INFLUENCE OF FIBER PROPERTIES ON THE UNEVENNESS OF WOOL YARN

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Annotation

This article presents the results of a study the influence of the length and fineness of wool fibers on the mechanical characteristics, as well as the unevenness of wool yarn. A correlogram was built based on the change in the linear density along the length of the yarn, which makes it possible to determine the wavelength of the prevailing periodic changes in thickness.

Key words: woolen yarn, linear density, unevenness, correlogram, wavelength.

Of particular relevance is the search for ways to increase production in combination with the rational use of wool raw materials. In this case, one should focus on an integrated approach to the production and processing of wool, as a single, inextricable process. The main properties of wool fibers include fineness (average diameter), linear density and strength. The diameter of wool largely determines the technology of its processing into yarn and plays a decisive role at all stages of production and processing to finished products. Fineness underlies the scientific and technical classification of wool, and the study of the features of its formation and connections with other characteristics of sheep determines the current possibilities of using new scientifically based methods of selection and use of wool in the processing industry in the wool industry [1].

One of the main tasks facing the textile industry is to improve the quality, performance and appearance of yarn and yarns.

The yarn structure is characterized by the following indicators; a) degree of twist; b) the nature of the fibre arrangement along the length of the yarn; c) the number of fibers and their location in the cross section of the yarn; d) uneven distribution of fibres in the yarn, both in quantity and in their quality. Therefore, for its study, in order to ensure the stability of spinning, weaving and finishing processes, more advanced testing devices of a new generation and appropriate methods for assessing its properties are required. The increased hairiness and unevenness of the yarn reduce the use of the strength of the fibers in the yarn, due to which its mechanical properties are deteriorated, and the breakage during rewinding and processing in weaving is increased.

To study and predict the influence of the properties of wool fibers on the quality characteristics of wool and half-wool yarn, the mechanical characteristics of wool fibers and merino sheep breeds were determined, given in Table 1.

Table 1

Mechanical characteristics of wool fibers

Fineness, microns	19,16	20,96	20,06
Breaking load, sN	7,8	9,3	10
Absolute error, km	21,5	20,9	20,6

To study the significance of the influence of geometric parameters on the mechanical characteristics of wool fibers, an analysis of variance was carried out. The estimate of the factor dispersion is greater than the estimate of the residual dispersion, so we can immediately assert that the null hypothesis about the equality of mathematical expectations across the sample layers is not true. In other words, in this example, the Laplace criterion has a significant influence on the random variable.

Using experimental data using the method of regression analysis, regression calibration dependences of the breaking load of wool fiber on length and fineness were constructed, presented in Fig. 1-2.

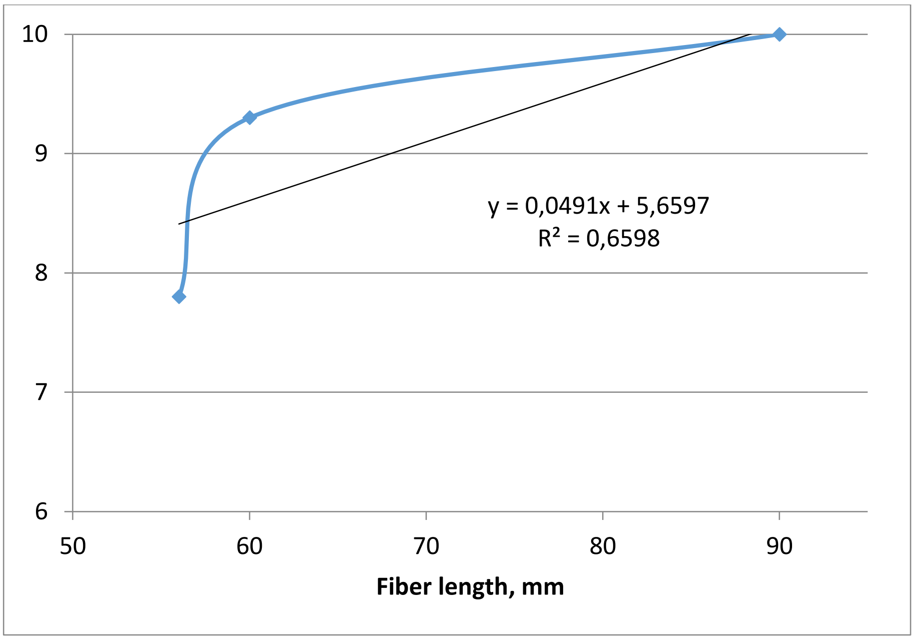

Fig. 1 Graph of the breaking load of wool fiber versus length

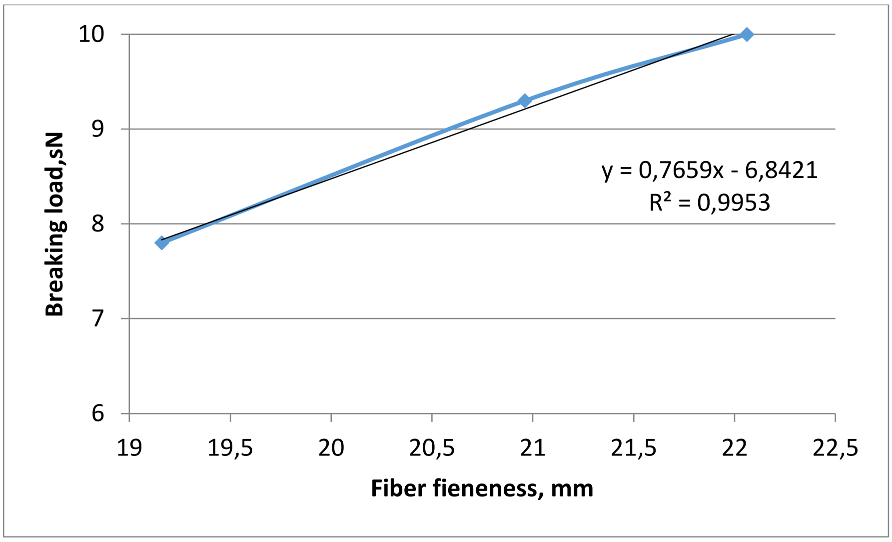

Fig. 2 Graph of the breaking load of wool fiber versus fineness

As a result, a study of the dependence of the breaking load on the length and fineness of wool fibers determined that the influence of fineness on fiber strength is greater, the coefficient of determination is 99%, than the influence of the length of wool fiber on mechanical characteristics, where the coefficient of determination is 66%.

During the research work, the unevenness of wool yarn and its effect on the technological process was also investigated. Unevenness of spinning products (unevenness of yarn and semi-finished products by linear density) is one of the most significant factors determining their consumer quality and economic indicators of production processes [2]. Particularly important in practical terms is the frequency of variation of the linear density of the yarn. Analysis of the nature of the frequency of oscillations allows to identify the wavelength of these oscillations. Knowing the speeds of individual organs and successive extractions of the product, it is possible to establish the reason for the occurrence of periodic unevenness of woolen yarn.

To fully describe random functions, a special characteristic called a correlation or autoclorrelation function is introduced, which for a number of values is calculated using the formula 1 and on the basis of which a correlogram can be constructed.

Until now, the linear density of wool yarn has been studied as a certain random value in the assumption of the constancy of technological conditions throughout the duration of the studies, that is, as a value whose law of distribution remained unchanged over time. However, technological conditions change over time. In particular, they may be changed periodically if any mechanism of the machine having the periodic movement is decoupled. If technological conditions are considered unchanged, then by measuring linear density at certain intervals, you can obtain various summary characteristics, but to determine the nature of the sequential change, a random function is determined, the graph of which is a correlogram [3].To study the unevenness of wool yarn, a correlation analysis of the change in unevenness by the linear density of wool yarn was carried out for 25 measurements every 50 mm. The results of measurements are recorded in Table 2, according to which the diagram is plotted (corellogram). To construct a correlogram, it is necessary to calculate the value of the autocorrelation function for various values using the formula (2). To study the unevenness of wool yarn, a correlation analysis of the change in unevenness by the linear density of wool yarn was carried out for 25 measurements every 50 mm. To construct a correlogram, it is necessary to calculate the value of the autocorrelation function for various values (τ = 0, 1, 2, 3, 4, 5) using the formula (1).

$$r_x(\tau)=\frac{\sum_{i=1}^{S=n-\tau}\delta_i\delta_{i+\tau}}{\sqrt{\sum_{i=1}^{S=n-\tau}\delta_i^2\cdot\sum_{i=1}^{S=n-\tau}\delta_{i+\tau}}}=\frac{A_\tau}{\sqrt{B_\tau C_\tau}},(1)$$

where $\delta_i = x_i-\bar{x}$; $\delta_{i+\tau}=x_{i+\tau}-\bar{x}$,

$A_\tau=\sum_{i=1}^{n-\tau}\delta_i\delta_{i+\tau}$; $B_\tau=\sum_{i=1}^{n-\tau}\delta_i^2$; $C_\tau=\sum_{i=1}^{n-\tau}\delta_{i+\tau}^2$, (2)

The graphical image of the dependency gives the desired correlogram.

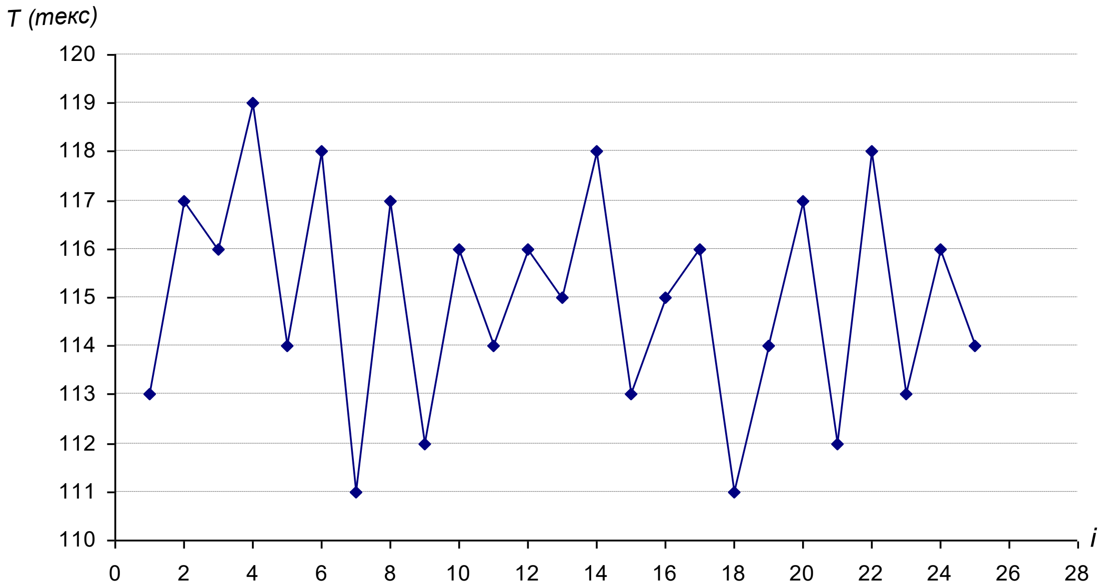

Fig. 3 Correlogram of wool hardware yarn by linear density

To determine the wavelength of the prevailing periodic changes in the thickness of woolen yarn, we determine three values [3,6]:

τ_1- the first point of intersection of the correlogram with the abscissa axis;

τ_2- for the minimum (negative) value x;

τ_3- for the maximum (positive) value;

Since the thickness of the yarn has both random and periodic fluctuations, the corelogram has the form obtained on the graph. In this case, to determine the prevailing wavelength in the change in the thickness (linear density) of woolen yarn, use one of the following approximate relations if the distance between adjacent measurements $L_0 \neq 0$

$\lambda \approx 4\tau_1 l_0$; $\lambda \approx 2\tau_2 l_0$; $\lambda \approx \tau_3 l_0$, (3)

$\lambda \approx 4\tau_1 l_0 \approx 4\cdot 0{,}5\cdot 50 \approx 100\,мм$, (4)

$\lambda \approx 2\tau_2 l_0 \approx 2\cdot 1\cdot 50 \approx 100\,мм$, (5)

$\lambda \approx \tau_3 l_0 \approx 2\cdot 50 \approx 100\,мм$, (6) Since the results for the prevailing wavelength are the same, it is possible to find the sources of this unevenness, knowing the design features of the wool spinning machine.

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