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Influence of the Cotton-Raw Drying Regime in Drum Dryer on the Density Part of the Defects and Litter Impurities in Fiber

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ABSTRACT: In scientific literature, there is no common opinion about the effect of the drying process on the density part of the defects and litter impurities in the fiber. The article reveals the regularities of the change in the density part of the defects and litter impurities in the fiber after purification and dinning of raw cotton dehydrated under different conditions and multiplicities, according to which it will be possible to recommend optimal drying parameters for obtaining high-quality fibers.

KEY WORDS: Raw cotton, Fiber, Drying, Drying regime, Litter, Defect, Moisture, Drying agent, Drying rate, cleaning, Ginning.

I.INTRODUCTION

The density part of the defects and litter impurities affects the formation of yarn and fabric. Especially the rind with fiber, nodules and flagella are considers the most harmful, from the spinning-technological point of view (pass into the tissue).

Raw cotton, supplied from farms to cotton-ginning enterprises, is a multicomponent material and consists of fiber, seeds and foreign impurities attached to the pulp. In turn, seeds consist of peel and kernel, and foreign impurities are mineral impurities, stone, leaves, etc., which have different physic-mechanical, hygroscopic properties and different humidity, even under the same conditions. Therefore, drying a material such as raw cotton requires a specific approach, since these components of the raw materials are in constant interaction with the exchange of heat and moisture, and we need to find a drying regime that does not degrade qualitative indicators like fibers, and seeds.

II. LITERATURE SURVEY

The regulated technological process provides drying of cotton up to 8-9% of humidity [1], which is justified by the efficient operation of further technological machines. Achieving this, especially with an increased initial moisture content of cotton, is a significant difficulty, since the moisture extraction of existing dryers is limits by their technological capabilities.

In scientific literature, there is no common opinion on the effect of the drying process on the content of defects and littered fiber. The contradictory nature of the dependencies obtained by different authors can be explained, obviously, by the difference in drying conditions in the experiments (in a thermostat, drying cabinet, special devices, etc.) and the non-conformity of these conditions to the convective drying conditions used in industry (considerable temperature variation and moisture retention in the drying process), as indicated by the large ranges of the revealed extreme temperature regimes, and also by the fact that the influence of the initial state (moisture, looseness) of raw cotton on the change in a fiber structure, therefore, the choice of temperature regimes was not given the predominant value.

In drum dryers, the drying process is accompanies by shredding of raw cotton. This leads to a change in the structural composition of raw cotton, activation or passivation of littered impurities. It is known that loosening of raw cotton has a significant effect on the parameters of the purification process [2] and ginning [3].

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III. METHODOLOGY

Our studies were carried out on a 2SB-10 (2СБ-10) dryer with the temperature of the drying agent $T_{c.a.}$=100 and 200°C ($-x_3$, $+x_3$), with production rates 3,5 and 10 tons per ($-x_2$, $+x_2$) hour for wet cotton. The object of research was cotton raw variety of C-6524, with industrial grade II, with initial moisture content $W_{c/s}$=10,5 and 22,3% ($-x_1$, $+x_1$) [4-6].

The experiments were carried out at one-, two- and three-time drying.

The selected samples of raw cotton determined the qualitative and quantitative characteristics of raw cotton and its components. The remaining part of the sample of raw cotton spread on the steels for further drying in natural conditions.

The dried samples of raw cotton cleaned from fine and coarse (UXK) litter, and then subjected to ginning (5DP-130) and fiber cleaning (3OVP). After ginning raw cotton and cleaning the fiber, cotton fiber taken to analyze the density part of the defects and litter impurities in the fiber.

To compare the results, a control sample is a fiber sample versus fiber obtained after solar-air drying.

All the planned experiments carried out in three surfaces.

After the experiment, the cotton fiber, as well as the raw cotton analyzed for the content of defects, according to the adopted methods and the state standard.

The analysis of the regression equations obtained shows that all the adopted factors significantly influence the output parameters either independently or in interaction.

Mathematical processing of the results of the experiments made it possible to obtain separate equations of regression for each frequency of drying.

IV. EXPERIMENTAL RESULTS

In order to determine the influence of the temperature of the drying agent and the productivity of the dryer on the density part of the defects and litter impurities in the fiber, we analyzed the following regression equation:

- for one-time drying:

The dryer on the density part of the defects and litter impurities in the fiber:

$$y_{n.з.} = 5{,}52 + 0{,}449x_1 + 0{,}27x_2 - 0{,}109x_3;$$

The dryer on the density part of the defects in the fiber:

$$y_{n.} = 2{,}33 + 0{,}158x_1 + 0{,}116x_2 - 0{,}046x_3;$$

The dryer on the density part of the litter impurities in the fiber:

$$y_{з.} = 3{,}2 + 0{,}29x_1 + 0{,}157x_2 - 0{,}063x_3;$$

- for double drying:

The dryer on the density part of the defects and litter impurities in the fiber:

$$y_{n.з.} = 4{,}99 + 0{,}425x_1 + 0{,}23x_2 - 0{,}136\,x_3;$$

The dryer on the density part of the defects in the fiber:

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$Y_{n.} = 2,15 + 0,15x_1 + 0,1x_2 - 0,06x_3$;

The dryer on the density part of the litter impurities in the fiber:
$Y_{з.} = 2,84 + 0,275x_1 + 0,13x_2 - 0,076x_3$;

- for three-time drying:

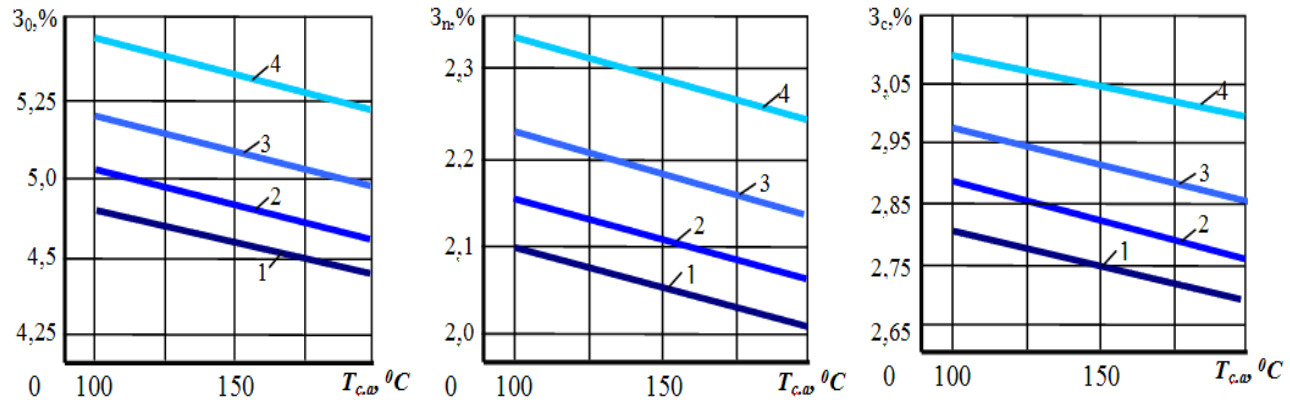
The dryer on the density part of the defects and litter impurities in the fiber:
$Y_{n.з.} = 4,41 + 0,497x_1 + 0,256x_2 - 0,096x_3$;

The dryer on the density part of the defects in the fiber:
$Y_{n.} = 1,96 + 0,177x_1 + 0,11x_2 - 0,04x_3$;

The dryer on the density part of the litter impurities in the fiber:
$Y_{з.} = 2,45 + 0,32x_1 + 0,146x_2 - 0,056x_3$.

V.CONCLUSION AND FUTURE WORK

For the mass fraction of defects and weed impurities in the fiber for a single drying regression coefficient b_1=0,449; at a double 0,425, and at three-fold drying 0,497. This shows that the three-fold drying of high-moisture cotton raw material adversely affects the mass fraction of defects and impurities in the fiber, since excessive shoveling of the wet raw material results in the firing of the fibers, which leads to the appearance of such defects as gin, In addition, passive sores are actualized, which during the purification process will be difficult to remove.



a) *b*) *c*)

Fig. 1. Dependence of the dryer on the density part of the defects and litter impurities in the fiber (a), defects (b) and littered impurities in the fiber (c) on the temperature of the drying agent at the initial moisture content $W_{c/s}$=10,5% with a single drying of raw cotton.
1,2, 3, 4 – respectively, at a performance of 3,5; 5; 7 and 10 t/h

Also, the productivity of the drying drum on the mass fraction of defects and impurities in the fiber adversely affects: b_2=0,27 for a single drying, 0.23 for a double and 0.256 for three times.

The high temperature of the drying agent positively affects the mass fraction of defects and weed impurities in the fiber: b_3=-0,109 with a single drying. This is explained by the fact that as the moisture content of raw cotton decreases during drying, the passive fine litter in the coolant flow is removed from the drying drum, especially when double drying (b_3=-

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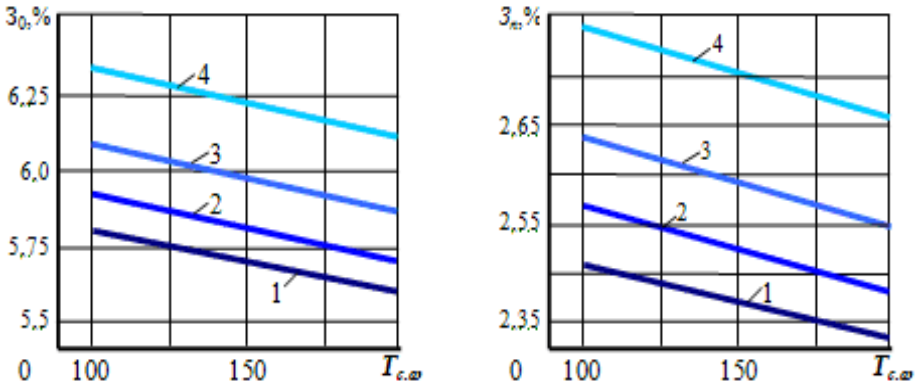
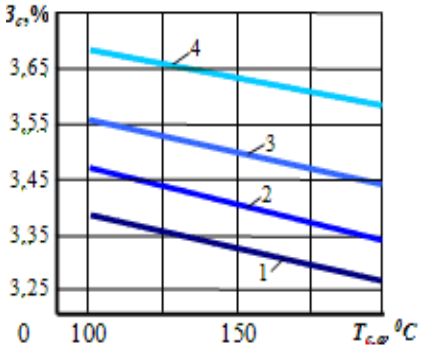
0,136). But when drying three times the temperature of the drying agent decreases (b_3=-0,096), because despite the relatively low moisture content of raw cotton, most passive sours are removed by previous drying processes, and the remaining ones are converted to active litter, which can be removed by compulsory (mechanical) influences.

To analyze the mathematical models obtained, a numerical calculation of the output parameters is gives for different values of the main factors.

The results of numerical calculations obtained by mathematical processing are presents in the form of graphs in Fig. 1-5.



a) *b*)



c)

Fig. 2. Dependence of the dryer on the density part of the defects and litter impurities in the fiber (a), defects (b), and littered impurities in the fiber (c) on the temperature of the drying agent at the initial moisture content $W_{c/s}$= 22,3% with a single drying of raw cotton.
1, 2, 3, 4 – respectively, at a performance of 3,5; 5; 7 and 10 t/h

As evident from the figures, with increasing temperature of the drying agent, there is a tendency to reduce the content of defects and litter of fiber. Obviously, with a single drying, raw cotton with a lower moisture content in the drum loosens well, and rubbings are passivate, and the cleaning process is more convenient (Figure 1). This is confirms by the fact that for analysis we subjected to cleaning and ginning raw cotton without drying (after air-solar drying) and got a fiber with 5,8% of defect and littered content. Raw cotton with moisture content $W_{c/s}$ = 22,3% (Figure 2) after drying, cleaning and ginning reaches 6,36% defect and littered content, than without drying. Obviously, when drying raw cotton with high humidity in the drum, the litter is activates and further processes (purification, ginning) are less successful (more lumps are formed, etc.).

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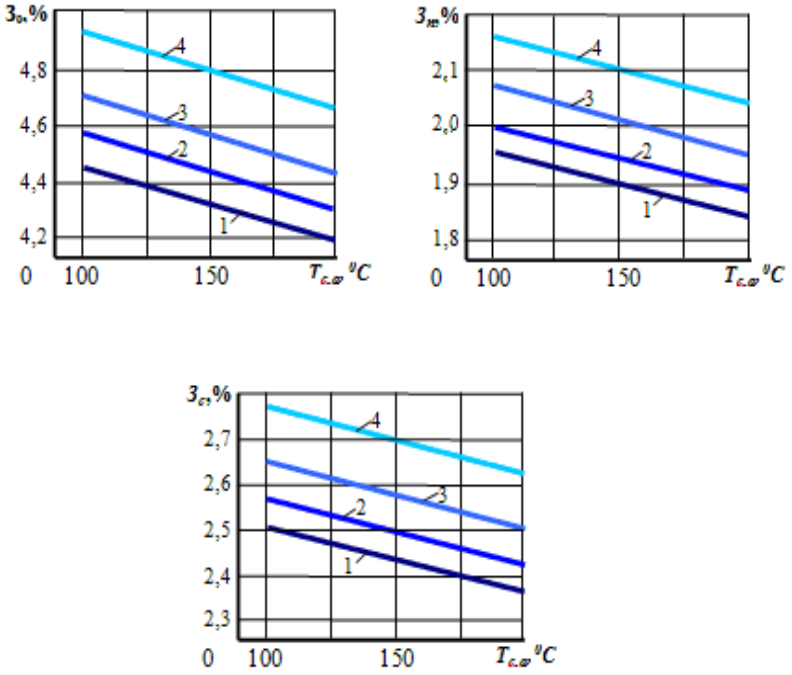

Fig. 3. Dependence of the dryer on the density part of the defects and litter impurities in the fiber (a), defects (b), and littered impurities in the fiber (c) on the temperature of the drying agent at the initial moisture content $W_{c/s}$= 10,5% double drying of raw cotton.
1, 2, 3, 4 - respectively, at a performance of 3,5; 5; 7 and 10 t/h.

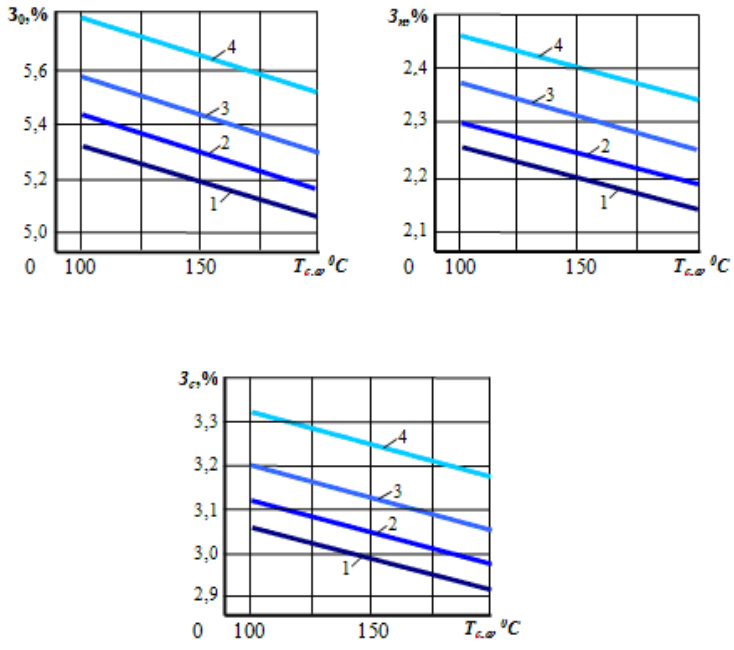

Fig. 4. Dependence of the dryer on the density part of the defects and litter impurities in the fiber (a), defects (b), and littered impurities in the fiber (c) on the temperature of the drying agent at the initial moisture content $W_{c/s}$= 22,3% for double drying of raw cotton.
1, 2, 3, 4 - respectively, at a performance of 3,5; 5; 7 and 10 t/h.

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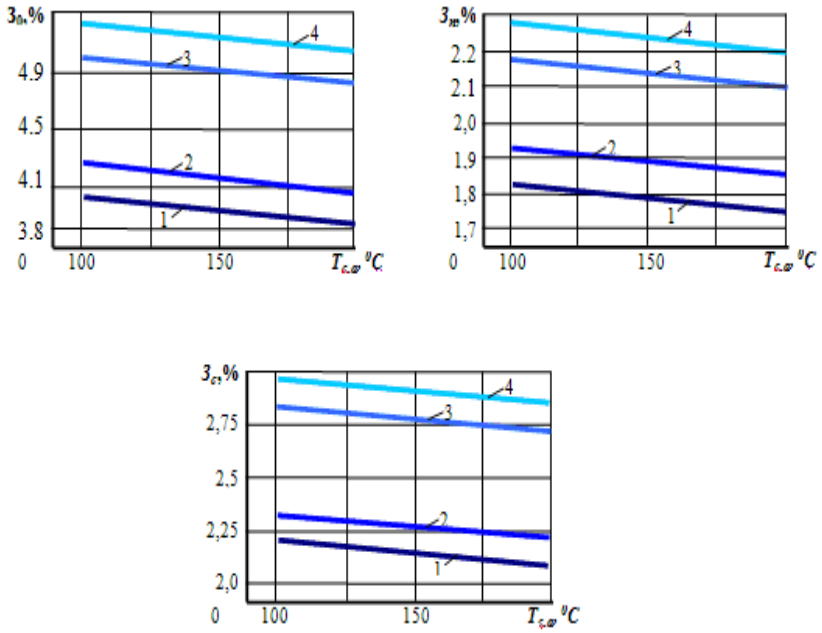

Fig. 5.Dependence of the dryer on the density part of the defects and litter impurities in the fiber (a), defects (b), and littered impurities in the fiber (c) on the temperature of the drying agent with a three-fold drying of raw cotton. 1, 2 - at a capacity of 7 and 10 t/h, respectively, with an initial moisture content of $W_{c/s}$=10,5%; 3, 4 - at a capacity of 7 and 10 t/h, respectively, with an initial moisture content of $W_{c/s}$=22,3%.

The content of defects and littering of the fiber, both for single and double and triple drying, also tend to decrease with increasing temperature of the drying agent and a decrease in the productivity of wet cotton raw (Figure 3- 5).

It significant in [7] that the application of the temperature of the drying agent T = 200 ° C leads, along with a decrease in the content of littered impurities in raw cotton, to the formation of such defects as rind fiber, down, nodules, the most harmful from a spinning-technological point of view. Our experimental studies carried out according to a special method, i.e. after the drying process, raw cotton brings to a moisture content of about 8% under natural conditions, processed regardless of the drying regimes under equal conditions, (cleaning from small and coarse litter, ginning, and fiber cleaning). Our results shows that it is not the temperature affects to as such harmful defects, but the moisture content of raw cotton does affects when it is processing.

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