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Improvement of Equipment and Technology of Drying of the Cotton Mass and its Technological Assessment on the Basis of its Thermal Properties

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ABSTRACT: The article presents physical-colloidal and biomechanical changes of cotton. In order to increase the vibration level of raw cotton in the drum, reduce the amount of raw cotton falling sharply from the blades, by optimizing the speed of rotation of the drum, as well as the analysis of uniform heating and drying of the cotton mass, the results of theoretical studies of the heat transfer process of the mass are presented. Based on the analysis and research results, a drying method based on accelerating the process of heat transfer of cotton by increasing the impact surface of cotton by changing the design of the heat transfer device of the cotton drum dryer is proposed.

KEYWORDS: Physical-colloidal, biomechanical, drum dryer, cleaning, physical-mechanical, spinning, operational, hot air, shovel, temperature, humidity, weight, cotton, fiber.

I.INTRODUCTION

Cotton raw material is a material consisting of three different components, which are not identical in structure. These components include – fiber, peel and core. Cotton fiber refers to capillary – perforated materials. The fiber is located on the entire surface of the seeds and consists of 97% cellulose. The length of the fiber, depending on the type and variety, averages 25-50 mm. with a thickness of 15-25 microns, the thickness of sowing ranges from 0.25 to 0.4 mm. The chemical composition of the peel consists of 40-45% cellulose, 20-25% lignin, 28-30% lectazone, 3% protein, 2-3% powder (ash). Weed kernels are mainly composed of fats and proteins. It consists of carbohydrates, crystalline and colloidal sugars, pectin substances in the colloidal-dispersed state. Seeds by their nature belong to colloidal materials, the composition refers to the capillary-hole materials. Cotton raw material refers to colloidal capillary-hole materials as the drying object.

II. SIGNIFICANCE OF THE SYSTEM

Due to the diversity of the morphological structure of the components of raw cotton moisture in them is also different. When wet cotton raw materials, each component will have moisture in accordance with its physical properties. With the loss of moisture from the raw cotton components, irreversible physical, colloidal and biomechanical changes occur. Therefore, the main problem when drying cotton is to preserve the technological properties of the material. The peculiarity of wet storage of raw cotton strongly affects its production and processing. Reducing the humidity level is carried out by means of high temperatures in the production and differs from the complexity of its control. From this point of view, one of the main operations: during the primary processing of raw cotton, especially after machine harvesting, it is drying. In the process of primary processing of regulated cotton raw materials, the drying function is assigned to the drying and purification plants. In recent years the cotton industry for drying of raw cotton are used the convective-drum dryers brand SXL-1.5 M, 2SBS (with drying and movement of material are superimposed in the opposite direction), and the tumble dryer of the brand SXB-1.5 M, 2SB-10, SBO (the cotton-the raw material and the drying agent is moved in one direction).

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III. LITERATURE SURVEY

It is worth noting that the acceleration of the drying process in drum dryers is mainly due to the use of coolant at high temperatures. At the same time, due to the lack of uniform drying, the moisture content of the fiber is lower than the norms provided for by the technological regulations for processing raw cotton (5.5%). As is known, the regulated pre-treatment process requires reducing the humidity of raw cotton 1-2 grades to 8%, and low grades to 9%, since the processing of raw cotton with excess moisture leads to a deterioration of the cleaning process, reducing the efficiency of cleaning due to the high viscosity of fibers with dirty impurities. The increase in the number of defects and contaminants in the fiber for each process of excess cotton moisture reaches 0.7-1.0%.

Fiber production at a humidity of raw cotton 8-9% increases the cleaning efficiency of cleaners, improve the collection process and provides the content of defects and impurities in the norms, calculated on O'zDst 604-2001. Once again, we note that the excess dried fibers lose their valuable natural properties, become brittle, deteriorate natural, physical,mechanical, spinning and operational properties of fibers and products from them, increasing the number of defects and impurities in the fiber. It finds its confirmation in a series of completed works. Thus, the analysis of literature sources shows that the efficiency of the drying process in drum dryers can be achieved using high temperatures, but such parameters of the drying agent are not recommended in order to maintain the natural properties of the fiber.

With this in mind, drum dryers of the 2SB-10 and SBO brands are currently used in the cotton industry. Drum dryers brand 2SB-10 supply, the drum and the chimney alone involves. The drying drum with a diameter of 3200 mm and a length of 10000 mm is made of steel sheet with a thickness of 2 mm. On the inside there are twelve longitudinal blades that slide at the seams and pull out across the drum. Shovels up to 500 mm are arranged radially and ensure stable operation of the dryer when the drum rotates at a frequency of 10 months/min, as well as when the drum is filled by 30%. Inside the drum there is a stop grid consisting of three rods 3000 mm long, at a distance of 6000 mm from its front wall; they are stretched on the side wall of the drum parallel to its longitudinal axis with the help of crosses, thanks to the grid, the time of finding raw cotton in the drum under the action of the drying agent increases, which helps to reduce the heat consumption for drying.

Scientists, experts "Partsanacortes" and JSC "SKB Cotton gins", JSC developed the drum dryer with the cleaning section of the brand of SBO. In the SBO dryer, simultaneously with the drying of raw cotton, small dirty impurities are cleaned. In its design, unlike 2SB-10, at the last three meters of the process, the periphery of the dryer is made of sheet metal with holes and hardened into a sealed chamber. In the sector of falling raw cotton with a shovel above the drum there is a longitudinal tube with a nozzle on the wall of the chamber. The air absorbed by the fan sprays cotton falling from the blades in the opposite direction. When this occurs, accelerating the decomposition of the dirty impurities. The cleaning efficiency of fine impurities reaches 40%. The main disadvantages of drum dryers 2SB-10 and SBO are low productivity in humidity, as well as strict temperature regulation of drying (up to 280^0C). Therefore, drying with high humidity (above 17%) occurs in them either at low yields, or with double drying before reaching the norm. The analysis shows that the internal shovels of the 2SB-10 and SBO drum dryers are not evenly distributed over the size of the raw cotton drum drying chamber. Most often, cotton with cuttings falls on large pieces, heat does not reach it, that is, only the surface layers of the pieces are dried, and the process of wet and heat exchange slows down. The most effective effect of the drying agent on the drying material occurs in the fall zone. If the residence time of the material in the dryer is 6 minutes, the period of falling from the blades is 1.2-1.5 minutes. This means that by increasing the surface of the falling raw cotton and the time of exposure to the drying agent can accelerate the drying process to improve technology, drying technology and design of drum dryers. General provisions Bannikov G. V., A. I. Buldakov, R. P. Nikitin, A. V. Korotkova, G. P. Hamburg, A. P. Parpiev, M. R. Rahmonov, M. S. Sadikov, A. Kayumov, A. Mamatov, M. Gapparov, A. Osmonkulov and other scientists have conducted research.

IV. METHODOLOGY

The study showed that the drying process can be accelerated by streaming spraying with a drying agent in a cotton layer during the last three meters of the drum length by the movement of the material. G. P. Hamburg studied the process of drying raw cotton in a drum dryer with radial transfer of the coolant. Scientists have found that the process of drying raw cotton can be accelerated by rational transfer of coolant in the cotton layer at a speed of more than 30 m/s at a temperature of 100-1300S. To improve the design of the drum dryer for raw cotton, a large amount of work was performed by G. V. Bannikov. Was determined the geometrical indexes of the drum, the diameter and internal structure and rotation frequency. The proposals were introduced into the production of the 2SB-10 drum dryer. In this work, it is

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concluded that the requirements for raw cotton from known dryers satisfy the coolant moving along the flow of raw cotton drum dryers. A. P. Parpiev ways to accelerate the drying process of raw cotton in convective dryers were studied. Scientists have found that one of the main factors affecting the intensity of drying are the internal design parameters of the drum, whose function is to evenly distribute the drum section with the maximum use of the volume of the dryer for drying raw cotton. In the drum dryer, the process of whipping raw cotton was very low and amounted to 11%, the increase in its cost to 25% was achieved by accelerating the process by 2.5 times.

Thus, the analysis of earlier works on drum drying shows that the performance of dried raw cotton directly depends on the humidity and other basic indicators characterizing the operation of the dryer, on the time spent raw cotton in the drying chamber, three degrees of vibration, the flow rate of coolant and the filling factor. In the existing 2SB-10 and SBO dryers, when the drying agent is consumed within 15-25 thousand m^3/h, the dried cotton moves quickly across the drum, which requires an artificial stop. The study of suspended grids installed on the 2SB-10 dryer showed that cotton with cuttings is not evenly distributed across sectors, large gangs are often formed on the grid, which increase the circular motion leading to the loss of cotton with cuttings. In the performed work the SBT dryer consisting of the drying drum divided into 3 independent sections with additional built-in shovels is offered. The idea laid down by the author in this design is that due to the maximum use of the volume of the dryer and reducing the height of the fall, the residence time of raw cotton in the dryer increases. However, because of the frequent blockages, the restructuring of the drying system SBT were not widely introduced. This situation requires an increase in the time spent raw cotton in the drum dryer. M. Gapparova studied the effect of the temperature regime on the quality of the fiber. When the fiber is heated to 70^0C, yellow spots begin to appear on its surface, which reduce the color and appearance of the fiber. Dry cotton is recommended in mild temperature conditions, i.e. at temperatures up to 160^0C for smooth drying. V. A. Kayumov on the basis of experimental study of production conditions, a mathematical model of the drying process of raw cotton on a drum dryer is based on multiple drying. The procedure of drying in ravishes associated with the initial moisture content of raw cotton is proposed. However, the disadvantages of drying in the drum dryer remained unchanged. Some researchers have tried to speed up the drying process using a vibration procedure. These results are not widely used in practice due to insufficient drying intensity. In the work of A.V. Korsukova, the conditions and possibilities of accelerating the process of convective drying of raw cotton by spraying winds at high temperatures and humidity of the drying agent are indicated.

With the help of experiments it was found that the use of a drying agent with a high moisture content (40g/kg or more) accelerates the process only when the temperature is above 1500S. These recommendations are widely used because of the complexity of the preparation of the drying agent and the size of the fire hazard, as well as reducing the quality of the fiber. To improve the efficiency of drying R. P. Nikitin, and T. D. proposed by Kaldybaeva improved the dryer, where the increase of humidity is achieved by the addition of the heated flange to cotton-the raw and the additional heat from the infrared radiation, while maintaining the increased capacity of drying length of the drying drum. In order to introduce heating of the drum flange, the dryer 2SB-10 is surrounded by a heat-shielding chamber where the drying agent is transferred from the heat generator.

The drying agent used in the chamber is then transferred to the drying drum. It was found that the transfer of additional heat from the heated flange to the raw cotton will increase the degree of moisture. However, due to such shortcomings as strict drying, high coolant temperature, high power consumption, insufficient efficiency of infrared light dispersion, fire hazard, fiber quality deterioration, production of improved dryer has not been implemented. A.Usmonkulova studied the laws about finding analytical solutions to the heat transfer process and mass transfer on the distribution of heat by the mass of fibers on different criteria of similarity and theoretically studied the heating of the fibers in the Fly tissue and the evaporation of moisture. The paper States that in order to increase the level of vibration of raw cotton in the drum, reducing the amount of raw cotton coming from the blades simultaneously, by optimizing the speed of rotation of the drum, while ensuring that part of the raw cotton falls out of the raised blades, and the remaining part was transferred to the falling blades. Also, the drum has an air chamber, which is surrounded by a heat-protective layer of the surface.

V. EXPERIMENTAL RESULTS

But the proposed method has many disadvantages:

- additional hot air pipe leads to the accumulation of raw cotton in the front of the drum as a result of reducing the hot air pressure in the main heat agent pipeline;

-due to the clogging of various mesh holes with impurities, which makes it difficult to transfer air from the additional pipe;

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-this also leads to an increase in the load of the drying drum on the bases with the recommended optimum speed of 13 months/min and their failure.

Taking into account these shortcomings, based on theoretical and experimental studies and analysis of the drum dryers, as a result of the implementation of the idea, which was to increase the heating of the drum crust, the titration of cotton in the drop zone and make maximum use of the inner surface of the drum for intensive conductive heat exchange with cotton, the improvement of the drum dryer was carried out. Fig. 1 shows the proposed scheme of the dryer. The dryer works as follows. Hot air from the heat generator to 10,000 m3/s through pipes 1 and 2 is transferred to the dryer and the air chamber, respectively.

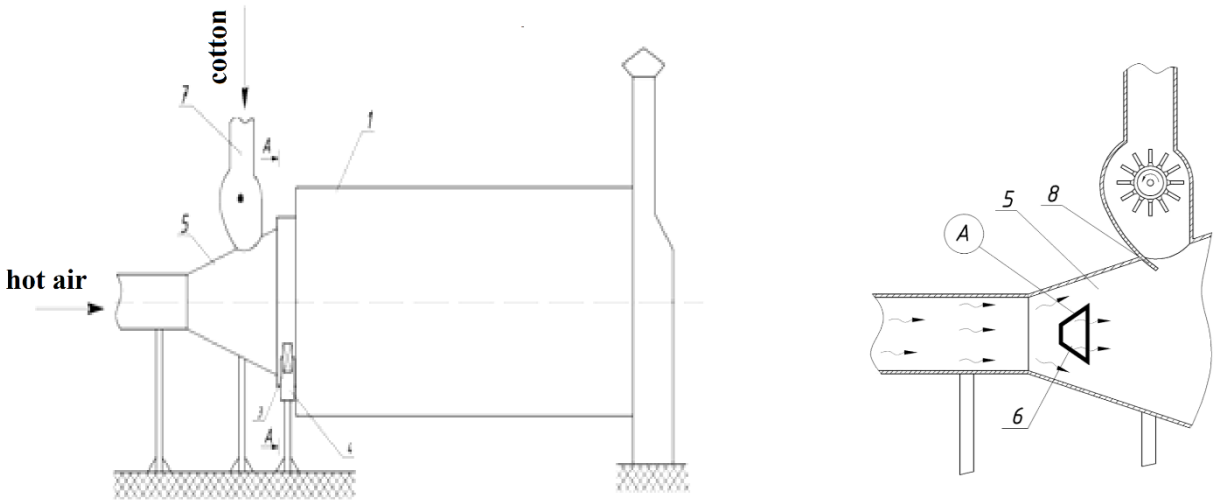

Fig. 1. The proposed scheme of the dryer

The hot air enters the air chamber and covers and heats the drum shell and then enters the drum through 8 different surfaces. Hot air coming through the nozzle 1, prevents the accumulation of cotton in the initial part of the drum. In the drum rotation, heat exchange occurs between the cotton and the hot air, as well as the shell of the drum, the cotton wool dries, the used hot air comes out through the nozzle 6. The main task is to use cotton in the drop zone for adequate cut and intensive heat exchange of the right side of the drum. This required optimizing the amount of rotation of the drum so that the cotton lying on the blades rising up the surface of the drum section evenly and evenly falls about half. And the remaining cotton should be sprayed with shovels, front, fallen shovels. As a result, the heat exchange surface of cotton with the inner surface and the drum blades increases sharply in a convective and conductive way. At the same time, due to the simultaneous reduction of the amount of cotton in the fall zone and the use of a useless zone for drying by the conductive method, the heat exchange process is accelerated. Conditions of stable operation of the drum dryer-the fall of cotton remaining on the blades, 1.5 times during the rotation of the drum. In this regard, in order to determine the number of revolutions of the drum, ensuring the presence of cotton on all the shovels of the drum, based on the results of a study conducted at the Kagan cotton plant, the regression equation is obtained:

$$Y=9,15+2,82X_1-0,85X_2+0,58X_3-0,43X_1X_2$$

where Y is the humidity of the dryer - %, X_1, X_2va X_3 is the initial humidity of cotton, respectively,the performance of the dryer and the number of revolutions.

The task was to find the optimal value of X_3, ensuring the presence of cotton on all shovels of the drum. On the basis of the conducted experiments it was found that the above conditions are provided at the speed of the drum dryer 13 months/min. The proposed dryer has been tested to determine the optimum heating temperature of the drum crust. As a result of experiments on the method of mathematical planning and processing of their results, the following equations of adequate regression were obtained:

$$u_1=12,8+4,75x_1+1,15x_2-0,85x_3-0,37x_1x_3$$

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$$u_2=5,62+0,51x_1+0,31x_2-0,11x_3$$

Here $u_1$va u_2 is the initial moisture content of cotton, respectively, after drying of the cotton, as well as the number of defective impurities and impurities in the fiber,x_1, x_2, x_3 is the initial moisture content of cotton, the performance of the dryer and the heating temperature of the drum shell. Due to the increase in the internal parts of the drum and the crust temperature from 35^0C to 70^0C,an increase in the humidity of cotton by 64.2% (relative) was revealed. This fact indicates the possibility of accelerating the process of heat transfer and mass conductive method of drying cotton, and drying should be organized at the maximum permissible temperature of heating the drum. The results of the proposed production testing of the dryer and the indicators of economic efficiency assessment are also presented. The tests were carried out in cotton of grades II, III and IV, hand-picked at Peshko, cotton cleaning plant, with an initial moisture content of 13.1%, 16.4% and 18.57%, and impurities of 6.3%, 11.23% and 15.4%, respectively. When using a heated dryer, there was an increase in the efficiency of the process equipment of the cotton cleaning enterprise, the efficiency of cleaning up to 88.2%, the mass fraction of defective mixtures and impurities in the fiber decreased to 0.5% (ABS).

VI. CONCLUSION AND FUTURE WORK

On the basis of the above analysis and research, it was found that by changing the design of the heat transfer device of the drum dryer can be achieved by accelerating the heat exchange process by increasing the surface of the impact of cotton, new methods of drying cotton raw materials and its components, which is a new innovative technology.

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