

Theoretical research of the improved condenser device used in technology of lint separation

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Abstract. The article analyses the disadvantages of lint condensers that used to separate lint from cotton seeds in the cotton gins. The processes taking place in the machines during the separation of lint fibers from the air flow, the operational and structural parameters of the lint condenser are considered. In order to increase the energy saving and efficiency of the condenser machine in separating lint from the air stream, the ways to eliminate the shortcomings of the machine and the instructions for improving the condenser are explained. Taking into account the increase of the population in the world and their need for cotton fiber raw materials to a certain extent, we need to increase production capacity, efficiency and productivity of cotton ginning enterprises by replacing or improving obsolete machines.

1 Introduction

Implementation of the large-scale scientific and research work on the improvement of the methods and technology for the initial processing of seed cotton and their scientific basis is becoming important worldwide. In particular, it is necessary to develop an effective technology for the initial processing of cotton, to determine the scientific indicators of processing after separating from the cotton seed fiber, to determine the indicators of the working parts of the machines involved in the separation of secondary fibers, lint and waste from the air.

Comprehensive measures are being implemented in our republic in order to implement modern forms of organization of cotton-textile production, to form market relations between cotton-growers and cotton-processing enterprises, and to increase their profitability and, at the same time, the competitiveness of manufactured products. This article serves to a certain extent in the implementation of tasks stated in Resolution of the Cabinet of Ministers "On measures to organize the activities of cotton raw material cultivation and processing cooperatives" No. 398 dated June 22, 2020, Decree of the President of the Republic of Uzbekistan "Strategy of the development of New Uzbekistan for 2022-2026" No. DP-60 dated January 28, 2022, Resolution of the President of the Republic of Uzbekistan RD-179 dated March 25, 2022 and other documents related to this activity [1].

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In particular, the task on “...increasing the competitiveness of the national economy, reducing the consumption of energy and resources in the economy, and widely introducing energy-saving technologies into production” is defined. One of the important issues in performing this task, including in the initial processing of cotton, is the creation of an improved effective technology for separating lint from the fiber-separated seed.

Taking into account is a great need for cotton fiber raw materials in the world production, it is shown that great attention should be paid to reducing the cost of cotton fiber raw materials and increasing its quality by saving the energy costs spent in separating the secondary fiber from the air during the initial processing of cotton. Nevertheless, at present, in the scientific research on improving the technological process of separation of secondary fiber from air, the effective solution of changing the condenser machine technology based on new directions has not been sufficiently determined [2].

2 Materials and methods

Proposed condenser belongs to the cotton ginning industry and is used in cotton ginning plants to transfer the fiber from the linter's common lint chain to the press's slant chain.

The prototype of the proposed condenser is a lint condenser containing a perforated drum and a vacuum valve mounted on rotating shafts in a hermetic housing. The main disadvantage of this condenser is the high aerodynamic resistance of air intake by the fan from the perforated drum, which increases the power consumption of the electric motor of the fan.

A large part of the power of the fan electric motor is used to overcome the aerodynamic force generated during the movement of air through the perforated drum openings. Besides, a large part of the power of the fan electric motor is used to change the direction of the air flow that is sucked in through the holes opened in the drum, then their direction of movement is turned to the side of the outlet hole, and they merge into the general air flow.

When the air flows out of the perforation holes, the combined air flows from these flows in the drum have a high speed directed almost transversely to the direction of movement of the air flow. Such an intersection of the directions of the air streams spraying from the holes and their combined flow creates a resistance to the movement of the combined air flow and a resistance along the entire length of the drum. In addition, when the direction of movement of air currents is changed, their turbulence increases and the turbulence of the combined air flow increases, which creates additional aerodynamic resistance to its movement. This additional resistance is due to the increased frictional forces of air turbulence in the combined flow of air sucked against the inner surface of the mated drum.

The purpose of the improved device is to reduce the aerodynamic resistance of the air drawn from the drum of the condenser coil.

This task is solved by the presence of a convex weld seam from the top of the drum to the base along the screw line on the surface of the cone.

The installation of the shaft in the drum with mesh symmetrically to its axis of rotation, with the tip of the cone directed to the closed side surface of the drum, and the base being placed on the open side surface of the drum, ensures that the cross-sectional area of the slot between the inner surface of the drum and the surface of the cone is uniformly reduced from the end of the cone in the direction of its base. Because this gap is reduced and the amount of air drawn from the drum is practically unchanged, the air speed in the drum increases uniformly along its length from the closed side surface to the open side surface [3-4].

As a result of this, firstly, the turning of the air flows in the drum in the direction of exit from the perforated holes and their connection to the combined air flow accelerates, and secondly, the speed of movement of the combined air flow increases. As a result of the increase in the speed of the air in the stream, its turbulence decreases, that is, the number of air clumps decreases, which ensures a decrease in the total force of friction on the inner

surface of the drum when they meet and, accordingly, a decrease in the aerodynamic resistance of the drum to the movement of air sucked from it.

The spiral arrangement of the convex weld on the surface of the cone from its tip to the base ensures their direction along the screw line when they meet the layers of the combined air flow adjacent to the cone. This, in turn, leads to a twisting of the combined air flow around the cone and an increase in its speed and, accordingly, an increase in dynamic pressure in all sections of its cross-sectional area, as a result of which the frictional force of the edge layers of the air flow along the entire length of the drum decreases, which, accordingly, is installed on its shaft reduces the aerodynamic resistance of the cone-shaped drum. Thus, the application of a convex weld along the screw line on the surface of the cone also solves the problem of a useful model [5].

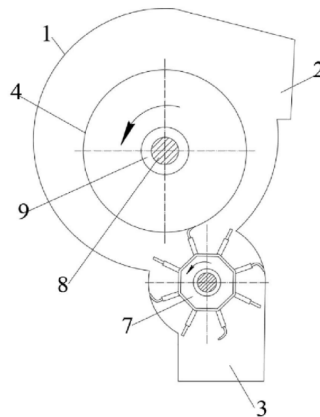
The scheme of the proposed lint condenser is shown in Fig. 1, the cross-section of the drum 4 and the cone 9 is shown in Fig. 2, and the drawing of the cross-section of the convex weld is shown in Fig. 3.

The condenser has a sealed housing 1 with inlet 2 and outlet 3 openings. In the housing 1 there is a drum 6 with closed 5 and open 6 side surfaces, as well as a vacuum valve 7. The open side surface of the sieve drum 4 is connected to the suction opening of the fan (not shown in Fig. 1) by means of a short pipe 12.

A cone 9 is mounted on the shaft of the sieve drum 4 symmetrically to its axis of rotation, its tip is on the closed side surface 5 of the drum 4, and the base of the cone 11 is on the open side surface 6 of the drum 4, and its tip 10 is on the surface of the cone 9 convex weld 13 is located along the screw line to 11.

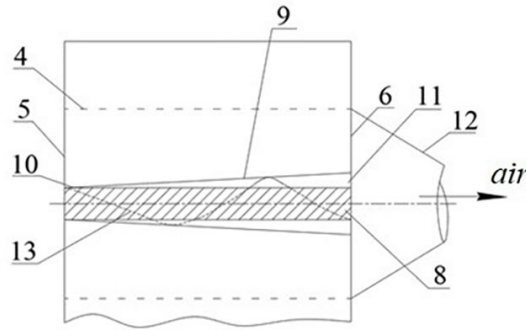
The proposed condenser works in the following order. The air generated in the sieve drum 4 is sent by means of a fan to the inlet 2 of the sealed housing 1 connected to the pneumatic transport of fiber. The fiber in the air-carrying body 1 is sucked into the holes of the perforated drum 4, and the air is sucked into its inner surface through the hole of the met drum and then into the suction hole of the fan (not shown) through the hole 6 connected with the short pipe 12. Fibers absorbed on the surface of the perforated drum 4 are removed from its surface by means of a vacuum valve 7 and removed from the body of the condenser 1 through the discharge hole 3.

Inside the perforated drum 4, the cone 9 installed on its shaft ensures an increase in the speed of the intake air and a decrease in accumulation, as a result of which it is possible to reduce the aerodynamic resistance of the perforated drum to the intake air and reduce the power consumption of the corresponding fan electric motor.



housing-1; inlet-2; outlet-3; sieve drum-4; vacuum valve-7; shaft-8; cone-9.

Fig. 1. The scheme of the proposed lint condenser.



sieve drum-4; closed-5; side surfaces-6; shaft-8; cone-9; top cone-10; cone base-11; short pipe-12; convex weld-13.

Fig. 2. The cross-section of the drum of condenser.

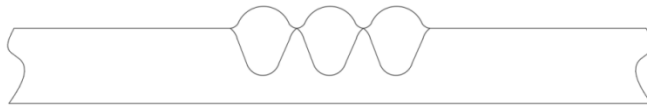


Fig. 3. the cross-section of the convex weld.

The angle of sharpness of the cone should be about 10-15 degrees. At the same time, it is expected to save up to 5% of power. It should be noted that the formation of a weld along the screw line on the surface of the cone corresponds to the intended technology of its preparation (Fig. 4).

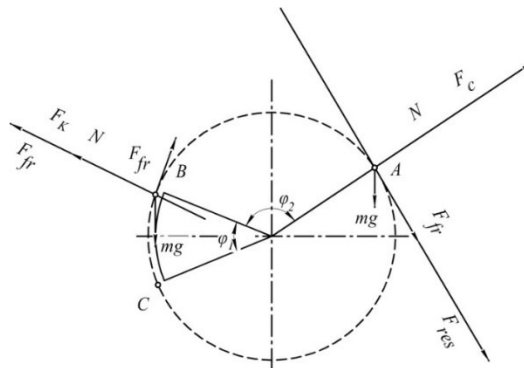


Fig. 4. movement of fibers on the surface of the condenser drum.

$$\begin{aligned} \overline{AB} &= S_1 \\ \overline{BC} &= S_2 \\ \varphi_2 &= 0 \div 120^\circ \\ \varphi_1 &= 0 \div 45^\circ \end{aligned}$$

Let us formulate the differential equation of motion of the fibers at the arc spacing on the mesh drum surface $\overline{AB} = S_1$

$$m \cdot \ddot{S}_1 = N + F_c + F_K + P_B + mg + F_{fr} + F_{res} \quad (1)$$

Where the external forces acting on the fibers on the mesh drum surface N- normal pressure force, mg- The gravity of the fibers, F_c - centrifugal force, F_K -Koroliis force, F_{fr} -

friction force, F_{res} - resistance force, $P_{a,p}$ - air pressure force, $P_B = A|\cos(\omega t + \alpha_0)|$ - suction force fiber, $F_c = mv^2R$; $F_K = 2\omega\dot{S}$; $F_{res} = kv^2$; $F_c = m \cdot \frac{v^2R}{R^2} = m \cdot \frac{\dot{S}^2}{R}$
 $F_{fr} = f \cdot N$.

We calculate the projection of the external forces acting on the fibers along the normal axis.

$$\bar{N} + F_c + F_K - P_B - mg \sin(\omega t + \alpha_0) = 0$$

The normal compressive strength is:

$$N = P_B + m \cdot g \cdot \sin(\omega t + \alpha_0) - F_{M.K} - F_{kop} N = A \cdot |\cos(\omega t + \alpha_0)| + m \cdot g \cdot \sin(\omega t + \alpha_0) - m \cdot \omega^2 \cdot R - \frac{m \cdot \dot{S}^2}{R} \quad (2)$$

The force driving the fibers on the surface of the mesh drum is determined as follows:

$$F_{res} = k \cdot v^2 + m \cdot g \cdot \cos(\omega t + \alpha_0)$$

The speed of fibers is determined by $v^2 = (\omega R - \dot{S})^2$

$$F_{res} = k \cdot (\omega \cdot R - \dot{S})^2 + m \cdot g \cdot \cos(\omega t + \alpha_0) \quad (3)$$

Substituting equations (2) and (3) into equation (1), we form a second-order inhomogeneous differential equation:

$$m\ddot{S} = f \cdot (A \cdot \cos(\omega t + \alpha_0)) + m \cdot g \cdot \sin(\omega t + \alpha_0) - m \cdot \omega \cdot R - m \cdot \omega^2 \cdot R - \frac{m \cdot \dot{S}^2}{R} + k(\omega \cdot R - \dot{S})^2 + m \cdot g \cdot \cos(\omega t + \alpha_0);$$

Dividing this equation by the mass of the opposite side, obtain the following equation.

$$\ddot{S} = \frac{f}{m}(A|\cos(\omega t + \alpha_0)|) + g \cdot \sin(\omega t + \alpha_0) - \omega^2 \cdot R - \frac{\dot{S}^2}{R} + \frac{k}{m}(\omega \cdot R - \dot{S})^2 + g \cdot \cos(\omega t + \alpha_0) \quad (4)$$

Using the equations of S.M. Targ, we determine the movement of fibers on the mesh drum surface (4)

$$\dot{S}_1 = \frac{f}{m} \cdot A \cdot \cos(\omega t + \alpha_0) + g \cdot \sin(\omega t + \alpha_0) + g \cdot \cos(\omega t + \alpha_0) - \omega^2 \cdot R - \frac{m \cdot \omega^2}{R} + k \cdot \omega^2 \cdot R^2 - 2 \cdot k \cdot \omega \cdot R \cdot \dot{S} + k \cdot \omega^2$$

$$\ddot{S} + 2 \cdot k \cdot \omega \cdot R \cdot \dot{S} = \frac{f}{m} \cdot A \cdot \cos(\omega t + \alpha_0) + g \cdot \sin(\omega t + \alpha_0) + g \cdot \cos(\omega t + \alpha_0) + \omega^2 \cdot \left(k \cdot R^2 + k - R - \frac{m}{R}\right)$$

$$\ddot{S} + 2 \cdot k \cdot \omega \cdot R \cdot \dot{S} = \left(\frac{f}{m} \cdot A + g\right) \cos(\omega t + \alpha_0) + g \cdot \sin(\omega t + \alpha_0) + \omega^2 \left(k \cdot R^2 + k - R - \frac{m}{R}\right) \quad (5)$$

We express the homogeneous equation of the left part of the equation (5) as follows

$$\lambda^2 + 2kR\omega\lambda = 0 \quad (6)$$

The general part is determined as:

$$y_1 = c_1 e^{\lambda_1 t} + c_2 e^{\lambda_2 t} \quad (7)$$

Where $\lambda_1 = 0$ $\lambda_2 = -2 \cdot k \cdot R \cdot \omega$ then we express equation (7) in the following form:

$$y_1 = c_1 + c_2 e^{-2 \cdot k \cdot R \cdot \omega \cdot t} \quad (8)$$

A specific solution of the right side of equation (5)

$$y_2 = N_1 \cdot \cos \omega t + N_2 \cdot \sin \omega t \quad (9)$$

We define as follows

$$\begin{aligned} \dot{y}_2 &= -N_1 \cdot \omega \cdot \sin \omega t + N_2 \cdot \omega \cdot \cos \omega t \\ \ddot{y}_2 &= -N_1 \cdot \omega^2 \cdot \cos \omega t - N_2 \cdot \omega^2 \cdot \sin \omega t \end{aligned} \quad (10)$$

Substituting equations (10) into equation (5), we determine the constant coefficients.

$$\begin{aligned} -N_1 \cdot \omega^2 \cdot \cos \omega t - N_2 \cdot \omega^2 \cdot \sin \omega t - 2 \cdot k \cdot \omega \cdot R \cdot N_1 \cdot \omega \cdot \sin \omega t + 2 \cdot k \cdot \omega \cdot R \cdot N_2 \cdot \omega \cdot \cos \omega t &= \left(\frac{f \cdot A}{m} + g\right) \cos \omega t + g \sin \omega t \end{aligned} \quad (11)$$

By equating the coefficients in front of $\sin \omega t$ and $\cos \omega t$ from equality (11), we create the following system of equations

$$\begin{cases} -N_1 \cdot \omega^2 + 2 \cdot k \cdot \omega^2 \cdot R \cdot N_2 = \frac{f \cdot A}{m} + g \\ -N_2 \cdot \omega^2 - 2 \cdot k \cdot \omega^2 \cdot R \cdot N_1 = g \end{cases} \quad (12)$$

where $N_1 = -\frac{(\frac{f \cdot A}{m} + g + 2 \cdot k \cdot g \cdot R) \cdot \omega^2}{\omega^4 \cdot (1 + 4 \cdot R^2 \cdot k^2)} = -\frac{\frac{f \cdot A}{m} + g + 2 \cdot k \cdot g \cdot R}{\omega^2(1 + 4 \cdot R^2 \cdot k^2)}$; $N_2 = -\frac{g + 2 \cdot k \cdot R \cdot (\frac{f \cdot A}{m} + g)}{\omega^2(1 + 4 \cdot R^2 \cdot k^2)}$

We put the coefficients determined in equation (12) into equation (9).

$$y_2 = -\frac{\frac{f \cdot A}{m} + g + 2kRg}{\omega^2(1+4R^2k^2)} \cos \omega t - \frac{g+2kR(\frac{f \cdot A}{m}+g)}{\omega^2(1+4R^2k^2)} \sin \omega t \quad (13)$$

Then the equation of motion of the fibers on the mesh drum surface will be as follows:

$$S_1 = y_1 + y_2 = c_1 + c_2 e^{-2kR\omega t} \frac{\frac{f \cdot A}{m} + g + 2kRg}{\omega^2(1+4R^2k^2)} \cdot \cos \omega t - \frac{g+2kR(\frac{f \cdot A}{m}+g)}{\omega^2(1+4R^2k^2)} \sin \omega t + \omega^2 \left(kR^2 + k - R - \frac{m}{R} \right) \quad (14)$$

Using the initial condition of the initial movement of fibers on the mesh surface, we determine the constant values of C_1 and C_2

$$f=0; S_1=0; \dot{S}_1=0.$$

$$\begin{cases} c_1 + c_2 - \frac{\frac{f \cdot A}{m} + g + 2kRg}{\omega^2(1+4R^2k^2)} + \omega^2 \left(kR^2 + k - R - \frac{m}{R} \right) = 0 \\ -2kR\omega c_2 - \frac{g+2kR(\frac{f \cdot A}{m}+g)}{\omega(1+4R^2k^2)} = 0 \end{cases} \quad (15)$$

C_1 and C_2 values, determined in equations (15), we put into equation (14).

$$S_1 = \frac{\frac{f \cdot A}{m} + g + 2kRg}{\omega^2(1+4R^2k^2)} - \omega^2 \left(kR^2 + k - R - \frac{m}{R} \right) + \frac{g+2kR(\frac{f \cdot A}{m}+g)}{2kR\omega^2(1+4R^2k^2)} - \frac{g+2kR(\frac{f \cdot A}{m}+g)}{2kR\omega^2(1+4R^2k^2)} \cdot e^{-2kR\omega t} - \frac{\frac{f \cdot A}{m} + g + 2kRg}{\omega^2(1+4R^2k^2)} \cos \omega t - \frac{g+2kR(\frac{f \cdot A}{m}+g)}{\omega^2(1+4R^2k^2)} \sin \omega t + \omega^2 \left(kR^2 + k - R - \frac{m}{R} \right) \quad (16)$$

Equation (16) is the equation of motion due to air absorbing fibers on the mesh drum surface around an arc $\varphi_1 = 0 \div 120^\circ$. In the theoretical analysis of the problem of reducing the fibers falling into the waste through the air pipe and also saving the energy spent on air consumption by rational selection of several parameters have been analyzed in graphs using Maple software. By choosing a rational value of the air intake speed from the given graphs, it is ensured that the fibers do not escape through the air pipe to the waste and thus the question of the correct distribution of energy consumption is presented; the analysis of the movement of fibers in the range of coverage angles $\varphi_1 = 0 \div 120^\circ$; $\varphi_2 = 0 \div 45$ from the movement of fibers on the surface of the mated drum is presented; mainly the movement of fibers under the influence of suction air speed in the initial range $\varphi_1 = 0 \div 120^\circ$ and the movement of free fibers without the influence of suction air in the range $\varphi_2 = 0 \div 45$ are given. The movement of fibers on the surface of the mated drum at different values of the speed of the suction air was analyzed (Figure 5) [6-7].

We construct the differential equation of motion of fibers at the interval of arc $\overline{BC} = S_2$ - on the surface of the mesh drum

$$m\ddot{s}_2 = \overline{F}_c + \overline{N} + F_{fr} + mg \quad (17)$$

We analyze the movement under the influence of external forces acting on the fibers on the surface of the mesh drum along the arc BC. In the improved mesh drum, a blind is installed along the arc BC, thereby ignoring the compressive force acting on the fibers.[8]

First, we calculate the projection of the external forces acting on the fibers along the normal axis

$F_K + \overline{N} + F_c - mg \cos \omega t = 0$, from this we determine the normal pressure force acting on the fibers on the surface of the drum.

$$N = mg \cos \omega t - m\omega^2 R - 2\omega \dot{s} \quad (18)$$

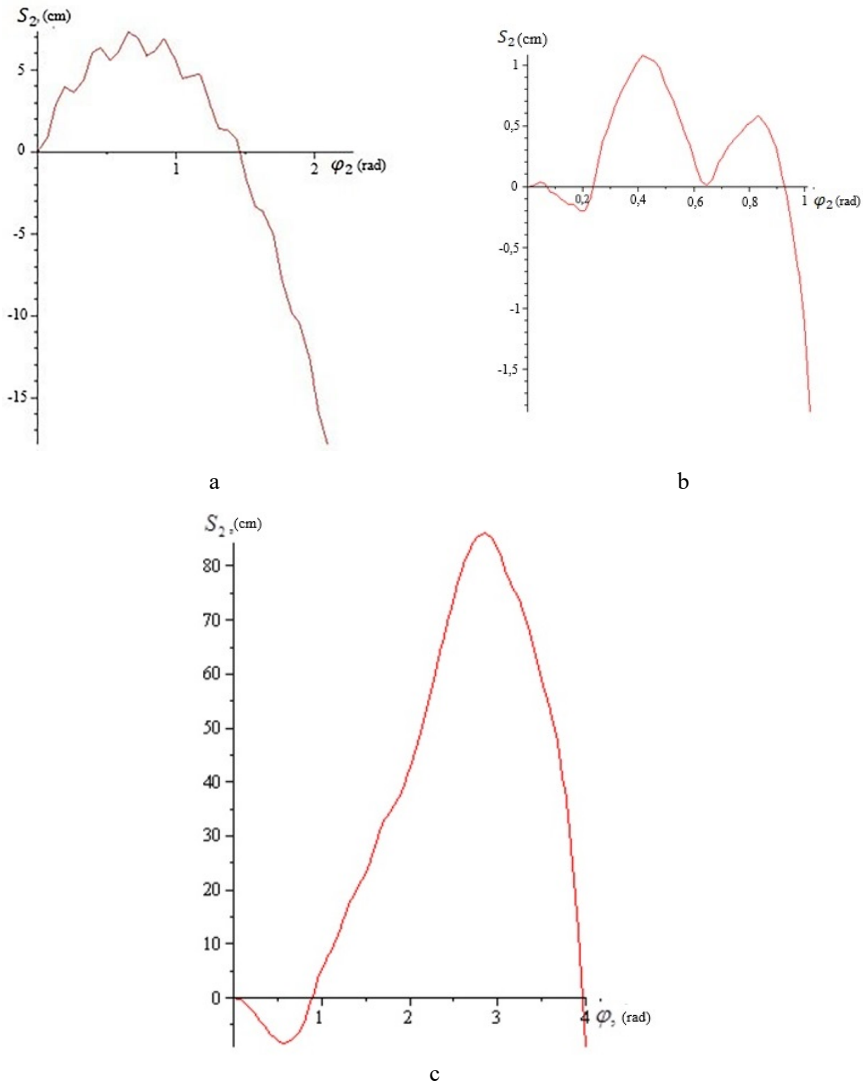


Fig. 5. Graphs of values of dependence of the movement of fibers *a*, *b* and *c* on the surface of the mesh drum on the coverage angle and different air suction speeds $v_1 = 6 \text{ m/s}$; $v_2 = 6, 2 \text{ m/s}$; $v_3 = 6, 5 \text{ m/s}$.

Substituting equation (18) into equation (17) we create a second-order inhomogeneous differential equation.

$$\begin{aligned}
 m\ddot{s}_2 &= fm g \cos \omega t - fm \omega^2 R - 2f \omega \dot{s}_2 + mg \sin \omega t \\
 m\ddot{s}_2 + 2f \omega \dot{s}_2 &= fm g \cos \omega t - fm \omega^2 R + mg \sin \omega t \\
 \ddot{s}_2 + 2 \frac{f \omega}{m} \dot{s}_2 &= fg \cos \omega t + g \sin \omega t - f \omega^2 R \tag{19}
 \end{aligned}$$

We express the homogeneous equation of the left part of the equation (19) in the following form.

$$\lambda^2 + 2 \frac{f \cdot \omega}{m} \cdot \lambda = 0 \tag{20}$$

The general appearance is defined as follows:

$$y_1 = c_1 e^{\lambda_1 t} + c_2 e^{\lambda_2 t} \tag{21}$$

Where $\lambda_1=0$, $\lambda_2 = -2\frac{f\cdot\omega}{m}$ then we express the expression of equality (22) as follows:

$$y_1 = c_1 + c_2 e^{-2\frac{f\omega}{m}t} \tag{22}$$

The specific solution of the right side of equation (19)

$$y_2 = N_1 \cos \omega t + N_2 \sin \omega t \tag{23}$$

We define as follows

$$\begin{cases} \dot{y}_2 = -N_1 \cdot \omega \cdot \sin \omega t + N_2 \cdot \omega \cdot \cos \omega t \\ \ddot{y}_2 = -N_1 \cdot \omega^2 \cdot \cos \omega t - N_2 \cdot \omega^2 \cdot \sin \omega t \end{cases} \tag{24}$$

By putting the expressions (24) into the equation (19), we determine the constant coefficients

$$-N_1 \cdot \omega^2 \cdot \cos \omega t - N_2 \cdot \omega^2 \cdot \sin \omega t - 2 \cdot N_1 \cdot \frac{f\omega^2}{m} \sin \omega t + 2 \cdot N_2 \cdot \frac{f\omega^2}{m} \cos \omega t = f \cdot g \cdot \cos \omega t + g \cdot \sin \omega t \tag{25}$$

By equating the coefficients in front of $\sin \omega t$ and $\cos \omega t$ from equality (25), we create the following system:

$$\begin{cases} N_1 = \frac{\Delta N_1}{\Delta} = -\frac{f \cdot g \cdot (m+2) \cdot m}{\omega^2 \cdot (m^2+4 \cdot f^2)} \\ N_2 = \frac{\Delta N_2}{\Delta} = \frac{g \cdot (2 \cdot f^2 - m) \cdot m}{\omega^2 (m^2+4 \cdot f^2)} \end{cases} \tag{26}$$

We put the values of coefficients N_1 and N_2 determined in equations (26) into equation (23)

$$y_2 = -\frac{f \cdot g \cdot (m+2)}{\omega^2 \cdot (m^2+4 \cdot f^2)} \cdot \cos \omega t + \frac{g \cdot m \cdot (2 \cdot f^2 - m)}{\omega^2 \cdot (m^2+4 \cdot f^2)} \cdot \sin \omega t \tag{27}$$

We express the specific and general solutions, that is, the general equation of the movement of fibers on the surface of the drum under the influence of the air barrier on the surface of the mesh drum $S_1 = y_1 + y_2$ as follows:

$$S_2 = C_1 + C_2 \cdot e^{-2 \cdot f \cdot \frac{\omega}{m} t} - \frac{f \cdot g \cdot (m+2)}{\omega^2 \cdot (m^2+4 \cdot f^2)} \cdot \cos \omega t + \frac{g \cdot m \cdot (2 \cdot f^2 - m)}{\omega^2 \cdot (m^2+4 \cdot f^2)} \cdot \sin \omega t \tag{28}$$

From the equation (28), we determine the constant values C_1 and C_2 using the initial condition $f = 0$; $S_2 = 0$; $\dot{S}_2 = 0$

$$\begin{cases} C_1 + C_2 - \frac{f \cdot g \cdot m \cdot (m+2)}{\omega^2 \cdot (m^2+4 \cdot f^2)} = 0 \\ -2 \frac{f\omega}{m} C_2 + \frac{g \cdot m \cdot (2 \cdot f^2 - m)}{\omega \cdot (m^2+4 \cdot f^2)} = 0 \end{cases} \Rightarrow C_2 = \frac{g \cdot m^2 \cdot (2 \cdot f^2 - m)}{2 \cdot f \cdot \omega^2 \cdot (m^2+4 \cdot f^2)}, \quad C_1 = \frac{g \cdot m}{2 \cdot f \cdot \omega^2}$$

we put the determined values C_1 and C_2 into the equation (28).

$$S_2 = \frac{g \cdot m}{2 \cdot f \cdot \omega^2} + \frac{g \cdot m^2 \cdot (2 \cdot f^2 - m)}{2 \cdot f \cdot \omega^2 (m^2+4 \cdot f^2)} e^{-2 \frac{f\omega}{m} t} - \frac{f \cdot g \cdot m \cdot (m+2)}{\omega^2 \cdot (m^2+4 \cdot f^2)} \cos \omega t + \frac{g \cdot m \cdot (2 \cdot f^2 - m)}{\omega^2 \cdot (m^2+4 \cdot f^2)} \sin \omega t - \omega^2 \cdot R \cdot f \tag{29}$$

Equation (29) is an equation representing the free movement of fibers on the surface of the mesh drum in the range of arc $\varphi_2 = 0 \div 45^\circ$. Based on the theoretical analysis of the movement of fibers under the influence of the air barrier, the rational parameters for reducing air consumption, increasing energy efficiency by ensuring the free fall of fibers, and preventing free fibers from being thrown into the waste were analyzed in graphs using Maple software [8].

3 Results and discussion

The difference of the cotton fiber condenser with one side surface closed, the other open and mounted on a shaft in a hermetic casing attached to the suction hole of the fan, as well as a vacuum valve, is that a cone is installed symmetrically on the axis of rotation of the shaft inside the drum, the tip of which is oriented towards the closed side surface of the drum, and the base is on the open side surface of the drum.

According to condenser differs in that a convex weld is placed on the surface of the cone along the screw line from the tip to the base.

The improved condenser unit belongs to the cotton ginning industry and serves to transfer the fiber from the common fiber conveyors of the gins or fiber cleaners to the main drum of the press.

The function of the improved condenser device is to reduce the aerodynamic resistance of the air drawn from the condenser drum.[10]

The solution of the task is that cone is placed symmetrically to its axis of rotation inside the drum with a shaft on the shaft, its upper part is directed to the closed side surface of the drum, and its base is located on the open side surface of the drum and along the screw line on the surface of the cone, there is a convex weld from the top of the drum to the base.

The installation of the shaft in the drum with mesh symmetrically to its axis of rotation, with the tip of the cone directed to the closed side surface of the drum, and the base being placed on the open side surface of the drum, ensures that the cross-sectional area of the slot between the inner surface of the drum and the surface of the cone is uniformly reduced from the end of the cone in the direction of its base. Since this gap is reduced and the amount of air drawn from the drum is practically unchanged, the air speed in the drum in this gap also increases uniformly along its length in the direction from the closed side surface to the open side surface [4].

The installation of the shaft in the drum with mesh symmetrically to its axis of rotation, with the tip of the cone directed to the closed side surface of the drum, and the base being placed on the open side surface of the drum, ensures that the cross-sectional area of the slot between the inner surface of the drum and the surface of the cone is uniformly reduced from the end of the cone in the direction of its base. Since this gap is reduced and the amount of air drawn from the drum is practically unchanged, the air speed in the drum in this gap also increases uniformly along its length in the direction from the closed side surface to the open side surface.

As a consequence, firstly, the turning of the air flows in the drum in the direction of exit from the perforated holes and their connection to the combined air flow accelerates, and secondly, the speed of movement of the combined air flow increases. As a result of the increase in the speed of the air in the flow, its turbulence decreases, that is, the number of air clumps decreases, which ensures a decrease in the total force of their friction on the inner surface of the perforated drum and, accordingly, a decrease in the aerodynamic resistance of the drum to the movement of air sucked from it [9-10].

The spiral arrangement of the convex weld on the surface of the cone from its tip to the base ensures their direction along the screw line when they meet the layers of the combined air flow adjacent to the cone. This, in turn, leads to a twisting of the combined air flow around the cone and an increase in its speed and, accordingly, an increase in dynamic pressure in all sections of its cross-sectional area, as a result of which the frictional force of the edge layers of the air flow along the entire length of the drum decreases, which, accordingly, is installed on its shaft reduces the aerodynamic resistance of the cone-perforated drum. Thus, the use of a convex weld along the screw line on the surface of the cone also solves the problem of an improved condenser device.

4 Conclusion

In conclusion, it can be said that the analysis of the condenser device used in the cotton ginning enterprises of our Republic to separate lint fibers from the air flow revealed that there are several shortcomings in it. As a result of the research, it was clarified that the design defect of existing condensers is the loss and damage of the lint. A new design has been developed to eliminate design defects.

An example of these is an increase in air resistance in the condenser, a relatively large amount of free fibers in the outlet, the number of blockages, etc. Our proposed improved deaeration condenser machine overcomes these shortcomings, and if this improved condenser is implemented in cotton primary processing plants, the efficiency, productivity and energy efficiency of deaeration of lint fibers will be achieved.

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