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THE INFLUENCE OF THE MOISTENING PROCESS ON THE PROPERTIES OF REGENERATED FIBERS

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Abstract
The article investigates the effect of preliminary moisture conditioning of yarn-containing textile waste on the quality of secondary fibers. Two humidification methods were examined — water treatment and emulsion treatment using a 3% OP-10 surfactant solution. It was found that the optimal moisture content of the processed material (10–11%) increases fiber plasticity and strength while reducing brittleness and the proportion of short fibers. Emulsion treatment ensures more uniform moisture distribution and improved fiber uniformity. Preliminary moistening is recommended as an effective method for improving the quality of secondary fibers during textile waste recycling.

Keywords: Secondary waste, yarn waste, cutting, opening, humidification, emulsion, fiber, length, strength.

Introduction

The processing of yarn-containing textile waste and scraps, cuttings of various fabrics, which are secondary raw materials for the spinning industry, is one of the priority areas for the rational use of resources and sustainable development of the industry. The main goal of processing secondary material resources consisting of yarns is to obtain fibrous mass. Obtaining fiber from waste such as yarn waste, ends and cuttings of threads allows reducing the volume of primary resources, lowering the cost of textile products and reducing environmental impact.

The technology for processing secondary resources is complex and depends on many factors - the composition of the waste, their physico-mechanical properties, degree of contamination, moisture content, and features of the technological equipment [1]. Processing is typically carried out in small batches, each with individual characteristics.

The processing of yarn textile waste ensures the production of a greater quantity of textile products by involving additional raw materials in the industry [2]. Many scientists have been involved in developing optimal methods for obtaining regenerated fibers, including Prof. Saprykin D.N. [3], Prof. Frolova I.V. [4], Larionova M.D. [5], Gorkova A.G. [6]. Therefore,

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this research work aims to determine the possibility of improving fiber quality by increasing the moisture content of the yarns as an addition to the technology of processing yarn waste and thread scraps.

It is known that moisture content is an important technological indicator for cotton fiber and products made from it. At low moisture content, fibers become brittle, their fragility increases, and the likelihood of destruction under mechanical stress rises. Optimal moisture content ensures elasticity, reduces internal friction, and promotes uniform separation of fibers during opening.

Waste in the form of yarn waste, cuttings, and thread ends generated during textile production are repeatedly subjected to mechanical loads, causing them to lose a significant portion of their moisture. This worsens processability and reduces the quality of the obtained secondary fibers.

Experimental Part

Based on the set goal, under production conditions, collected waste of yarn waste and ends of yarn, twisted threads were investigated. Results obtained from studying three batches showed moisture content variation ranging from 4.8 to 5.3%. Many studies have shown that under the impact of mechanical shocks occurring during the opening of waste at such moisture content, the proportion of short fibers may increase due to fiber breakage, average length may decrease, and breaking load may reduce [7, 8].

Our task was to determine the effectiveness of two methods for increasing the moisture content of the processed yarn-containing textile waste. To improve the processability of secondary textile raw materials and enhance fiber quality, two methods of preliminary moistening were tested:

Water moistening – spraying ordinary water under pressure onto an evenly distributed layer of waste about 8 cm thick, followed by holding in a sealed chamber.

Emulsion treatment – spraying a 3% solution of OP-10 surfactant instead of water, ensuring uniform moisture distribution and softening of the fiber structure.

A compressor with a pressure of 2 atm was used for spraying the liquid (water, emulsion), providing fine dispersion spraying. For uniform moisture distribution, the waste was stored in the chamber for 36 hours. When determining the moisture content of samples taken from the chambers after the specified period, it was found that the moisture content of the treated samples was: 10.7% for water moistening; 11.3% for emulsion treatment.

After sorting the thread waste, they were shredded on a rotary cutting machine and processed on a six-drum opening machine ST-T36. Then, samples taken from the last drum were tested on the Uster HVI 1000 instrument. During sorting, incompletely opened thread residues were manually removed from the obtained fibrous mass; their quantity amounted to 4.2% for samples treated with water and 3.1% for samples treated with emulsion. The results of determining the properties of the regenerated fibers are presented in Table 1.

Table 1 Test Results of Secondary Fiber Properties

No.	Indicators	Initial Waste	After Water Moistening	After Emulsion Treatment
1	Moisture Content, %	5.1	10.7	11.3
2	UHML, [mm] Upper Half Mean Length	25.47	27.38	27.92
3	UI, [%] Uniformity Index	64.9	72.6	73.4
4	SFI, [%] Short Fiber Index	19.9	14.4	15.6
5	Str, [g/tex] Relative Breaking Tenacity	29.2	30.72	31.4
6	Elg [%] Fiber Elongation	7.2	7.3	7.4
7	Total Neps cnt [Cnt/g] Neps Count	590	489	376
8	Mass Fraction of Incompletely Opened Threads, %	5.4	4.2	3.1

Discussion of Results

The test results showed that preliminary moistening of the waste positively affects the quality of the obtained secondary fibers. Moisture content almost doubles after moistening and stabilizes after emulsion treatment. This contributes to increased fiber plasticity. Fiber length increases, indicating more complete opening and less damage after treatment. The growth in the uniformity index shows that the fibers become more uniform in length, which improves the quality of subsequent yarn. Strength increases, indicating the restoration of fiber integrity and improvement of interfiber bonds after treatment. A slight increase in elasticity confirms increased flexibility and improved fiber structure. The number of neps noticeably decreases – by almost 37% by the end of the treatment. This indicates better cleaning and opening of the mass. The reduction in the amount of incompletely opened waste indicates more effective fiber separation and reduced mechanical damage.

From a physico-chemical point of view, the improvement in properties is explained by the increase in fiber elasticity due to the weakening of intermolecular hydrogen bonds and increased mobility of cellulose macromolecules. During emulsion treatment, an additional effect of surfactant penetration into the capillary structure of the fibers is observed, which contributes to reduced internal friction and better opening.

Conclusions

The results of the conducted research have both scientific and applied significance. The implementation of the method of preliminary moistening of yarn-containing textile waste before mechanical processing significantly improves the quality of secondary fibers. The optimal moisture content is 10–11%, which ensures increased plasticity and reduced brittleness of fibers under mechanical stress.

The use of preliminary moistening methods, especially emulsion treatment, can be recommended for implementation at domestic enterprises processing secondary textile waste to increase the yield and quality of secondary fibers. The obtained results can be used in the development of technological regulations and equipment for processing yarn-containing waste in Uzbekistan, which will reduce the consumption of primary resources and increase the environmental sustainability of the industry.

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