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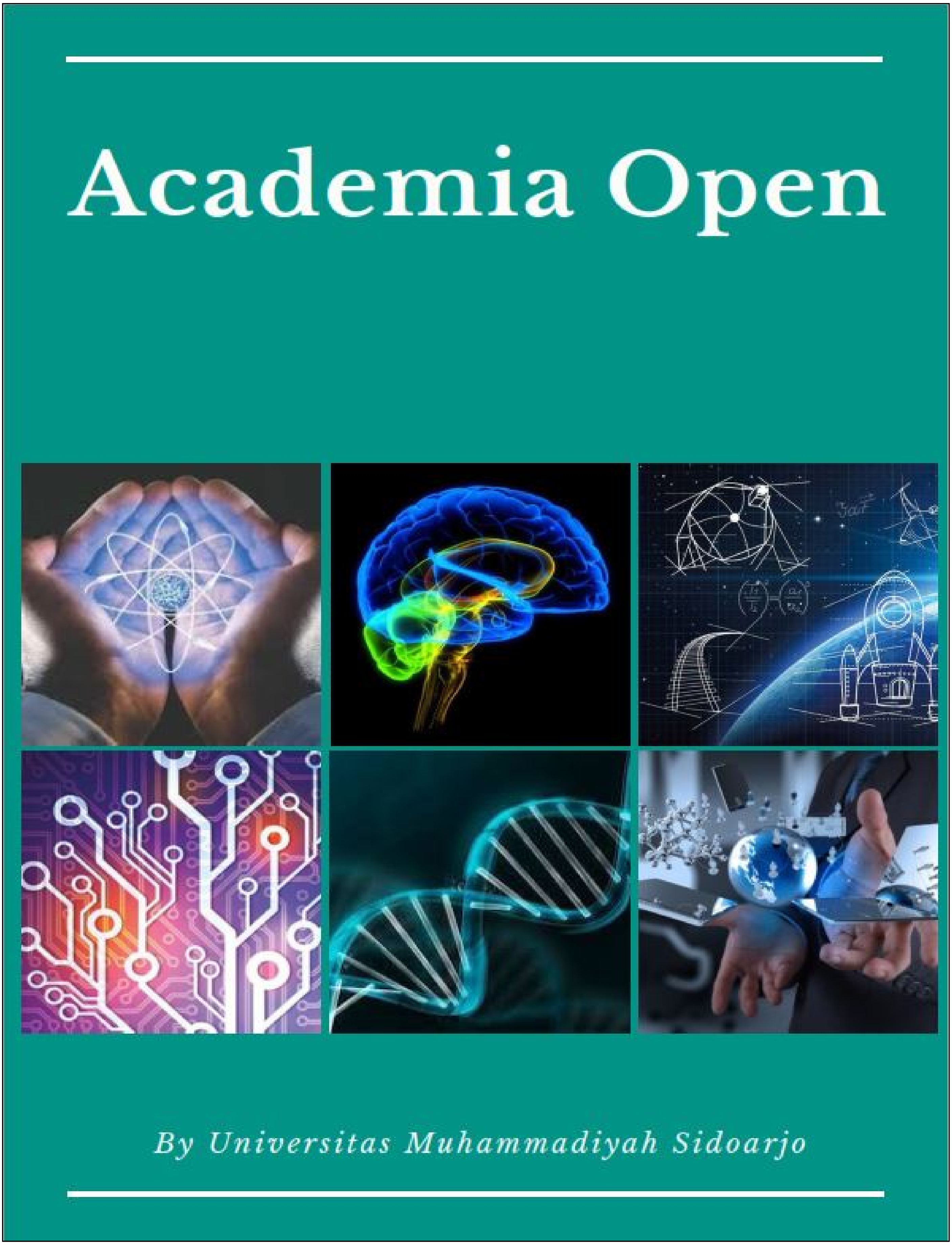

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Intensifications of the wooling mechanism with increasing electric conductivity of fibers

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Abstract

The wide possibilities of modifying manufactured industrial fibers aimed at improving their physico-mechanical properties, structural and technological parameters. In connection with the above, it was of interest to study the effect of a number of water-soluble compositions based on a poly-quaternary salt of dimethyl-allyl-β - methacryloyloxyethylammonium bromide in combination with glycerin on the structural and physico-mechanical properties of protein fiber, and also to study the effect of the composition on wool spinning and the quality of wool yarn .

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Introduction

It should be noted that not all problems encountered in our lives are economic. Political, biological, social, cultural and philosophical issues are often dominant. But it should be borne in mind that any of these problems will always have an economic dimension, economic consequences. Society must solve them in order to function normally. At the same time, the determining factor for each individual and society is the satisfaction of constantly growing and expanding needs.

The relevance of the work. At present, the revival and successful development of the domestic textile and light industry is possible only with the wide use of scientific developments to create progressive processes in the textile industry. Priority are those areas of research that allow you to move from basic research to technologies for producing fibrous materials of improved quality.

Objective

For the production of textile products that can compete with the products of leading foreign companies, the tasks of improving the quality of yarn, as well as the quality of the machines and technologies that produce it in spinning, come to the fore. Theoretical studies of processes implemented in production are one of the main sources and reserves for improving these processes, improving the quality of products being created, developing new more advanced machines in the industry and modernizing existing ones.

Object and research methods

The electrical conductivity of the solution was determined using the R-38 rheochord bridge at a temperature of 20 ± 1^0C and was calculated by the formula Figure 1:

$$H = \frac{I}{Rx} \cdot \frac{l}{S}$$

Figure 1.

Where: **Rx**- electrolyte solution resistance;

l- distance between electrodes;

S- electrode area;

l/S- the instrument constant is called the “vessel resistance capacitance”. To find **l/S =const** and conductivity measurements were poured into a vessel 40 мл 0,2H fixanal solution KCl , kept the vessel in a thermostat at a temperature 25^0C 15 min. Then determined the conductivity of the solution KCl for t $=25^0$C, taken from the directory. Knowing *H- KCl* and *Rx* , the electrical conductivity of the solution was calculated.

The results obtained and their discussion

Friction is one of the reasons for the appearance of electric charges on the surface of insulators. The difficulty in analyzing this is the low reproducibility of the results. There are no general rules to predict the significance and polarity of electric charges, especially when working with technical materials used in industry. To determine the sign of the charge in contact between different materials, so-called triboelectric rows are compiled. Every material is charged with a positive charge in contact with any of the following materials of the series Table 1.

Asbestos	Cotton
Glass	Tree
Mica	Red wax
Wool	Ebonite
Fur	Copper, brass, silver
Lead	Sulfur
Silk	Platinum mercury

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Aluminum	Rubber
Paper	

Table 1. *Triboelectric series for various materials*

In 1898, Coen (Coehn) found that a material with a high dielectric constant is positively charged from non-conductive materials. The table is given. 2 compiled by Freytag. Other hypotheses regarding the appearance of electric charges are carried out below. Henry [2] considered the following hypotheses explaining the process of electrification of dielectrics:

a) the Helmholtz hypothesis described earlier - friction increases the number of contact points on surfaces and changes surfaces by deforming them and removing surface films;

b) the establishment of equilibrium due to the redundancy of particles of opposite sign on the two surfaces under consideration. In dielectrics, the effects of the concentration of charged particles become very important;

c) the kinetic effect is assumed that under normal conditions on one of the surfaces, prior to its contact with another surface, there is a double layer and friction between them leads to the transition of the upper part of the layer to another surface;

d) electrochemical effect - the Helmholtz hypothesis postulates the existence between the surfaces of an electrolytic film (absorbed water);

e) piezoelectric effect - it is assumed that the pressure between the surfaces leads to partial polarization of one of them;

f) the piezoelectric effect arising at heated points as a result of friction;

g) kinetic effect due to the appearance of a thermal gradient normal to the friction surface under asymmetric friction. If the friction is symmetrical, then electric charges on both contacting surfaces can appear for the same reason. This effect seems rather general.

To improve the processing process and product quality in production, moisturizing, emulsification and oiling of protein fibers are widely used. The sizing operation consists of applying in the form of tiny droplets of a sizing emulsion on the surface of the fibers. An emulsion, as a rule, consists of three components: fat, water and an emulsifier. Often an antistatic agent is also added to the emulsion. The mechanism of action of moisture on the wool is as follows; It was noted above that the molecular structure of keratin is characterized by the spatial conformation of helical linear macromolecules with various transverse bonds of different strengths. It is known that keratin protein fibers contains a large number of polar groups. Therefore, intermolecular and intramolecular bonds, if they are not interfered with by the presence of water molecules, impede the action of deforming forces with great force. When water molecules penetrate the structure of keratin, they are hydrated by polar groups of macromolecules, as a result of which the effect of mutual attractive forces is weakened. Moisture absorption is accompanied by a significant swelling of the fiber in the transverse direction, which causes the breaking of weak but numerous hydrogen bonds and the weakening of the van der Waals forces. Moisture acts as a plasticizer, resulting in increased deformation of protein fibers.

. Modification of these fibers gives them new predefined properties, and thereby improves the quality and expand their application [3].

To modify the main types of chemical fibers produced on an industrial scale, a variety of methods have been proposed that are carried out in various ways at different stages of the technological process.

The work [4] is devoted to the study of the permissible intensity of electrification for various machines during spinning. The intensity of the electrification of protein fibers is influenced by many factors: the washing method, the amount of residual fat, diameter, length and degree of entanglement of the fibers, their moisture content. The effect of humidity on the electrification of protein fibers was studied in [5]. The process of electrification of protein fibers is also influenced by residual protein fat. The results of studies [6] showed that with an increase in the amount of residual fat, the electrification of the protein fiber decreases slightly. However, the fat content in the analysis of the electrification of protein fibers should be attributed to weakly acting factors.

In order to clarify the possibility of using aqueous solutions and their salts, as well as individual components of the composition, the physicochemical properties and their interaction with protein fibers were studied. The degree of interaction was characterized by wettability and flooding of protein fibers. A study of the influence of the nature and concentration of a water-soluble polymer and its salts showed that solutions of all selected high molecular weight compounds practically wet protein fibers to a small extent Table 2.

The concentration	Appearance	Relates.	Electrical	Protein wettability	Protein

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of the polymer kg / m3	solution	viscosity,dl / g	conductivity, 10-4Ом-1	per 60 sec.,%	Floatability, hours
Polydimethylaminoethyl methacrylate					
0,5	whitetransparents lightlyyellowish. coloring	4,30	1,10	12,0	24
1,5		5,40	1,35	15	24
2,5		8,60	3,55	20	24
5,0		15,50	7,30	20	24
10,0		43,50	13,20	25	24
dimethyl allyl - β - methacryloyloxyethylammonium bromide					
0,5	white transparent	1,10	1,41	40	15
1,5		1,30	1,75	50	20
2,5		1,43	2,13	70	24
5,0		1,83	3,06	80	24
10,0		3,10	5,10	100	24
polydimethylaminoethyl methacrylate with monoacetic acid					
0,5	whitetransparent	1,110	0,051	40	10
1,5		1,215	0,060	60	15
2,5		1,321	0,069	90	20
5,0		1,321	0,095	100	24
10,0		1,486	1,050	100	24

Table 2. *Physico-chemical properties of aqueous solutions of composite polymers and their salts from concentration*

The degree of wettability of the fibers in these solutions, regardless of the nature and concentration of the water-soluble polymer and its salts, is very low. It should be noted that the wettability of protein fibers in solutions of all polymers and their salts at various concentrations is significantly higher than in distilled water. This phenomenon is apparently explained by the fact that at the interface between the protein fiber macromolecules it is in the solid state, and the solutions of water-soluble polymers and their salts significantly decrease the surface tension. This phenomenon is observed in the case of a mixture of solutions of various polyelectrolyte polymers. In addition, the presence of protein carboxyl, carbonyl, amine and other groups in keratin macromolecules may contribute to the formation of complex compounds between the functional groups of polymers and their quaternary ammonium salts.

The value of electrical conductivity in solutions of polydimethyl-allyl - β - methacryloyloxyethylammonium bromide is due to the presence of ions of functionally active groups in its composition, which have great mobility.

Therefore, the application to the wool of solutions based on water-soluble polymers and their salts, which contributes to an increase in the mechanical properties of the fiber, leads to an intensification of the process of wool spinning, accompanied by an increase in yarn yield and a decrease in breakage of the roving during spinning Table 3.

Indexes		Factory	Solution PDMAEAB
Openness of roving, pcs per 1000 ver / hour	fact.	207	177
	in condition	200	200
The mass of volumes in kg.	fact.	68,5	108,3
	in condition	72,69	115,3
Mass of fumes	fact.	5,70	4,18
	in condition	5,98	4,28
in condition fact.	fact.	11,0	12,5
	in condition	17,59	17,6
in condition fact.	fact.	4,06	4,06
	in condition	7,6	3,72
in condition fact.	fact.	11,0	12,5
	in condition	17,59	17,6
in condition	fact.	95,94	95,94
	in condition	92,40	96,28

Table 3. *The effect of a solution of PDMAEAB and factory sizing on the breakage of the roving and the yield of*

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yarn

It should be noted that, as a result, static electricity contributes to a strong dissolution of the roving, which results in a violation of the parallelization of the fibers and, consequently, a decrease in its strength. This, in turn, increases the likelihood of a break in the roving. Therefore, it was necessary to study the effect of solutions of water-soluble polymers and their salts on the formation of an electric charge in semi-finished products and yarn. To do this, we measured the magnitude of the electric charge at various stages of spinning Table 4.

The voltage of the electric charge in the experimental batch in all cases is lower than in the control, which is a consequence of the stabilized humidity and antistaticity of the polymer composition. The composition used contributed to an increase in the electrical conductivity of the fibers, which leads to a decrease in the voltage of the electric charge.

equipment identification	With PDMAEAB solution	With factory composition
Melangeer Mod 29	6,0	8,0
The tape machine I per. Maud. 25	11,2	20,8
Tape machine II per. Maud. sixteen	5,3	11,0
Tape machine III per. Maud. four	0,4	1,0
Roofing machine RM-3	0,03	0,15
RN-2 spinning machine	0,2	0,7

Table 4. *The effect of solutions of water-soluble polymers on the electrostatic charge (w / cm)*

The achieved results of moisture stabilization and the reduction of the electrostatic charge of the protein fiber using water-soluble polymers have a beneficial effect on subsequent processing processes. The adhesion of the fibers improves, as a result of which the number of coils on the cylinders and rollers decreases. A decrease in the number of windings leads to a decrease in product unevenness and breakage, and an increase in yarn yield. Also, the straightness of the fibers is maintained, contributing to their better movement relative to each other. In addition, a decrease in electrostatic charge, rationing of humidity of semi-finished products affect the reduction of dust in the air in the working area on the quality of semi-finished products.

Indeed, the refinement of protein fiber on baking-trepid aggregates reduces to the stabilization of free radicals arising during mechanical operations by the addition of acceptor substances, which increases the interfiber adhesion forces, reduces the promiscuity and the transition of long fibers into short ones not suitable for yarn. The research results indicate that the moisture content of unbleached protein fiber is reduced in comparison with that enriched in all technological transitions of processed foods and yarn. The overestimated humidity value of the enriched protein fiber allows it to be elasticized, to improve the spinning process and reduce the electrostatic charge, which has a positive effect on reducing the windings on the rollers and cylinders.

It should be borne in mind that even at a very low sliding speed, both a certain bearing capacity and significant hydrodynamic resistance take place [7]. In this case, the pressure can turn out to be substantially greater than the harzews (Fig. 1).

Figure 1 The dependence of the friction force on the surface roughness at various sliding speeds, cm / s: 148.0 (1); 74.0 (2); 29.6 (3); 14.8 (4); 7.4 (5). The parameter λ is: 1; 2; 3;

It can be seen from the figure that even at sufficiently low speeds and at $\lambda = 3$, i.e. when the probability of direct contact is small, with relative sliding of two parallel planes, a certain bearing capacity arises, which increases slightly with increasing σ (from $\lambda = h / \sigma$; h is the thickness between the middle lines of the fiber irregularities).

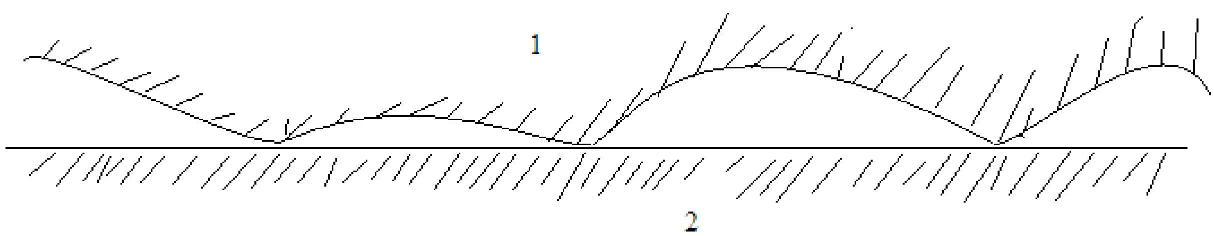

Figure 2. ***The contact pattern of an elastic rough surface (1) with a smooth rigid (2).***

Thus, it can be expected that under conditions of boundary humidity, most of the load, even at speeds of the order

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of tens of centimeters per second, is balanced due to hydrodynamic effects.

Thus, under normal conditions of boundary friction, the bearing capacity is determined mainly by the area of the actual contact, while the magnitude of the friction force depends on the resistance that arises when the roughness approaches. Consequently, there are hardly any friction regimes in the presence of humidity in which the hydrodynamic effects would not have a definite value.

It should be noted that in the boundary lubrication mode, significant stresses arise on the surface, including tensile stresses, which leads to fatigue wear in the absence of direct contact of rubbing bodies.

Conclusion

Thus, the essence of the effect of a sizing emulsion on protein fibers is to reduce the friction forces between the fibers, to sharply increase the flexibility of both individual keratin macromolecules and its supramolecular formations and protein fibers in general, which contributes to an increase in the deformability and electrical conductivity of the fibers. These factors, in turn, reduce the bonding of fibers in the total mass and facilitate the process of their separation during scratching.

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