feed. The two components as outlined above in Table (1) were carded on Rieter C4-1 machine. carded sliver of the two components were blended at Hispa blender draw frame.

Open-End Yarn of different counts would be spun from different blends at different twist multipliers as given in Table (4). The machine was set up to run at 45000 r.p.m rotor speed and combing roller speed was optimized at 8000 r.p.m. Details of this spin are alsogiven in Table (5).

2.3 Design of Experiments :

From individual waste component and blends, a rotatable central three variable design of Box and Hunter[14] was set up in order to optimize, the waste blend proportion, twist multiplier and yarn linear density. Three variables mentioned will be referred to as X1,X2, and X3 respectively. The response surface consists of the main characteristics of the yarns (strength extension, regularity, yarn imperfections and the quality index) derived from three parameters as show in Table (7).

The design adopted was therefore of the Box-Hunter type with three variables. The levels chosen for each variable. are shown in Table (4), considering the previous paractical experiences [15,16].

The earlier studies has shown that knitting yarns can be spun on the new rotor spinning [15] with twist multiplier αe 3.1-4.1 and count range from Ne 6 to Ne 30 and cotton, cotton/polyester fibers were used. On the other hand, the figures of Rieter docomentation[16] indicate that spinning limits of noil and cotton waste fibers. The count range extends from Ne 3 to 22 Ne with optimum twist multiplier αe 5.1.

2.4 Measurements :

(i) Measurements of fiber parameters :

Individual waste fibers and waste belends were analyzed by the testing loboratory of the company's "Delta spinning and weaving Co". to show fiber length and short fiber percentage (using Fibrograph), Trash content % (using the shirley analyzer) and fiber strength using pressely tester. The results are shown in Table (1) and (2).

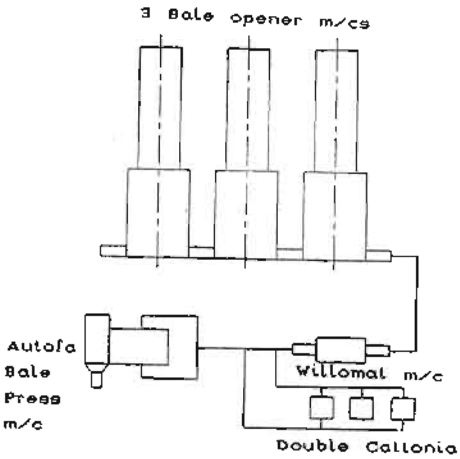
(ii) Measarements of yarn properties :

The uster Evenness tester Type II was used, the rate of traverse of the yarn being 200 m/min and the integration time 1min. ten cheese of yarns were tested i.e 2000 meter per yarn were performed at the same time yarn imperfections were recorded with these sensetivities + 50% for thick places, - 50% for thin places and +200% for neps.

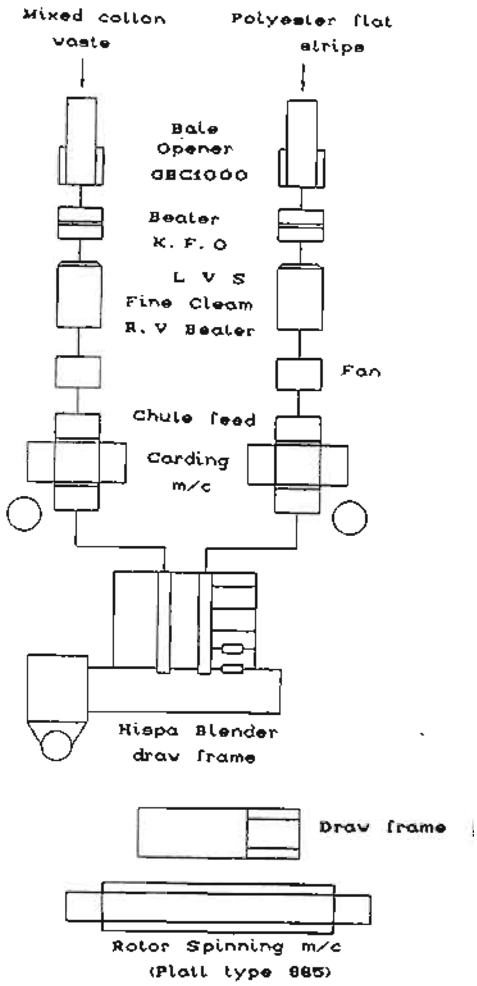
Uster Tensomat tester was used for measuring strength characteristics and 100 tests per yarn were performed, each with tested length 50 cm and breaking time 30 sec. as shown in Table (6).

Table (1) Properties of Individual waste Component

Fiber Properties	Raw Material			
	Cotton Waste			Polyester waste
	Penumafil	Comber Noil	Card Strips	Flat strips
Fiber Length (Fibrograph)				
Mean Length (M.L)	13.2	16.6	15.78	22.8
Effective length	24.81	19.51	27.73	35.15
Length at 2.5%	21.8	25.10	24.9	32.8
" " 50%	8.5	10.2	9.79	13.2
Uniformity Ratio	39	40.6	39.32	40.2
Short fiber content	23.6	20.11	21.74	16.32
Fiber Fineness (Shirley Meter)				
Finenenss (ug/inch)	3.4	3.22	3.14	-
(milltex)	129	138	140	156
Maturity (%)	86	80	77	-
Fiber strength (pressely)				
Pressely Index	8.69	7.94	7.11	10.22
Trash content (Shirley Analyzer)				
Trash %	1.1	1.4	11.4	–
non lint %	2.6	2.8	22.7	–



Line (1) Trutzschler precleaning
for individual component
waste cotton



line (2) Trutzschler

Fig (1). Schematic Diagram of Fiber Processing

Table (2) Blend Fibers Properties

Blend Proportion		Fiber Parameters						
		Fiber length				Finenss	Pressely	Trash
M C W / PF W		L 2.5%	L 50%	U.R	Sh.F	(millitex)	index	%
100		23.8	8.8	36.97	24.23	167	7.13	2
80 /	20	27	10.2	27.77	21.97	164	8.13	1.8
50 /	50	28.3	11.0	38.87	19.93	158	8.54	1.9
20 /	80	32.2	12.7	39.44	17.84	159	9.61	1.0
	100	32.8	13.2	40.24	16.32	156	10.2	-

Table (3) Details of blend proportions and type of waste

Waste Type	Code	Fiber Composition %				
Polyester Waste Flat Strips	PF W	100	80	50	20	0
Cotton Waste	(M C W)					
card strips	CS	-	10	25	40	50
comber noil	N	-	7	17.5	28	35
penumafil	SS	-	3	7.5	12	15
Blend level		100/0	80/20	50/50	20/80	0/100

Table (4) Experimental Levels.

Levels	Blend ratio (MCW/PFW) X1	Twist Factor (xe) X2	Yarn Count (Ne) X3
- 1.682	0/100	4.13	6 (98 tex)
- 1.00	20/80	4.80	10
0	50/50	5.20	16
+ 1.00	80/20	5.60	22
+ 1.682	100/0	6.27	26 (22.7 tex)

Table (5) Construction Details of Experiments

Experimental trail	Coded Variables		
	X1	X2	X3
1	-1	-1	-1
2	+1	-1	-1
3	-1	+1	-1
4	+1	+1	-1
5	-1	-1	+1
6	+1	-1	+1
7	-1	+1	+1
8	+1	+1	+1
9	-1.682	0	0
10	+1.682	0	0
11	0	-1.682	0
12	0	+1.682	0
13	0	0	-1.682
14	0	0	+1.682
15	0	0	0
.	.	.	.
.	.	.	.
20	0	0	0

(Table 6)

Yarn Preperties

Exp. No.	Yarn Tenacity g/tex.	Yarn ext. E%	Uniformity U%	Thin places	Thick places	neps	Quality indix
1	9.75	10.7	12.1	25	97	156	6.89
2	11.02	6.1	13.2	17	50	58	4.07
3	10.28	10.7	12.6	45	77	104	7.34
4	11.28	6.7	13.0	19	36	41	4.65
5	9.30	8.2	14.5	147	135	242	4.21
6	8.06	5.1	15.1	113	62	173	2.18
7	9.01	8.8	13.9	127	135	247	4.56
8	9.40	5.7	14.9	91	71	236	2.88
9	14.6	12.9	14.1	46	39	43	10.69
10	11.58	5.8	14.8	73	114	203	3.63
11	8.16	13.1	12.9	30	40	115	6.63
12	9.09	8.3	13.8	21	16	550	4.37
13	11.98	19.7	14.5	3	53	37	16.42
14	7.57	14.9	14.9	126	121	436	6.06
15	10.34	7.6	13.3	20	105	180	4.73
16	10.22	7.7	12.7	15	60	115	4.96
17	10.04	7.1	12.4	45	45	115	4.59
18	9.81	6.8	13.6	3	255	240	3.29
19	9.91	7.1	11.32	0	15	80	4.98
20	10.0	7.5	11.44	0	26	70	5.26

Table (7)

Response Surface

$$Y = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_1^2 + B_5 X_2^2 + B_6 X_3^2 + B_7 X_1 X_2 + B_8 X_1 X_3 + B_9 X_2 X_3 + B_{10} X_1 X_2 X_3$$

TERM	Yarn tenacity g/tex	Extension E%	Uniformity u%	Thin places	Thick places	neps	Quality index
B 0	10.07914	7.569994	12.45277	13.12698	83.64453	235.6627	4.756236
B 1	-.2677651	-1.958842	.3133794	-4.297608	-7.255512	2.037403	-1.544969
B 2	.249355	-.459076	7.416745E-02	-2.573874	-4.787171	11.62348	-.1258208
B 3	-1.023745	-1.060038	.9682808	42.40737	18.8526	94.78483	-1.94395
B 4	.9151541	-.3734812	.6918689	20.61901	1.53741	-68.49356	.1358757
B 5	-.6681791	.1052424	.3017979	8.562272	-15.66117	66.08088	-.4527765
B 6	-.2603778	2.445668	.2486064	22.39206	5.260813	-19.38011	1.582684
B 7	.1699998	7.499993E-02	-3.750003E-02	-2.5	1.875	11.625	5.999998E-02
B 8	-.3900001	.3	1.250017E-02	-4.5	-6.125	10.125	.225
B 9	3.250003E-02	7.500005E-02	-.1375002	-8	5.375	17.125	2.499968E-03
B 10	.2375	-7.500005E-02	.1374999	2.000001	.375	2.875	2.750006E-02
Correlation Coefficent	0.92	0.80	0.90	0.94	0.88	072	0.82

3. Results and Discussion :

3.1. Fiber Properties :

Experimental investigation of trash content of the various cotton waste components showed that only cotton flat strips contained 11.4% and the other's comber noils and penumafil contained only 1.4 %. This meant that a short blow-room cleaning line could be used for blend components as explained in experimental plan.

Tables (1,2) list the fiber properties and it can be seen that : All materials had a reasonable effective fiber length and span length at 2.5% (24 mm to 32 mm) with short fiber content depending on the type of waste(16% to 24%).
In general, from the practical results it can be seen that the fiber parameters of the individual components are acceptable compared with the standard fiber properties(7) desired for roter spinning and other systems. Also, a correct fiber blend selection can be made in terms of fiber fineness, length and strength and consequenthy the fiber can be spun on open - end m/c.

3.2 Yarn Tenacity :

For coarse open - End yarn, Ne 6 to Ne 16, count with different twist multiplier, the strength of 100% polyester "flat strips" yarn is similar to 100% MCW yarns, Fig (2), while blends of the two component show a lower tenacity than that for 100% single component. on the other hand for O.E yarns (Ne 16 - 26), the increase of MCW in blends causes a reduction in yarn tenacity. The difference is almost ranged between 3-5 g/tex at low twist. At normal twist the variation is about 2 to 3 g/tex while for high twist level the difference is diminished.

For blends containing high percentage of PFW the decrease in yarn linear density at high twist causes a reduction in yarn tenacity about 2.2 g/tex, 1.2 g/tex at normal twist and at low twist there is no change in yarn tenacity. while for blends 50/50 the decrease in yarn linear density (tex) causes a reduction in tenacity approximately 2.4 to 3.6 g/tex and 3.6 to 5 g/tex for 100% MCW yarn depending on the twist level.

3.3 Breaking Elongations of Yarn:

Fig.(3) Represents contours of Open-end yarn extension for three levels of twist multipler. The results show that the twist affect significantly the breaking extension It was found that, at low twist and an increase of PEW waste fiber in blends causes an improvement in open end yarn extension.A higher values (5.7% to 17.7%) obtained at twist 4.2 Xe while it ranged between 4.6% and 15% at high twist. Also, for yarn count up to Ne 16, the extension varies between 15% - 17% for PEWfiber waste and 10% to 12% for mixed cotton waste fibers. On the other hand, yarn count between 20 Ne and 26 show a lower breaking extension 10-12% for PEWfiber waste and 7% - 9% fer mixed cotton waste fibers.

3.4. Yarn Regularity :

Fig. (4) represent contours of the response surface, for X2 = -1, X2 = 0 and X2 = +1, i.e for three levels of twist multiplier with the previously mentionend zone of yarn linear density and blend proportions. It is found that an increase in PE waste in blends causes an improvement in O.E yarn regularity. Abetter values of U % = 12 is observed for blends (50/50) and coarser count between Ne 6 and Ne 16. while the regularity drops very sharply (upto U % 16) with a decrease in yarn linear density upto 22.7 tex (Ne 26). Also, the contours suggests that regularity deteriorates when blends contains higher percentage of MCW that those obtained for 100% PEW component at all twist multipliers.

3.5 Yarn Imperfection :

(i) Thin places / 1000 m : Aminimum value of thin places occurs for coarse counts (Ne 6 to Ne 16) at blend level 50 MCW/50 PEW with different twist multipliers. It ranged up to 30 places /1000 meter. while for open-end yarn count (Ne 16 to 26 Ne) the results show a high number of thin places (50 to 80 /1000 meter for the same parameters as shown in fig. (5).

(ii) Thick places /1000 m : The contours, Fig. (6), indicate that a higher rate of thick places (90 to 140 / 1000 meter) and decrease gradually with the increase of MCW in the blends especially at Fine counts of O.E yarn (Ne 16 to Ne 26). On the other hand, for coarse counts (Ne 6 to Ne 16) the variation in thick places remain constant with varying the blend levels. Also, it show a lower number of thick places (10-77 per 1000 meter) than those obtained for fine counts at different blend levels and twist multipliers.

(iii) Neps / 1000 meter : 100 %PF.W and MCW yarns show a similar results of neps while 50/50 blend show a higher values than these obtained for the individual components. Also. Finer counts show a higher level of neps than those fer coarser count as shown in fig (7).

3.6. quality Index :

This Index as explained previously, is the product of tenacity and elongation and divided by the uster C.V% It may be observed that, from fig. (8), the quality index is more sensitive to the decrease in yarn linear density than to the change in fiber blend composition. For 100% PEW yarns the quality index falls from 12.6 to 6.4 as the linear density varies from 98 tex (Ne 6) to 23 tex (Ne 26). Also, it varies between 8 and 2 Q.I for 100% MCW yarns, while for blends, it is found for the same yarn counts a drop in index is being observed between 10.5 to 4.5. Also, if the values of quality index of 6 and above are taken as the optimum ones, it is clearly that they only occure for blends composition between 50 MCW/ 50 PEW and 100% PEW and for twist multiplier up to Xe 5.2 and yarn counts between 98 tex (Ne 6) and 40 tex (Ne 16).

For fut Ther details of yarnpropertoes, se^ apned'x A ^ Fig 9,10,11,12,13,14and 15).

Conclusion:

The present study permits the following conclusions to be drawn:

(i) The inclusion of polyester waste fibers (Card Strips) in blend composition resulted in :
- Wast with a longer fiber length requires a different preparation sequence.
- Polyester card strips increase the effective fiber length of the mix, which will be directly affecting the strength of the rotor yarns produced.
  Also the jtrash content is decreased which will affect the number of rotor ends down.

(ii) Properties of the individual waste components and blends are acceptable compared with the standard fiber properties desired for rotor spinning and other systems. This leads to that all the used fibers were satisfactory spun into yarn counts ranging from 98 tex to 22.7 tex.

(iii) Spinning of open-end yarn with different blend compositio from mixed cotton waste and Polyster card strips shows that:
- Yarn properties were satisfactory for yarn count up to Ne 20 (34 Nm), twist multiplier up to α_e 5.2 (α_m 158) and fiber compostion 50 MCW/50 PEW to 100% polyster waste fibers.
  The yarn strength was 7.7 to 12.3 g/tex, yarn extension 4.4% to 17.7% average regularity (U %) 11.8% to 13.6% and yarn quality index up to 12.7 were obtained.
- It is not recommended todd use twist multiplier higher than α_e 5.2 or to produce yarn with fine counts. An increase in both factors beyond the above mentioned limits leads to deterioration in yarn properties especially when spinning from 100% mixed cotton wast fibers.

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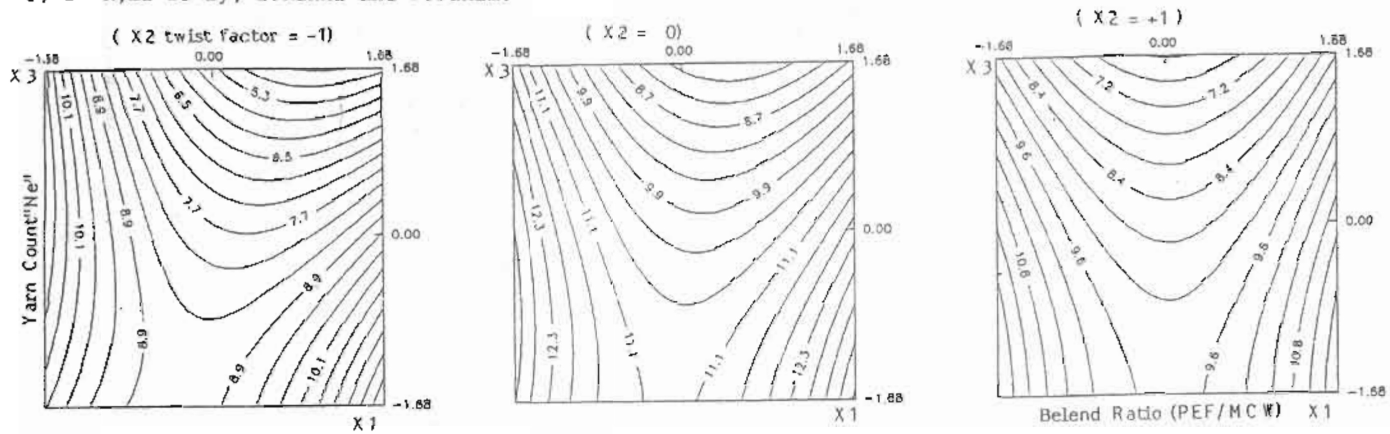


Fig. (2) Contours for tenacity.

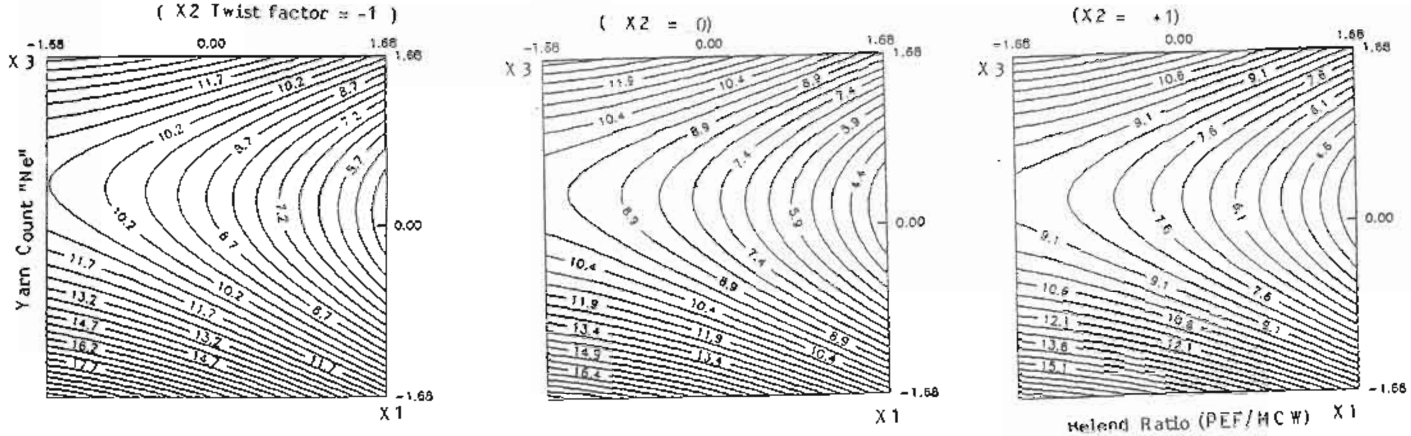


Fig. (3) Contours for elongation at break.

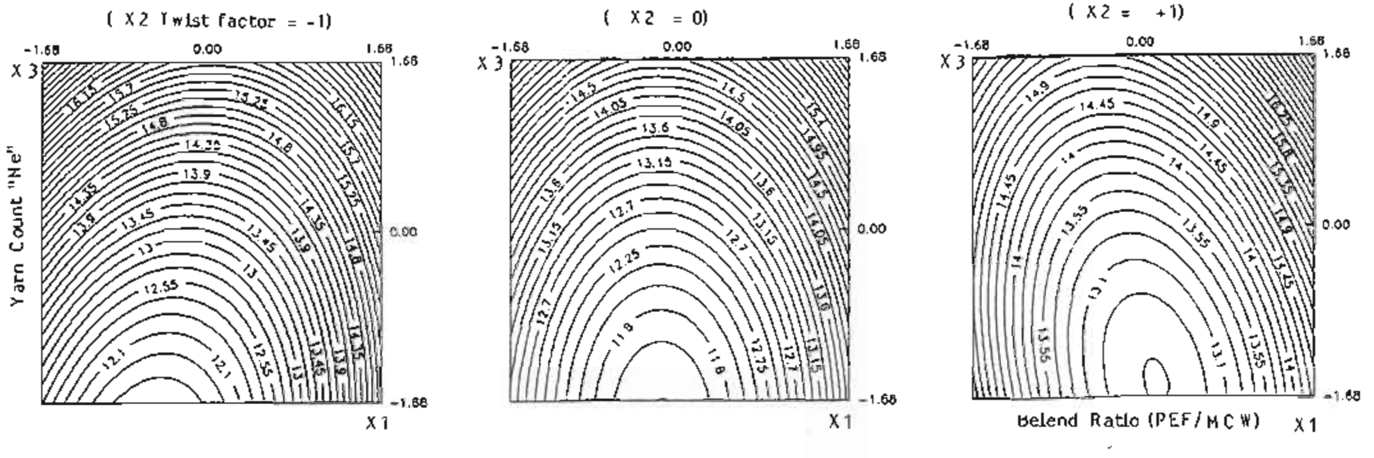


Fig. (4) Contours for regularity.

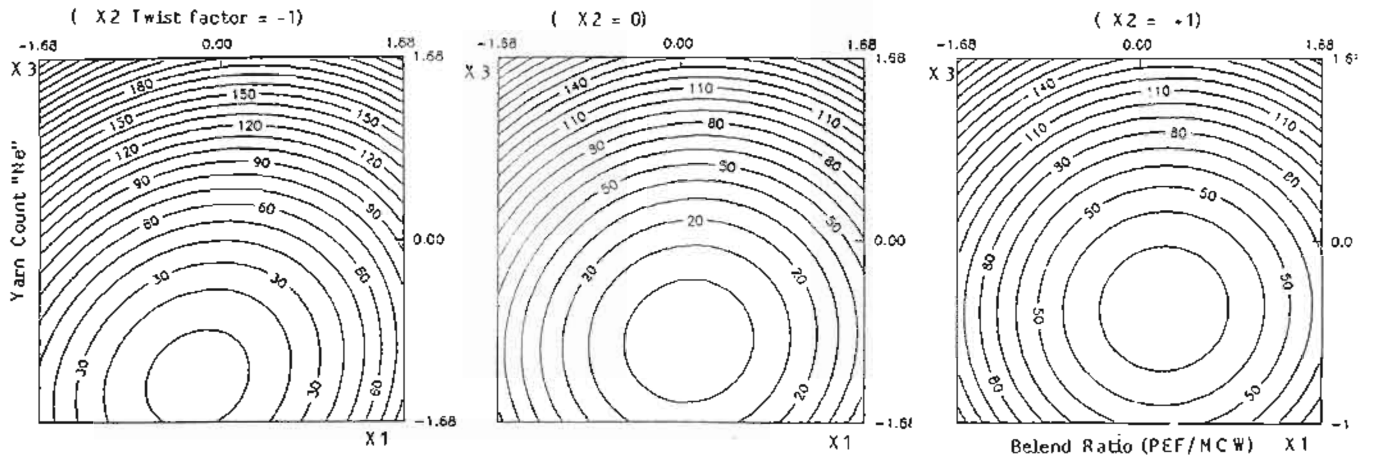
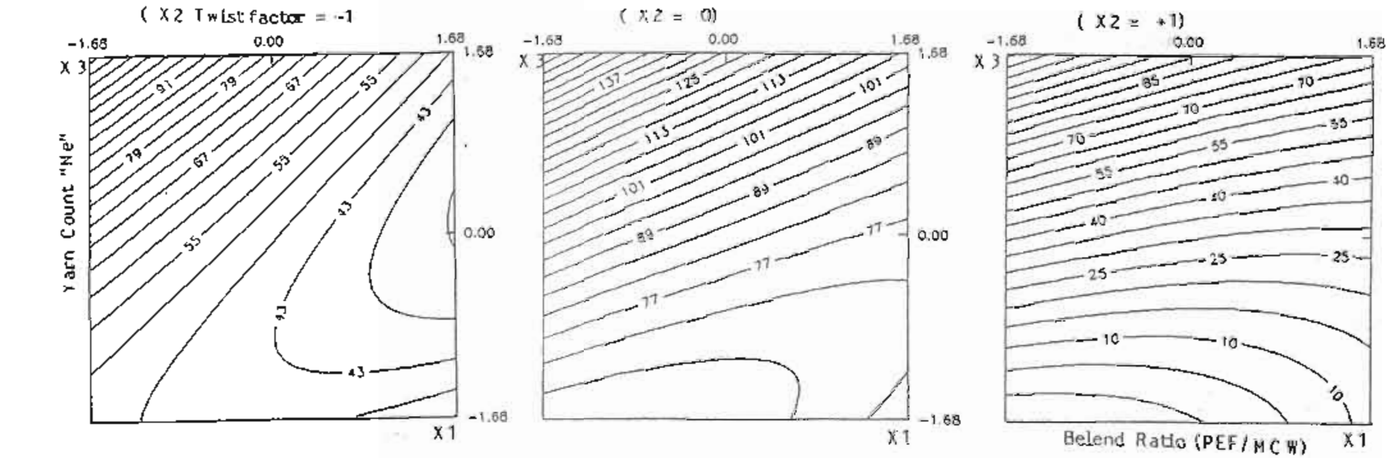


Fig. (5) Contours for 'Yarn Imperfection. (thin places /1000 m).



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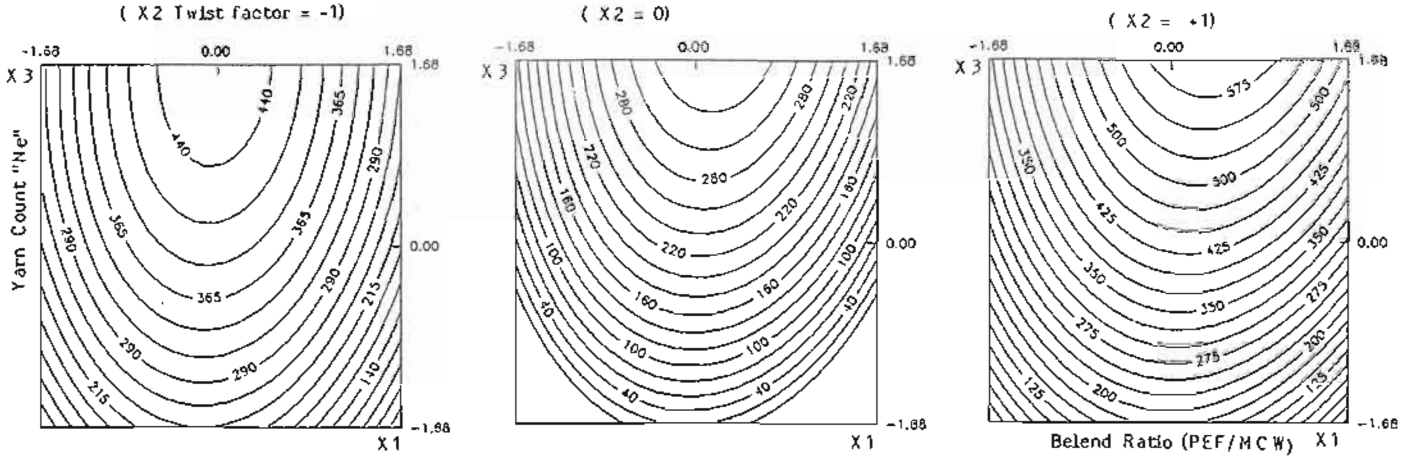

Fig. (7) Contours for Yarn Imperfection. (neps)

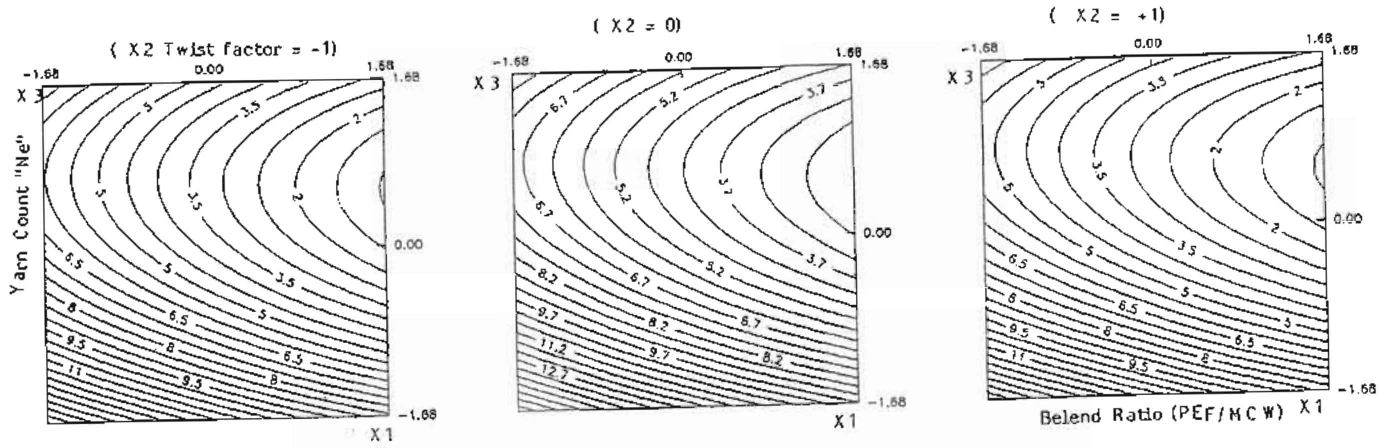

Fig. (8) Contours for Yarn Quality index.

Appendix A (Fig. 9, 10, 11, 12, 13, 14 and 15).

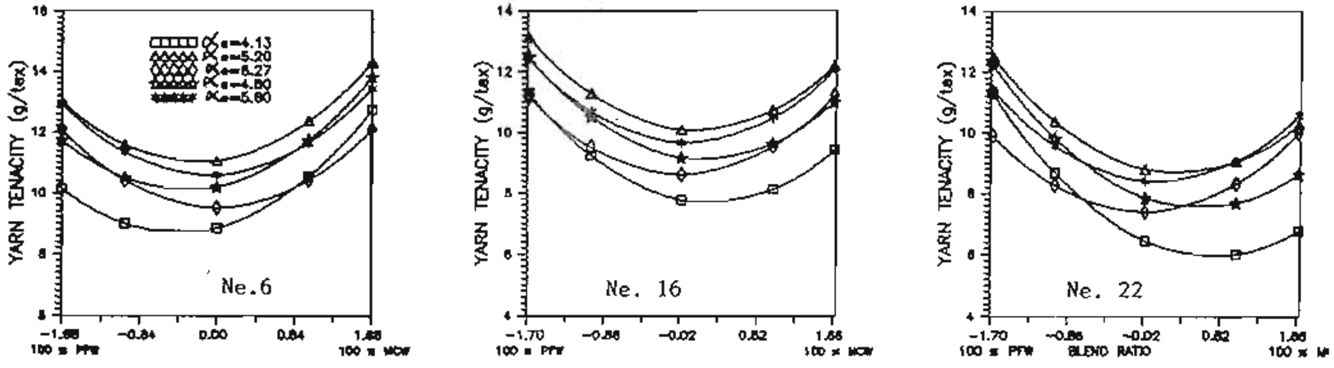

FIG (9) TENACITY FOR OPEN END

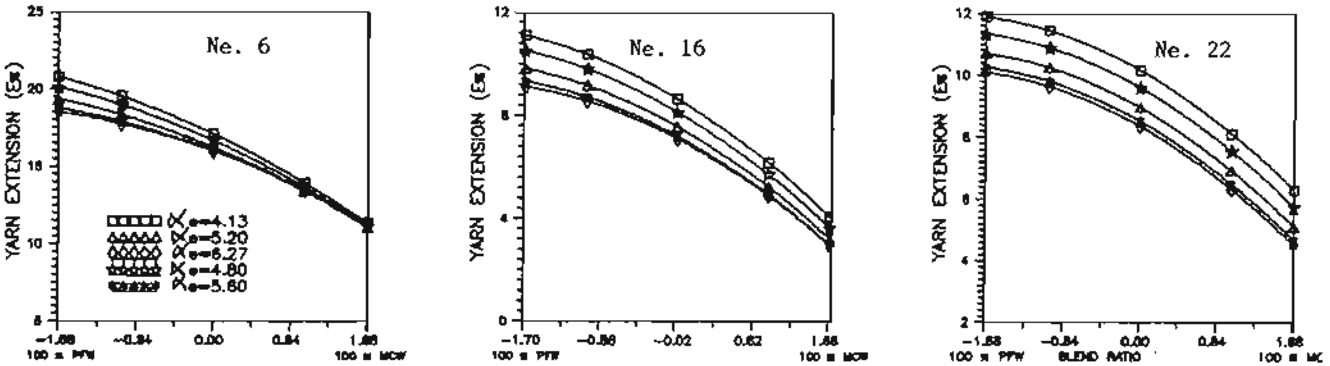

FIG (10) EXTENSION FOR OPEN END YARN

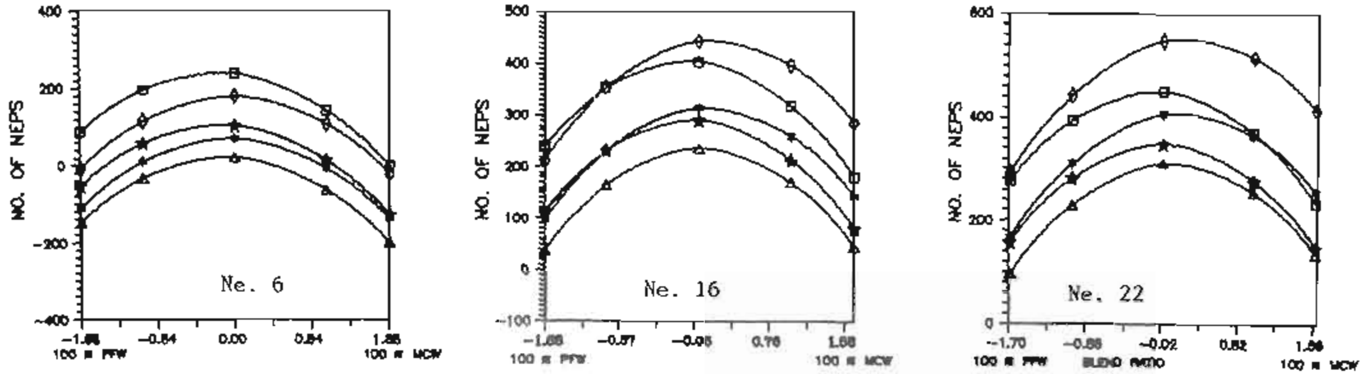

FIG (11) NO. OF NEPS FOR OPEN END YARN

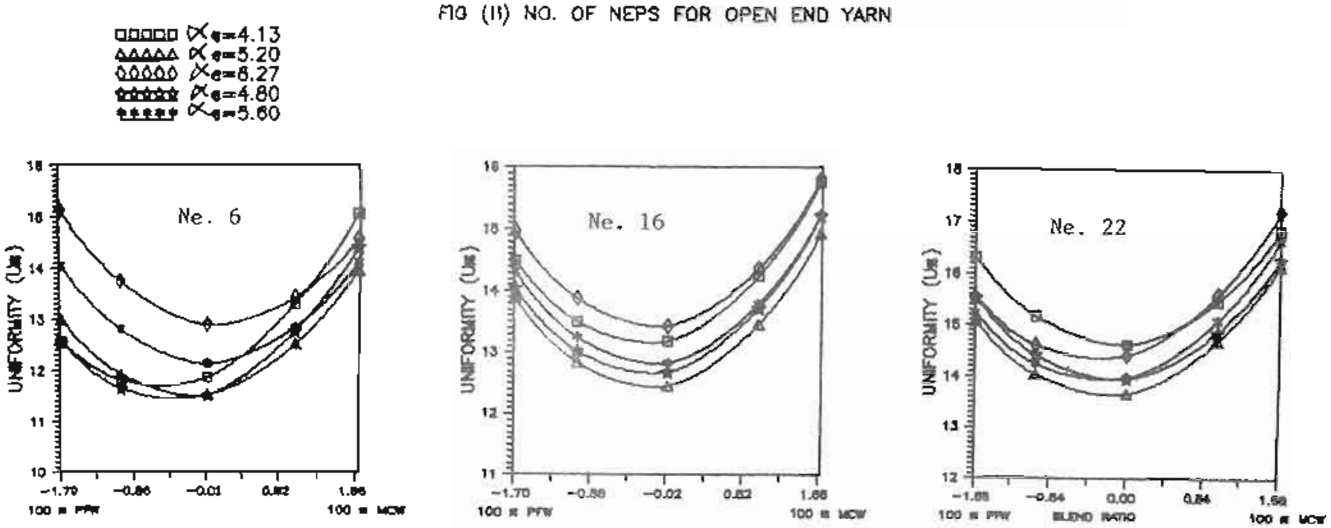

FIG (12) UNIFORMITY FOR OPEN END YARN

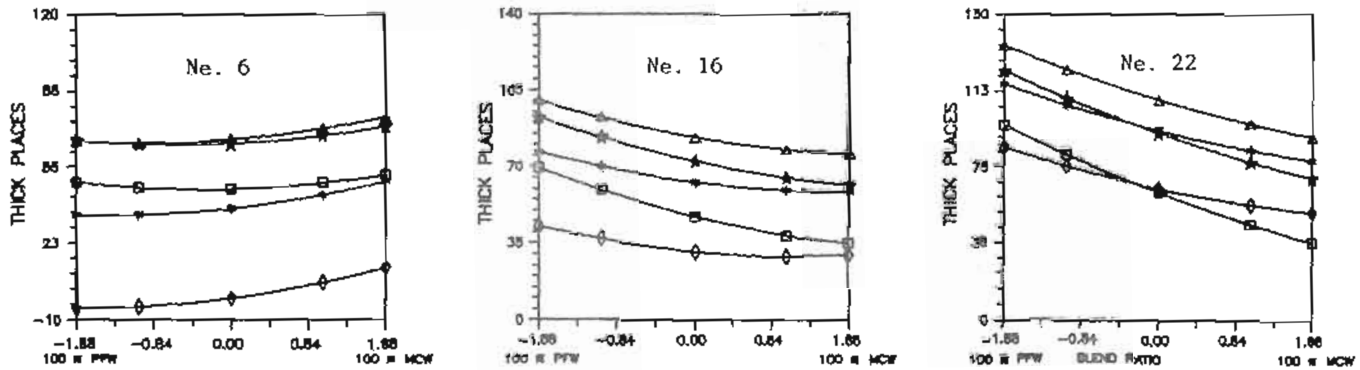

FIG (13) THICK PLACES FOR OPEN END YARN

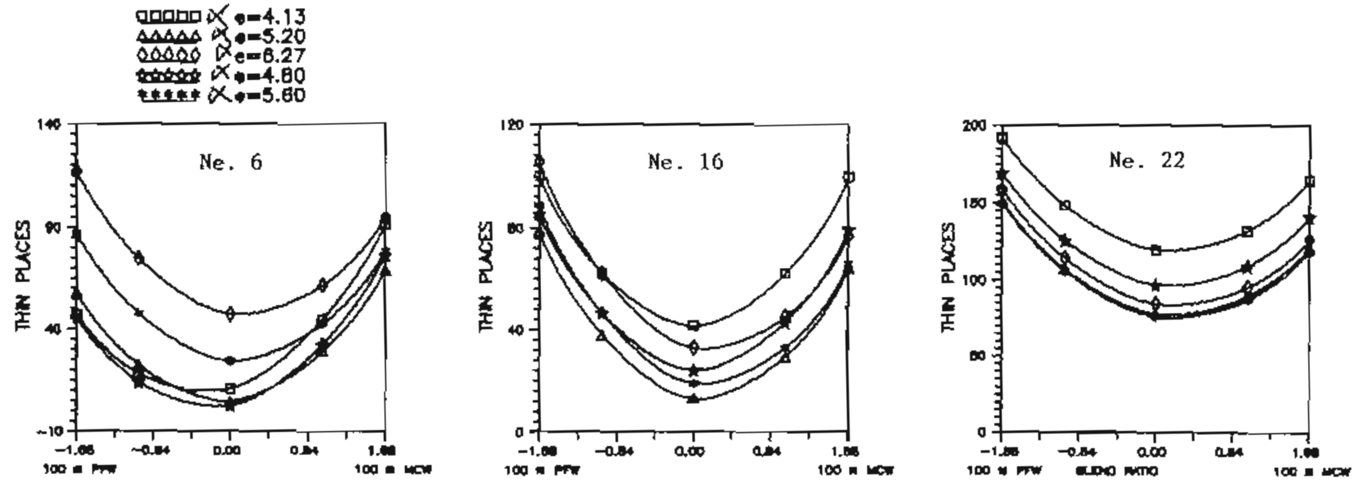

FIG (14) THIN PLACES FOR OPEN END YARN

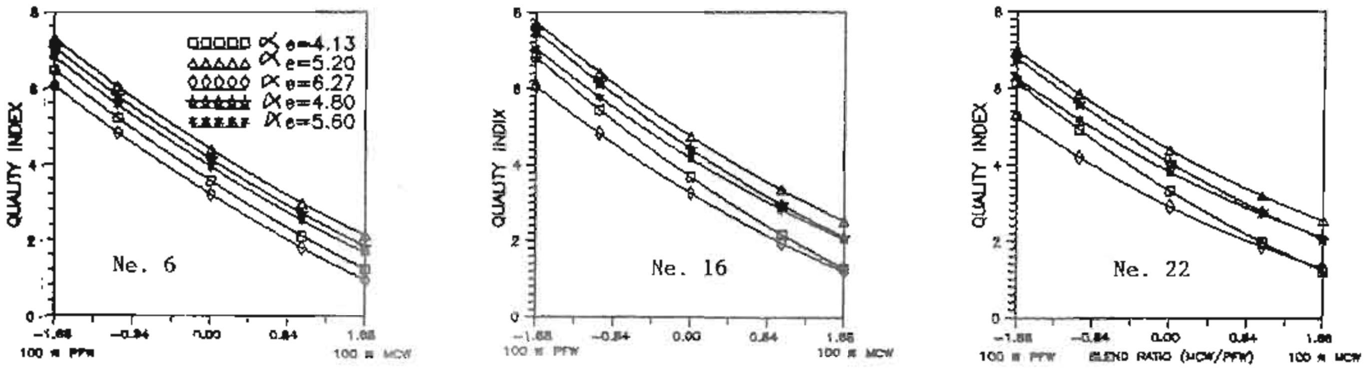

FIG (15) QUALITY INDEX FOR OPEN END YARN