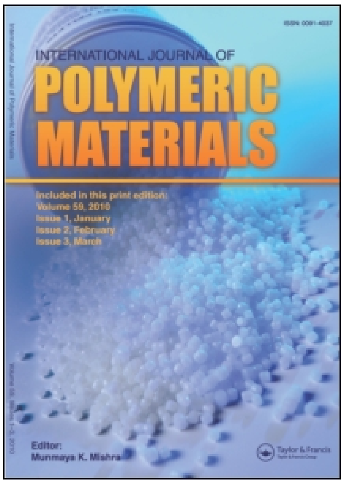

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The Effect of Cotton Yarn Properties on Yarn End Breakage

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In this work the effect of cotton yarn properties on yarn end breakage was investigated. The yarn nominal linear densities were 20, 25 and 36 tex and each of them had three levels of twists. Following yarn properties were investigated: linear density, twists, tensile strength, elongation at break and irregularity. Standard methods were applied to determine these yarn properties and hronometric method for yarn end breakage was used. It was only the yarn linear density, among all yarn properties, that showed significant correlation with yarn end breakage (–0,75 to –0,96). It was shown that about 80% of all yarn end breakage are occurred in places with fineness lower than average cross section of the yarn that point out that the thin places of the yarn are inclined to breaking. Also, the mutuality effect of geometrical characteristics and physical–mechanical properties of the yarn on end breakage was investigated.

Keywords: Cotton yarn; yarn end breakage; geometrical characteristics; physical–mechanical properties; correlation coefficient; yarn linear density.

INTRODUCTION

Yarn breakage during the spinning process is a characteristic of textile material that causes a disarrangement in yarn structure, disturbs the technological process of spinning and results in low quality of the yarn and its products. The increasing of the spindle speed, as a reserve of the increasing of the ring spinning frame production, is limited by the increasing breakage. So, increase in production as well as achieving better quality of yarn can be realizes only by decreasing the breakage.

Starting from the attitude that the yarn end breaking, among the other factors, depends on the yarn properties, it was interesting to investigate the yarn end breakage for yarns with different structure parameters. On the base of this it would be possibly to estimate the yarn quality and its dynamic lasting as well as the prognosis of yarn breakage in subsequent process. Also, the mutuality effect of geometrical characteristics as well as physical–mechanical properties of the yarn on the end breakage is of great importance for estimating the yarn quality.

THEORETICAL PART

In this work the effect of cotton yarn properties on yarn end breakage was investigated. Also, the mutuality effect of geometrical characteristics (linear density and twists) and physical–mechanical properties (tensile strength and irregularity) of the yarn on the end breakage were investigated. This information can be used for foreseeing the quality of the products (cloth, knitted fabric). Thus, this work is a contribution to the study of the essence of the end breakage and its functional changes at different yarn structure parameters. This would cause the improvement of the technical-economic indicators, and the methods of the yarn breakage control would become prophylactic that would enable a transition from a passive statement of breakage to an active management of the technological process.

EXPERIMENTAL PART

Cotton yarns with nominal linear densities of 20, 25 and 36 tex and three levels of twists for each of them were used (820, 893 and 923 m^{-1}, 723, 740 and 820 m^{-1}, 629, 675 and 690 m^{-1} respectively). Thus, nine variants of cotton yarns with different structure parameters were supplied for estimating the effect of cotton yarn properties on yarn end breakage. Russian cotton fiber I class and Greek cotton fiber for preparing the spinning blends were used. The properties of the fibers used are given in Table I.

The cotton yarns are spun on ring spinning frame TB-1 Krushik, Valjevo with 432 spinning spindles. Following yarn properties were investigated: linear density, twists, tensile strength, elongation at

TABLE I Fiber properties used in spinning blends

Type of cotton	*Cotton part in the blend (%)*	*Staple length (mm)*	*Effective length (mm)*	*Mean length (mm)*	*Linear density (dtex)*	*Tensile strength (cN/dtex)*
Greek	75	27/29	28.0	17.0	1.34	4.3
Russian I class	25	33/34	33.5	20.5	1.65	5.1

break and irregularity. Standard methods were applied to determine these yarn properties and hronometric method for yarn end breakage was used. It was done 10 measurements from 10 full bobbins, that is, total 100 measurements for each variant. End breakage for any charging was carried out. Linear regression analysis was used for determining the effect of cotton yarn properties on yarn end breakage.

RESULTS AND DISCUSSION

The results getting for the average values of the yarn properties and yarn end breakage are presented in Table II. The linear correlation coefficients between end breakage and yarn properties are given in Table III.

It can be seen that only the yarn linear density, among all yarn properties, shows significant correlation with yarn end breakage (Tab. III). Average correlation coefficients were: –0,87, –0,90 and –0,91 for the yarn with 20, 25 and 36 tex respectively.

It was found that about 80% of all yarn end breakage are occurred in places with fineness lower than average cross section of the yarn that point out that the thin places of the yarn are inclined to breaking.

Not existing higher correlation among the other yarn properties and yarn end breakage can be ascribe to two reasons. First, the yarn end breakage is a rear manifestation that occurs on 3000–5000 m of yarn while the yarn length that is an object of the quality testing is much shorter. Therefore, yarn property that is measured off, can be brought in connection to the yarn end breakage only if its average value is very nearly to the extreme one that is necessary to may declare that it comes to end breakage event. Second, the yarn irregularity can not be completely described only by measuring the Uster value. This value is a basic but is only one of the numerous possible cuttings

TABLE II Yarn properties and yarn end breakage

Variant	*Statistic property*	*Linear density (tex)*	*Number of twists (m^{-1})*	*Tensile strength (cN/dtex)*	*Elong. at break (%)*	*Uster value (%)*	*End breakage (no/100 km)*
	$\bar{x}$	19.93	839	13.46	5.53	15.64	18.22
1	SD	0.39	18.93	0.45	0.41	0.67	2.69
	CV	1.95	2.25	3.34	7.41	4.32	14.79
	$\bar{x}$	19.40	918	14.30	5.83	15.80	15.05
2	SD	0.57	16.15	0.47	0.38	0.63	2.30
	CV	2.93	1.76	3.28	6.51	3.99	15.30
	$\bar{x}$	20.51	955	14.27	6.23	16.31	14.38
3	SD	0.41	16.42	0.47	0.49	0.76	1.93
	CV	2.00	1.32	3.43	7.86	4.65	13.42
	$\bar{x}$	24.64	721	12.61	6.01	15.21	14.41
4	SD	0.43	9.22	0.66	0.35	0.67	2.05
	CV	1.74	1.28	5.23	5.82	4.40	14.24
	$\bar{x}$	23.77	760	12.99	6.40	15.32	13.63
5	SD	0.39	19.92	0.63	0.31	0.58	2.58
	CV	1.64	2.62	4.85	4.84	3.78	18.93
	$\bar{x}$	24.86	842	12.85	6.99	15.59	12.78
6	SD	0.53	8.79	0.56	0.53	0.58	2.86
	CV	2.13	1.04	4.36	7.58	3.72	22.31
	$\bar{x}$	35.56	634	14.74	7.20	14.94	12.50
7	SD	0.43	14.64	0.54	0.50	0.46	1.93
	CV	1.22	2.31	3.66	6.94	3.08	15.44
	$\bar{x}$	35.72	673	15.14	7.37	15.04	12.01
8	SD	0.56	15.70	0.46	0.47	0.51	1.90
	CV	1.56	2.33	3.04	6.37	3.39	15.82
	$\bar{x}$	35.65	698	14.92	7.56	15.09	11.93
9	SD	0.69	14.16	0.39	0.46	0.57	1.58
	CV	1.94	2.03	2.61	6.08	3.78	13.24

TABLE III Correlation coefficients of the yarn variants

Variant	$r_{eb,Tt}$	$r_{eb,Tm}$	$r_{eb,P}$	$r_{eb,E}$	$r_{eb,U}$
1	−0.75	0.44	0.08	0.14	0.44
2	−0.94	0.42	0.13	0.08	0.45
3	−0.96	0.47	0.28	−0.31	0.04
4	−0.85	0.19	−0.15	0.03	0.57
5	−0.91	0.14	−0.13	−0.26	0.16
6	−0.93	−0.28	−0.31	−0.18	−0.17
7	−0.86	−0.62	−0.24	−0.07	−0.03
8	−0.92	−0.20	0.30	−0.15	0.01
9	−0.96	−0.64	−0.23	−0.37	−0.12

that may be used for measuring the irregularity. It is understandable that uster values of two yarns may be equal, although they have not the same values of the variance of the linear density.

The mutuality effect of geometrical characteristics (linear density and twists) as well as physical – mechanical properties (tensile strength and irregularity) of the yarn on the end breakage are illustrated in Figures 1 and 2 respectively. It is obvious that the yarn with lower linear density (20 tex) and average number of twists (836 m^{-1}) shows maximum end breakage, while the yarn with higher linear density (36 tex) and lower number of twists (636 – 688 m^{-1}) shows minimum end breakage (Fig. 1). Regarding to mutuality effect of yarn physical – mechanical properties on the end breakage, the lowest yarn end breakage is achieved for the yarn with higher tensile strength and lower irregularity (Fig. 2).

Thus, for previously estimating the yarn end breakage is not enough the testing procedures commonly known in practice up to now. Besides, not measuring factors, as for example characteristic of friction, free fibers and impurities in the yarn and the roving, can cause the large part of breakage. Further, end breakage distribution is not equal on all spinning bobbins. Some of the bobbins may be damaged and the great percentage of yarn end breakage is due to them.

Though, the yarn linear density, opposite of the other yarn properties, shows significant correlation with yarn end breakage. Thus, the

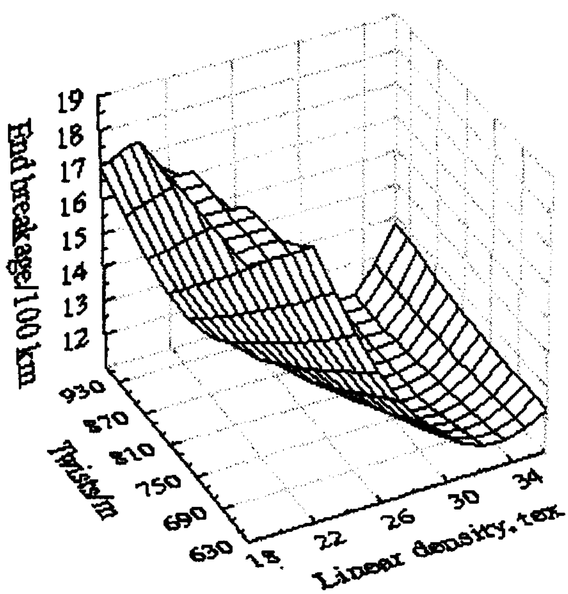

FIGURE 1 The effect of geometrical characteristics of the yarn on the end breakage.

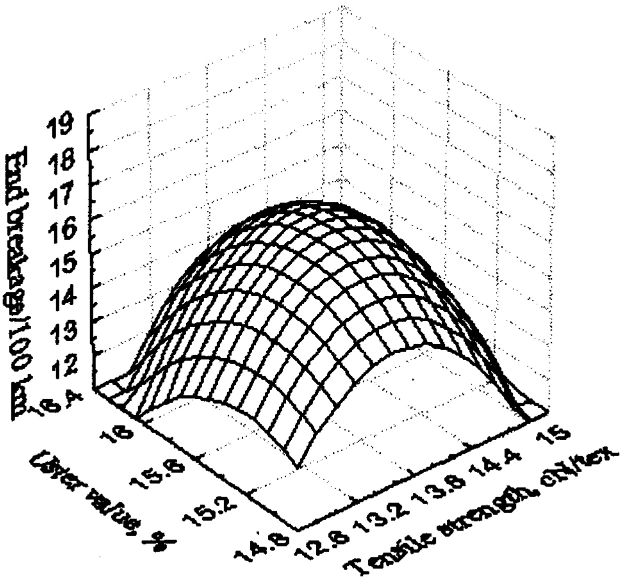

FIGURE 2 The effect of physical–mechanical properties of the yarn on the end breakage.

only way on which the changes of linear density can effect on the yarn end breakage is through the larger or smaller frequency of the yarn thin places. In other words, this correlation brings to conclusion that the thin places in the roving apt to drafting have tendency to breaking. When this thin place, indeed, will result in break depends on the yarn tenacity in the moment when the yarn will pass from the delivery rolls of the drafting mechanism to the spinning bobbin. So, local yarn linear density in the place of break has a great part in yarn end breakage.

CONCLUSION

On the base of the experimental results following can be concluded:

- The most important factor for yarn end breakage is yarn linear density.
- Only the yarn linear density, among all yarn properties, showed significant correlation with yarn end breakage (–0,75 to –0,96) that point out that the thin places of the yarn are inclined to breaking.

- About 80% of all yarn end breakage are occurred in places with fineness lower than average cross section of the yarn. Thus, it can be suppose that local yarn linear density in the place of break shows great effect on yarn end breakage. So, yarn end breakage is due to a fault in the yarn structure.
- End breakage in combination with indicators of geometrical characteristics and physical–mechanical properties offers an entire sight on maximum yarn quality that will be enable getting product with optimal characteristics.

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