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A new technology for cleaning primary silk fibers from plant impurities in the preparation of raw materials for liquid paper

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Annotation. In the development of the rational technology of purification of prevodchik Uzbek-English ternary Los, it is necessary first of all to take into account the properties of interaction of foreign particles with fibers. The main mass of foreign mixtures of fibrous mass in the primary Los corresponds to fragments of branches or stems on the stalk and dry particles of mulberry tree. With silk fibers, the ilakish strength of the stem branches fluctuates between 1.56 and 2.76 sN teks intervals and mainly depends on the material of the STEM and the hem-budurdig of the surface. The friction coefficient on the surface of plant particles of silk thread is much higher than on the metal surface (except for the straw handle), and the roughness of these Horn surfaces will be higher

Key words: primary los silk fiber, plant mixtures, fiber mass, cocoon, silk fibers, liquid wallpaper

When developing a rational technology for cleaning primary smut, it is first necessary to take into account the properties of foreign particles binding to fibers. The main mass of foreign impurities in the fibrous mass of primary smut corresponds to fragments of branches or stems in the bundle and dry particles of mulberry. The adhesion force of silk fibers to the bundle branches varies from 1.56 to 2.76 sN tex and mainly depends on the material of the bundle and the roughness of the surface. The coefficient of friction of the silk thread on the surface of plant particles is much higher than on a metal surface (except for straw bundles), and the roughness of the surfaces of these branches is high. Also, fragments of branches or stems of the bundles are torn off when separating cotton-like smut from broom bundles. The material of the branches depends on the bundle material. Usually, for broom-shaped bundles, woody plant branches (mulberry tree branches, gooseberry, etc.) or herbaceous shrubs, plants (thousand heads, straw, etc.) are used.

The beginning of the winding of the cocoon shell of the mulberry silkworm begins with the natural connection of the bundle branches with short fibers that connect them separately and create a limited space for forming the cocoon. This is done by gluing with a layer of sericin, which has high adhesive properties. In the first stage of forming the shell, the worm releases a drop of silk from itself, glues it to the bundle branches and stretches the thread from itself. By gluing the bundle shapes with short tangled sections of the thread (Figure 1a), the worm delimits the cocoon shell formed by the worm (Figure 1b) and only then wraps the shell (Figure 1c).

During the collection, packaging and transportation of primary moss, secondary binding of fibers with branches, i.e. additional entanglement, occurs due to friction. The cross-sectional shape of the branch fragments is a voluminous round or edgy body with a maximum transverse dimension of less than 3 mm.

In the longitudinal direction, the particles have an uneven thickness and a smooth (straw bundles) or rough surface from the remaining knots from the shoot (Fig. 2a).

Leaf fragments, in comparison with branches, often have a smooth-edged shape of any configuration with tree-like veins, which are retained in the fibrous mass due to friction. These fragments are not very intertwined with the fibrous mass and are easily removed.

In analyzing the efforts required to remove plant impurities, we experimentally investigated the forces of adhesion of fibers to various plant branches.

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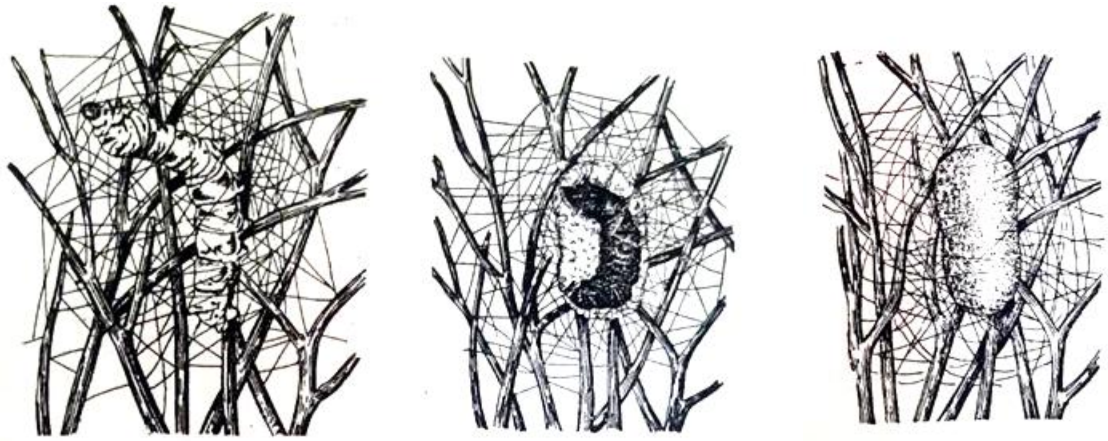

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a) cocoon winding area; b) shell formation; c) cocoon winding
Figure 1. Formation of cocoon shell on a broom handle
- tension of the moving thread in the branch, sN
- tension of the leading thread in the branch, sN
- friction force
- thread covering angle

a) Stem fragments b) Leaf fragments
Figure 2. Fragments of plant mixtures

The force required for the thread to move along the surface of the horn is determined by the moment of displacement of the thread and the weight of the load required to initiate movement. The results of measuring the forces for separating the threads from the glued areas and the calculated friction coefficients of the silk fiber on the surface of the horn are presented in Table 1.

Table 1
Average values of the tension of the threads (R) along the branches of the bundle and the coefficient of friction of the silk fiber (μ)

Material of the bundle	R, sN	μ
Gozapoya	2,73±0,48	0,35
Mulberry branches	2,81±0,52	0,33
Millet heads	2,63±0,86	0,36
Straw	1,56±0,63	0,27

Based on the experimental results, the following were found:

a) the adhesion force between silk fibers and the stalks of the stalk varies from 1.56 to 2.76 sN tex and mainly depends on the stalk material and the roughness of the surface;

b) the coefficient of friction of the silk thread on the surface of plant particles is much higher than on a metal surface (except for straw stalks), which is explained by the high roughness of the stalk surfaces.

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There is a physicochemical adhesion between natural silk fibers and stalks, and when cleaning the fibrous mass, it is necessary to break the glued sections. This can be achieved by mechanical methods - breaking and breaking the contact points, or by hydrothermal weakening of the adhesive properties of sericin after wet-heat treatment.

The first option involves applying mechanical stress to the threads, which, as a result, leads to the rupture of the bonding points, or the breakage of the thread itself, or the fragmentation of the mixtures into much smaller fragments. Due to the high adhesion strength of the fiber glue with plant mixtures, cleaning is effective in existing methods of cleaning fibrous materials.

Due to the lack of suitable technologies and machines for cleaning the fibrous mass from plant mixtures by a wet-hot method, wet silk waste is not used for processing.

Taking into account the above, a new, fundamentally different technology for separating plant particles from fibers is needed when cleaning the fibrous mass from plant mixtures.

According to the existing classification of the relationship between moisture and material, plant branches and woody grasses belong to the capillary-porous body. The peculiarity of such materials is that when moisture is completely lost, they become brittle, do not crumple, and crumble into powder when mechanically rubbed.

Since the main mass of plant impurities in the fibrous mass of the primary los consists of fragments of dry leaves and woody stems of shrub plants, one of the methods for their purification is the fragmentation of large fragments into small powdery particles. As a result, such fragmented particles can be destroyed by shaking and combing on any machine.

In order to implement the technology for cleaning natural silk fiber waste in practice, it is necessary to develop a complex technology for drying and cleaning the fibrous mass from crushed particles.

The use of dried stems, plant branches and shrubs as bundles, as well as long-term cocooning, harvesting, transportation and temporary storage of primary moss, under atmospheric conditions, that is, under given temperature and humidity conditions, the moisture content of plant mixtures decreases to the standard moisture content of the material. At an air humidity of 65% and a temperature of 200C, dried mulberry wood particles have an equilibrium moisture content of approximately 25%, and the moisture content of wood additives is 12.2%. The equilibrium moisture content of plant mixtures varies continuously and depends on the season (humidity and temperature parameters of the external environment). The moisture content of unwooded plant particles, taking into account the elasticity of the mixture, becomes brittle, and bringing the moisture content of the material to a critical moisture content allows them to be crushed into small particles. The crushed particles, which have minimal tangles and adhesion, are easily separated from the total mass and are removed by simple shaking or combing. Therefore, for effective cleaning, it is necessary to dry the fibrous mass to a critical moisture content. Then, the plant mixtures should be mechanically crushed.

For this purpose, experimental studies were conducted in laboratory conditions to determine the drying parameters of plant particles. For this, samples weighing 100 g (fragments of bunches and bunches of branches) were dried in a drying chamber of a conditioned apparatus to a constant weight. The chamber maintained a soft temperature regime of 600C, the maximum permissible to preserve the properties of sericin. The moisture content of the material was determined by measuring the weight of the sample every 30 minutes during drying in a standard way. The process continued until the weight of the sample remained unchanged in the last 3 measurements.

It is assumed that the main process of moisture loss proceeds according to an exponential function approaching the asymptotic equilibrium moisture in the heat transfer parameters and in this case is carried out at a temperature of 600C. Consequently, the drying process in a capillary-porous body occurs at the second critical point of the drying curve, mainly in the zone of decreasing drying rate.

In addition, the graph shows the regularity of drying efficiency for the first 3-4 hours.

Since the maximum moisture loss at significant energy costs was 0.5-1%, the efficiency of subsequent drying was low.

It should also be noted that leaf fragments are easily ground into powder at a moisture content of 4.5-5%. At approximately the same moisture content, the stems of grasses and shrubs were observed to break into much larger fragments, and additional mechanical grinding was required for their conversion into powder.

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Based on the studies conducted, it was found that for drying plant mixtures in a gentle mode without causing sericin destruction and denaturation, it is sufficient to process the fibrous mass at a temperature of 600C for 3-3.5 hours.

In industrial conditions, when drying cotton-like loose fibrous mass, it is possible to use cocoon dryers of the SK-150K type or standard KS-1 or KS-2 chamber dryers used in waste processing shops at cocooning enterprises for drying fibrous materials.

From the point of view of material strength, brittleness is understood as the ability of a material to break without forming significant residual deformations. Fibrous structural materials that are part of tree and plant mixtures are capable of taking large loads in tension compared to compression. This property leads to a much easier breakdown of plant particles during compression. This serves as the basis for determining the state of plant particles during compression, their structure and the method of applying the load.

Passing the fibrous mass three times through a system of sawn rollers ensures the destruction of mechanical and adhesive bonds between the fibers and branches, crushing and the removal of crushed particles. To further remove plant particles, it is sufficient to comb the fibrous mass with a needle set of needle-like combs.

According to the results of experimental studies, after the first pass through the SH-1-2, the contamination of the fibrous mass decreased by 8.3%, after the second pass by 10.1%, and in the needle-like comb by 27.8% in the first combing, and by 9.0% after the second combing.

Table 2

Changes in the degree of contamination of the fibrous mass by cleaning and vacuuming processes in clamps and needle rollers

Processes	Pollution, %	Fiber length, mm	
		average	staple
Initial raw material	58,6	31,2	36,6
First crushing and cleaning in clamps	50,3	29,6	34,9
Second crushing and cleaning in clamps	40,2	27,3	33,8
First screening and cleaning in a needle roller	12,4	26,3	32,8
Second screening and cleaning in a needle roller	3,4	25,8	31,6

Accordingly, as a result of intensive crushing of plant mixtures by the crushing rollers of the clamps and combing of the crushed particles in the sets of needle rollers, the contamination of the canvas decreased by almost 20 times, which reached the permissible limit for technical purposes.

According to the results obtained, the main cleaning of plant mixtures from the fibrous mass was carried out at the stage of processing on needle rollers after the initial crushing of particles in the clamps. The cleaning efficiency did not increase significantly during subsequent mechanical processing. Therefore, processing more than two passes is not considered rational.

Morphological analysis of the fibrous mass showed that processing on clamps and needle rollers reduces the contamination of the fibrous mass (Fig. 3, 4, 5), while the swarfs come out in different forms in terms of size and plant particles (Fig. 6).

Based on the conducted studies, a new technology for cleaning cotton-like loose fibrous mass from plant particles was proposed.

The preliminary sifting was carried out on the needle rollers at a temperature of 600C for 300-360 minutes on the SH-1-2 pinching machine, the fibrous mass was finally cleaned and dried, only after which it was determined that the fibrous mass was suitable for the preparation of liquid paper material. The developed technology provides the desired level of purification of the fibrous mass necessary for the production of liquid paper materials used for technical purposes by the gluing method.

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Figure 3. Appearance of primary moose wool after drying

Figure 4. Appearance of primary moose wool after the first processing stage

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Figure 5. The cleaned state of cotton wool after the first processing stage in the needle-wheel crusher

Figure 6. Plant mixture with dust and dirt

The experiment showed that the physical, mechanical and technological characteristics of the new type of liquid paper showed its suitability for use as a self-adhesive material for technical and household purposes. The linear density of the primary pulp in the plant bundles was 0.25-0.34 tex, consisting of a mixture of fibers with a length of 5 to 90 mm. The main share of the primary pulp in the bundle is highly contaminated with leaf particles and branch fragments (up to 59.3 %). The fibrous mass is mechanically and chemically bound to leaf particles and branch fragments, therefore, it requires the use of new technologies for their purification.

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