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IMPROVEMENT OF PREPARATION OF COTTON FOR CLEANING TECHNOLOGY

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Abstract: The article is devoted to the preparation of cotton for the ginning process, in which the problem of transferring cotton to ginning for heating is studied. The introduction of pneumatic transport to the cleaning equipment after the cotton drying drum at the ginning plants and its shortcomings are analyzed. It was found that the electricity consumed is high and the temperature of cotton decreases sharply as a result of airborne transmission.As a result of the experiment, the effect of air velocity on the cooling of fibers and seeds was determined by the nature of changes in their temperature and the decrease in moisture content of cotton. In order to make effective use of the heat received by the cotton in the drying drum, it was recommended to use a mechanical conveyor during the transfer to the cleaning.The experiment was based on the fact that when the cotton is transported on a mechanical conveyor, the temperature drop of the dried fiber is kept to a minimum and it is allowed to be cleaned when heated. It has been shown that the transfer of cotton to a mechanical conveyor for cleaning can increase the heat utilization factor for drying by allowing the hot air leaving the drying drum to be used for additional heating of the cotton. The direction of scientific research to be carried out in this field was suggested.

Keywords. Cotton moisture, fiber and seed temperature, pneumatic transport, drying drum, cotton gin, mechanical conveyor

INTRODUCTION

Analysis of the current state of cotton drying and ginning techniques, technologies and research on their improvement, improvement of ginning efficiency, improvement of existing gins, creation of new ones and optimal preparation for ginning as an object of cotton processing, namely cotton structure, fiber moisture and temperature showed that it is happening in supply directions [1, 2, 3, 4, 5].

Extensive research has been conducted to improve existing and create new ones, based on the main working elements, geometric and speed parameters, technological parameters of saw and pile drum sections. New designs of cleaners based on various configurations of pile and saw drum sections for cleaning of small and large contaminants have been developed [6, 7, 8, 9, 10].

Full use has been made of the available capacity of the existing cleaners. However, research has not been sufficient to ensure that the second direction is to prepare the cotton for cleaning and to ensure that the fiber moisture and temperature are at optimal values in the cleaning process. Studies [11, 12] have found that there are no technical solutions that provide these parameters, although it is recommended that the fiber temperature be 40-50 ℃ and the humidity 6-7% for high cleaning efficiency.

The existing techniques and technologies of primary processing of cotton include the process of drying cotton to prepare it for cleaning, in which it is adapted to the cleaning of heat and moisture at the expense of drying cotton in drying drums.

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Preparation of cotton for cleaning consists mainly of drying and transfer of cotton to cleaning, the analysis of which showed the following.

The air consumption for drying cotton is 15000 ÷ 25000 $m^3/hours$, the utilization factor is 0.35-0.4%.

If the heat transferred to the drum is determined as follows [13]

$$Q = L * c_x t$$

where L-air consumption $m^3/hours$, c_x-heat capacity of hot air kDj / kg ^{0}C; t-hot air temperature, ^{0}C.

If L= 20000 m^3/h, t =100 and 200 ^{0}C, c_x = 1 kDj / kg, at t =100 ^{0}C

Q = 2000000 kDj/h, at t = 200 ^{0}C Q = 4000000 kDj/h, heat is consumed and 1200000 and 2400000 kDj/h of heat are wasted, respectively.

The sharp rise in fuel prices in recent years will require the search for measures to reduce the share of fuel drying in the cost of drying cotton.

Analysis of the transfer scheme for drying and cleaning of cotton (pic. 1) shows that the used air is released into the atmosphere without transferring the heat to the cotton, and the dried cotton is transferred to the separator SS-15A and cooled in an air stream at a speed of 25-30 m/s.

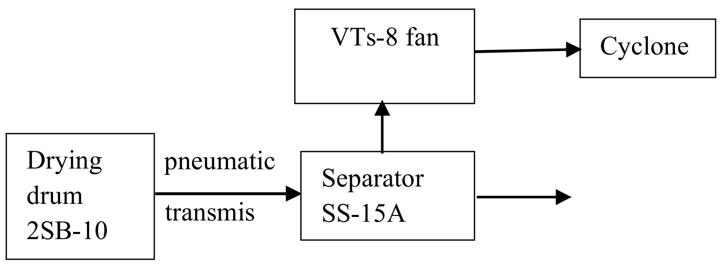

FIGURE 1. Scheme of transfer of cotton to cleaning

Cyclones use 58 kWh of electricity to transport cotton and 19,000 $m^3/hours$ of air purification.

In this case, an energy-saving option is proposed, in which the cotton coming out of the drying drum is fed to a hermetically sealed belt conveyor with a capacity of 4.5 kW / h and transferred to the cleaning screw. As a result, the cotton goes into the cleaning process hot without cooling.

The main purpose of the article is to determine the temperature change in the transmission options of cotton in the pneumatic and conveyor.

METHODS OF CONDUCTING EXPERIMENTS

The experiment was conducted on cotton S65-24, grade III, with a moisture content of 19.1% and a contamination of 6.3%.

The experiment was conducted in two stages. In the first stage, 100 g of the sample was taken, thermocouples were placed on the seeds and fibers, and the fiber temperature was heated to t_T = 40-50-60 ^{0}C in the laboratory dryer SXL-3.

The sample was then taken and placed in an air supply device with a special fan and the air speed was cooled at V = 0-5-10-15 m / s and the temperature of the seed and fiber was measured every 5 seconds.

It is known that [14, 15] cotton speed $V_p = (0{,}5\text{-}0{,}6) * V_x$ when the air speed in pneumatic transmission is 25-30 m / s that is, the selected air velocities correspond to the relative velocities of the air cotton in the pneumatic transport of 10-15 m / s.

In the second stage of the experiment, a sample of 100 g was taken, heated for t in the first stage, then cooled in the first stage mode by pulling it, and the change in mass was measured every 5 seconds.

RESULTS AND THEIR ANALYSIS

The experimental results are presented in Tables 1 and 2.

TABLE 1. Moisture content of cotton W = 19.1%, weight of sample Mn = 100 g, change of mass and moisture of cotton during cooling of fiber with temperature t_T = 60C

Cooling time, s	Air speed, m / s											
	V=0			V=5			V=10			V=15		
	Change in cotton mass $M_{н}$, g	Decrease in cotton mass $\Delta M_{н}$, g	Cotton moisture %	Change in cotton mass $M_{н}$, g	Decrease in cotton mass $\Delta M_{н}$, g	Cotton moisture %	Change in cotton mass $M_{н}$, g	Decrease in cotton mass $\Delta M_{н}$, g	Cotton moisture %	Change in cotton mass $M_{н}$, g	Decrease in cotton mass $\Delta M_{н}$, g	Cotton moisture %
0	92,91	7,08	10,67	94,74	5,26	12,84	95,18	4,82	13,26	94,54	5,46	12,60
5	92,90	0,01	10,66	94,62	0,12	12,70	95,09	0,09	13,15	94,50	0,04	12,55
10	92,94	+0,03	10,70	94,53	0,21	12,59	94,99	0,19	13,03	94,44	0,10	12,48
15	92,96	+0,05	10,72	94,49	0,25	12,54	94,96	0,22	13,0	94,35	0,19	12,37
20	92,96	+0,05	10,72	94,36	0,38	12,39	94,96	0,22	13,0	94,30	0,24	12,31
25	92,97	+0,06	10,73	94,30	0,44	12,32	94,94	0,24	12,97	94,28	0,26	12,29
30	92,98	+0,07	10,74	94,27	0,47	12,28	94,93	0,25	12,96	94,27	0,27	12,28
35	92,98	+0,07	10,74	94,22	0,52	12,22	94,90	0,28	12,93	94,23	0,31	12,23
40	92,98	+0,07	10,74	94,22	0,52	12,22	94,87	0,31	12,89	94,19	0,35	12,18
45	92,99	+0,08	10,75	94,21	0,53	12,21	94,83	0,35	12,84	94,12	0,42	12,10
50	92,99	+0,08	10,75	94,21	0,53	12,21	94,79	0,39	12,80	94,10	0,44	12,08
55	92,99	+0,08	10,75	94,20	0,54	12,20	94,75	0,43	12,75	94,08	0,46	12,05
60	92,99	+0,08	10,75	94,19	0,55	12,18	94,72	0,46	12,71	94,07	0,74	12,04

TABLE 2. Fiberglass cooling with an initial temperature of 60 ^{0}C

№	Cooling time, s	Variation in fiber and seed temperatures, ^{0}C							
		V=0		V=5m/s		V=10m/s		V=15m/s	
		Seed	Fiber	Seed	Fiber	Seed	Fiber	Seed	Fiber
1	0	49,78	60,45	48,55	60,70	50,70	61,05	49,98	60,45
2	5	49,55	59,90	48,15	58,65	49,95	59,73	48,90	57,35
3	10	49,30	59,38	47,65	56,15	49,08	58,83	47,93	55,78
4	15	48,83	58,63	47,20	54,48	48,05	57,00	46,60	54,08
5	20	48,38	58,10	46,70	52,68	47,13	54,58	45,43	52,58
6	25	47,80	57,50	46,15	51,53	46,40	52,58	44,73	50,90
7	30	47,43	56,93	45,53	50,18	45,53	50,15	43,68	49,10
8	35	47,03	56,45	44,70	48,20	44,90	48,73	42,88	47,50
9	40	46,60	55,83	44,03	47,03	43,98	47,13	41,55	45,78
10	45	46,05	55,18	43,13	46,28	43,30	45,60	41,00	44,08
11	50	45,83	54,48	42,58	45,58	42,33	44,38	40,38	42,68
12	55	45,60	53,75	42,08	44,83	41,73	43,80	39,65	41,60
13	60	45,40	53,08	41,38	44,10	41,13	42,90	38,75	40,05

As can be seen from Table 1, the sample weight decreased from 92.91 g to 95.0 g due to moisture separation before the fiber was heated to 600C, and the moisture content of the cotton also decreased proportionally. When the air velocity V_x=0, the mass and moisture of the cotton increased insignificantly due to condensation from the air. When the air velocities were 5, 10, and 15 m / s, the cotton humidity decreased by 0.66, 0.55, and 0.56%, respectively, i.e., the construction process continued. It should be noted that in a pneumatic conveyor, the moisture content of cotton is reduced mainly due to the release of moisture from the fiber. In the drying drum, the fiber that dries more than the seed increases the unevenness of the construction as a result of the heat accumulated in it, i.e. the release of additional moisture, resulting in an over-drying condition. The effect of air on the seed is not significant because the time is short. Moisture release from it is low.

The analysis of the cooling process in the pneumatic transfer of cotton (Table 2) showed the following:

• In the process of heating cotton to 60 ^{0}C, the difference in fiber and seed temperatures is significant, ranging from 11-12 ^{0}C. This condition has an effect on the cooling and moisture separation of the fiber and seed in the pneumatic transmission of cotton;

• as the air velocity V increases, the decrease in fiber seed temperature increases with V = 0, while the fiber temperature decrease is 7,37 ^{0}C, while in seed 4,38 ^{0}C, at V = 15 m / s it is 20,4 ^{0}C and 11,23 ^{0}C, respectively;

• It was found that there is a possibility of achieving a minimum drop in the heating temperature of the cotton when the cotton is air-cleaned from the drying drum.

It is known that the cooling time of cotton depends on the distance between the drying drum and the gin, and the heating temperature in different cotton gins depends on a number of factors, including drying temperature, cotton productivity, air consumption and initial moisture content of cotton. The analysis of the drying regimes of cotton ginning enterprises showed that the temperature of cotton after drying is from 40 ° C to 60 ° C.

As can be seen from Table 3, even at a fiber heating temperature of 40-50°C, the nature of changes in the temperatures of the cotton fiber and the seed is the same as at a fiber heating temperature of 60°C, and the fiber temperature decreases with increasing air velocity.

TABLE 3. Temperature variation in fiber and seed pneumatic transport

<table>
<tr><td rowspan="4">№</td><td rowspan="4">Cotton heating temperature, ^{0}C</td><td colspan="12">Cotton a moisture, fiber and seed temperatures</td></tr>
<tr><td colspan="12">Air speed, m/s</td></tr>
<tr><td colspan="3">V=0</td><td colspan="3">V=5</td><td colspan="3">V=10</td><td colspan="3">V=15</td></tr>
<tr><td>Decreased humidity ΔW, %</td><td>Fiber temperature, ^{0}C</td><td>Seed temperature ^{0}C</td><td>Decreased humidity ΔW, %</td><td>Fiber temperature, ^{0}C</td><td>Seed temperature ^{0}C</td><td>Decreased humidity ΔW, %</td><td>Fiber temperature, ^{0}C</td><td>Seed temperature ^{0}C</td><td>Decreased humidity ΔW, %</td><td>Fiber temperature, ^{0}C</td><td>Seed temperature ^{0}C</td></tr>
<tr><td>1</td><td>40</td><td>0,10</td><td>6,5</td><td>3,9</td><td>0,89</td><td>12,0</td><td>5,0</td><td>1,63</td><td>15,1</td><td>6,1</td><td>1,87</td><td>16,7</td><td>6,6</td></tr>
<tr><td>2</td><td>50</td><td>0,17</td><td>8,8</td><td>2,2</td><td>0,62</td><td>14,1</td><td>6,0</td><td>1,0</td><td>16,0</td><td>7,2</td><td>1,27</td><td>18,3</td><td>8,8</td></tr>
<tr><td>3</td><td>60</td><td>+0,1</td><td>7,4</td><td>4,4</td><td>0,66</td><td>16,6</td><td>7,2</td><td>0,53</td><td>18,2</td><td>9,6</td><td>0,65</td><td>20,7</td><td>11,23</td></tr>
</table>

A significant decrease in cotton moisture content (1.63 ÷ 1.87%) at fiber temperatures of 40 and 50 °C can be explained as follows. When cotton is heated with hot air at a temperature of 100 ° C, the process of moisture separation begins. In this case, moisture evaporates mainly from the fiber and the construction speed is maximized. When the heating temperature of the fiber is between 40 and 50 °C, the construction process continues when the cotton sample cools down, resulting in a significant decrease in the cotton moisture content. Since the heating time is relatively long when the fiber is heated to 60 ° C, the release of moisture is greater during the heating period, and free moisture is released in the fiber, resulting in a sharp decrease in moisture release during cooling. It should be noted that due to the large uneven structure in the drying drum, the fiber is over dried, while the release of moisture during cooling is not considered a positive condition, the moisture content of the fiber is further reduced.

CONCLUSION

1. Analysis of existing technology of drying and cleaning of cotton. The use of a pneumatic vehicle to transfer dried and heated cotton to the gin showed a sharp drop in fiber temperature and high electricity consumption.
2. The nature of changes in cotton humidity, fiber and seed temperatures as a result of cooling cotton at different air speeds was determined.
3. As the air velocity V increases, the fiber and seed temperatures decrease more V=0, while the fiber temperature decrease is 7,37^{0}C, 4,38^{0}C and 20,4 and 11,23^{0}C, respectively, at V = 15 m / s.

As a result of the experiment, it was found that it is possible to achieve a minimum decrease in the heating temperature of the cotton when it is transferred to the cleaning of the drying drum without the help of air.

After the cotton drying drum, the option of transferring the cleaners by mechanical transport was recommended.

We believe that the following issues need to be addressed in order to implement the recommendations made by a number of researchers that the cotton temperature should be 40-50^{0}C in cleaning processes.

First of all, the development of a hermetic conveyor, ensuring that the temperature of the cotton is 40-50^{0}C by transferring part of the hot air leaving the drying drum to the conveyor, depending on the temperature of the dried cotton.

It is necessary to determine the regularity of cooling in cotton cleaning equipment, if necessary, to use the option of providing additional hot air to the cleaners.

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