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CHARGING OF SYNTHETIC FIBERS AND IMPROVE EMULSION

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Abstract. This paper proposes an emulsification device in a new improved method of antistatic processing of synthetic fibers. The priorities of the influencing factors in the device were taken as the magnitude of the polarized field voltage, the distance between the field-generating electrodes, and the percentage of emulsion, and their change intervals were determined experimentally. The analysis of the mechanical properties of the yarns obtained from the cotton-nitron blending showed that the elongation of the cotton fiber was lower than that of the nitron fiber, while the yarn strength was much higher in the 80/20 cotton-nitron blending and the yarn strength in the 50/50 cotton-nitron blending was lower. It should be noted that in the cotton-nitron blending, the stiffness of the yarn decreases as the bundles of Nitron fibers increase by up to 50%. The use of the proposed emulsification device effectively recycles fibrous materials, reduces the electrification of the fiber and improves the quality of the yarn obtained from them. Fibers are dielectric, ie synthetic fibers have polarization properties with very low friction, and it has been found that emulsification of fibers in an improved way to reduce it is highly effective.

INTRODUCTION

The expansion of the range of yarns, one of the products of the textile industry, and the sharp increase in demand for it have led to the improvement of equipment for technological processes.

It was necessary to identify all the factors affecting the production process, analyze them and find appropriate solutions to fulfil the tasks set by the President and the Government of the Republic of Uzbekistan.

The generation of static charge in chemical fibers and yarns and their ability to accumulate is called their electrification. In the process of mechanical processing of fibers and yarns, mutual and metal surfaces are rubbed against each other, resulting in the so-called charges, ie strong electrification.

Especially synthetic fibers are strongly charged. As a result, the fibers are crushed and technological processes are disrupted.

Therefore, the study of electrification is a topical issue, to which many studies are devoted [1 ÷ 15].

The rapid growth of synthetic fiber production in the overall balance of textile raw materials requires the deepening of their processing processes in textile enterprises.

It has been noted that the introduction of high-speed processing processes for such fibers, especially polyester fiber and polyacrylonitrile (Nitron) fiber, poses great challenges due to a large amount of static electricity charges in the fiber [2].

The use of open-end and ring spinning machines to produce yarn from a mixture of cotton with chemical fibers, particularly polyester and Nitron fibers, has many advantages, but has been studied to cause static electricity charging problems in the semi-finished product preparation system for spinning [3].

Static electrification of fibers, which prevents an increase in the speed of the technological process, is observed primarily when the friction of individual fibers is relatively less connected to each other and has faster movement.

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It is noted that electrostatic charges are formed as a result of the mutual friction of the fibers during the carding process. In most cases, these charges are insignificant in relation to the mass of the fiber in contact with the working parts of the process equipment.

The charged fibers adhere to the working parts of the machines, causing the fibrous material to be trapped. The resulting product leads to structural unevenness, and sometimes disruption of the technological process [4].

J.I. Frenkel has criticized the branch theory of the electrification of dielectrics. He does not consider the theory of electrification of dielectrics, which is a modified version of the theory of metals, to be correct.

The accuracy of this conclusion is confirmed by the presence of a triboelectric voltage series for fibrous materials describing the electrostatic properties of different fibers.

The determination of the surface charge density of fibers follows from some theoretically grounded and experimentally proven laws representing the relationship between the charge densities on the surface of a flat material.

The velocity of the material is V, and the specific resistance of the surface is seen in Rg [5-6]. Due to the maximum separation of the fiber during processing on carding machines, almost every fiber tuft was affected by the card clothing teeth. It separates from them at high speed.

It leaves no room for charge dissipation and the degree of fiber separation is significant, creating the conditions for strong electrification of the fibers. The latter disrupts the carding process, causing the fibers to burn and the sliver from the carding to become uneven.

When the charge reaches a certain amount, the fiber is polished and pushed along the edges. In this case, a tuft of synthetic fibers sticks to the crawling, squeezing and passing through the funnel, and as a result, the sliver breaks.

In some studies, it has been found that the total limit condition for the charge value for synthetic fibers is 10^{-4} Kl/g. If the charge is more than 10^{-4} Kl/g, electrostatic noise is mentioned to occur. Depending on the unit area, the charge density value of 4×10^{-2} Kl/cm2 corresponds to the previously given results and is also applicable when processing in a carded fiber production line using a bunker supply for the card sliver.

It is mentioned that due to strong electrification, the wick begins to corrugate in the formation channel. It should be noted that because the fibers in the sliver are better bonded, electrostatic noise is observed at higher charge densities.

During the processing in the draw frame machine, it was found that the condition must be observed in order to eliminate the interference in the electrification of the fibers.

The problems that arise during the processing of synthetic fibers have been achieved by partially improving the quality of the yarn by using different emulsions.

In the processing of synthetic fibers V N Vanchikov [8] noted that as a result of increasing the speed of the working parts of the carding machines and the adhesion of synthetic fibers to the surface during continuous carding, the coarse unevenness can be increased, and to reduce unevenness.

The specific volume of the electric field characterizes the transmission of electric charges in a substance under external influence. In the analysis of physical models, it is important to know the passage of electric current through polymers and the dependence of force when using these materials.

It should be noted that electric current through a piece of matter is associated with basic processes such as dissociation and ionization of molecules and the recombination of atoms, carriers, directional diffusion, the transfer or passage of charged particles in an electric field, and the establishment of different polarities between the two media.

Due to the presence of free charges in polyester and nitron fibers from synthetic fibers, the formation of a positive charge free charge on one part of the fiber surface and a negative charge free charge on the other part under the influence of an external electrostatic field has been noted in [9 - 10].

Fibers and threads are characterized by their ability to generate and accumulate static electricity. Emulsions can be strongly electrified when rubbed against each other, on the machine bodies, in the process of mechanical technology of yarns, and fibers and yarns with the same charge can push each other and return. The technological process is disrupted and other undesirable events occur. The strongest electrified chemical fibers and yarns (chlorine, acetate, nylon, etc.). Natural fibers (wool, silk) are also electrified, but very rarely.

The decrease in the electrification of synthetic yarns is facilitated by an increase in relative humidity, their coating with an oil film or antistatic emulsions in the form of hygroscopic salts, polyol alcohols, soaps, cations and other substances. In addition, ionization devices are used to electrify fibers, their opposite, at the point of movement of the threads. The surface charge density of the fibers indicates that their relative humidity was 44 and 64%, respectively. It follows from this data that the highest electrification occurs in chlorine, Acetochlorine, and Anide yarns. With an increase in relative humidity from 44 to 64%, the surface density of nitron, acetate yarns decreases by almost 32 times. A significant decrease in the electrification of other yarns was also found in [11 - 12].

Particular attention is paid to improving product quality and production efficiency. In addition, these synthetic fibers have a high mechanical resistance and do not react with organic solvents. Its specific electrical resistance is from 1 Ohm to 10 Ohm, above which all other substances are not affected. Nitron fibers are weather resistant and have the greatest resistance to strong acids. They are widely used in the manufacture of carpets, fur coats and filter materials. It has been noted in the works [13-14] that chemical fibers significantly improve their quality and appearance due to their widespread use in natural fiber blends in the production of new textile products.

The electrical conductivity of wires is seen in the description of the process of movement of electric charges under the influence of an external electric field [15].

Conductive fibers are related to the currents flowing in the yarn material and depend on the current density, exposure time, and electric field strength, temperature, composition, structure, size, and shape. Most textile fibers and yarns are dielectrics, and the basic laws of dielectric materials are specific to them. The current in the wires decreases in time, which is due to the movement of the connected charge-dipoles and the occurrence of processes close to the electrode. When dielectrics made up of polar molecules are placed in an electric field, the forces acting on each dipole in the direction of the field strength are created. But the full turn is prevented by thermal action. As a result, positive charges move in the direction of the electric field, while negative charges move in the opposite direction. In general, all types of polarization result in the formation of positively charged charges at the points where the external field voltage lines exit the dielectrics and negatively bound at the points of entry into the dielectrics [16]. Because this conductivity is so large, currents that dissipate them must occur at large values of voltage in the conductors. Therefore, the field strength in the conductors will be relatively small. A strong electric field has long existed only in dielectrics, in which mutual molecular forces bind charge carriers and free electrons are scarce. A strong electric field can also occur in a vacuum. One of the physical properties of a vacuum is that it can contain an electromagnetic field. An electric shift occurs under the influence of voltage in an environment where an electric field is generated. In the molecules of some dielectrics, the positive nuclei of the atoms move in one direction, and the orbits of the electrons move in the opposite direction. In other dielectrics, the molecules are composed of positive and negative charges (dipoles) separated from each other in space; in such dielectrics the dipoles are rotated under the influence of an electric field. Both the displacement of the charges and the rotation of the dipoles consist of the polarization of the dielectrics. It is known that drafting and doubling processes are carried out on draw frame machines. The main function of draw frame machines is to draft and thin the product, straightening and parallelizing the fibers. When processing a blending of synthetic and cotton fibers, problems arise when it comes to carding after several passes, especially in Nitron fiber mixtures, because the static charge of nitron fibers is known. Drafting and doubling processes are carried out on draw frame machines. This is because the Nitrone fiber has a water absorption of only 2%. This resulted in static charging of the nitron fibers when they were carding so that they did not completely cover the surface of the fiber when the emulsion was applied to the nitron fibers. These differences became apparent when the draw frame sliver was first passed through the draw frame machine. In the draw frame machine, the sliver is inserted into the stretching device by means of a feeding pair on the surface of the supply table. In it, the elongated thinned product is directed to the compaction hole and after turning into a sliver, it passes through the guide channel through the flattening rollers, the sliver is pulled by means of roller rollers and cans. The slowing down of the flow of charged fibers when they go to the condenser due to slip charging on the surface of the slivers supply table, which goes through the above processes, leads to thinning of the sliver and an increase in the number of breaks. This negative condition was not observed during the processing of emulsified fibers in the mixture, but a positive effect of emulsification was observed. [17].

The reason for this is that the water absorption of nitron fiber is only 2%. Therefore, it was observed that the nitron fibers emulsified without passing through the polar electric field are statically charged on the carding, some of which remain in the sliver of the carding machine and other parts, and the surface is unevenness and Neps on the surface.

Today, the rapid growth of synthetic fiber production in the overall balance of textile raw materials requires the deepening of their processing processes in textile enterprises. With the introduction of high-speed processing processes for such fibers, especially polyester and nitron fibers from synthetic fibers, great difficulties arise as a result of the increase in static electrification in the fiber. At the same time, the demand for chemical fiber and mixed fiber yarn products is growing in the textile industry. Several sources have mentioned that the electrification of chemical fibers during spinning has a negative effect on the quality of the yarn. To date, emulsification in various drugs has been introduced to overcome this problem, in particular, manual, mechanized, chamber emulsification methods have been used in production. It is known that the electrical resistance of a fibrous material has been studied in emulsification studies. It has been shown that the lower the electrical resistance of the fibrous material being processed, the lower its electrification and the higher the charge leakage rate. It should be noted that the electrical resistance of individual fibers is less practical than the resistance of the fiber mass, because in the latter case the contacts are made with the fibers. It is also noted that fibrous material can be used at any stage of processing to measure resistance to fiber mass. Although many problems in the synthetic fiber processing process have been successfully solved, other problems arise from time to time as a result of the introduction of new technological processes, equipment efficiency, and increased volumes of synthetic fiber processing. Without reliable quantitative and qualitative data on the degree of electrification of yarns obtained during the processing of polyamide fibers, it is impossible to accurately assess the problems caused by static electricity charges and develop effective measures to eliminate them. Unlike processes in which dielectric polarity is reversible, as a result of electrical conductivity, a residual current is established only due to the movement of free charges.

Improving the quality of yarn obtained from fibrous materials is done by reducing electrification by improving the quality of emulsification by processing the fibers in a high-voltage electric field. To do this, the surface of the fibers must be completely covered with an emulsifier. To solve this problem, a special device was developed, which is made in the form of a conveyor belt mounted on a frame and mounted on the outlet of the hoist. It is solved by equipping the fibrous material with potential and grounded electrodes that provide high-voltage processing. To feed the processing, after the impact zone of the electrodes in front of the heater, which performs electric field and drying of the fibrous material before emulsion. However, in a continuous technological process, the fibers are processed in a high-voltage electric field for a certain period of time to produce a yarn that is delivered using a conveyor belt. They are then emulsified and dried using a heater. When processed in a high-voltage electric field, the fibers are covered with an electric charge. As a result, the surface of the fibers is completely covered with emulsion, their adhesion to metal surfaces is prevented, and the quality of the spun yarn is improved. The fibrous material emulsification device is shown in Figure 1.

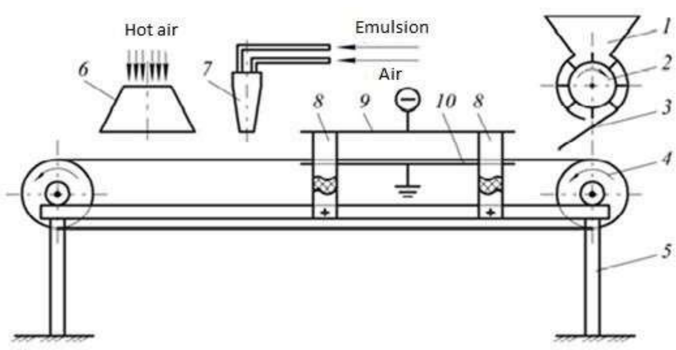

FIGURE 1. Fibrous material emulsification device

In the textile industry and in the emulsification of fibrous materials, it can be used to improve the quality of yarn. Improves the quality of yarn made from fibrous materials. By processing fibrous materials in a high-voltage electric field, it will be possible to reduce the electrification of the yarn and consequently improve its quality. The fibrous material emulsification device is coaxially mounted in a horizontal cyclone chamber with conical inlet and outlet tubes, equipped with sprayers that deliver the processing medium. The device is produced in the form of a conveyor belt mounted on a frame. It is mounted at the outlet of the loading hopper and is equipped with potential and negative electrodes that allow the fibrous material to be processed into a high-voltage electric field before emulsification. One with sprayers to deliver the processing agent is placed in front of a heater that dries the emulsified fiber material after the electrodes are in the impact zone.

The fibrous material emulsification device includes 1 loader, 2 suppliers, 3 slope boards, 4 conveyor belts, 5 frames, 6 calorie pads, 7 injectors, 8 dielectric supports, 9 potential electrodes and a grounded electrode takes. The loading bunker 1, the feeder 2, the slope board 3 and the conveyor belt 5 are located in the frame and are driven by an electric motor (not shown in the figure). The dielectric supports are connected to the frame 8 by 5 bolts and are equipped with potential 9 and ground 10 electrodes. In this case, the potential electrode 9 is mounted on the conveyor belt 4 and the underground part is at its bottom. Depending on the physical and mechanical properties of fibrous materials, high-voltage voltages of different sizes are applied to the electrodes. To do this, there are devices on dielectric bases to adjust the distance between the electrodes. After potential 9 and grounded 10 electrodes, there are 7 injector guides for emulsion (processing) using compressed air. At the end of the conveyor 4 are mounted 6 heaters that provide hot air to the emulsified fiber material.

The emulsification device of fibrous materials works as follows. Using the supplier 2 and the slope board 3, the fibrous material is uniformly fed to the moving conveyor belt 4. At this time, depending on the physical and mechanical properties of the fibrous materials, a high voltage is applied from the power source to the potential 9 and to the grounded 10 electrodes. The fibrous material passing between the potential 9 and the grounded 10 electrode is polarized and the fibers are aligned in the direction of the high-voltage electric field transmission lines. When leaving a high-voltage electric field, the fibrous material is emulsified with a processing agent 7 and an air stream. After emulsification, the fibrous material is dried in a continuous process using a 6-heater and the next process is sent to form a yarn. This results in the surface of the fibers being completely coated with the emulsion and drying with a heater to form a thin protective layer on the surface of the fibers that protects them from overcharging. Sticking to the metal parts of the machine, i.e. during the processing of the fibrous material, prevents its electrification and improves the quality of the spun yarn. Multivariate mathematical planning methods are widely used in the study of technological equipment and operating parameters of various devices. This is because unrelated factors affect the efficiency of equipment operation to varying degrees at the same time. It is known that synthetic fibers are first processed and then antistatic, ie emulsified, to obtain a finished product. A special device has been created to improve the emulsification process of synthetic fibers and achieve greater efficiency. Its working principle is to spray an emulsion on a synthetic fiber passed through a polar electric field. Preliminary experiments have shown that several factors affect the properties of the mixed yarn obtained by emulsifying a synthetic fiber in an emulsification device. The magnitude of the voltage applied to the electrodes of the device, the distance between the electrodes, and the percentage of emulsion. The interaction of the factors with each other was avoided and the values of their levels were selected. In the study, before processing a bundle of synthetic fibers, the fibers are passed through a polarized area to eliminate weak charges on the surface, and the weak charges are replaced by positive charges and treated with a negatively charged special liquid. Due to the alkalinity of the liquid falling on the surface of the fibers, the decomposition into particles is shown in Figure 2 (a), a bunch of synthetic fibers, and 2, a special liquid.

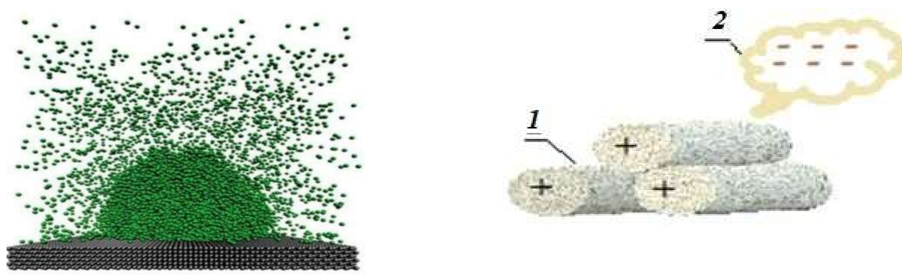

FIGURE 2. Synthetic fibres, the attraction of dielectric particles to a charged parts

It is useless to confuse the bound charge of the dielectric with the polarity with the charge on the surface of the fibers. the surface charge of the fibers consists of a certain amount of free electricity, which can exist for a long time regardless of the electric field. In most cases, it is caused by the friction of any two parts against each other, in which case a body with a large dielectric constant is positively charged.

The advanced method emulsified nitron fibers with cotton fiber 80/20, 70/30, 60/40 and 50/50 cotton-nitron blended yarns were tested on the USTER® device. The results of Rkm and SV {Rkm} of the obtained yarns are given in Table 1.

TABLE 1

Mechanical properties of cotton-nitron blended yarn Rkm, SV {Rkm}

№	Option of blending	Parameters	
		R_{km}	CV{R_{km}}.
1	80/20	14.1	9
2	70/30	11.6	6.9
3	60/40	10.3	10
4	50/50	7.8	7.6

The analysis of the mechanical properties of the yarns obtained from the cotton-nitron mixture showed that the elongation of the cotton fiber was lower than that of the nitron fiber, while the yarn strength was much higher in the 80/20 cotton-nitron mixture and the yarn strength in the 50/50 cotton-nitron mixture. It should be noted that in the cotton-nitron mixture, the stiffness of the yarn decreases as the bundles of nitron fibers increase by up to 50%. Analysis of the above indicators The results of Rkm and SV {Rkm} are shown in the histogram in Figures 3.4.

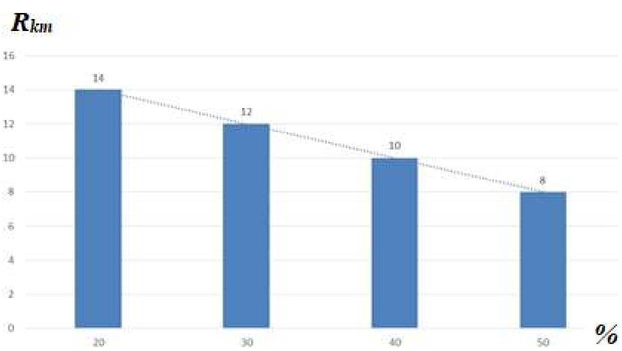

FIGURE 3. Rkm index of yarns obtained from cotton-nitron blending

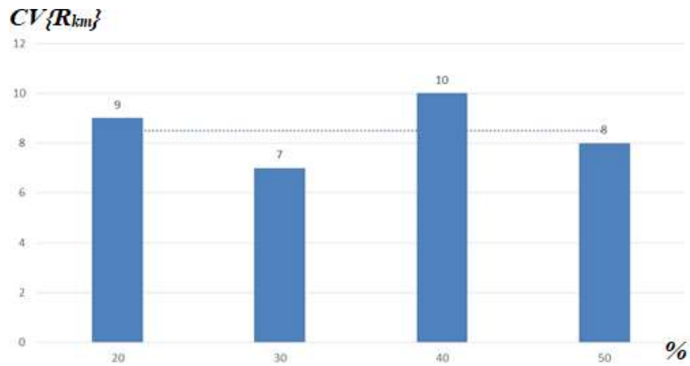

FIGURE 4. SV {Rkm} index of yarns obtained from cotton-nitron mixture

Thus, in order to obtain high-quality yarn from a cotton-nitron blending, an advanced method of yarn production with a high strengthens from a mixture of emulsified Nitron fiber with 20 and 30% cotton fiber was developed.

CONCLUSION

The use of the proposed emulsification device allows efficient processing of fibrous materials, reduces the electrification of the fiber and improves the quality of the yarn obtained from them. Fibers are dielectric, ie synthetic fibers have polarization properties with very low friction, and it has been found that emulsification of fibers in an improved way to reduce it is highly effective. In order to obtain high-quality yarn from cotton-nitron blending's, a high-strength yarn technology was developed from 20 and 30% Nitron mixture emulsified in an improved way.

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