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Changing the Cotton Fiber Temperature

Ruzmetov R.I., Madumarov I.D., Gapparova M.A., Tuychiev T.O

Absract: ***The article investigates the dependence of the temperature of cotton fiber on the time spent on drying-cleaning equipment. The study also investigated the effect of hot air velocities on cotton. According to the study, the increase in hot air temperature for drying from 2.5 m/s to 7 m/s leads to an increase in the temperature of the fiber to 10 ÷ 12 ^{0}C. It was found that the increase in the temperature of the fiber can be achieved by increasing its velocity without increasing the air temperature.***

Keywords: Cotton fiber, drying, cleaning, cotton moisture, cotton fiber temperature, drying agent temperature, air velocity.

I. INTRODUCTION

Gradual and sustainable development of the cotton industry, introduction of modern equipment in the industry, increase of the level of efficient and rational use of production capacities, production of competitive products on the world cotton market. In this regard, special attention is paid to the improvement of high-efficiency cotton drying equipment and the creation of resource-saving technologies in the global cotton industry. However, the analysis of cotton drying and cleaning equipment used by foreign and local cotton factories shows that today there are no effective solutions to the creation of high-efficiency cotton cleaning technologies. Initial processing of cotton starts with drying, as the quality of cotton products and the efficiency of process equipment depend on the moisture content of the cotton. More than ten thousand types of materials have been dried up in the world, of which cotton is a multicomponent material with a variety of trophophysical properties and is one of the most complex drying facilities. Therefore, the quality of cotton in the drying process, the selection of drying modes of the equipment, the detailed study of the properties of cotton as a drying material and the process of drying equipment [1]. The intensity of the drying process and the moisture performance depends on the initial parameters of the cotton. Convective drying depends on the movement of moisture from the interior of the material to the surface, the heat and moisture exchange between the material and the external environment.

The amount of heat transferred from hot air to cotton is expressed by the following equation [1].

$$Q=KP_{da}\cdot F(t_1-t_2) \quad (1)$$

here, heat exchange between the K-drying agent and cotton coefficient, kdj/m^2 hr*grad;

P_{da}- hot air volume, m^3/hour;

F- heat-absorbing surface, m^2

t_1-t_2=$_\Delta$t – difference between drying agent and cotton temperature, °C.

We can see that the amount of heat transferred from the hot air to the cotton depends on the heat transfer coefficient between the drying agent and the cotton, the amount of heat absorbed by the drying surface, and the temperature difference between the hot and the cotton. It is evident that this can be achieved by increasing the heat exchange between the material and the environment to accelerate the drying process, and by increasing the heat transfer coefficient.

In drum dryers, the drying agent acts not only as a heat carrier but also as an agent that absorbs moisture and removes it from the drying chamber.

The amount of moisture evaporating from the surface is calculated using the following equation [1]:

$$\frac{dW}{d\tau}=ß(p_m-p_w)dF \quad (2)$$

here, $\frac{dW}{d\tau}$- moisture evaporation from the material, kg/h;

ß- coefficient of evaporation;

F- area of the evaporation surface, m^2;

p_w- Percent pressure of water vapor in hot air, N/m^2;

p_m- vapor pressure on the material surface N/m^2;

The formula shows that moisture evaporation depends on the surface area of the cotton, which increases the moisture content of the cotton, which increases the moisture content of the surface of the material and the moisture content inside the material. The rate of moisture evaporation on the surface of the material is also influenced by the pressure of the vapor in the environment, and the lower the pore pressure, the faster the moisture evaporation occurs. The reduction of the vapor pressure in the drying agent can be achieved by the supply of a new drying agent that is not used in the drying process.

II. FORMULATION OF THE PROBLEM.

Based on the theoretical research, the technology of high-speed drying agent proposed in the process of cotton drying process, the ability of the drying agent to perpendicular to the cotton stream, the high degree of clutter (in the case of lumps and drifts, but not the arrows), always lower than the material vapor pressure and allow air moisture content of 6-8 g/kg [2; 3].

Based on the above considerations, the aim was to investigate the effect of hot air temperature and velocity on changes in cotton fiber temperature. The experiments were carried out in cotton varieties S-6524, of the 1st grade variety, with an initial humidity of 9.20% and 11.05 %, and a pollution of 3.20% and 2.98 %.

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* Correspondence Author
Ruzmetov R.I*., Tashkent Institute of Textile and Light Industry, Researcher
Madumarov I.D., Tashkent Institute of Textile and Light Industry, Doctor of Technical Sciences.
Gapparova M.A., Tashkent Institute of Textile and Light Industry, candidate of technical sciences.
Tuychiev T.O., Tashkent Institute of Textile and Light Industry, Ph.D.

The air velocity required for drying cotton during experiments is 2.5; 4.0; 5.5 and 7.0 m/s with temperatures 120; 140; 160 and 180 °C, drying time was taken at 10, 20, 30 and 40 seconds. State standards O'z DSt 643:2006 and O'z DSt 644:2006 are used to determine the moisture content of cotton dried cotton [4; 5].

The first section of the LCM instrument was used to conduct the experiments to remove cotton from the dirt. Depending on the time ratios of the unit, the lid was moved to the Dirty Cleaning Unit in the required seconds, and the cotton was placed in a polyethylene sack and immediately measured using a contact thermometer with an accuracy of 0.01 °C.

The SXL-3 ventilator spindle was adjusted to maintain the required air speed. The air velocity was determined by measuring the velocity of air coming out of the inlet of the heat agent transmission tube from the SXL-3 device to the LCM. The size of the inlet section of the heat transfer pipe to the LCM is measured using a cross-anemometer that measures the velocity of air coming out of this perimeter to 30 m/s.

An additional automatic was mounted on the SXL-3 to transfer the required air to the LKM, and the capacity of the tubular heat generators was increased. Temperature was determined using a mercury thermometer.

Initial Cotton Pollution Level before Experimentation it is defined on the basis of State standard O'z DSt 592. After setting the required regime, 300 g of cotton samples were obtained using the method described in the state standard O'z DSt 643 on the scales with a accuracy of 0.01 g. After the sample was supplied to the LKM device, the heat was transferred and the release time was recorded. After the required time, the cap of fine dirt from the cotton was opened and placed in a polythene sack, and immediately the temperature of the cotton fiber was measured on the contact thermometer. Then the moisture content of the cotton was determined on the VXS-M1 using the method described in the State Standard O'z DSt 644. During the experiment weighed the separated impurities, and the efficiency of the sample and device purification was determined. The experiments were conducted in three repetitions to avoid possible errors.

III. SOLUTION METHOD

During the drying of cotton the physical and mechanical changes of fiber occur. The amount of these changes depends on the initial moisture content of the cotton, the heating temperature of the cotton and the duration of the drying process. Determining the dependence of these factors on the drying process is important in maintaining the spinning properties of fiber, which is one of the main tasks of the cotton drying process.

The first heat treatment of cotton has been used by mankind since ancient times. This is not reflected in the technological processes of domestic cotton processing. This process is effectively used in US cotton processing technology. Of course, the local cotton gin is heated during the initial processing of cotton. However, heating the cotton is not intended to increase the temperature of the fiber, but to dry it to air humidity. During the drying of cotton, the temperature of the fiber falls to its purification process and does not exceed 25-30 °C. [7] The study showed that the fiber coefficient increases as the temperature of the fiber increases. This increases the permeability of the fiber shock by the drum drum, and the efficiency of cleaning is directly proportional to the shock force's transmission to the fiber. In the study [8] the optimum temperature of the fiber during drying was determined to be 65÷70 °C, which mainly investigated the effect of the fiber on appearance.

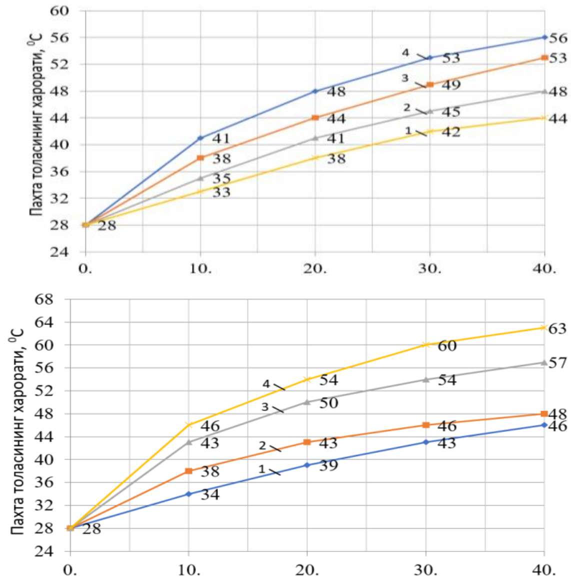
Scientists of JSC "Pakhtasanoat Scientific Center" and the Tashkent Institute of Textile and Light Industry revealed changes in the quality of the fiber during drying and suggested different modes of drying operation. This study was mainly done on drum-type dryers.

IV. ANALYSIS OF THE RESULTS

Figure 1-4 shows graphs of the change in cotton fiber temperature dependence of the drying agent velocity.

Figure 1 (a) shows that the moisture content of the cotton is 11.05%, with the air velocity for drying at 2.5 m/s and the temperature at 120 °C, the temperature of the cotton fiber after drying the cotton for 10 seconds. (curve 1), cotton the temperature after 20 seconds of drying is 38 °C, the temperature after 30 seconds is 42 °C, and the temperature after 40 seconds is 44 °C.

When the air temperature for cotton drying is 140 °C (curve 2), the temperature of the cotton fiber reaches 35 °C in 10 seconds, up to 41 °C in 20 seconds and 45 °C in 30 seconds. After drying for 40 seconds, the temperature increases to 48 °C, which is about 18-20 ° C. The air temperature is 160 °C (curve 3); the temperature of the cotton fiber after drying the cotton for 10, 20, 30 and 40 seconds is 38; 44; 49 and 530C, and the temperature at 180 °C is 41; 48; Up to 53 and 56 °C. The air temperature for cotton drying is 120 °C, with an increase in the temperature of the dried cotton fiber up to 16-18 °C for 40 seconds, and the temperature of the cotton fiber by 20-22, when the temperature increases to 140, 160 and 180 °C; Increase in the range of 24-26 and 27-29 °C is observed.



Time of Cotton on Equipment, Sec

a) b)

1, 2, 3, 4 - 120, 140, 160, 180°C, respectively

Figure 1. Graph of dependence of changes in the cotton fiber temperature at drying time (humidity a) - 11.05% and b) -9,20%, air speed 2.5 m/s)

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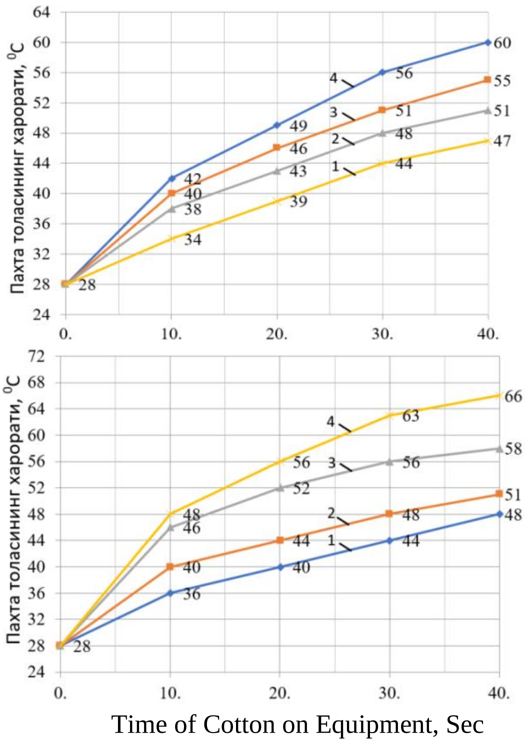
In Figure 1 (b), the moisture content of the cotton is 9.20%, with the air temperature for drying at 120 °C and the temperature of the cotton fiber after drying for 10 seconds (Curve 1), after 20 seconds of drying, the temperature is 39 °C, after 30 seconds the temperature is 43 °C, and the temperature after dried for 40 seconds is 46 °C. When the air temperature for cotton drying is 140 °C (curve 2), the temperature of the cotton fiber is 38 °C in 10 seconds, 43 °C after 20 seconds, 46 °C after 30 seconds and 48 ° after 40 seconds. C. are forming. The temperature was 160 °C (curve 3) and the temperature after cotton drying for 10, 20, 30 and 40 seconds was 43; 50; Increase in temperature from 54 to 57 °C, and temperature at 180 °C is 46; 54; An increase of 60 and 63 °C is observed. When the air temperature for cotton drying is 120 °C, the temperature of the fiber is 16-18 °C, and the temperature is 19-21, 28-30 and 34-36 °C when the air temperature rises to 140, 160 and 180 °C the number of rise temperature of cotton fiber in the process of cotton cleaning recommended temperatures of 45-50 °C [9], with a 9.2 percent cotton drying rate of 2.5 m / s with a temperature of 160 °C within 15 seconds, the temperature increases to 48 to50 °C. Figure 2 (a) shows a time-varying temperature of the dried cotton temperatures at different temperatures at 4.0 m/s for air drying with 11.05% humidity.

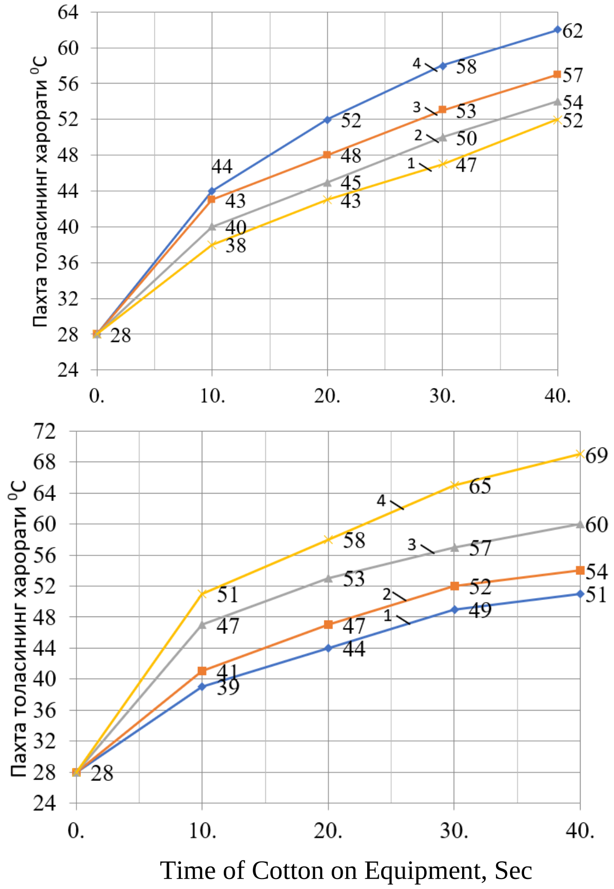
The air temperature was 120 °C after 10 seconds of drying, the temperature of the cotton fiber was 34 °C. The temperature is expected to rise to 140 °C, cotton temperature to 38 °C in 10 seconds, to 43 °C in 20 seconds, to 48 °C in 30 seconds and to 51 °C after 40 seconds. The air temperature is 160 °C and the temperature is 40, respectively, after drying the cotton for 10, 20, 30 and 40 seconds; 46; 51 and 55 °C, with temperatures reaching 180 °C; 49; Up to 56 and 60 °C. Air temperature was 120, 140, 160 and 180 °C, and the temperature of cotton fiber 19-21, 22-24; Increase of 26-28 and 31-33 °C is observed.



a) b)

1, 2, 3, 4 - 120, 140, 160, 180°C, respectively

Figure 2. Graph of dependence of changes in the cotton fiber temperature at drying time (humidity a) - 11.05% and b) -9,20%, air speed 4.0 m/s)



a) b)

1, 2, 3, 4 - 120, 140, 160, 180°C, respectively

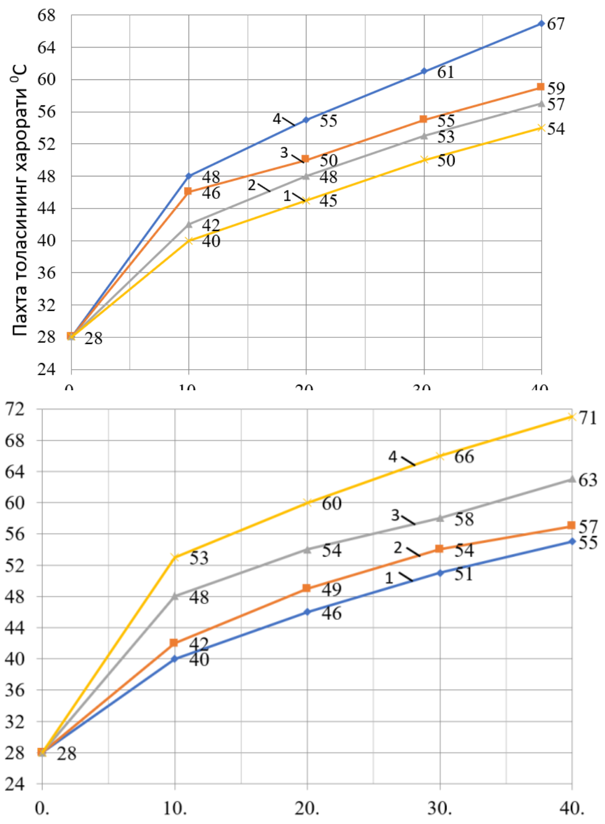
Figure 3. Graph of dependence of changes in the cotton fiber temperature at drying time (humidity a) - 11.05% and b) -9,20%, air speed 5.5 m/s)

Analyzing the graphs in Figures 3 and 4 show that the temperature of cotton fiber increases with increasing air velocities and temperatures for cotton drying.

As shown in Figure 2 (b), the air temperature is 120 °C, its velocity at 4 m / s and 10 seconds drying, the temperature of the cotton fiber is 36 °C, and after 20, 30 and 40 seconds the temperature of the cotton fiber is 40, 44 and 48 °C. The air temperature for cotton drying is 140 °C and after 10, 20, 30 and 40 seconds, the temperature rises to 40, 44, 48 and 51 °C. Likewise, the air temperature for drying is 160 and 180 °C (curves 3-4) and the temperature of the cotton fiber after drying for 10, 20, 30 and 40 seconds is 46; 52; 56; 58 and 48; 56; 63; Up to 66 °C.

As shown in the graphs, the temperature of cotton fiber for drying up to 11.05% with temperature of 120 0C and the speed of 2.5 m / s, when the cotton fiber temperature increases by 48-50 0C for 40 sec. It takes 36 seconds to raise the cotton fiber temperature to 48 ° 50 ° C.

When the temperature is increased to 5.5-7.0 m / s it takes 32 and 25 seconds, respectively, to raise the cotton fiber temperature to 48-50 0C. Air temperature for cotton drying is 140 0C, speed 2.5; 4.0; At 5.5 and 7.0 m / s, it took 36, 30, 25 and 20 seconds to raise the cotton fiber temperature to 48-50 0C, and to 30, 28, 20 and 20, respectively. 15 seconds and 25, 20, 15 and 10 seconds, when the temperature rises to 180 degrees.



Time of Cotton on Equipment, Sec

a) b)

1, 2, 3, 4 - 120, 140, 160, 180°C, respectively

Figure 4. Graph of dependence of changes in the cotton fiber temperature at drying time (humidity a) - 11.05% and b) -9,20%, air speed 7.0 m/s)

The moisture content of the cotton is 9.2%, the temperature of the hot air 120 °C, with a speed of 2.5 m/s, 38 seconds increase of cotton fiber temperature 48-50 °C, while the temperature of hot air is 4.0; Increasing to 5.5 and 7.0 m/s, we see that the temperature of the cotton fiber can rise to 48-50 °C for 30.28 and 20 seconds, respectively. As well as the rest of the graphs, the rapid increase in the temperature of cotton fiber can be achieved by increasing the temperature and speed of hot air drying.

IV. CONCLUSION

The study found that the rate of hot air for drying increased from 2.5 m/s to 7 m/s, leading to an increase in the cotton fiber temperature by 10 to 12°C. As a result, it is proved by the practical experience that increasing the temperature of the fiber, even without increasing the temperature of the hot air, can be achieved by increasing the temperature of the hot air. Considering the fact that the temperature of hot air in the cotton fiber exceeds 55-60°C and negative impact on the natural quality of the fiber, it will be possible to obtain a high-quality product by introducing the results of this study into production. It also saves fuel consumption for hot air.

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