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Analysis of Quality Indicators of Yarns with Mixed Composition

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Abstract: The article analyzes the properties of yarns with mixed content and determines the change of its quality indicators depending on the content of the yarn. According to the percentage composition of linear density 50 tex thread, the changes in breaking strength, variation coefficient of breaking strength, elongation at break were analyzed under the influence of the changed values of the parameters for the thread obtained by pneumomechanical method. A full-factorial experiment was conducted in the production of yarns obtained from a mixture of fibers of different composition, and regression equations were created based on the input and output parameters of the processing of the experimental results based on the quality indicators of the yarns. The Cochrane test was used to test the degree of variance variances. In order to check the adequacy of the linear model based on the regression equation, the residual variance was determined by Fisher's test, and the Student's test was used to evaluate the regression coefficients.

Keywords: Mixed yarns, linear density, tensile strength, coefficient of variation in tensile strength, elongation at break, input and output parameters, regression models, dispersion analysis.

Enter. The performance of spinning mills is estimated by the number of interruptions per thousand cells per hour. Because the number of interruptions has a great impact on the quality of the thread, the machine's performance and labor productivity, and increases its cost. The greater the break, the more the main working time of the spinner is spent on connecting the thread. For example, a spinner uses 70% of its time (1000 cams/hour) with 200 interruptions; 50% when there are 150; 30% for 100; At 50 it spends 15% of its time threading. As can be seen from the example, the smaller the interruption, the more the spinner can control the camera. Breakage largely depends on the quality of cotton, the technical condition of machines and the optimal selection of technological factors, the correct organization of work. According to the work experience of spinning factories, the number of interruptions per 1000 cells/hour should not exceed 30-40 when the above rules are fully followed. If the interruption is small, the spinner spends a lot of time cleaning the machine, It is spent on maintaining its technical condition is the main guarantee of reduction. There are two ways to increase the productivity of the spinner: increasing the speed of the chambers and the warp yarn reduce mass. But, when the speed of the cameras is increased, the thread the disconnection will increase dramatically. It is machine and labor productivity decreases, raw materials, turning cotton into waste and getting yarn from cotton reduces the percentage [1-2]. Therefore, on the basis of yarn production

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by mixing Typha fiber with cotton, all-round economy is achieved, and by producing yarn with natural mixed content, yarn quality is improved, and productivity increases.

Conduct research. In order to improve the quality indicators of textile yarns, 50-tex yarn was obtained by mixing 20-25% Typha fiber with cotton fiber at the enterprise of "Sagdiana Teks Prom Invest" LLC, and the quality indicators were analyzed. A full factorial experiment was conducted based on the results of the preliminary research conducted at the company "Sagdiana Teks Prom Invest" LLC, and the results are presented in Table 1. As input parameters for conducting a fully factorial experiment - thread tension, cN; - thickness of the thread, 1m/bur; - the rotation acceleration of the camera, min - 1, as output parameters U1 - breaking force of the thread, sN; U2-coefficient of variation in tensile strength, %; U3 – yarn elongation at break, % was selected and experimented.

Table 1

	Factors				Indicators of the output parameter, Y_{uv}			$S^2_{u1}\{Y\}$	$S^2_{u2}\{Y\}$	$S^2_{u3}\{Y\}$
	x_0	x_1	x_2	x_3	Y_1	Y_2	Y_3			
1.	+	-	-	-	368	9	15	4	3	3
2.	+	+	-	-	384	10	16	12	4	3
3.	+	-	+	-	393	8	15	7	6	4
4.	+	+	+	-	384	9	15	4	4	6
5.	+	-	-	+	410	11	18	4	3	4
6.	+	+	-	+	380	8	17	3	3	4
7.	+	-	+	+	382	9	17	4	3	7
8.	+	+	+	+	383	9	17	7	29	4
Amount					3492	73	128	45	29	35
Average					386,5	9,125	16	5,625	3,625	4,375

Regression equations were created based on the input and output parameters in processing the experimental results based on the yarn quality indicators. In addition, Cochrane's criterion was used to check the degree of mutual difference between the variances. Based on the polynomial regression equation, the residual variance was determined by Fisher's criterion to test the adequacy of the linear model. Student's criterion was used in the evaluation of regression coefficients and the analytical results of fibers were used [3-4].

According to the quality indicators of yarns, x_i - are considered as independent input parameters obtained in the experiment. The coded values of the factors are used to write the x_1, x_2 experimental plan and to process the experimental results. x_i It was found that coded (dimensionless quantity) and physical (natural) variable are x_i related in the following ratio [5-7].

$$X_i = \frac{x_i - x_{i0}}{\Delta i}$$

here: $\Delta_i = (x_{i\max} + x_{i\min})/2$ natural value variation interval; - the natural value of the zero level, $x_{i0} = (x_{i\max} - x_{i\min})/2$ $x_{i\max}$ ва $x_{i\min}$ - the natural value of the lower and upper level of the factor. Encoding the factors is equivalent to moving the coordinate origin to the point of the main factor level of the factors (the central point O of the experiment) and changing the scale. All encoded factors are dimensionless and normalized quantities. These values are called the level of the factors.

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A fully factorial experiment is one in which the levels of possible combinations (sets) of factors are realized. If "k" factors vary on two levels, all possible sets are N2=2k. If "k" factors vary by three levels, then N3=3k. All encoded factors are dimensionless and normalized quantities [8]. During the experiment, they took the values -1, 0, +1.

Based on Table 1, the processing of the results of the full factorial experiment is carried out in the following processes:

We remove indicators that differ sharply in style.

Statistical processing of the obtained results was carried out in the following order. We use Koxren criterion to check the degree of mutual difference of variances determined in each variant of parallel experiments with the same number of repetitions. This is the statistic for this criterion

$G=\frac{S_{umax}^2}{\sum_{u=1}^{N} s_u^2}$ = 7/35=0,2 is considered.

We find the tabular value of the Koxren criterion. $G[p_D = 0{,}95;\ f\{S_u^2\} = m-1 = 3-1 = 2;$ $N = 8] = 0{,}516.$ So the multivariate regression model $G_R = 0{,}148 < G_T = 0{,}516$. G_R =0,2<G_T =0,516 is equal to [9]. Using the indicators in Table 1, regression coefficients were calculated and the results are presented in Table 2.

Table 2

Sample thread options	b_0	b_1	b_2	b_3	b_{12}	b_{13}	b_{23}	B_{123}
1	386,5	-2,0	-4,0	2,4	0,3	-0,48	-4,8	4,8
2	9,125	-0,125	0,375	0,125	0,375	-0,75	0,125	0
3	16,0	2	0	0,61	-2	0,56	2	0,12
Significant regression coefficients when the calculated results of the Student criterion are compared to the results in the table								
1	-	b_1	b_2	b_3	b_{12}	b_{13}	-	-
2	-	-	b_2	-	b_{12}	b_{13}	b_{23}	
3	-	-	-	b_3	-	b_{13}	b_{23}	B_{123}

Based on the calculated results, multifactor regression models were obtained:

$Y_1 = 386{,}5 - 2{,}0X_1 - 4{,}0X_2 + 2{,}4X_3 + 0{,}3X_{12} - 0{,}48X_{13}$

$Y_2 = 9{,}125 + 0{,}375X_2 + 0{,}375X_{12} - 0{,}75X_{13} + 0{,}125X_{23}$

$Y_3 = 16{,}0 + 0{,}61X_3 + 0{,}56X_{13} + 2{,}0X_{23} + 0{,}12X_{123}$

The significance of the regression coefficient using Student's test, $t_R\{b_i\}$ accounting value t_T compared with the tabulated value. In this $t_R > t_T$ and the hypothesis about the significance of the regression coefficient was not rejected.

For the example under consideration, we obtained the following regression model based on the results of the full factorial experiment, taking into account only the significant coefficients. Figure 1-3 shows the graph of the target surfaces to illustrate the results of the regression models.

$x_1 = -1. - 0.9..1 \quad x_2 = -1. - 0{,}9..1 \quad x_3 = 1.$

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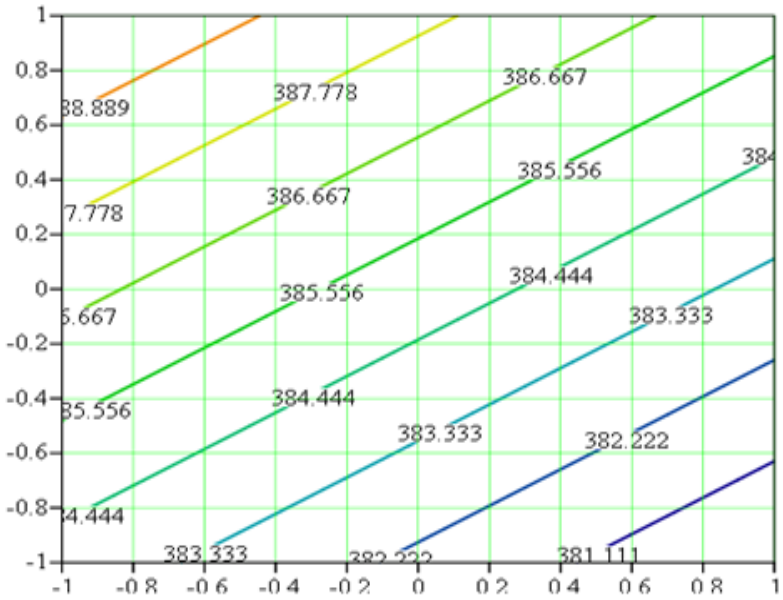

Figure 1. A graph of the target surface of the thread breaking force.

$x_1 = -1. - 0.9..1 \;\; x_2 = -1. - 0,9..1 \;\; x_3 = 1.$

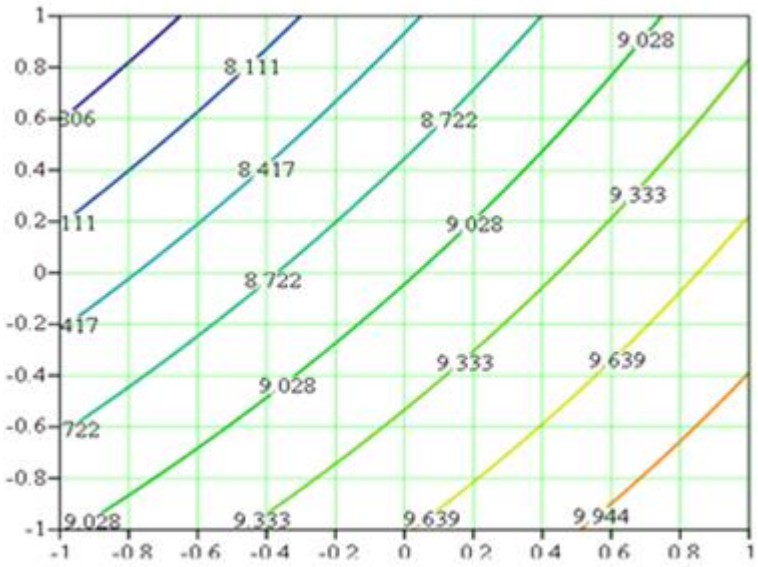

Figure 2. the coefficient of variation of the tensile strength of the yarns target surface graph.

$x_1 = -1. - 0.9..1 \;\; x_2 = -1. - 0,9..1 \;\; x_3 = 1.$

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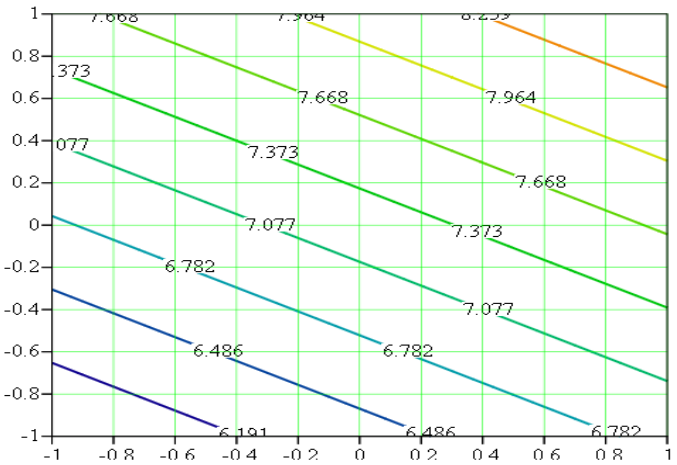

Figure 3. Elongation of threads at break target surface graph

In short, regression equations were created on the basis of the input and output parameters in the processing of the experimental results based on the tensile strength and elongation at break of the threads. The Cochrane test was used to test the degree of variance variances. To check the adequacy of the linear model based on the regression equation, the residual variance was determined by Fisher's test, and the Student's test was used to evaluate the regression coefficients. Appropriate rational values of the output parameters were determined through the factor interval.

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