Results Of Studying The Operational Process To Improve The Existing Aspiration System

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Abstract

The article presents the results of a study conducted to substantiate the directions for improving the existing aspiration system of the UHK aggregate used for cleaning raw cotton at the "Angor" cotton processing enterprise in Surkhandarya region. The study examines the amount of fine impurities generated during the operation of the aspiration system, the fractional composition of the impurities, their transportation through aspiration pipelines, and the cleaning processes within the system.

Keywords: Cotton, section, cleaning, impurity, aspiration, pneumatic pipeline, cyclone, diffuser, pressure.

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1. Introduction

As a test object, the aspiration system of the UHK raw cotton cleaning unit at the "Angor" cotton processing enterprise in Surkhandarya region was selected [1] (Figure 1).

Figure 1. View of the existing aspiration system of the UHK aggregate at the "Angor" cotton processing plant,

selected as the test object.

As can be seen from Figure 1, the suction pneumatic pipelines from each section of the existing aspiration system of the UHK cotton cleaning unit are connected in series, starting from the cotton input part of the UHK unit, to a main pneumatic pipeline, the diameter of which gradually increases.

The aspiration system shown in Figure 1 was conditionally divided into four sections. The first section was taken as a pneumatic pipeline connected to the bunker where fine impurities are separated from the 1HK cleaner located at the initial part of the UHK aggregate. The second, third, and fourth sections were considered as pneumatic pipelines connected to the bunkers for fine impurity separation, located in the intermediate parts of the UHK aggregate's large impurity cleaning sections.

First of all, when conducting the experiments, we took into account the recommendations of the "Markaziy Paxta Sanoati Ilmiy-Tadqiqot Instituti" (MPSITI), according to which the volume of air to be extracted from each waste bunker of the cleaning unit should be 0.5 m3/s, and the diameter of the pneumatic pipeline should be 160 mm [2].

Experiments were conducted under production conditions to determine the concentration of dusty air generated in the aspiration system of the UHK cotton cleaning unit at the "Angor" cotton processing plant, which was selected as the test object.

For this purpose, the amount of fine impurities supplied to the aspiration system from the sections of the UHK cotton cleaning unit at the "Angor" cotton processing plant in Surkhandarya region was determined experimentally.

The parts consisting of four spiked drums in each fine-purpose cleaning section were examined separately. Since the last (fourth) section of the UHK aggregate contains only two spiked drums, the waste obtained from this section was conditionally multiplied by two.

During the experiments, raw cotton of the Bukhara-102 selection variety, industrial grade 2, with a impurity content of 6.8% and a moisture content of 9.2%, was initially processed. The amount of fine impurities separated from the first, second, third, and subsequent sections of the UHK aggregate (counted from the cotton input side) was determined. For this purpose, the aspiration pipes of the fine-impurity cleaning sections of the UHK aggregate were disconnected, and the impurities separated during cotton cleaning were collected from the lower part of the aggregate. The productivity of the UHK aggregate in cotton cleaning was 6,800 kg/h. The duration of each experiment was set at 20 minutes. The obtained results are presented in Table 1 [3].

Table 1

The amount of impurities separated from the fine-impurity cleaning sections of the UHK aggregate.

Repetition of experiments	Amount of trash separated from the sections of the UHK unit, kg/percent				Total amount, kg/percent
	first	second	third	fourth	
1.	22/38.6	16/28.1	11/19.3	8/14.0	57/100
2.	24/43.6	14/25.4	10/18.2	7/12.8	55/100
3.	20/35.7	15/26.8	12/21.4	9/16.1	56/100
average	**22/39.3**	**15/26.8**	**11/19,6**	**8/14.3**	**56/100**

As can be seen from the experiment results in Table 1, the amount of small impurities separated from the cleaning sections of the UHK cotton cleaning unit is highest at the cotton input of the unit, and then decreases as shown in Table 1. Thus, as a result of the intensive separation of small trash impurities in the sections at the head of the UHK unit, their amount was 39.3% of the total amount of separated trash impurities (Fig. 2).

From the obtained data, it can be concluded that the concentration of dust in the dusty air, which is absorbed into the aspiration system from the sections of the cotton-cleaning unit of the UHK at the cotton input, is higher than in the other sections.

Fig. 2. Appearance of waste from the waste bunker of the sections of the UHK cotton cleaning unit

Because, according to the recommendations [2], the amount of air sucked from the waste bunker of each section of the UHK cotton cleaning unit (0.5 m3/s) is equal to each other, more dust (waste) is being transported compared to equal air consumption.

Unfortunately, the aspiration system shown in Figure 1 will be relatively inefficient, since the connecting pneumatic pipe of a large diameter is installed in the final cleaning section of the UHK unit. If the concentration of dusty air increases further along the length of the UHK unit and additional air suction occurs due to the loss of airtightness of the pneumatic pipe, the efficiency of the cleaning system may significantly decrease, or a blockage may form in the pneumatic pipe. Because the degree of efficiency reduction depends on the tightness of the aspiration system and the dispersion or fractional composition of the dust (Fig. 3).

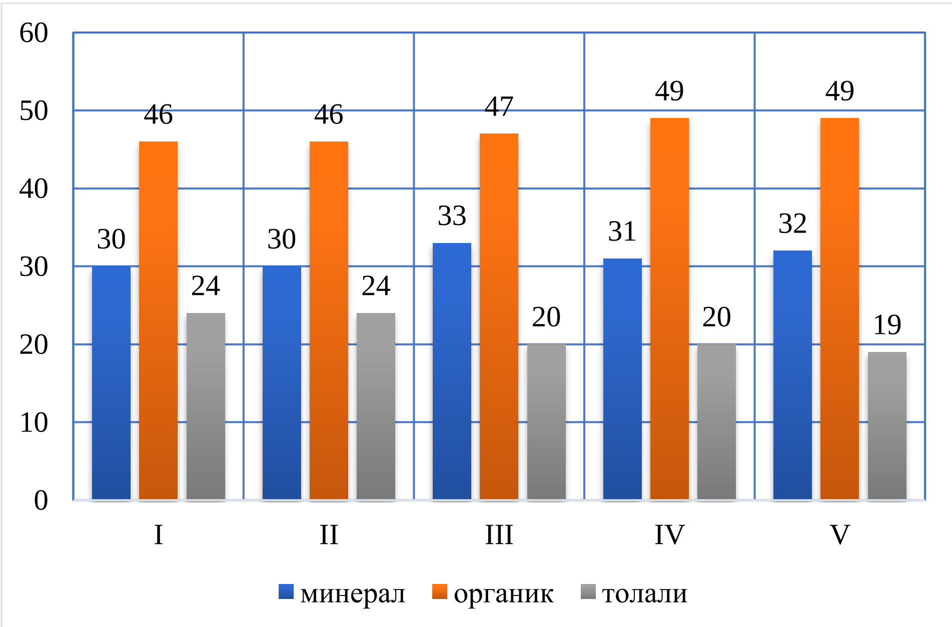


Fig. 3. Fractional composition of waste from the cotton ginning process by cotton industry grades.

From the histogram in Figure 3, it can be seen that during the cotton cleaning process, the amount of mineral waste varies by industrial varieties up to 30-32%, the amount of organic waste varies up to 46-49%, and fiber waste varies up to 24-19%, a large amount of organic waste is released during the cotton cleaning process, which depends on the cleaning effect, which should be taken into account when adjusting the aerodynamic regime in the aspiration system.

Significant progress can be achieved in solving the environmental problems of cotton ginning enterprises by optimizing the operation of pneumatic transmission and aspiration systems aimed at reducing the use of technological air. This will allow for the development of an aspiration system with optimal technological parameters for cotton cleaning equipment, eliminate discrepancies in the characteristics of cyclones and centrifugal fans, and, as a result, increase the efficiency of dust removal.

In particular, a centrifugal fan will be used to deliver dusty air from the aspiration system to the cyclone. The air efficiency of the centrifugal fan must correspond to the hydraulic resistance arising from the cyclone's volume. In addition, the velocity of dusty air transported by the centrifugal fan at the entrance to the cyclone should have a value that ensures maximum separation of the dusty mass introduced into the cyclone from the air.

The spraying pipe of the suction fan in the aspiration system of the existing UHK unit has a rectangular cross-section F0 , to which a cylindrical diffuser with a length l and a cross-section equal to F1 is connected. With the expansion of the diffuser by an angle α, the airflow velocity before entering the air duct can vary from V0 to V1 (Figure 4).

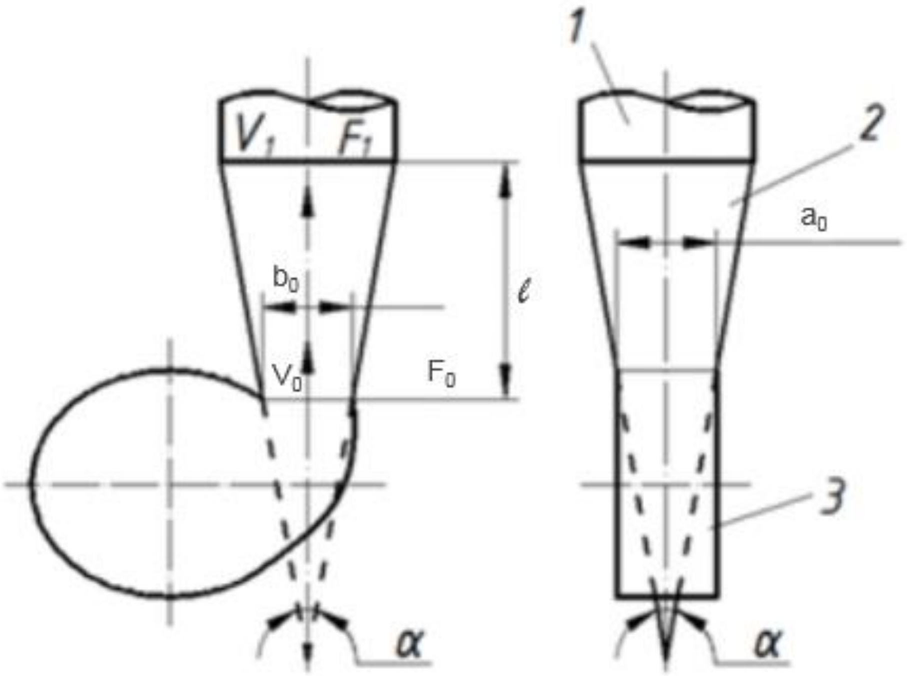
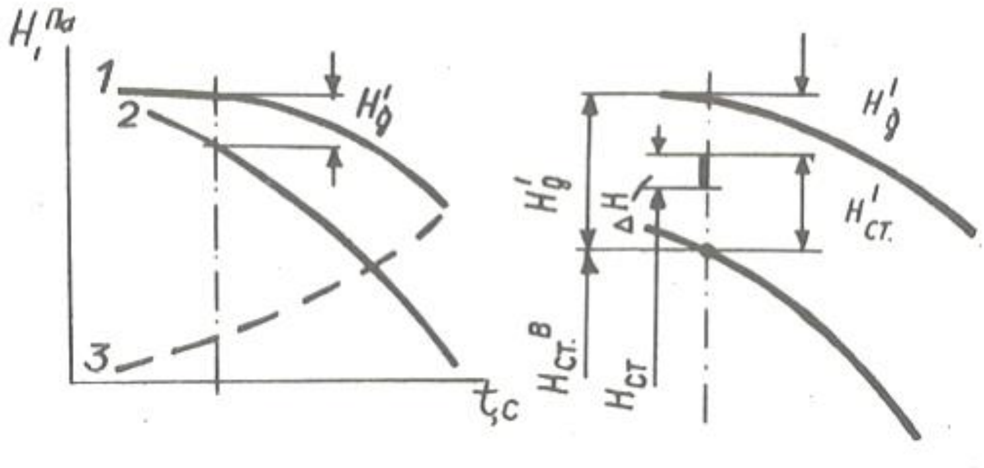


Fig. 4. Diagram of the diffuser with the fan

1-air duct; 2-diffuser; 3-ventilator

In the diffuser, due to its expansion, part of the dynamic pressure changes to static pressure, and as a result, the air flow velocity decreases from V0 value to V1value. As a result, the additional static pressure H1st is determined by the loss of dynamic pressures H1g in the narrow section of the diffuser and H11g in the wide cross-section, taking into account ΔH [4, 5, 6] (Fig. 5).



5 - Fig. Aerodynamic characteristics of the centrifugal fan and pressure changes

Pressure: 1-full; 2-static, 3-dynamic

From the above analyses, we can conclude that the dust air purification efficiency of the existing UHK unit's aspiration system is low, and we can observe the rise of dust air upward through the exhaust pipe of centrifugal cyclones at many cotton ginning plants. In order to eliminate these shortcomings, research areas were selected, and a plan for conducting practical experiments was developed.

The dust collection effect of the UHK unit's aspiration system, the difference in air pollution entering and exiting the dust collector (cyclone), was determined using the following expression:

$$\eta = \frac{d_1 - d_2}{d_1} \cdot 100 \text{, \%} \quad (1)$$

where: d_1 -dust content of the air entering the dust collector, mg/m^3;

d_2 - dust content of the air emitted from the dust collector, mg/m^3.

We determine the hydraulic resistance of cyclones as follows:

$$\mathrm{P} = \frac{\rho * V^2 * f}{2} \quad (2)$$

Here: ρ is the air density in the calculated part of the cyclone, respectively, kg/m^3.

V- air velocity, m/s.

f - hydraulic resistance coefficient.

The air velocity is determined by the following expression.

$$V = \sqrt{\frac{2g}{\gamma} P_d} \quad (3)$$

Bu yerda, P_d- dynamic pressure, Pa;

g- free fall acceleration, m/s^2;

γ —air density, kg/m^3.

The density of air, its pressure and temperature are determined by the following expression according to the Clapeyron formula [6]:

$$\rho_0 = \frac{\rho}{RT} \text{ kg/m}^3 \quad (4)$$

Here, ρ-absolute air pressure, mm Hg;

T- absolute temperature, ^{0}C;

R is a relative air constant, having different values for different gases, but not dependent on temperature and pressure (for air R =287 J/kg.K).

(for standard conditions, at T= 200C, ρ=101325 Pa, R=287 J/kg.K.)

$$\rho_0 \frac{101325}{287\ (273+20)} = 1{,}2 = \text{kg/m}^3 \text{ will be equal to.}$$

Air consumption is determined by the following expression.

$$Q=V_{mid}\cdot F \quad (5)$$

In this case: F - cross-sectional area of the air duct, m^2;

V_{mid}- average air velocity, m/s.

A U-shaped pressure gauge was used to determine dynamic pressure, and a pyto tube was used for measurement.

If we assume that the waste separated from the sections of the UHK unit, obtained in the experiments in Table 1 above, is conditionally 100% absorbed into the aspiration system and transported to the cyclone, then by simple arithmetic calculations we can determine the concentration of dusty air for the entire aspiration system and for each section.

The total amount of waste emitted from Table 1 was 56 kg in 20 minutes. If we assume that the air content in the aspiration system of the UHK unit is 6.0 m3/s:

The amount of dust absorbed by pneumatic transport per second Mh:

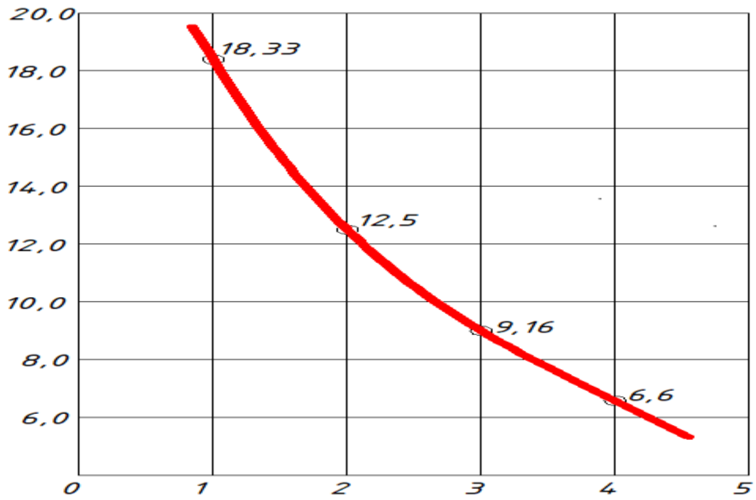
$$Mh = \frac{56000}{20x60} = 46.6 \text{ g/s} \quad (6)$$

In this case, the concentration of dusty air sucked into the aspiration system of the UHK unit will be equal to:

$$46.6 \text{ g/s: } 6.0 \text{ m}^3\text{/s} = 7.76 \text{ g/m}^3 \quad (7)$$

By the same method, we can determine the concentrations of dusty air sucked into the aspiration system for each selected section of the UHK unit for cleaning cotton, using the experimental results obtained in Table 1. In this case, it was taken into account that two suction pipes are connected to each suction section, and the amount of suction air in each suction pneumatic pipe is equal to 0.5 m3/s.

The calculation results are presented in the form of a graph in Figure 6



Designation of UHK unit sections

Fig. 6. Concentration of exhaust air sucked from each selected section of the UHK cotton cleaning unit

As can be seen from the analysis of the graph in Fig. 6, the concentration of dusty air sucked into the aspiration system in each selected section of the UHK unit differs sharply across the sections. Due to the fact that the first section of the UHK unit for cleaning cotton, on the side of receiving cotton, releases the largest amount of dust waste, the concentration of dusty air absorbed into the aspiration system from this section is the highest and is 18.33 g/m3.

2. Conclusion

In the section of the UHK unit for cleaning cotton near the discharge of cleaned cotton, that is, in the selected section 4, the concentration of dusty air absorbed into the aspiration system is the lowest and is 6.66 g/m3. Consequently, a relatively small amount of dust is released from this section.

From the foregoing, it can be concluded that the installation of pneumatic pipes of the same diameter in all sections of the UHK unit for cleaning cotton, selected as the test object, and the suction of the same amount of air will inevitably lead to inefficient operation of the aspiration system.

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