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Rigidity and Resistance of Sized Yarn

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Abstract: The article analyzes the influence of sericin on the physicochemical properties of the starch composition, determines the optimal concentrations of sericin in the sizing composition. The optimal ratio of starch and sericin in the sizing polymer composition has been established. The influence of the concentration of dressing components on the physical-mechanical and operational properties of the sized yarn has been studied. The expediency of the development of scientific research and practical developments in the chosen direction is substantiated.

Keywords: Fiber, structural elements, yarn, polymer composition, phase, sericin.

In the process of weaving, the warp threads are subjected to repeated force action during repeated stretching. Therefore, to assess the mechanical properties of the main threads, multi- cycle tensile characteristics are widely used, in particular endurance n_p, the number of tensile cycles that the material withstands before its destruction [1].

With repeated stretching, complex structural changes occur in fibers and threads, and hence changes in mechanical properties, and the results of these changes are of a different nature at different stages of stretching. Two opposite processes take place here: firstly, the improvement of the structure due to the orientation of structural elements (molecules, microfibrils , fibers) in the direction of tension and, due to this, the strengthening of the interaction between the elements; secondly, the deterioration of the structure in the places of defects, the occurrence and growth of cracks, leading to the destruction of the material. It is known that the structure of most fibers and threads changes in three phases as it is repeatedly stretched. In the first phase, which usually takes place during tens of hundreds of stretching cycles, there are mainly displacements of those structural elements that interact little with their surroundings. In the fibers, individual links of whole molecules and macrofibrils are displaced . In the threads, the arrangement of individual parts of the fibers or filaments that are not sufficiently clamped during twisting changes. As a result, the structural elements are more oriented along the longitudinal axis of the fibers (or threads), interact better with each other due to intermolecular bonds, friction forces, etc. These phenomena are accompanied by an increase in residual elongations, which consist mainly of irreversible plastic deformation, as well as a slowly disappearing part of elastic deformation. In subsequent cycles, the rapid increase in elongations slows down sharply, and the structure of the thread stabilizes to a certain extent[2-8]. The destruction of the structure is weak and does not cause deterioration of the mechanical properties.

In the second phase, if the structure of the fibers and threads is good, and the magnitude and frequency of stretching are such that they cause only rapidly reversible deformations, consisting mainly of elastic and rapidly relaxing elastic components, as a result of the impact, there is no significant deterioration in the structure of the material and, as a result, it remains almost unchanged. The material withstands a very large number of stretches, often in the tens and hundreds of thousands. The development of structural defects and the accumulation of irreversible deformations, consisting of slow elastic and plastic parts, proceed at a slow pace. After a large number of cycles, some irreversible deformation accumulates and the third phase begins.

In this phase, the process of deterioration, loosening of the structure proceeds relatively quickly. In

places of defects, stresses are concentrated, the main crack begins to grow, the rapid accumulation of plastic deformations and, due to the displacement of molecules and fibers, from the gaps [9-15].

The data obtained by us on the endurance of cotton yarn sized with starch dressing and dressing with a polymer composition are shown in Table 1.1.

From table 1.1. it follows that in all cases, the endurance index improves. Usually it is directly related to the concentration of dressing and glue , but since the dressing (polymer composition) contains less polymer than the dressing without sericin , it is clear that an increase in concentration is not in this case the reason for the increase endurance. It can be assumed that the main role in this belongs to the structural changes in the polymer film during the modification of starch with sericin .

Table 1.1. Rigidity and endurance of sized yarn

No.	Dressing composition	Yarn stiffness (arb . e din)	Endurance (in cycles)
1	7% starch	0.216	4452
2	8% starch	0.284	3958
3	Polymer composition (4% starch-0.20% sericin by weight of dry starch)	0.164	10197
4	Polymer composition (5% starch-0.15% sericin by weight of dry starch)	0.190	8401

It can be assumed that in the case of using a sizing polymer composition based on starch and sericin , due to an increase in the plasticity, elasticity and elasticity of the size film, the first phase of the structure -formation of sizing yarns proceeds faster, easier and more efficiently and ensures yarn stability in the second phase. Which ultimately contributes to an increase in the endurance index of sized yarns?

In the process of weaving, various deformation forces are applied to the warp yarn, including torsion deformations. In order to determine how a thread resists changing its shape during torsional deformation, its torsional rigidity is studied. The torsional stiffness C (Nm /rad) is a physical characteristic representing a proportionality factor between torque and relative angle of twist, equal, if the shape of the thread is considered a cylinder, to the product of the shear modulus G and the polar moment of inertia I_p . C \ u003d G I_p \u003d 72 / t^2 .

The shear modulus is applied to textile fibers and threads when small external tensile forces are applied to them for a short time. Similarly, the torsional stiffness of textile yarns can be used when, for a short time, calculated in fractions or at most units of seconds, small relative twisting angles (usually not more than 2 kr / cm) are given. Such deformations are typical in the process of weaving, therefore, for assessing the quality of sized yarn, the stiffness index (or stiffness coefficient) during torsion, determined using the KM-20 torsion pendulum according to the standard method, is very important [16-27]. The determination of torsional stiffness is necessary because this indicator characterizes the fixation of the twist of the yarn. Without fixing the twist of the yarn during the sizing process, it is possible to return the rotation of the pile of yarn around its axis, which contributes to greater adhesion of the pile of adjacent threads during shedding and surf of the weft thread on the loom.

Data from the study of yarn stiffness in torsion are shown in Table 1.1, from which it can be seen that the stiffness of cotton yarn sized with polymer compositions containing 4% starch and 0.20% sericin is somewhat less than that of cotton yarn sized with 7% starch dressing. The reason for this is that the decrease in starch concentration.

In the case of dressing based on 5% starch and 0.15% sericin, the stiffness of the yarn increases. However, studies of breakage showed that the stiffness values are not critical, the yarn did not become very brittle and the breakage did not increase due to this. It can be assumed that the increase

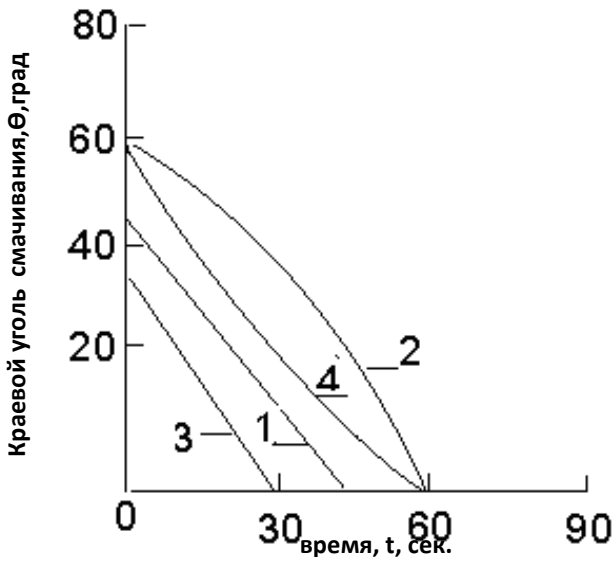
in torsional rigidity, which is a consequence of an increase in elastic and elastic properties, which, together with plastic properties, are components of the shear deformation and, since the first two are reversible, the twisted fiber or thread tends to unwind, while an unwinding moment arises. An increase in the torque value, expressed as an increase in stiffness, indicates an increase in the elastic and elastic properties of films of 4% starch dressing with 0.20% sericin , compared with films of 7% starch.

Sized yarn, in addition to good physical and mechanical properties, must also have good sorption properties (wetting, swelling, solubility) to ensure ease of desizing [28].

The study of the wettability of sizing samples showed that all samples in almost all experimental experiments are wetted almost instantly (within 30 seconds). Wetting time data depending on the wetting angle for "star points" are presented in Fig. 4.2. It follows from this that for samples sized with a starch dressing with a minimum starch concentration, the minimum dissolution time and wetting angle correspond, and for a sample with a maximum starch content, the wetting angle and, accordingly, the wetting time is longer.

The minimum content of sericin causes an increase in the wetting angle and time, and with an increase in the content of sericin , the wetting angle and the time required for the spreading of the formed drop are correspondingly smaller. This, apparently, is explained by the fact that sericin promotes an increase in the hygroscopicity of systems [29-30].

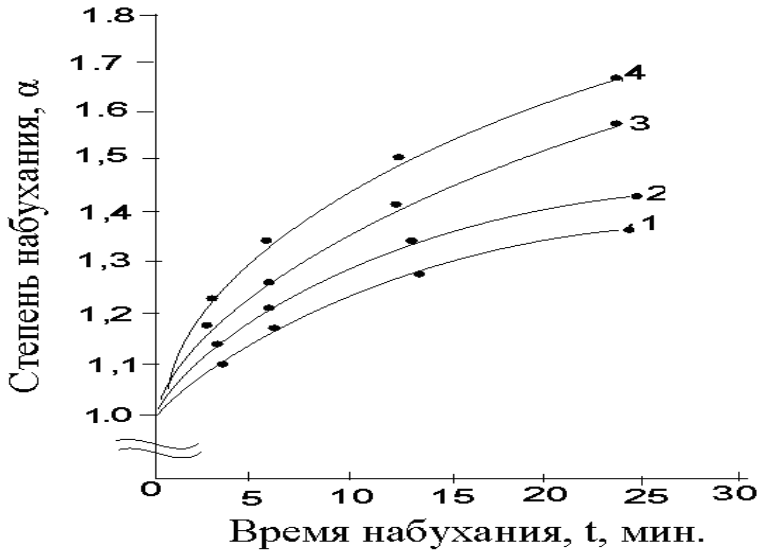
Swelling capacity of sized yarns was determined by the degree of swelling by the change in diameter upon contact with water. These changes in the degree of swelling for cotton yarn sized with 7 and 8% starch dressing and optimal compositions: 4% starch - 0.20% sericin and 5% starch - 0.15% sericin are shown in Figure 1.1.



1-4% starch, 2-8% starch, 3-4% starch - 0.20% sericin ,

4-8% starch - 0.15% sericin

Figure 1.1 Changing the contact angle for "star" points experiment.



1-4% starch, 2-8% starch, 3-4% starch - 0.20% sericin

4-5% starch - 0.15% sericin .

Figure 1.2. Swelling kinetics of sized cotton yarn

From drawings 1.2. it follows that the degree of swelling of yarns sized with dressing containing sericin is higher than for yarns sized with dressing without sericin . The reason for this, in all likelihood, is an increase in the sorption properties and swelling of the sericin-containing polymer films themselves, which, as a result of the formation of ionized aqua complexes , are characterized by increased sorption properties, as a result of which both the swelling and solubility of the films increase [31-32].

Thus, sizing polymer compositions based on rice starch, PAA, and sericin significantly increase the efficiency of a number of technological processes, in particular, sizing. The optimal ratio of PAA and sericin was found, which provides high tensile strength of yarn and breaking elongation corresponding to production requirements.

Due to the higher separation stability of the dressing prepared on the basis of starch, sericin and PAA, loss of dressing caused by equipment shutdown during three-shift operation is completely eliminated. It became possible to use sizing compositions after 12-16 hours of their storage directly in the troughs of sizing machines, while there is no need for heating.

The study of the process of desizing of cotton yarn sized with 5% starch sizing and modified sizing containing sericin and PAA showed that the use of sericin and PAA in the composition of starch sizing does not lead to deterioration in the desizing process. When preparing cotton fabric containing dressing based on starch, with ericin and PAA, the process is accelerated and the quality of preparation is improved, the quality of the prepared fabric is increased.

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