OPTIMIZATION OF THE DRAFTING SYSTEM FOR THE RING SPINNING. PART I

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Abstract
The analysis of the factors that may affect the yarns evenness in spinning mill is related to the adjustments and working of the drafting systems. The influences of the top arm pressures and the roller settings for drafting on cotton ring spinning were studied. Original software named STAT-ATF was used to emphasize the effect of these factors on the yarns' evenness.

Keywords: cotton, yarn, drafting system, ring spinning, USTER TESTER 4, statistical analysis of variation.

INTRODUCTION

Yarn quality comprises the raw material quality and the quality of the processing. Major quality problems that have their origin in yarn manufacturing are still available as feedback from the weavers and knitters, too. The overall quality characteristics of the yarns are always the features depending on the yarns processing according to their destination in fabrics and any disturbing factor in spinning can lead to poor quality and to economical issues [1, 2].

Having in account the revolutionary manufacturing in spinning mills, was redefined yarn quality as a combination of four basic elements: the consistency (yarn evenness and appearance integrity by mean thick places, thin places and neps), the bulk integrity (count, density and twist), the surface integrity (hairiness, diameter and shape) and finally but not less important, the purity (foreign fibers, seed coat, trash and dust) [3, 4]. Just like that, in today's spinning are still available many factors that contributing to some kind of quality gap; two of these are the lack of complete integration of the fiber quality aspect in the process of yarn manufacturing (related to the process of cotton fiber selection) and the difficulty of handling the variability in fiber properties (related to cotton fiber blending) [3, 4, 5].

Numerous studies on the ring spinning frames have shown that the adjustment of the drafting rollers requires the simultaneous and broad consideration of the technological and mechanical factors involved in its operation [1, 2, 3, 6, 7].

The analysis of those factors that may affect the evenness of the linear density of yarns in actual spinning circumstances is related to the structure and operation of the drafting systems [6, 7].

In this paper, the influence of top arm pressures and roller settings for the drafting on cotton ring spinning was studied.

EXPERIMENTAL PART

In order to emphasize the impact of the drafting systems adjustment on the yarn's evenness features, this paper outlines the study of the 29.4 tex cotton-type yarns, spun from 55% cotton /45% Leacryl on the Unirea FBC ring spinning frame. This was equipped with 3-line double apron drafting rollers SKF-PK 225 for cotton, man made fibers and cotton - type mixtures spinning [8].

In Table 1 are presented the adjustment parameter's values for optimal processing on the SKF-PK 225 drafting system, according to the SKF statements [9].

An adequate spinning processing of the cotton-type mixtures requires a broad consideration of the drafting system with specific adjustments and also, of their side effect on the yarn consistency.

Table 1. Adjustments for PK 225 drafting systems

Roller size ,mm		Load setting, daN		Range clips, OLC	Hardness of Cots (rear/front), Shore	Rear draft gauge (Total draft gauge)
Bottom	Top					
I 27 II 25 III 27	1 -28 2- 25 3- 28	14 10 14	color code ”green”	yellow lilac white	75/75	1,15…1,3 (25…45)
		18 10 14	color code ”red”	yellow lilac white	83/75 83/83	1.3 (23...25)

Three binary mixtures named R_{02}, R_{03} and R_{04} were processed from Russian cotton and Leacryl cotton-type into 0.74 ktex roving for ring spun yarns. The multi-factor variance analysis was applied as a strategy in the assessment of some adjustments influences in drafting system, on the yarn evenness.

Employment of the original software namely STAT-ATF it supposed to facilitate the optimization of the yarns' features in drafting system on the ring spinning frame [8]. Based on the algorithm of the Hierarchical Classification with Three Factors of Variation, STAT-ATF software was designed using the Delphi development integrated medium (Inprise Corporation registered trademark) with Pascal and Data Base Engine Paradox. Statistical Analysis with STAT-ATF can be made with any available version on 32 bit of the Windows operating system.

In this paper, STAT-ATF software was employed for analyzing the experimental results (yarn evenness) depending on several factors that acting in the same time over the threads: rollers loading, opening at apron release point and the hardness of cots. Therefore, the most important factors and the assessment of their effects was determined in processing of the 0.74 ktex roving (preliminary draft 1.3 and total draft 25.2) with 33.5 mm average length of fibers from mixture recipes.

Table 2. Hierarchical scheme with three causes of variation

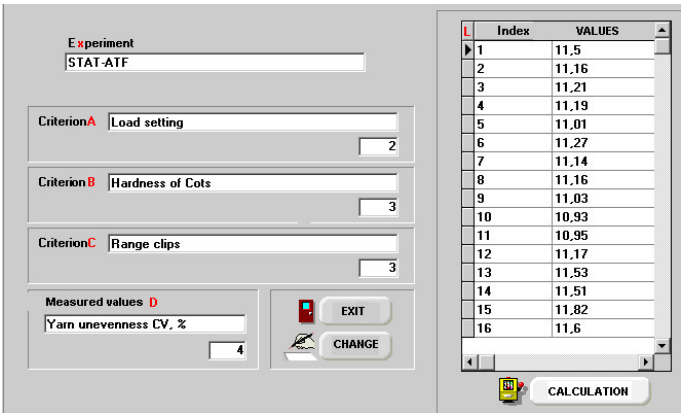
Load setting	Hardness of Cots, ^{0}Sh	Range clips	Yarn unevenness CV, %			
			1	2	3	4
14/10/14	75/75	yellow	11.5	11.16	11.21	11.19
		lilac	11.01	11.27	11.14	11.16
		white	11.03	10.93	10.95	11.17
	83/75	yellow	11.53	11.51	11.82	11.6
		lilac	11.75	11.91	11.89	11.82
		white	11.8	11.67	11.96	11.61
	83/83	yellow	11.97	11.87	11.92	11.76
		lilac	12.18	12.06	12.01	12.15
		white	12.25	11.95	12.12	12.33
18/10/14	75/75	yellow	10.84	10.89	11.01	10.81
		lilac	11.71	11.41	11.54	11.41
		white	11.41	11.37	11.25	11.42
	83/75	yellow	10.36	10.49	10.3	10.56
		lilac	11.17	11.16	11.38	11.27
		white	11.16	11.33	11.37	11.42
	83/83	yellow	11.48	11.24	11.36	11.26
		lilac	11.88	11.85	11.91	11.56
		white	12.1	11.87	11.93	11.82

Table 2 shows the three causes of variation A, B and C, which were assimilated in this paper, as follows:

A–Load setting on the top rollers: standard load (color code ”green”) 14/10/14 daN and maximum load (color code ”red”) 18/10/14 daN;

B–Hardness of cots; were used Armstrong cots in the following combinations: 75/75^{0}Sh; 83/75^{0}Sh; 83/83^0 Sh;

C–distance “x” between the double aprons (adjusted by using the gauge clips); in the short staple field for top apron cradle OH 62 are available distance clips OLC: yellow (with “x”=2.2 mm), lilac (with “x”=2.5 mm) and white (with “x”=2.9 mm).



a. The main window of STAT-ATF software

Experiment STAT-ATF

Cause of variation	Squares sums	Freedom degree	Mean squares	F_{ratio}	F_{tables}
A	1.9536	1.0000	1.9536	133.1079	4.02
B	5.7978	2.0000	2.8989	197.5163	3.16
C	2.1395	2.0000	1.0697	72.8861	3.16
Interact AB	2.1968	2.0000	1.0984	74.8373	3.16
Interact AC	1.2708	2.0000	0.6354	43.2930	3.16
Interact BC	0.4180	4.0000	0.1045	7.1196	2.54
Interact ABC	0.1797	4.0000	0.0449	3.0602	2.54
Experimental error	0.7926	54.0000	0.0147	-	
Total	14.7487	71.0000	-	-	

OK

b. The working window with corresponding analysis of variance

Figure 1. STAT–ATF dialogue windows for drafting systems adjustments in ring spinning

Also, Table 2 shows the unevenness average values for the 29.4 tex yarns spun with the previously mentioned adjustments. In laboratory was carried out the accurately testing with USTER® TESTER4 laboratory system, as fallow: every yarn sample with 10 packages, 400m/min testing speed, 2.5 min. testing time/sample and 1 km yarn testing length / sample.

The second stage of the variance analysis consists of the determination of the effects for the grouping criteria, by comparing the dispersions caused by significant factors and the dispersion due to random factors. In Figure 1 are presented the dialogue windows after the successive steps and carried out the F test.

To test if the factors’ effect (causes of variation) is statistically significant, it must compare each value F ratio with those from the F distribution tables; for the degrees of freedom, are identified the theoretical values of F at a level of probability of 5%.

RESULTS

From the above studies (laboratory analysis and statistical analysis) the following can be drawn:

1. As a source of individual variation, each of the considered factors in the experiment (load settings, shore hardness of cots and range clips) has a powerful influence on the yarn quality, by mean of the variation of their level ($F_{ratio}A > F_{tab}A$; $F_{ratio}B > F_{tab}B$; $F_{ratio}C > F_{tab}C$);
2. The results of the experimental variants where the variation source was given by the combined effect of the two factors (by double interaction), also emphasize the significant effects of the levels of variation on the yarn unevenness ($F_{ratio}AB > F_{tab}AB$; $F_{ratio}AC > F_{tab}AC$; $F_{ratio}BC > F_{tab}BC$);
3. Finally, the effect of the triple interaction considered as a source of variation, consists from the overall influence of the all factors (load settings, shore hardness of cots, range clips) on the values of yarn unevenness (F_{ratio} ABC>FtabABC).
4. For the spinning of the 29.4 tex cotton / Leacryl yarns, with increase in shore hardness form 75 °Sh to 83 °Sh, the coefficient of mass variation increase for all the other settings. This is due to the fact that lower shore hardness cot helps for increase in area of contact with the bottom

roller cots, which significantly shortens the uncontrolled area between apron to cot nipping point. In this paper were used blended yarns, and the use of softer cots can lead to frequent cots roller lapping and faster wear. This is due to the fact that acrylics are bulky fibers and therefore exerts maximum abrasion over the cots.

5. The upright distance between the front edges of top apron cradle and the bottom apron nose bar determine the intensity of the fiber control between top and bottom aprons. So, the selection of the gauge clips can be a compromise: narrow opening assures good qualities of the yarn, but under certain circumstances like 55 % cotton /45 % Leacryl mixture it may affect negatively the drafting operation.

The lack of correlation of the processed raw material with all these factors it may turn into disturbance that can affect the yarns evenness.

CONCLUSIONS

Drafting components have a significant influence on yarn quality and also, on the production costs in the ring spinning.

For a reduced unevenness of the cotton – type yarns, there is a limit up to which an increase in the fibers tension while going through the aprons is required. The adequate combination of the shore hardness cots for the rear / front top rollers with load setting on the top rollers and by choosing the gauge aprons, depend always on the raw material.

This article deals with the mathematical relationship between load settings, shore hardness of cots, range clips and yarn unevenness. The change in 29.4 tex cotton/Leacryl yarns property like unevenness has been reported from the above studies that included laboratory analysis and statistical analysis.

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