THEORETICAL AND PRACTICAL FOUNDATIONS OF THE UCHDM DELINTERING MACHINE

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Annotatsiya. Maqolada delinterning yuqori kamerasida qirib olingan kalta tolalarning kombinatsiyalashgan arra-metall cho‘tkali silindri sirti bo‘ylab ko‘chishi $r(t_1) < r_0$ shartini bajarsa, bunday massadagi tolalar kombinsiyalashgan arra-metall cho‘tkali silindri sirtida saqlanib qolishi, agar $r(t_1) > r_0$, u holda bunday kalta tola kombinatsiyalashgan arra-metall cho‘tkali silindri sirtidan ajralib, erkin tolaga aylanishi sharti aniqlandi. O‘tkazilgan ko‘p omilli tajribalarda delinterning maqbul parametrlari xaqida ma’lumotlar keltirilgan.

Kalit so‘zlar: delinter, chigit tuksizlantirish, kamera, arra-metall cho‘tka, kombinatsiyalashgan, kuch, omil.

Аннотация. В статье установлено, что если выполняется условие, что короткие волокна, соскобленные в верхней камере делинтера, движутся вдоль поверхности комбинированного пильно-металлического щеточного цилиндра, то волокна такой массы останутся на поверхности комбинированного пильно-металлического щеточного цилиндра, а если , то такое короткое волокно отделится от поверхности комбинированного пильно-металлического щеточного цилиндра и превратится в свободные волокна. Представлены данные об оптимальных параметрах делинтера в проведенных многофакторных экспериментах.

Ключевые слова: удаление волокон древесины, удаление шерсти, камера, щетка для пильного металла, комбинированный, коэффициент мощности.

Abstract. The article establishes that if the condition is met that the short fibers scraped off in the upper chamber of the delinter move along the surface of the combined saw-metal brush cylinder, then fibers of such mass will remain on the surface of the combined saw-metal brush cylinder, and if, then such a short fiber will separate from the surface of the combined saw-metal brush cylinder and turn into free fibers. Data on the optimal parameters of the delinter in the conducted multifactorial experiments are presented.

Keywords: delinter, cotton seed delinting, chamber, saw-metal brush, combined cylinder, force, factor.

Machines of the UCHDM type are designed for delinting seeds, ensuring a delintiness of up to 0.5% when preparing delinted seeds and up to 2.00-5% when preparing less delinted seeds. The UCHDM type machine is used in the equipment complex of single-stage delinting shops, as the machine itself performs two stages [1, 2].

The positive aspect of the technical solution developed by JSC "Paxtasanoat ilmiy markazi" is that it prevents the seeds from mixing with the suction pipe of lint separated from the upper chamber. However, replacing the saw cylinders used in the upper working chamber of the UCHDM seed delinting machine with cylinders with metal brushes can lead to a decrease in its productivity.

In addition, in our opinion, the closed multifaceted chamber used in the upper working chamber of the UCHDM machine may have caused an increase in mechanical damage to the seeds.

Theoretical research was carried out using the laws of mechanics, algebra, and descriptive geometry. Experimental studies were conducted on an experimental sample of a delinter using appropriate GOST standards, existing and specially developed methods. The results of the experiment were processed on a computer using mathematical statistics.

The angle between the radius of the saw blade and the direction of the cylinder wire with a metal brush (the brush wires are bent in the direction of the cylinder's movement) is taken *as. D Determine the coordinates of the point by (x, y).*

In the chosen coordinate system, their expressions are as follows:

$$x = (R + r\cos\beta)\cos(\omega t + \alpha_0)$$
$$y = (R + r\cos\beta)\sin(\omega t + \alpha_0) \quad (1)$$

here - the angle formed by the radius of the saw disc with *the axis ox* at the initial moment.

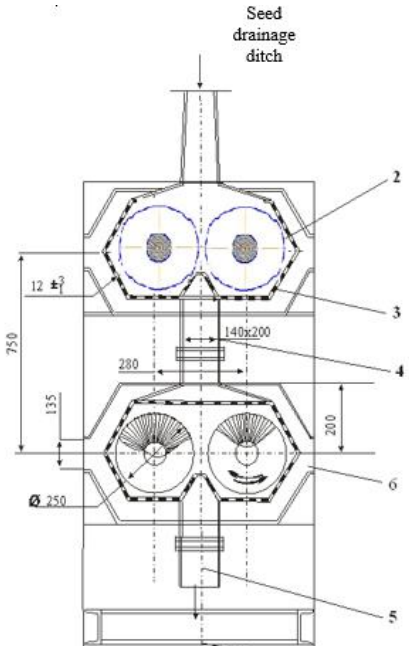

Fig. 1. Side view of the seed delinting machine, improved according to the developed technical solution

1. frame; 2 - saw or combined (saw-brush) cylinder; 3 - chamber casing; 4 - transition channel; 5-seed discharge chute; 6 - lint suction opening

Based on the foregoing, a technical solution for improving the UCHDM seed delinting machine was developed.

In the research process, methods of theoretical and applied theory of machines and mechanisms, mechanics, higher mathematics and vibration theory, mathematical modeling of technological machine operating processes, mathematical statistics, and computational mathematics were used.

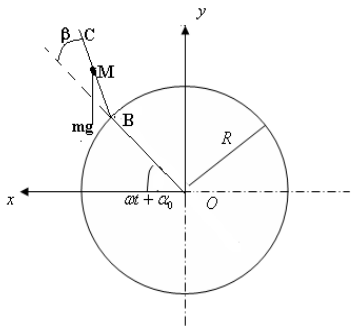

Fig. 2. Diagram of the movement of a short fiber with a mass of *m* over a brush wire

Determine the forces acting on the short fiber scraped with combined saw-metal brush cylinders. These are the force of gravity of the fiber, the force of friction, and the force of action of the suction air along the brush wire.

During the movement of the combined saw-metal brush cylinders, the direction of the action of these forces changes. Therefore, the preservation of the scraped short fiber on the brush wires or its free movement depends on the mass of the fiber, the rotation speed of the saw-metal brush cylinder, and the force of the suction air. The forces of gravity and friction acting on short fibers depend on the angle formed by the brush cylinder wire relative to the saw blade and the speed of the working cylinder. Using Figure 3, we find the projections of the force of gravity and the friction forces in the direction of the brush wire [8]:

$$F_{TP} = f \cdot N \qquad (2)$$

Here: m - short fiber mass;

N - normal force acting on a short fiber, taking into account gravity, centrifugal force, and Coriolis force, it looks like this:

$$N = 2m\omega\dot{r}\cos\beta + mg\cos(\alpha_0 + \omega t + \beta) + m(r\cos\beta + R)\omega^2\sin\beta \qquad (3)$$

In addition to these forces, the centrifugal force on the fiber:

$$m(R + r\cos\beta)\omega^2\cos\beta \qquad (4)$$

And the force of air suction is affected by:

$$F_0 = c(v_0 - \dot{r}) \qquad (5)$$

Here: - air velocity in the direction of the brush wire;
s - air resistance coefficient.
Taking these forces into account, we write the equation of motion of the short fiber along the brush wire [9, 10]:

$$m\ddot{r} = m(R + r\cos\beta)\cos\beta\omega^2 - mg\sin(\alpha_0 + \omega t + \beta) - f\left[2m\omega\dot{r}\cos\beta + mg\cos(\alpha_0 + \omega t + \beta) - \right.$$
$$\left. - fm(\cos\beta + R)\omega^2\sin\beta + c(v_0 - \dot{r})\right. \quad (6)$$

We can rewrite this equation as follows:

$$\ddot{r} + \dot{r}(2\omega\cos\beta + \gamma) - r\omega^2(\cos\beta - f\sin\beta)\cos\beta =$$
$$= R\omega^2(\cos\beta - f\sin\beta) - g[\sin(\alpha_0 + \omega t + \beta) + f\cos(\alpha_0 + \omega t + \beta)] + \gamma v_0 \quad (7)$$

here $\gamma = c/m$
Using the following notations $\alpha = \alpha(t) = \alpha_0 + \omega t + \beta$, $n = (2\omega + \gamma)/2$, $c_0 = \cos\beta - f\sin\beta$, $a = c_0\omega^2$, $b = R\omega^2 c_0 + \gamma v_0$, we reduce equation (6) to the following form.

$$\ddot{r} + 2n\dot{r} - ar = b - g[\sin\alpha(t) - f\cos\alpha(t)] \quad (8)$$

Equation $r = r_1,\ \dot{r} = 0,\ t = 0$ (8) is integrable $0 < t < t_1$ in the interval when, where; $t_1 = \frac{L}{\omega}$,
L- length of the arc of the saw blade in contact with the airflow.
The solution of equation (6) satisfying the above conditions has the form:

$$r = Ae^{k_1 t} + Be^{k_2 t} - \frac{b}{a} + A_0\sin(\omega t + \alpha_0 + \beta) + B_0\cos(\omega t + \alpha_0 + \beta) \quad (9)$$

here:

$$A = \frac{c_1 k_2 - c_2}{k_2 - k_1};\ B = \frac{c_2 - k_1 c_1}{k_2 - k_1};\ c_1 = b/a - A_0\sin\alpha_1 - B_0\cos\alpha_1;$$
$$c_2 = -\omega(A_0\cos\alpha_1 - B_0\sin\alpha_1);\ k_1 = -n + \sqrt{n^2 + a};$$
$$k_2 = -n - \sqrt{n^2 + a};\ B_0 = g\frac{\omega^2 + a + 2n\omega f}{\Delta};\ A_0 = g\frac{\omega^2 + a - 2n\omega f}{\Delta}; \quad (10)$$
$$\Delta = (\omega^2 + a)^2 + 4n^2\omega^2;\ \alpha_1 = \alpha_0 + \beta.$$

By depicting the solution of equation (6) in the form of a graph at different masses, it is possible to analyze the preservation of short fibers on the surface of a combined saw-metal brush cylinder or cases of separation from it.
Graphs of the change in fiber displacement r (t) over time in a cylinder with a combined saw-metal brush according to the calculation results are presented in Fig. 4. The

calculation yields t1=0.0125 sec. Analyzing the graphs, it was established that short fibers with masses m=0.1 g and m=0.2 g are not stored in a combined saw-metal brush cylinder.

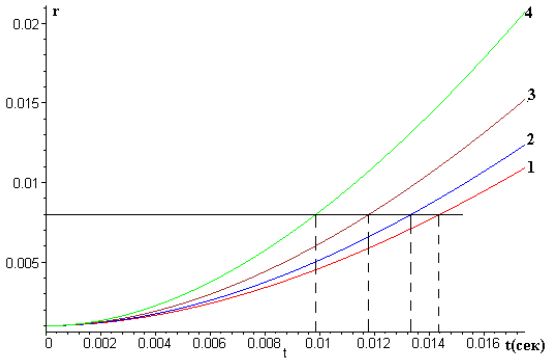

Fig. 4. Graphs of the displacement of short fibers of different masses over time on the surface of a combined saw-metal brush cylinder:
1. 2; 3; 4.

If the abrasive short fibers satisfy the condition of movement along the surface of the combined saw-metal brush cylinder, such a mass of fibers remains on the surface of the combined saw-metal brush cylinder, then such a short fiber separates from the surface of the combined saw-metal brush cylinder and turns into a free fiber. The following values were taken in the calculation:

$$R = 0.125m,\ L = 0.05m,\ c = 0.001Hc/m,\ v_0 = 10m/s, \omega = 7{,}5crl/s,\ r_1 = 1мм,\ r_0 = 2{,}0mm,$$

$$f = 0.2,\ \alpha_0 = 15^0,\ \beta = 15^0.$$

The adequacy of the regression equation and model obtained according to the Fisher criterion was determined, taking into account the calculated value of the Cochran criterion.

Conclusion: Multi-factor experiments were conducted through mathematical planning of the experiments. As a result of the conducted experiments, the following optimal parameters were obtained: $_{X1}$ - productivity of the improved delinter for the delinted seeds - 520 kg/hour, $_{X2}$ - air consumption from the upper chamber of the delinter - 1.5 m3/s, $_{X3}$ - rotational speeds of the combined saw-metal brush drum in the upper chamber of the delinter-810 rpm. Due to the fact that the upper chamber of the improved delinter was modified into a multifaceted one, and high-performance combined saw-metal brush cylinders were used in its chambers, and the product obtained from the upper chamber was separated using separate pneumatic pipes, it was possible to obtain 3-5% lint instead of lint.

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