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Investigation of the properties of textile waste used in the production of modified yarn

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ABSTRACT: One of the promising areas of solving the global problem of reducing energy and material costs in the production of industrial products is the maximum use of secondary resources. In this work, the modal, staple length, spinning capacity of fibrous waste, the minimum possible linear density of the yarn produced from this waste were studied.

KEY WORDS: waste, regeneration, modal length, staple length, linear density, spinning capacity, modified yarn

I. INTRODUCTION

One of the promising areas of solving the global problem of reducing energy and material costs in the production of industrial products is the maximum use of secondary resources.

In view of this situation, scientific research aimed at the development and implementation of technologies related to the regeneration of fibrous products from textile and garment wastes, the study of their technological properties and the reuse of these raw materials in the production of textile products is of high relevance.

It is impossible to produce competitive products without reducing the material intensity of textiles, that is, waste and secondary material resources must be used in addition to optimizing the assortment and structural properties of products. Currently, in the face of acute shortages of natural raw materials for the textile industry, the recycling and reuse of fibrous waste is of great economic importance.

To date, the possibility of using fibrous waste from the textile industry for the production of high-quality yarn has been studied by D.A. Polyakova, T.V. Kolmanovich, N.N. Khrushcheva, E.H. Geneman, V.M. Yudin, and others.

In the Republic of Uzbekistan, it is planned to create a 100% waste-free production facility with a closed chain "production of cotton raw materials - processing - finished products". In this regard, the problem of the production of competitive products considered in this work due to the deep processing of cotton fiber and the use of fibrous waste in the context of the introduction of the cluster development model is relevant and requires a comprehensive study.

II. METHODOLOGY

Determination of quality indicators of regenerated wastes of knitted production flap and weaving wastes, and yarn were carried out both according to standard methods provided by GOST and using modern measuring equipment. Experimental studies are staged and carried out on the basis of mathematical methods of planning an experiment, when processing their results, methods of mathematical statistics are used.

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Secondary or reduced fibers are valuable raw materials for the textile industry. They are used both in "pure" form, that is, without the addition of primary fibrous raw materials, and in admixture with the latter. Hardware yarn is obtained from the reduced fiber. In addition, bypassing the spinning step, nonwoven textile materials for various purposes are made from secondary fibers.

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When the reduced fiber is mixed with the original per fiber, raw materials are obtained for the production of high-grade yarn, which goes to the production of all types of textile materials. High-quality nonwoven materials are also made from it. The content of secondary fiber in the mixture can reach 80-90%, depending on the purpose of the yarn and the material.

Therefore, for the possibility of rational use of fibrous waste, knitted and weaving waste was studied in the production of medical bandages, for the production of competitive and economically viable textile products, which contributes to solving an important economic problem: reducing the cost of making yarn with efficient use of raw materials.

III. RESULTS AND DISCUSSION

The fiber length test results were processed using the Basic program to calculate the statistical characteristics of a random variable.

The test results are shown in Table 1.

Table 1. Statistical characteristics

Type of waste	S_1 - sum of variances of variants from conditional середины;	S_2 – sum of variances of variants from conditional середины;	S_3- sum of variances of variants from conditional	S_4- sum of variances of variants from conditional середины	Average Sample Value	Dispersion	Standard deviation	Variation factor	Quadratic irregularity	Asymmetry	Excess
From knitted flaps	476	2630	15944	103790	25,78	32,78	5,73	0,22	22,21	-0,06	226,35
Weaving waste (severe)	454	2676	17422	55268	18,58	22,2	4,71	0,25	25,36	-0,2	64,61
Weaving waste (bleached)	462	2658	17376	58214	19,75	23,09	4,81	0,24	24,33	0,22	91,39

Modal and staple lengths were calculated from the obtained averages according to the formulas:

$$L_{mod} = 1{,}19 \cdot L_{av.l} - 2{,}6 \quad , (1)$$

$$L_{st} = 1{,}02 \cdot L_{mod} + 2{,}6 \quad , (2)$$

Results of readings on modal and staple lengths of different types of wastes are given in table 2

Table 2. Modal and staple waste length

№	Waste name	Average fiber length, mm	Modal fiber length, mm	Staple fiber length, mm
1	From knitted flaps	25,78	28,08	31,24
2	Weaving waste (severe)	18,58	19,51	22,5
3	Weaving waste (bleached)	19,75	20,90	23,92

For the complex characteristic of the fibrous raw material, taking into account a number of its properties, an indicator called spinning ability of the fiber is used. The spinning capacity of the fiber is determined by the maximum length of the yarn, km, obtained from 1 kg of raw materials and meeting the requirements of the standard.

Spinning capacity of fiber, km/kg is calculated according to formula 3

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$$L_s = \frac{10 \cdot B}{T_s}, (3)$$

where B- fiber yield, %

T_s – minimum possible linear density of yarn from these fibers, tex

Thus, the spinning capacity of the fiber is characterized by:

1) in relation to quality of yarn, minimum possible linear density of yarn;

2) with a quantitative yield of yarn from the fiber, showing how much yarn by weight can be obtained from this fiber as a percentage of its weight.

The minimum possible linear density of cotton yarn can be determined by the formula of A.N. Solovyov

$$T_s = 1000 \cdot \left[\frac{2,65 \cdot \sqrt{T_b} / 1000 + b/(R_b \cdot z \cdot K \cdot \eta)}{1 - 0,0375 \cdot H_o - a/(R_b \cdot z \cdot K \cdot \eta)} \right]^2$$

where R_b- the relative breaking load of cotton fiber, sN/tex

a, b – are table coefficients for carded medium fiber cotton (a=11,7 and b=0,1)

L_{st}- staple fiber length, mm

H_0 – specific unevenness of yarn, characterizing the quality of the process (for carded spinning H_0 =4,5-5)

η - factor taking into account the state of the equipment (for normal state η =1)

$$z = 1 - \frac{5}{L_{st}}$$

The minimum possible linear density for knitted wastes (from flaps) is

$$T_s = 1000 \cdot \left[\frac{\frac{2,65 \cdot \sqrt{0,183}}{\sqrt{1000}} + \frac{0,1}{24,043 \cdot 0,8399 \cdot 0,95 \cdot 1}}{1 - 0,0375 \cdot 4,5 - \frac{11,7}{24,043 \cdot 0,8399 \cdot 0,95 \cdot 1}} \right] = 34,4 tex$$

The spinning capacity of the fiber at the output of the yarn is 75%.

$$L_s = \frac{10 \cdot 75}{34,4} = 21,8 km/kg$$

The minimum possible linear density for weaving wastes (bleached yarn) is

$$T_s = 1000 \cdot \left[\frac{\frac{2,65 \cdot \sqrt{0,254}}{\sqrt{1000}} + \frac{0,1}{16,53 \cdot 0,7908 \cdot 0,95 \cdot 1}}{1 - 0,0375 \cdot 4,5 - \frac{11,7}{16,53 \cdot 0,7908 \cdot 0,95 \cdot 1}} \right] = 72,6 tex$$

The spinning capacity of the fiber at the output of the yarn is 40%.

$$L_s = \frac{10 \cdot 40}{34,4} = 5,5 km/kg$$

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The minimum possible linear density for weaving wastes (harsh yarn) is

$$T_s = 1000 \cdot \left[\frac{\frac{2,65 \cdot \sqrt{0,254}}{\sqrt{1000}} + \frac{0,1}{15,75 \cdot 0,7778 \cdot 0,95 \cdot 1}}{1 - 0,0375 \cdot 4,5 - \frac{11,7}{15,75 \cdot 0,7778 \cdot 0,95 \cdot 1}} \right] = 104 tex$$

The spinning capacity of the fiber at the output of the yarn is 40%.

$$L_s = \frac{10 \cdot 40}{104} = 3,9\, km/kg$$

Test results showed that

1. It is observed that the average length of knitted waste is more than that of woven waste
2. Modal length respectively for knitted wastes is 28,08 mm for wastes (bleached) -20.9 mm, for harsh wastes – 19,51 mm
3. Staple length respectively for knitted wastes is 31,24 mm for wastes (bleached) -23,92 mm, for harsh wastes – 22,5 mm

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