DISTRIBUTION OF COTTON MASS BY AIR TRANSPORT PIPE LENGTH AND CROSS-SECTION

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Abstract. *In this article, the problems of creating and introducing effective technology of transportation in pneumatic transport by taking raw cotton as a specific body and transferring it at the same rate along the length of the air pipeline were considered. In the research conducted in production conditions, it was determined that the volume density of cotton changes in different sizes during the transfer of cotton to pneumatic transport.*

Keywords: *air transport, cotton, ventilator, unevenness, volume, density, distribution, speed, congestion, fiber, pressure, seed, steel.*

РАСПРЕДЕЛЕНИЕ МАССЫ ХЛОПКА ПО ДЛИНЕ И СЕЧЕНИЮ ТРУБ ВОЗДУШНОГО ТРАНСПОРТА

Аннотация. *В данной статье рассмотрены проблемы создания и внедрения эффективной технологии перевозки на пневмотранспорте путем взятия хлопка-сырца в качестве специфического тела и передачи его с одинаковой скоростью по длине воздухопровода. В исследованиях, проведенных в производственных условиях, установлено, что объемная плотность хлопка изменяется в разных размерах при передаче хлопка на пневмотранспорт.*

Ключевые слова: *воздушный транспорт, хлопок, вентилятор, неравномерность, объем, плотность, распределение, скорость, загруженность, волокно, давление, семена, сталь.*

INTRODUCTION

When a transported material (object) is introduced into the air transport pipe, the aerodynamic regime in the equipment changes completely. In this case, there is a force that pulls the material into the air stream, and the material follows the air inside the air duct under the influence of this force. Most scientists believe that the object is moved (moved) only by resistance forces, and model the parameters of the object's motion as a function of air speed only. If this were the case, fans that produce large airflow (ie, dynamic pressure) would be recommended for air transport equipment. In practice, fans and pumps (compressors) that generate more pressure are used for air transport. The main reason for this is that not only dynamic, but also static pressure plays a major role in air transport.

Tests show that cotton raw materials are transported by air several times in the cotton ginning enterprises operating in the republic. Depending on the mutual location of the shops and cotton warehouses in the enterprise, the number of cotton passes by air transport is up to 4-6.

METHODS

Centrifugal fans with VTs-8M, VTs-10M, VTs-12M brands, capacity 30, 55, 75 kW/h, air consumption 3.5, 5.5, 6.4 m^3/s, respectively is used. Steel pipes with a thickness of 2-3 mm and an internal diameter of 0.4 m are used as a material conductor (air pipe).

In many studies, the elements of air transport of raw cotton, as well as the laws of movement within the air pipeline, have been studied at different levels. In these researches, we put a slightly different problem - we analyze the process of cotton transportation by air, based on the laws and indicators determined in our current and previous research, based on engineering calculations.

Material handling performance is one of the main indicators of pneumatic equipment. It is defined as:

$$P = \frac{M}{t}, \tag{1}$$

where: M is the weight of cotton; t - transport time.

the mass of cotton over the entire length L of the air pipe using this integral:

$$M = \pi R^2 \int_0^L (1-m)\gamma dx,$$

(2)

Here: m is the porosity of the medium (cotton raw material), which should be determined by the flow equation. If there is an initial feed rate of the raw material v_0 and a rate at an arbitrary section of the air pipe v, then the following equality is valid in the stationary transfer mode:

$$1-m=(1-m_0)v_0\gamma_0/\gamma v, \tag{3}$$

Here m_0 and γ_0 are the porosity and density of cotton raw material at the entrance to the air pipe, v and γ the velocity and density of the raw material at an arbitrary section of the air pipe, which are determined using the additional equations explained above. If the density and speed of the raw material along the air pipeline do not change, then the equations $v=v_0$, $\gamma=\gamma_0$, $m=m_0$ and are valid, and $M=\pi R^2(1-m_0)L\gamma_0$ the volume occupied by the raw material is as follows:

$$V = M/\gamma_0 = \pi R^2(1-m_0)L, \tag{4}$$

volume $V_k = \pi R^2 L$ of the air pipe is the proportion (in percent) of the raw material volume along the air pipe $V/V_k=(1-m_0)100$. If, at the transfer limit $m_0=0.7$ (70%) $v = v_0$ (the speed of the raw material is equal to the speed of its transmission and does not change), the raw material 30% occupies part of the volume of the air pipeline. If the speed of the raw material increases to $v=nv_0$ ($n\geq1$)) and $\gamma=\gamma_0$ is accepted as , then $V/V_k=(1-m_0)/n$ we get the equation. In particular $m_0=0.7$, $n=1.5$ the raw material occupies part of the volume of the air pipe 20%, that is, with the increase of the speed of the raw material, the process of its fragmentation and division into separate pieces occurs **.**

The performance of the transportation process depends on the performance of the last element in the pneumatic device - the separator (this indicator is also referred to as the throughput). Existing separator equipment has the following performance:

- SS-15A type separator - 15 t/h.
- SX type separator - 22 t/h.

Technological machines, for example, a drying drum (model 2 SB-10, SBO) -10 t/h, machines for removing small impurities UXK and 1XK models 5-7 t/h, fiber separators (battery) have a productivity of around 10 t/h. Technological machines work The difference in productivity causes excess cotton to pile up in front of machines with lower productivity when they are working at full capacity. This, in turn, is inappropriate as it overcrowds the working areas and creates a fire hazard. Therefore, we make calculations based on the average indicator of productivity of most machines and equipment - P = 10 - 12 t/h.

If we transfer productivity from t/h to kg/s: P=(10÷12)t/s = 2.78÷3.33 kg/s. Shipping time can be determined as follows:

$$t = \frac{l}{v_m}, \qquad (5)$$

where: v_m is material (cotton) speed, m/s; l - transportation distance (airline length), m. From this, after simple substitutions, we get:

$$M = \frac{П \cdot l}{V_м}, \qquad (6)$$

the weight of cotton per length of M-air pipe . l This equation is valid under the following conditions: $\lambda > 0; v_m > 0$.

In our previous studies, we determined the velocities of cotton and air at the head of the pipe. In the first 1 m, the speed of the cotton is close to the speed of the conveyor belt. The speed of the used conveyor belt is 3 m/s. At the end of the distance of 1 m, the speed of cotton reaches 4.5 m/s. If we take the average value of the speed, v_m = 3.5 m/s. In that case, the work output is P =2.78 kg/s , when

l =1 m

$$M = \frac{2.78 \cdot 1}{3.5} = 0.8 кг;$$

P =3.33 kg/s , l =1 m

$$M = \frac{3{,}33 \cdot 1}{3.5} = 0.95 кг.$$

only 0.80-0.95 kg of cotton corresponds to the length of the air pipeline during air transportation .1 м

In our previous studies, it was determined that the density of cotton coming out of the gin is about γ36 kg/m^3, and if the mass of cotton is M = 0.79 - 0.95 kg, the volume of such a body is equal to:

$$V = M / \gamma = (0.79 - 0.95)/36 = 0.022\text{-}0.026 \text{ m}^3.$$

The volume of the air pipe 1 m long is $V_k = 1 \cdot p \cdot r^2 = 1 \cdot 3.14 \cdot 0.\ 2^2$ =0.1256 m^3. If we find their ratio in percentages:

$$\Delta V \% = (17.6 - 20.7)\%.$$

Later, the cotton speed increases and the air speed decreases. At a distance of 50 meters, the porosity of cotton increases by 2 times (from 0.4 to 0.8), while its density decreases by 2 times (γ=36/2=18 kg/m^3), the speed of cotton reaches 9-10 m/s (therefore, the average speed v_m = 6.5 m/s), the air speed decreases to 15 m/s. Assuming that:

$$M = \frac{(2.78 \div 3.33) \cdot 50}{6.5} = 21.38 \div 25.62 кг$$

The volume occupied by cotton is $\boldsymbol{V} = M / \gamma$=(21.38÷25.62)/18 = 1.19 ÷ 1.42 m ^{3}. The volume of a 50 m air pipe is $V_k = 50$ 0.1256 = 6.28 m ^{3}. If we find their ratio:

ΔV % = (19.0 – 22.6)%

RESULTS

If we analyze the obtained results (Fig. 1), in the case of cotton transportation by air transport, if it is assumed that the cotton is conveyed uniformly, the cotton occupies only 18-23% of the volume of the pipeline when it is spread along the length of the air pipeline. These calculations show that when transporting cotton by air transport, the main (large) part of the air pipe remains empty.

Of course, this part is occupied by air and has a large carrier potential. If we take into account that air and material velocities are much lower than calculated values in the calculations, our opinion about the inefficient use of air transport power seems to be more reasonable.

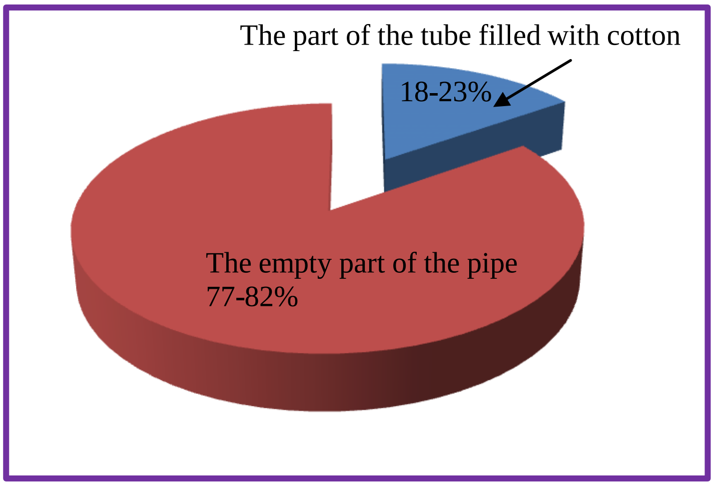

Fig.1 The share of cotton raw materials in the internal volume of the air pipe during the transportation process

At the same air speed, an increase in the cross-section of the air pipe leads to an increase in air consumption and, consequently, power, and a decrease in air consumption and power. Based on this, it can be concluded that the actual diameter of the air transport pipe is much higher than the required diameter $d = 0.4m$.

This diameter of the air pipe is based on the fact that it prevents clogging due to the transfer of cotton in the form of uneven, large layers at the beginning of the pipe and facilitates the formation of aeromixture in the initial part of the air pipe. Accordingly, ensuring that the cotton is fed tightly and uniformly ensures that the air pipe does not clog and the material moves easily in the air pipe, even with smaller diameters of the air pipe.

If the actual speed of the air is 20-25 m/s, if the diameter of the air pipe is 315 mm, the air consumption is $Q = FV$ = 1.9 ÷2.4 m ^{3}/s, if it is 355 mm, $Q = FV$ = 1.4 ÷1.8 m ^{3}/ decreases by s. However, until now, the research conducted by Kh. T. Akhmedkhodjayev [35] and S. Kadirkhodjayev [32] shows that cotton moves at this air speed, mainly in the lower part of the air pipe, in contact with the air pipe, in the form of jumps. This, in turn, has a negative effect on the quality of cotton. According to the results obtained by the authors, the cotton moves suspended in the air pipe at air speed of 28 m/s and higher. Based on this, we recommend choosing a carrier air speed of 28-30 m/s. For this, we have the opportunity to increase the air speed without excessive energy consumption due to the small diameter of the air pipe.

DISCUSSION

400 mm and the speed is 25 m/s, the air consumption is 3.14 m^3/s, while the diameter of the air pipe is 355 mm, and the speed is 29 m/s $Q = FV = 2.87$ m^3/s (or 8.6% less), the diameter of the air pipe is 315 mm, the velocity is 29 m/s, and the air consumption is $Q = FV = 2.26$ m^3/s (or 28% less). This, in turn, allows you to expand the radius of air transport, or use a fan with a lower power instead of a high-power one, and save electricity.

For example, if the VTs-10M fan is installed instead of the VTs-12M, the energy consumption can be reduced by 20 kW/h, if the VTs-8M fan is installed instead of the VTs-10M, it can be reduced to 19 kW/h. If it is taken into account that the cotton passes through pneumatic transport equipment many times, these numbers will be even higher. , that is, if the given recommendations are introduced not only to all pneumatic transport equipment in the enterprise, it will be possible to save 4-6 times more electricity.

In this case, the transition to the use of small-sized air pipes, in turn, allows to reduce the costs of cleaning the used air, to reduce the amount of fibers in the content of the used air, to reduce the consumption of metal, and to increase the operational characteristics of the air transport equipment.

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