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END-BREAKAGES OF CARDED RING-SPUN YARNS

BY

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الخلاصة : لاهمية عدد القطوع لكل ١٠٠٠ مرن · ساعة أثناء عملية الغزل على جودة الخيوط المنتجه وكفائة التشغيل فان البحث الحالى يهدف الى دراسة تأثير بعض العوامل على معدل القطوع اثناء انتاج خيوط مسرحه (٢٠ الى ٥٠ مترى) من قطن جيزه ٧٥· وصممت التجارب بتغيير عاملين (عدد البرمات، ومقدار السحب) عند مستويات مختلفة مع ثبات بقية العوامل الاخرى· وأيضا بأستخدام الطريقة الاحصائية "التجارب المتعددة العوامل "بتغيير ثلاثة عوامل (سرعة المردن ، وزن الدبله ، ووضع الدور) عند ثلاث مستويات (٣^٣)·

ومن النتائج أمكن تحديد التأثير المعنوى لكل عامل على حده والتفاعل بين كل عاملين وثلاث عوامل على معدل عدد القطوع· وتشير نتائج البحث بصفة عامه الى أن معدل عدد القطوع يتأثر معنويا بكل من اس البرم ، قيمة السحب ، سرعة المردن وكذلك وضع الدور· وبالاضافة الى العوامل السابقة·· يتأثر معدل القطوع أيضا بتفاعلات العوامل مع بعضها كما فى حالة سرعة المردن مع وضع الدور وكذلك سرعة المردن مع وزن الدبله·

ABSTRACT:

In the present work, the rate of end-breakages during the spinning of carded yarns 20 Nm up to 50 Nm from Egyptian (Giza 75) cotton fiber have been observed. The phenomenon has been investigated considring the effect of twist, draft, spindle speed, traveller weight and doffing position. The experiments were carried out by varying two-variables at different levels and three-variables using 3^3 factorial design technique. The results declared thatm the end-breakage rate was found to be influenced significantly by: twist, draft, spindle speed and doffing position.

In addition to the above parameters, the two-factor interaction such as spindle speed with doffing position and spindle speed with traveller weight affect significantly on the rate of ends down.

1. INTRODUCTION:

A low level of end-breakage rate at spinning machine is very important and most of textile research workers are fully aware of the factors influencing end-breakage rates. In general, end-breakage in ring spinning occurs due to the following factors:

i) Material parameters: Such as fiber length, Fineness, Strength and Frictional properties.

ii) Spinning frame variables: draft, ring diameter, shape and weight of traveller, coefficient of friction between traveller, yarn and ring, balloon high and diameter and spindle speed.

iii) Spinning condition: Such as roving feed characteristics, yarn twist, yarn thickness, humidity and temperature.

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Several number of papers dealt with the phenomenon of end-breaks in ring Spinning in terms of:

i) Studies on the end-breakage mechanism in spinning and discussing the problem in terms of a simple Mathematical model (1,2,3). The model involving several parameters such as spinning tension, regularity and angle of lead (2). Also such other factors as number of fibers and fiber strength (3).

ii) Studies of the dependence of end-breakage rate on several factors. The ATIRA (4) investigated the phenomenon relating to Spinning tension, Linear density and flow of twist into the strand between the roller nip and the lappet. Also, the interaction of twist and tension in relation to the occurance of end-breaks. Balasubramanian et al.(5) studied the end-breakage variation over the chase length. Also, they indicate that the ring rail movement is by itself a source of end-breaks in cop-build package. The effect of ring rail speed on end-breakage has been studied (6). They found a significant reduction in the number of end-breakages at lower ring rail speed. In another work (7), he studied the influence of feeding position of the roving, the application of condenser and doffing position on end-breakage.

iii) Studies on how to reduce end-breakage rate at the ring spinning machine. End-breakage is minimized by optimization of the traveller weight, the traveller type, the ring diameter and reduction of the ring rail speed (8). Also, a lower rate could be achievd by correct machine Settings, maintenance, humidity control and roving quality control (9).
On the other hand, automatic elimination of yarn breakage achievd by using a device move along the ring spinning frame and automatically detect and join-up any yarn breakages occuring during Spinning (10).

So far a little work has been done on the subject of end-breakage during Spinning in Egyptian Textile industry. Thus, the present work intended to examine the parameters which affect end-breakage. The investigation was carried out considering the effect of the following parameters:

i) Varying two paramcters, twist and draft at different levels.

ii) Varying three factors: Spindle speed, traveller weight and doffing position using 3^3 factorial design technique (11).

2. EXPERIMENTAL:

The experiments were designed for determining the rate of end-breakage for carded cotton yarns at ring Spinning machine due to:

2.1. Twist and Draft:

The two variables were changed while the other parameters were kept constant. Twist multipliers (α_m) were selected at five levels for each yarn count and the total draft varies with constant or/and different roving Linear density (tex.). The details of experiments of yarn prepartion are given in Tables (1.1), (1.2)and (1.3). The investigations were made for coarse and medium yarns, and the ends-down measurements were based on a study of 1000 spindle-hr.

Construction details of experiments of yarn preporation.
(Tables 1.1, 1.2 and 1.3)

Table (1.1)

Yarn Count Nm.	Roving Size Tex	Twist Multiplier, α_m					Designation
		91	103	115	127	139	
34	843.5	x	x	x	x	x	I (1-5)
	694.7	x	x	x	x	x	II (1-5)
	590.5	x	x	x	x	x	III(1-5)
	474.4	x	x	x	x	x	IV (1-5)

Spindle speed: 8600 r.p.m
Traveller weight: 110.7 mg.
Ring diameter: 57 mm.
Break draft: 1.21
Clips thickness: 5.7 mm.

Table (1.2)

Yarn Count Nm	Roving Size (Tex)	Traveller weight (mg)	Twist Multiplier, α_m					Designation
			85	97	109	121	133	
20	843.5	193.4	x	x	x	x	x	V (1-5)
24		171.8	x	x	x	x	x	VI (1-5)
28		150.8	x	x	x	x	x	VII (1-5)
30		129.4	x	x	x	x	x	VIII(1-5)

Spindle Speed: 8600 r.p.m
Ring diameter: 57 mm.
Break draft : 1.21
Clips thickness: 5.7 mm.

Table (1.3)

Yarn Count (Nm)	Roving Size (Tex)	Traveller weight	Twist Multiplier, α_m					Designation
			91	103	113	127	139	
34	590.5	110	x	x	x	x	x	IX (1-5)
40		210	x	x	x	x	x	X (1-5)
48		310	x	x	x	x	x	XI (1-5)
50		510	x	x	x	x	x	XII (1-5)

Spindle Speed: 11500 r.p.m
Ring diameter: 48 mm.
Break draft: 1.14
Clips thickness: 4.9mm.

2.2 Spindle Speed, Traveller Weight and Doffing Position:

The experimental design technique"3^3 factorial design" applied for end-breaks phonomenon to examine the main effect of three parameters: (N) spindle speed, (T) traveller weight and (D) doff position. Also, it was decided to investigate all combinations of three levels of each of these factors.

The standard form of 3^3 factorial design for three variables are shown in Table (2). All the factors in this work denote variables and the levels for each are at equal intervals of the variable as following:

i) Spindle speed (r.p.m): (-1) 8400, (0) 11000, (+1) 13600

ii) Traveller weight : (-1) 610, (0) 410, (+1) 210

iii) Doffing position : (-1) Bottom, (0) Middle, (+1) Top.

The other parameters of spinning were kept constant for producing carded cotton yarn 50 Nm with twist multiplier α_m 103.

Table (2) 3^3 Factorial Design.

Experiment Number	Factors level			End-Breakages per 1000 Sp. hr
	Spindle Speed N	Traveller weight T	Doffing position D	
1	-	-	-	y_1
2	-	0	-	y_2
3	-	+	-	y_3
4	-	-	0	y_4
5	-	0	0	.
6	-	+	0	.
7	-	-	+	.
8	-	0	+	.
9	-	+	+	.
10	0	-	-	.
11	0	0	-	.
12	0	+	-	.
13	0	-	0	.
14	0	0	0	.
15	0	+	0	.
16	0	-	+	.
17	0	0	+	.
18	0	+	+	.
19	+	-	-	.
20	+	0	-	.
21	+	+	-	.
22	+	-	0	.
23	+	0	0	.
24	+	+	0	.
25	+	-	+	
26	+	0	+	
27	+	+	+	y_{27}

3. RESULTS AND DISCUSSION:

3.1. Effect of Twist and Draft on End-breakage Rate:

The end-breakage results at ring spinning are plotted graphically in figures (1-4). Examination of the results relating to the influence of twist indicate that, as yarn twist increases the

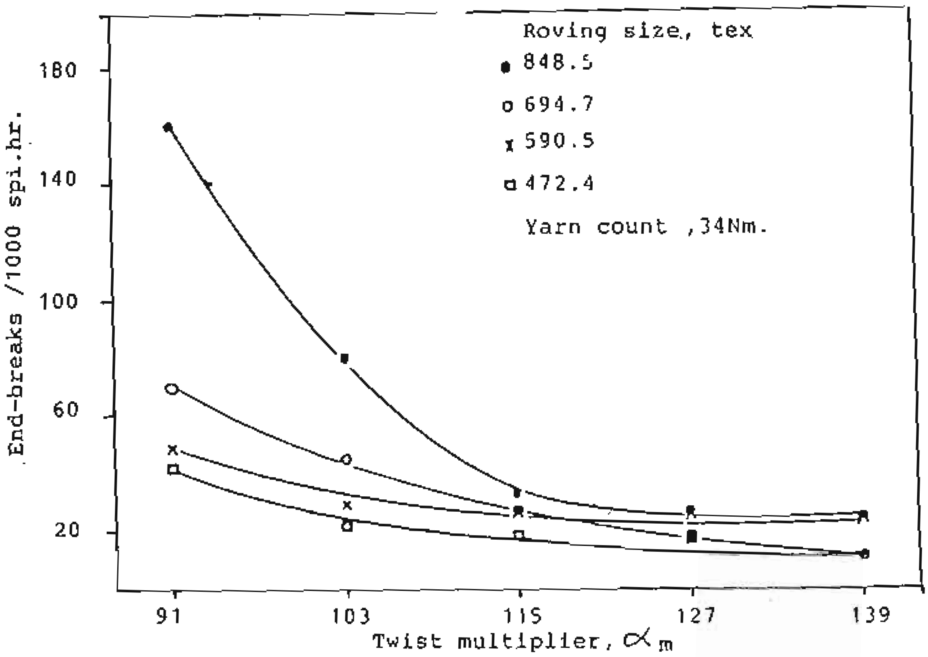

Fig.(1) Effect of spinning draft for producing 34 Nm at different twist multiplier on end-breaks.

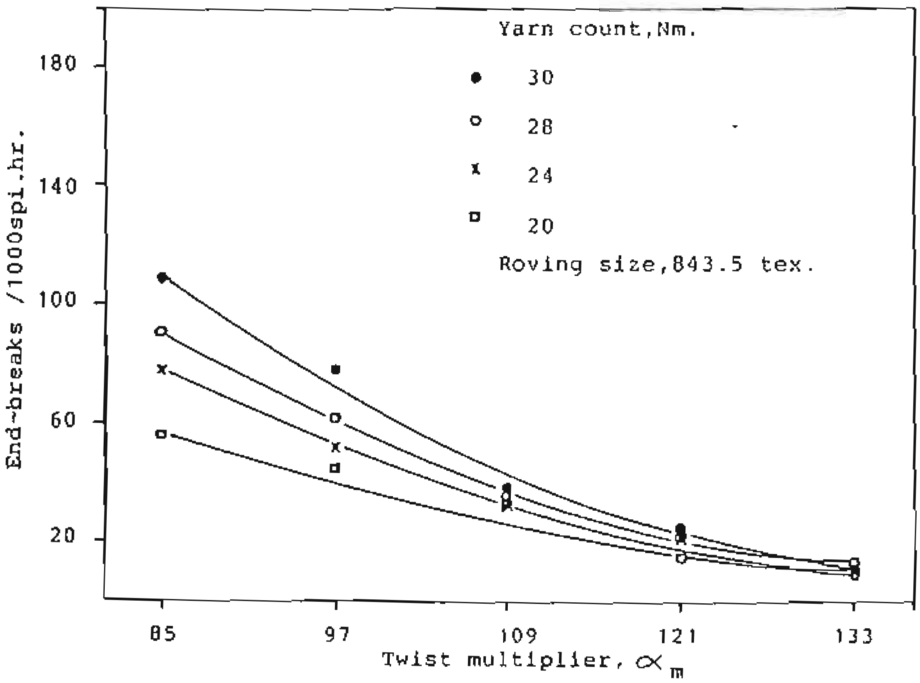

Fig.(2) Effect of draft for producing various yarn count at different twist multiplier on the rate of end-breakage.

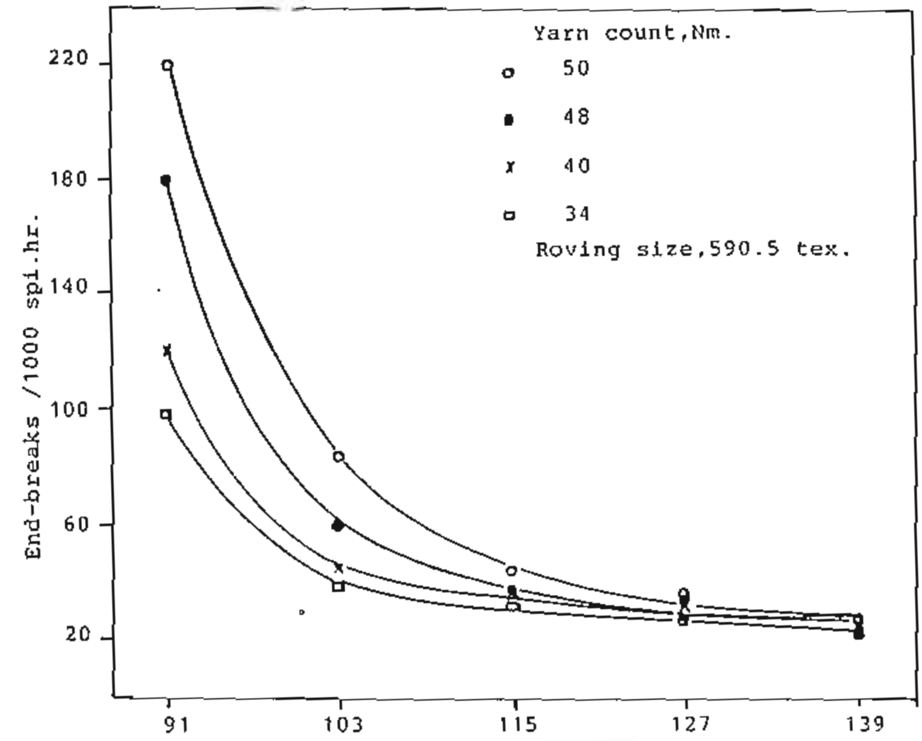

Fig.(3) Effect of draft for producing various yarn count at different twist multiplier on the rate of end-breakage.

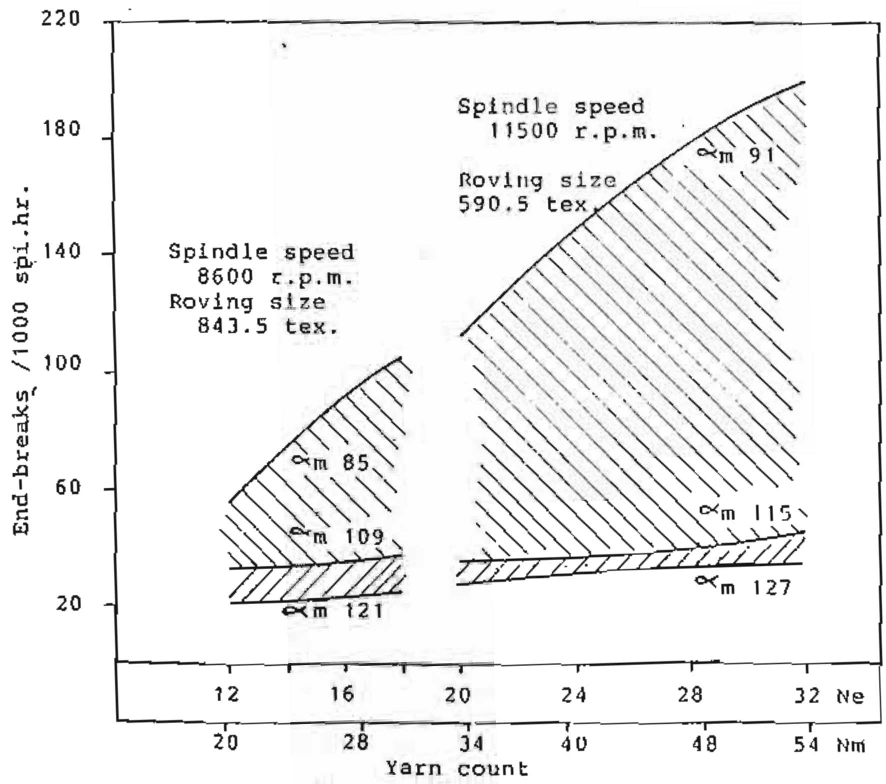

Fig.(4) Relationship between yarn count at different level of twist and rate of end-breakage.

rate of ends down gradually decreases. While at a certain number of twists the increases does not bring any reduction in ends down. At lower twist, the higher number of end-breakage observed can be explained by unfavourable strength-tension balance whereby the yarn is not able to withstand the prevalent tension. On the other hand, at high twist the yarn become fairly strong and resulting in a lower number of yarn breakage. The rate of yarn breaks does not differ much as the inserted twist is higher than α_m 109 for yarn count upto 30 Nm and more than α_m 115 for yarn count upto 50 Nm . This level of twists, as shown graphically in Fig.(4), corresponding to the yarn production with lower rate of ends down may be considered as a minimum twist multiplier.

The curves which indicate the effect of draft on end-breaks rate are given in figures (2) and (3), draft varies from 20 to 30 with roving size 590.5 tex (Fig. 3), while in Fig. 2 draft varies from 17 to 25 with Roving size 843.5 tex. The results indicate ahigher ends down as draft increases, as shown in figures (2-4), i.e. a higher rate of ends down accompaned with 50 Nm yarn count than those for 20 Nm yarn. This phenomenon is pronounced at twist multiplier up to α_m 115. At low twist the difference is statistically significant, while at high twist more than α_m 115 a slight difference has been observed. Also, in terms of varying draft and roving size for producing yarn count 34 Nm, as shown in Fig. (1), the results indicate that the course roving with higher draft resulted in a higher rate of end-breakage than those obtained with medium roving size at low draft.

The higher rate of ends down due to high draft values may be attributed to the yarn irregularity and imperfection occured during fiber drafting. This was explained by the earlier finding(4). The presence of thick place increase the chance of end-breaks for two reasons namely: increased Spinning tension and poor twist flow. Also, the chances of thin place resulting in an end-breaks are dependent on the Linear density of the preceding length of yarn.

3.2 Effect of spindle Speed, Traveller Weight and Doff. position Using 3^3 factorial design:

The end-breakage results due to the effect of the three-factors are shown in Table (3).

First, it will be assumed that the three parameters, spindle speed, Traveller weight and doff position are qualitative. The analysis of variances of 3^3 factorial design are shown in Table (4). From the qualitative analysis the following results can be deduced: The experiments indicate the dependence of end-breakage on the spindle speed as well as doff position. Also, the two-factor interaction show the dependence of ends down on the interaction between spindle speed and doff position (N.D.). On the other hand, the three factor interaction is statistically insignificant.

Since the two parameters, spindle speed and Traveller weight are quantitative, it's desirable to analyse their effects and interactions with the other factor into its Linear and quadratic components. The complete analysis of variance are given in Table (5).

Table (3) End-Breakage results at Ring Spinning m/c.

Traveller weight	Spindle Speed (r.p.m)								
	(-1)N_1			(0)N_2			(+1)N_3		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
	(-1)	(0)	(+1)	(-1)	(0)	(+1)	(-1)	(0)	(+1)
Doffing position:									
(-1) D_1	70	26	38	76	41	37	118	131	237
(0) D_2	45	21	25	54	33	33	79	118	92
(+1) D_3	36	12	23	43	26	29	63	92	116

Table (4) Analysis of variance of 3^3 Design both factors considered qualitative.

Source of Variation	Sum of squares	D.f	Mean squre	Variance ratio
(i) Main Effects:				
Traveller Weight(T)	965.629	2	482.815	1.040
Doffing position(D)	7045.629	2	3522.815	7.591***
Spindle Speed (N)	37872.297	2	18936.149	40.802**
(ii) Two-factor interactions:				
Doffing, Traveller(D.T.)	1614.812	4	403.703	0.869
Doffing, Spindle r.p.m(D.N)	7459.484	4	1864.871	4.018**
Traveller, Spindle r.p.m (T.N)	3660.148	4	915.037	1.972
(iii) Three factor interactions:				
(D.T.N.)	3712.742	8	464.093	
Total	62330.741	26		

(***): Significant at 99%
(**) : Significant at 95%
(*) : Significant at 90%.

It can be noticed that from the variance analysis, the main effect of spindle speed, either Linear or/and quadratic, is highly significant. Also, the Linear effect of doffing position is statistically significant, while the Linear and quadratic effects of traveller weight are insignificant.

For the interaction between spindle speed and traveller weight involving Linear component ($L_T L_N$) is significant. On the other hand the only component of the interaction between spindle speed and doff position which is significant is Linear (N)* Qudratic (D). While None of the traveller weight and doffing position interactions are not significant.

Table (5)

Source of variation		Mean Squares	Variance Ratio
(i) Main Effect:			
Traveller weight (T),	L	117.55	0.2530
	Q	848.07	1.8273
Doffing position (D),	L	6197.55	13.3540***
	Q	848.07	1.8273
Spindle speed (N),	L	3215.00	67.3350***
	Q	6622.29	14.2693***
(ii) Two-Factor interactions:			
Doff position and Traveller Wt.			
	$L_D L_T$	40.83	0.0879
	$Q_D L_T$	469.40	1.0110
	$L_D Q_T$	469.40	1.0110
	$Q_D Q_T$	476.69	1.0270
Spindle speed and Traveller.			
	$L_T L_N$	5208.30	11.2225***
	$L_T Q_N$	256.00	0.3516
	$Q_T L_N$	1995.11	4.2989*
	$Q_T Q_N$	0.03	0.00005
Doff position and spindle speed.			
	$L_D L_N$	1925.30	4.1480*
	$L_D Q_N$	693.44	1.4940
	$Q_D L_N$	765.44	1.6490
	$Q_D Q_N$	220.03	0.4740
(iii) Three Factor interactions:		464.09	

From the two waytables (Table 6), it can be seen that, the spindle speed has a significant effect on the end breakage whatever the condition of the other factors (Traveller weight and doff position). There is a higher rate of end-breakage at higher level of spindle speed (N_3= 13600 r.p.m). Also, the traveller weight effect has been noticed, the heavy traveller (T_3) especially at higher spindle speed resulting in a higher rate of end-breakage. While for the experimented yarn 50 Nm, traveller weight (T_2) resulted in a lower number of ends down at spindle speed 8400 r.p.m to 11000 r.p.m. On the other hand, the effect of doff positions with spindle speed (D x N) can be noticed in Table (6). The results indicate that a higher number of end-breakage at the lower doff position (D_1) than those obtained for middle and top doff position. These results are in agreement with the previous work (7). The effect attributable to the higher yarn tension and the increased angle of wrap of the strand around the front bottom roller, which inhibits the flow of twist to the nip, at the lower doff position.

Table (6) The two-way table for each pair of factors.

(DxT)

	T_1	T_2	T_3	Sum
D_1	264	198	312	714
D_2	178	172	150	500
D_3	142	130	168	440
Sum	584	500	630	1714

(DxN)

	N_1	N_2	N_3	Sum
D_1	134	154	486	774
D_2	91	120	289	500
D_3	71	98	271	440
Sum	296	372	1046	1714

(TxN)

	N_1	N_2	N_3	Sum
T_1	151	173	260	584
T_2	59	100	341	500
T_3	86	99	445	630
Sum	296	372	1046	1714

4. CONCLUSION:

The present study permits the following conclusions to be drawn:

1) The rate of end-breaks is influenced by twist and draft:
   i) As the imparted twist increases the number of ends down decreases.

   ii) At low twist levels,improper draft for the linear density of roving fed result in a higher rate of breaks. The influence of draft diminshed as twist increases to such level, at which the strength-tension balance has been achievd and consequently a lower ends-down occurs.

2) In addition to the influence of the above parameters, the effect of spindle speed, traveller weight and doff position on the end-breakage at ring spinning has been investigated using 3^3 factorial design. The experiments clearly indicate that:
   i) Higher spindle speed, low doff position give rise in level of tension and consequently higher rate of end-breaks.

   ii) The two-factor interaction such as spindle speed with doff position and spindle speed with traveller weight affect significantly on the rate of ends down. Thus:

   - Proper choice of traveller weight must be considered at higher spindle speed, and
   - Spindle speed must be decreased at low doff position. This prospect has been considered at the present time by ring-spinning machine producers (12).

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