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On the technological development of cotton primary processing, using a new drying-purifying unit

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Abstract: The article reflects feasibility study of conducting research on technological development of cotton primary processing with the modified parameters of drying and cleaning process for small litter. As a result of theoretical and experimental research, drying and purifying unit is designed, in which in the existing processes a heat source, exhaust fans, a dryer drum, a peg-drum cleaner of cotton and the vehicle transmitting raw cotton from the dryer to the purifier will be excluded. The experience has shown that when a drying-purifying unit is installed (with eight wheels) purifying effect on the small litter of 34%, ie cleaning effect is higher than of that currently in operation 1XK drum cleaner. According to the research patent of RU UZ FAP 00674 "Apparatus for drying and cleaning fibrous material" is received.

1. Introduction

It is known that, for a long time cotton has been considered as the main wealth of Uzbekistan. That is the reason Uzbek people call it "white gold". In the years of independence from 1991 to the present day harvest in the Republic has decreased from 4,440 mln. tonnes to 3,350 mln. tonnes, due to decreasing quenching areas of cotton sowing and increasing the areas for crops [1]. It should be noted, that this reduction did not affect adversely country's economy, on the contrary it increased. This can be explained by the fact that there was a shift from quantity to quality of the product. Thus, nowadays Uzbekistan, according to the status of developing, moved from agro-industrial to industrial-agricultural country. It is thanks to independence that our first President of the Republic of Uzbekistan - Islam Karimov provided.

In the country breeding varieties are mainly grown such as cotton An Bayaut -2, Andijan 35, Bukhara 6, Namangan 77, C-4727 and C-6524.

Processing of raw cotton is realized in cotton processing plants. In the country, there are 98 cotton processing plants. If to enumerate them by the regions of the Republic, then there are 8 plants in Tashkent region, in Syrdarya region-8, in Jizak Region-10, in Andijan region-10, in Namangan region-8, in Fergana region-7, in Kashkadarya region-10, in Surkhandarya region-10, in Samarkand region-10, in Navoi region-3, in Khorezm region-6, in the republic of Karakalpakstan-8 cotton processing plants.

The technological process of primary processing of cotton in Uzbekistan consists of several stages, and a number of transport vehicles and technological machines is used in it (figure 1).



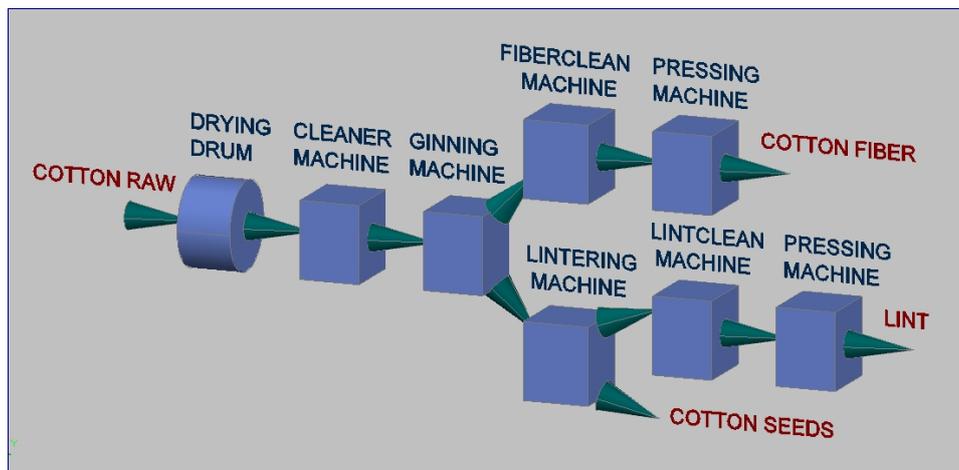


Figure 1. Technological process of primary processing of raw cotton.

At the beginning of the process, raw cotton is dried in a drying drum, then, using the separator, it is fed in the ginning machines, in which it is purified from small and large impurities. Raw cotton, purified from small and large impurities, using air transportation facilities, is fed to delivery auger that dispenses cotton-raw to gins. Fibres are separated from the seeds in it. Using the condenser, fiber is fed in the press, in which it is pressed into bales, and cotton seeds through the auger are transferred to the linter machine. Linter machine separates the remaining short fibers (lint) from cotton seeds.

At present, drying of raw cotton has a long drying time, which leads not only to overdrying of fiber and cotton seeds, and in addition to excessive expenditure of power and fuel. Overdrying of fibers can have a positive impact in the process of purification of raw cotton from foreign impurities, in such a way dried fiber is cleaned better from foreign impurities, but overdrying of seeds is affected adversely during ginning process.

2. Analytical part

As it is shown by numerous studies, conducted by various leading scientists in the direction of seed cotton drying [2-4] (Parpiev A P, Akhmatov M A, Gapparova M A, Usmonkulov A K and others), currently at the enterprises of cotton industry in Uzbekistan, drying process is still inefficient and overspends energy.

Available information on the previous studies of the drying process showed that all of the studies were carried out mainly in the narrow direction, studied only drying process or design of dryers. Applied in practice, technological regulation of cotton primary processing is made without taking into account the above facts, since research has not previously been carried out on the impact of cotton drying time for the next transition process and the main process of ginning and pressing. There is no research information in this direction abroad.

Earlier at AS «Paxta sanoat ilmiy markazi» techniques have been developed for experimental determination of strength and destruction force on cotton seed hull under laboratory conditions. These procedures may serve as a basis for the development of new methods to determine the effect of seed cotton drying time on the seeds hulls strength, strength of fiber attachment to the seed and plant development bench for experimental determination of the effect of drying time on the performance of ginning process. Thus, it may be noted that this problem has not previously been studied and has no analogues in the world.

It is found that a propulsive drum dryer type 2СБ -10 (figure 2) has the following disadvantages: According to the length and cross section, dried raw cotton is distributed unevenly. Cotton free zones form, in which the coolant flows out from the drier in transit and this leads to considerable loss of heat.



Figure 2. General view of the drum dryer 2CB-10

The coolant in length and cross-section of the drum is unevenly distributed. If the average speed when entering the drum is 7-8 m/s, then on the last meters of the drum it drops to 0.1-0.2 m/s. Constructive design of the dryer drum limits the speed of the coolant, entering the chamber. In order to prevent entrainment of incoming moist cotton along the drum, coolant velocity is maintained within 0,6-1,5 m/s.

The boundary layer is formed on the surface of the wet material, it creates a barrier to heat transfer. The speed of the incoming coolant (0.6-0.9 m/s) for boundary layer turbulence is inadequate [5]. In this regard, the heat in the material is passed only the thermal conductivity of the layer that affects in slowing down the process of heat and moisture exchange. Minimal residence time of raw cotton in the drum is still 5-6 minutes; the time of raw cotton fall from blades is only 1.0-1.5 min. The rest of the time cotton is in the passive drying zone that is in the zone of the blades.

As it is known, currently in the process of primary processing of cotton, drying time is not regulated although this has a significant impact on the quality parameters of the final product - cotton fiber and cotton seed. The drum dryer is used as a cotton dryer. Inside the dryer, raw cotton is subjected to prolonged drying up 6-10 minutes.

By overdrying of fibers and seeds their fragility is increased, especially the peel of seeds. As a result, during the ginning process shortening of fiber increases, which reduces spinning-technological properties and kindly leads to decrease of fiber value. Seeds pubescence grows after gin because fiber is not detached from the seed peel but it is broken on bending at the saw tooth. In separation of fibers from the seeds, as a result of the fragility of the rind seeds, peel of seed is destroyed and as a result formation of defects fiber increases- fiber cuticle and broken seeds, which leads to reduction in the quality of fiber into several classes. Destruction of the seeds hulls leads to deterioration in the quality of seeds. Prolonged heat also leads to drying of the seed kernel, which affects adversely the germination of seeds sown and can affect oil output from technical seeds. Overdrying also affects to fiber during pressing. Due to high elasticity of the fiber, lightweight fiber bales are obtained, that leads to over expenditure of packing materials and underloading of cars and to frequent destruction of strapping belts.

On the basis of all the above it can be argued that the current to date production schedules require major upgrade by using the results of research on the effect of drying time cotton on the process of ginning, which allows: reducing the cost of electricity, fuel and fiber loss, improve the quality of produced products.

3. Problems solving

The aim of research is to develop modernized technology of primary processing of raw cotton which allows to reduce the cost of electricity, fuel, as well as loss of production, improve the quality of produced products.

To run this program, conduct of theoretical and experimental studies is provided in both laboratory and industrial conditions, development of new methods for setting unique laboratory researches on identifying changes of detachment force of fiber from seed peel, depending on drying time, designing and manufacturing of special laboratory bench units.

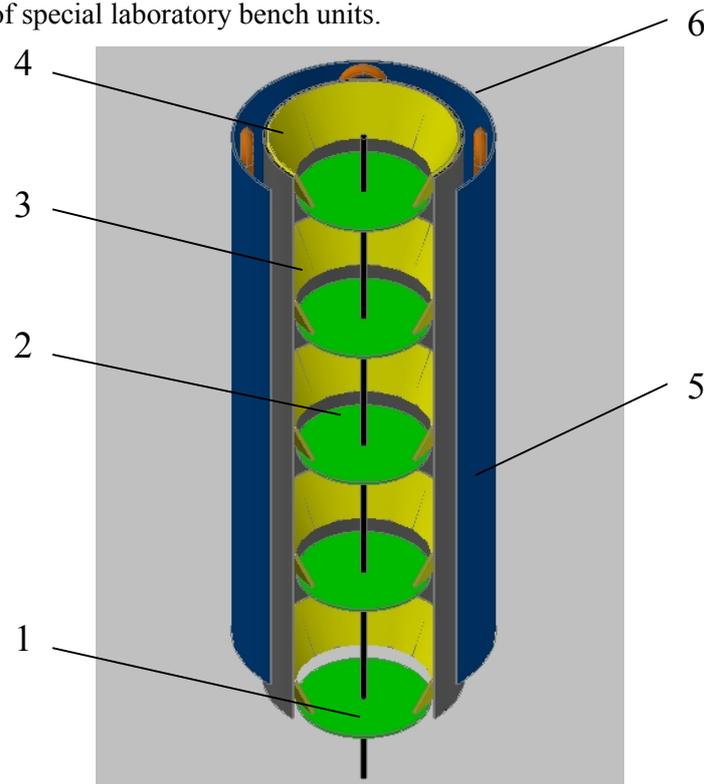


Figure 3. A new drying-purifying unit

1-rod; 2-disc; 3-guide; 4 –grid wire surface; 5-shell; 6-heating element.

As part of this work drying-purifying unit is designed (figure 3), under use of which in the current process, exhaust fans, dryer drum, a peg-drum cleaner of raw cotton and the vehicle transmitting raw cotton from the dryer to the purifier will be excluded [6].

Drying-purifying unit works as follows: fibrous material in feeder 8 from cell through feed rollers through inlet (not shown) is fed uniformly to disk 2 on shaft 1, constantly rotating through the motor; Under influence of centrifugal force the fibrous material 2 is ejected from the disk at a certain speed (depending on the number of revolutions of the shaft 1) on the perforated shell surface 4. The weight and windage of the fibrous material and foreign materials differ from each other, so they get different speed by throwing, as a result their intensive loosening is going on. When the disc is driving from 2 to 4, the treated material is cleaned by thermal agent, supplied into the perforated shell 4, from the heating elements (6) through the shell, in the final phase of flight a fiber material hits to perforated surface of shell 4.

As a result of loosened fibrous material impact with perforated surface of shell 4 intensive weed impurity liberation takes place in the annular space, formed between the shell and the fixed 4 cylindrical casing 5, pinned to the frame, and from there they are sent to the sunk waste. Purified fibrous material with a perforated surface roll down on the tray 3 on which it is supplied to the next disc, which repeats the process, described above. Trays are installed at an angle of at least 55° to the

plane of the disk 2. Cleaned and peeled material is got off a drum from below through the branch pipe. Treated (filled with water steam) heat agent from the top of the annular space formed between the shell 4 and the stationary cylindrical casing 5 is given to utilization.

4. Block diagram

A system block diagram of automatic control of temperature in the drying and purifying unit is developed (figure 4).

Algorithm of temperature controlling process inside the drying and cleaning unit is as follows:

On the scale of the "center" of the signal processing coming from the temperature sensors and giving a signal to the actuator to turn on or turn off heaters, required level of minimum and maximum temperatures, depending on starting source humidity of raw cotton is set.

The heaters power is turned on. Upon reaching the maximum temperature inside, the unit receives a signal from the temperature sensors in the "Center" signal processing, which instructs the actuator to shut off heaters. After that, the temperature drops inside the unit. Upon reaching the minimum temperature, according to the signal of temperature sensors, signal processing "Center" instructs the actuator to switch heaters. The process is constantly repeated.

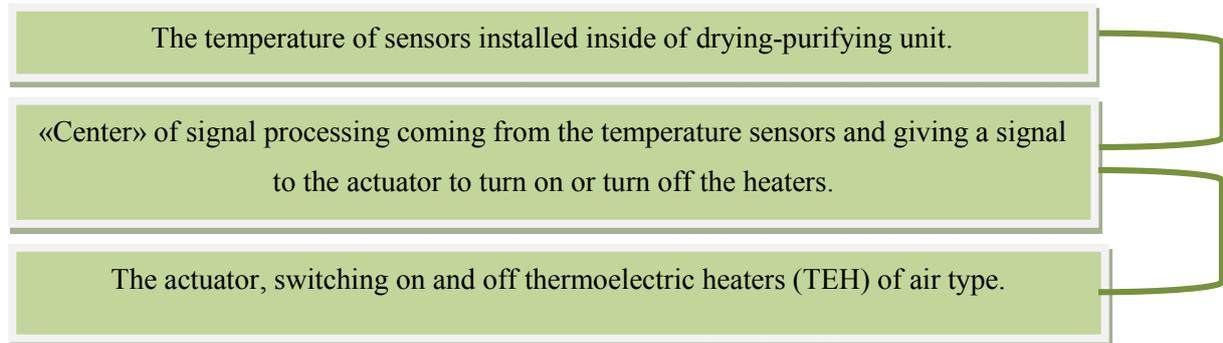


Figure 4. Block diagram of the system automatic temperature control

5. Experienced data

Investigations have been done on determination the cleaning performance from small litter.

Table 1 shows the results of studies to determine the cleaning effect on small litter of drying-purifying unit.

Table 1. Quality indicators of cotton raw on transitions cleaning.

Indicators	Cotton contamination, %	
	Overall	In the small litter
1. Raw cotton before cleaning	9.1	6.4
2. Raw cotton after cleaning		
600 turns/min	8.14	6.36
800 turns/min	7.81	6.10
1000 turns/min	7.46	6.07
3. Raw cotton after two cleaning		
600 turns/min	7.4	4.92
800 turns/min	7.12	4.64
1000 turns/min	7.2	4.70
4. Raw cotton after cleaning three times		
600 turns/min	7.14	4.56
	7.0	4.2

800 turns/min	7.13	4.36
1000 turns/min		
5. Raw cotton after cleaning four times		
600 turns/min	6.93	4.3
800 turns/min	6.95	4.16
1000 turns/min	6.86	4.25

6. Analysis of experiments.

Analysis of the data shown in figure 5 of the graph shows that when drying-purifying unit is installed (with eight wheels) purifying effect on the small litter may reach 34%, i.e. cleaning effect higher than of that currently operated drum cleaner 1XK.

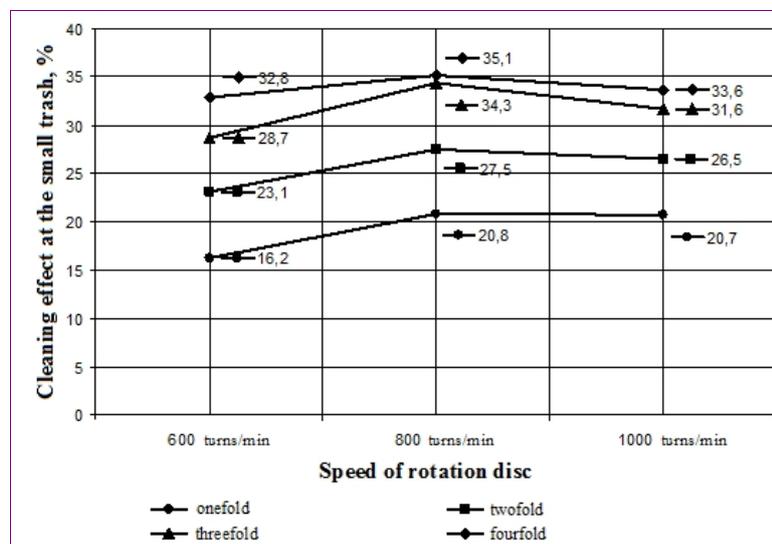


Figure 5. Graph of impact of speed and the number of disks of cotton cleaner unit on cleaning effect on the small litter

This cleaning effect is achieved due to the impact of raw cotton, issued from the rotating disk by centrifugal force and the subsequent impact on the mesh surface, through the hole of which small litter is screened.

According to the research, patent of RU UZ FAP 00674 "Apparatus for drying and cleaning fibrous material" is received.

7. Conclusions

1. As a result of theoretical and experimental studies, drying and purifying unit is designed, during use of which in existing processes, heat source, exhaust fans, dryer drum, a peg-drum cleaner of raw cotton and the vehicle transmitting raw cotton from the dryer to the purifier will be excluded.
2. Studies have shown that when drying-purifying unit is installed (with eight wheels) purifying effect on the small litter of 34%, i.e. cleaning effect is higher than of that currently in operation 1XK drum cleaner.
3. Preliminary calculations of economic efficiency suggests that it will be more than 100 mln. UZS per cotton plant per year, it will help improve environmental situation and working conditions.

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