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New resource-saving technology for processing unsuitable cocoons for unwinding in canvas

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ABSTRACT: Developed an innovative highly efficient resource-saving technology produce silk from cocoons unsuitable for unwinding. Established technological transitions and the corresponding types of equipment for the technological transition of new technology. The new technology allows processing unfit for unwinding cocoons in pulp silk improved quality, reduces manufacturing processes and equipment, improves the quality produced in spinning yarn production, saving raw materials and energy resources.

KEY WORDS: cocoon, waste, boiling, washing, wringing, pulp, silk, modernization, technology.

I. INTRODUCTION

In the modern period of market relations in the silk industry, the most acute issue is increasing the efficiency of processing raw materials and manufacturing products, improving and developing new resource-saving technologies for processing cocoon raw materials.

As known, all wastes of cocoon-winding production are collected and treated appropriately to preserve their valuable properties. The preparation of waste from cocoon-winding production for their further use is carried out in special workshops for the primary processing of waste, available at all cocoon-winding factories.

Depending on the origin, the waste of the cocoon-winding production is divided into waste from the sorting, cocoon-winding shops and control and cleaning departments.

The count of defective cocoons depends on the feeding conditions of the silkworm, climatic conditions, as well as on the organization of the blanks and the primary processing of cocoons.

Defective cocoons that can be unwound in one way or another are unwound into ordinary raw silk, and the cocoons that cannot be unwound are processed into yarn.

Sericulture and cocoon-winding production generate a significant amount of waste in the form of unwinding cocoons, fibrous waste from cocoons and pupae. Utilization of these wastes is of great economic importance, since for every kilogram of raw silk produced there are about 1 kg of various wastes [1, p. 368]. Meanwhile, the shells of defective cocoons and the fibrous waste of cocoon winding are valuable raw materials for the production of silk yarn used for the manufacture of a variety of consumer fabrics, as well as for the production of products for various technical purposes.

II. LITERATURE SURVEY

Known technology for processing defective cocoons, which consists in cutting the shell with knives, separating it from the pupa, followed by boiling and obtaining a silk mass [1, p. 368-370]. The disadvantage of this technology is that when cutting the shells with knives, the continuous thread is cut into separate uncontrolled segments of various lengths, which, after boiling, form a randomly entangled mass of fiber. In addition, short fibers fall out into the fleece during carding, which leads to a decrease in the yield of silk product (fleece) in the spinning industry.

There is also a known technology for the processing of cocoons that are not suitable for unwinding (odonki and cocoon non-unwinding), which consists in steaming the waste, separating the fiber from the pupa on a top with a smooth drum (obtaining a silk mass - canvas I transition), washing the remaining parts of odonk, processing them on a top with a peg drum with further washing and processing on a top with a needle drum (obtaining a silk mass - canvas II transition.) [1, p. 373-377]. The disadvantage of this technology is the short length of the fibers in the mass, their large contamination by the fragmented parts of the pupa, and the multitransition of the processing technology. In this case, the wastes of the

cocoon-winding production are steamed with live steam ([1], p. 373), where the sericin of the cocoon shell swells and softens. Further, on a top with a smooth drum, the fiber is separated from the shell and a silk mass of the I-transition canvas is obtained (Fig. 1a, a fragment of the canvas).

Much work in the study of the problems of waste-free technology for processing natural silk was carried out by Professor Kh.A.Alimova [2, 3]. In works [4, 5], the issues of processing of unsuitable for unwinding cocoons on loosening tops are considered. Problems of obtaining cocoon raw materials and some issues of processing natural silk threads are highlighted in the work [6].

In the world of textile science, research is being carried out to improve the processes of production of textile threads and yarns, processing of natural silk and textile waste. In the work of Nogueira G.M., Rodas A.C., Leite C.A., Giles C., Higa O.Z., Polakiewicz B., Beppu M.M. investigated the production and characterization of dense membranes from silk fibroin using silk fibrous waste. [7]. In the work of Wang, Shi. investigated the problems of processing silk textile waste [8].

III. METHODOLOGY

In the existing technology [1, p. 373-377], on a smooth drum, it is not possible to separate all the fiber from the odonk, some of it remains on the pupae. To separate this fiber, a top with a peg drum is used. At the same time, the remnants of odons that did not unwind during processing with a smooth top are washed, squeezed out in a centrifuge and processed on a top with a peg drum.

The canvases obtained by tops with a peg drum contain a significant amount of the pupa and its fragmented parts. When the pegs of a fast-rotating peg drum collide with odons, due to the high content of sericin and the high adhesion force of the cocoon threads with the shell due to the integrity of the shell, the shell and the cocoon thread break into uncontrolled segments of various lengths, which lead to a shortening of the fiber length in the product and deterioration of its quality. In addition, fibrous residues of odonets and short fibers fall out into waste, which leads to incomplete separation of fiber from the odon and a decrease in the yield of the product - silk mass.

For further loosening of the fiber, cleaning it from the pupa and forming the canvases, a top with a needle drum is used. To do this, the canvases removed from the peg drum are washed twice, wrung out, dried, processed on a top with a needle drum, and a canvas of the II transition is obtained (Fig. 1b), which is characterized by a high degree of contamination with small crushed parts of the pupa and a slight parallelism of fibers.

The purpose of creating a new technology is the development of such a new technical solution that would make it possible to completely separate the fiber from the cocoons and their parts that cannot be unwound and obtain a silk mass of improved quality, in which the fibers would have a higher length.

IV. EXPERIMENTAL RESULTS

A new technology has been developed for the processing of cocoons that are not suitable for unwinding (odonki, cocoon non-unwinding, leaky, twinned, ugly, carapace cocoons, hardened and others) into canvases (Fig. 1c), in which they are sequentially boiled, washed, squeezed out, dried, and separated from the fiber from the pupa, by exposure to a small floating needle set, and cleaning it on a cleaning agent (Fig. 2).

The boiling process is carried out in a conventional digester. For example, in a container with gas heating, where water is poured, cocoons are loaded, heat is supplied and boiling is performed. Boiling is carried out at a temperature of 95-100 ° C for 1.5-2 hours.

Boiling is carried out until the degree of digestion of sericin and destruction of the cocoon shell into a pulp, at which the bond strength of the shell structure elements (loops and bags) is reduced to a minimum. Then some object, for example, an ordinary stick or rod, produces a mechanical effect on the cocoons, for example, by stirring, which leads to the complete destruction of the shell structure, breaking the bonds between the structural elements (between loops and packages) and disintegration of the cocoon shell into a fibrous mass. elements (loops and bags) is reduced to a minimum. Then some object, for example, an ordinary stick or rod, produces a mechanical effect on the cocoons, for example, by stirring, which leads to the complete destruction of the shell structure, breaking the bonds between the structural elements (between loops and packages) and disintegration of the cocoon shell into a fibrous mass.

Further, after boiling, washing is performed, squeezing, for example, in a centrifuge, drying, in drying devices or convectively, and separation of the fiber from the pupa by exposure to a small floating needle set, on modernized spinning tops with a needle set [9, 10].

Exceeding the above upper limits of the temperature regime leads to intensive dissolution of the fatty substances of the pupa, and exceeding the boiling time also leads to a decrease in labor productivity, and a decrease in their lower limits

leads to a weakening of the boiling effect and insufficient digestion of the sericin of the cocoon shell, which ultimately makes the process fiber separation ineffective.

The exclusion in the new technology of the process of processing of cocoons on a top with a peg drum makes it possible to exclude the above-described undesirable consequences of this process, i.e. eliminate the rupture of the shell and cocoon thread into uncontrolled segments of various lengths, which lead to a shortening of the fiber length in the product and deterioration of its quality.

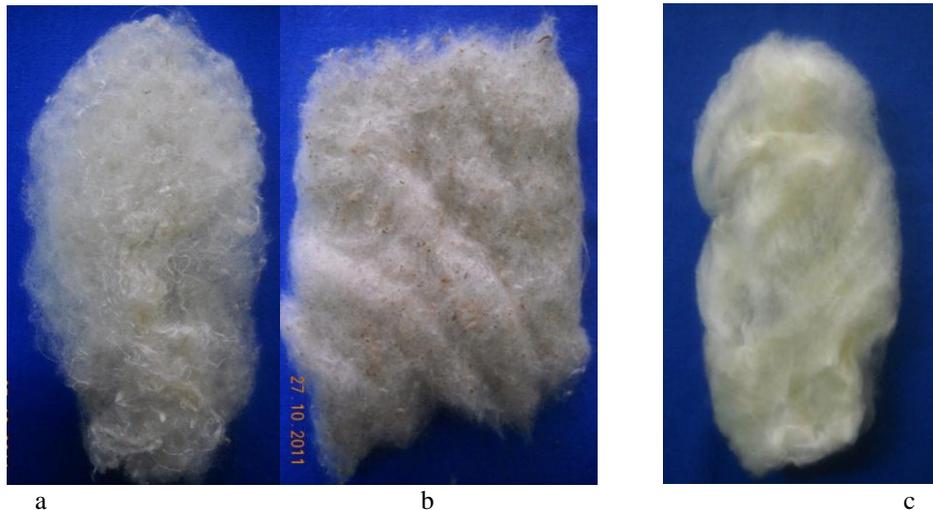


Figure. 1. a - canvas (fragment) of the 1st transition, b - canvas of the 2nd transition obtained using a known technology, c - the canvas obtained by the new technology

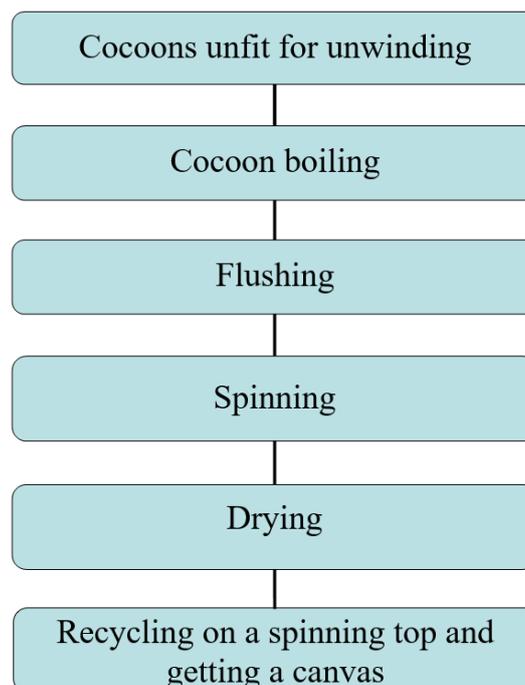


Figure. 2. New technology for processing cocoons unsuitable for unwinding

In addition, the elimination of this process makes it possible to exclude the release of fibrous residues of the shells of cocoons and short fibers into waste, to preserve them in the further processing process and thereby prevent incomplete separation of fiber from the cocoons and a decrease in the yield of the product.

The introduction into the new technology of the process of boiling cocoons in the indicated temperature-time regimes under mechanical action on the cocoons leads to the digestion of sericin, a decrease in the strength and breaking of bonds between the structural elements (between loops and packages) of the cocoon shell and the complete destruction of the cocoon shell into a fibrous mass. However, at the same time, the dissolved sericin is still preserved between the fibers.

Further, by carrying out the processes of washing and squeezing, the dissolved sericin is removed, and subsequently, by carrying out the drying process, the most favorable form of the pulp is achieved, which provides the most favorable conditions for the further process of separating the fiber from the pupa on a top with a needle drum, in which, due to the insignificant force adhesion of cocoon filaments due to the destruction of the cocoon shell to the fibrous mass and removal of sericin, the fiber is easily and completely separated from the pupa.

The elimination of the above-described destructive effect of the processing process on a top with a peg drum and thereby ensuring the safety and integrity of the fibers, as well as ensuring the creation of favorable conditions for the separation of the fiber from the pupa, provide, in turn, the complete separation of the fiber from the cocoons that are not suitable for unwinding and an increase in the length of the fiber in the product, thereby achieving an increase in the yield of a product and an improvement in its quality. At the same time, the canvas obtained using the new technology is characterized by high quality, the absence of clogging by small crushed parts of the pupa, a high degree of cleaning and parallelism of the fibers (Fig. 1c).

The use of the proposed new technology for processing cocoons unsuitable for unwinding allows:

- 1) process unwindable cocoons into improved fiber mass by increasing the fiber length in the product instead of:
 - a) a chaotically entangled mass of separate uncontrolled segments of various lengths of fibers obtained from rejected (spun) cocoons;
 - b) a tangled mass of fibers, clogged with fragmented parts of the pupa, in the canvases of I and II transitions, obtained during the processing of odons and cocoon unwrapping;
- 2) to improve the quality of the yarn produced in the spinning industry by using the fiber mass of silk of improved quality;
- 3) to achieve savings in raw materials in the production of yarn as a result of reducing the proportion of short fibers and their waste;
- 4) to achieve an increase in the yield of a marketable pupa due to a decrease in losses as a result of its fragmentation during the processing of cocoons;
- 5) to simplify the processing technology of cocoons unsuitable for unwinding and to reduce technological processes:
 - a) when processing defective (spinning) cocoons - cutting the shell;
 - b) when processing odons and cocoon unwinding - obtaining a canvas of the I transition on a top with a smooth drum, washing the canvases, wringing and drying, washing the remaining parts of odons, spinning, processing on a top with a peg drum, washing in a bath;
- 6) to simplify the design of the device for processing cocoons unsuitable for unwinding and to exclude the following means and equipment from the use:
 - a) when processing defective (spinning) cocoons - cocoon-cutting machines and units;
 - b) when processing odons and cocoon waste - steaming equipment, a top with a smooth drum, means for washing, wringing out and drying canvases, means for washing and wringing out the remaining parts of odons, a top with a peg drum.

Patent of the Republic of Uzbekistan № IAP 04621 " Method for processing of unsuitable for unwinding cocoons " was obtained for an innovative highly efficient resource-saving technology for producing silk from cocoons unsuitable for unwinding [11].

VI.CONCLUSION AND FUTURE WORK

1. A new highly efficient resource-saving technology for processing unusable cocoons for unwinding into canvases has been developed, technological transitions and corresponding types of equipment for technological transitions have been determined.

2. The new technology makes it possible to process cocoons that are not suitable for unwinding into a fibrous mass of silk of improved quality, to reduce technological processes and equipment, to improve the quality of yarn produced in the spinning industry, to save raw materials and energy resources.

3. Patent of the Republic of Uzbekistan № IAP 04621 "Method for processing of unsuitable for unwinding cocoons" was obtained for an innovative highly efficient resource-saving technology for producing silk from unusable cocoons for unwinding.

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Akhunbabaev Ulugbek Okhunzhonovich, Doctor of Philosophy in Technical Sciences (PhD) Deputy Director for General Affairs of the Uzbek Research Institute of Natural Fibers. 110 scientific papers were published, 7 patents for inventions and useful models were received. The area of scientific interests of Akhunbabaev Ulugbek Okhunzhonovich is: improving the technique and technology for the production of raw silk, improving the quality of textile fibers in accordance with the requirements of international standards, problems of processing cocoons unsuitable for unwinding, scientific foundations of the consumption rates of textile raw materials.