CALCULATION SCHEME OF A CLEANING DRUM WITH CURVED SPIKES

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Abstract: *This article presents a formula for determining the radius of a curved surface based on the equilibrium condition of a cotton piece on the curved spike surface during the cleaning of cotton from small impurities using drums with curved spikes.*

Keywords: *cleaner, small impurities, curved spike, radius, drum, angular velocity, friction, mass, displacement, reaction, air resistance, parameter, cleaning, efficiency.*

In the 1HK cleaning machine, cotton is repeatedly cleaned from small waste using four consecutively arranged drums of the same construction and operating mode [1,2]. However, the cleaning efficiency is not high and fiber damage is significant. In the proposed cleaner, the drum spikes are designed with a curved shape. As cotton passes through each of the four drums, the degree of loosening and the mass of captured cotton particles differ. Therefore, it is important to carry out theoretical studies to justify the curvature of the spikes on one drum.

Figure 1

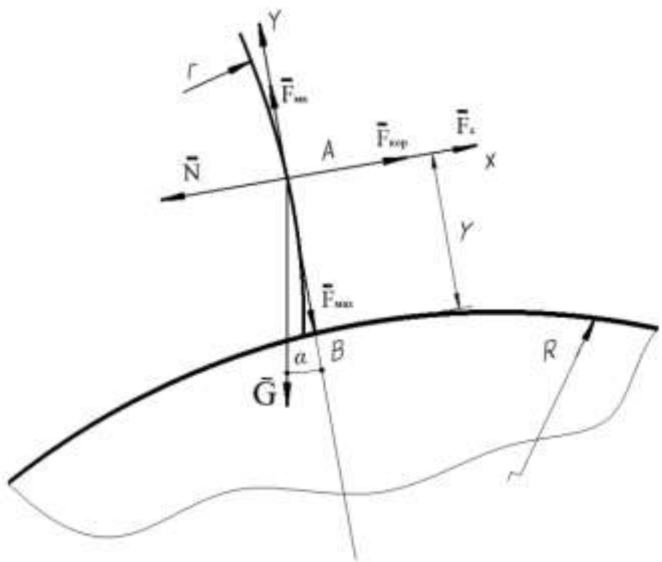

Figure 1 shows the calculation scheme for determining the equilibrium condition of a cotton piece on the surface of a drum with curved spikes. Based on this, the following forces act on the cotton piece: $\vec{G}$– gravity; $\vec{F}_{кор}$– Coriolis force; $\vec{N}$– reaction force; $\vec{F}_{ин}$– inertia force; $\vec{F}_{мқ}$– centrifugal force; $\vec{F}_{иш}$– friction force; $\vec{F}_{х}$– air resistance force [3,4].

Using an analytical expression based on references [7,8,9,10], the motion law of a cotton piece on the drum spike surface is derived as:

$$y = \left[\frac{fKRV_x^2}{m\omega^2} + \frac{(1-f^2)g}{2\omega^2(1+f^2} - \frac{\left(R + \frac{(1-f^2)}{2\omega^2(1+f^2)}\right) - \frac{fKV_x^2}{m\omega^2}\left(f+\sqrt{1+f^2}\right)}{2f}\right] \cdot$$

$$\cdot\, e^{-\omega t\left(f+\sqrt{1+f^2}\right)} + \left[\frac{\left(R + \frac{(1-f^2)}{2\omega^2(1+f^2)}\right) - \frac{fKV_x^2}{m\omega^2}\left(f+\sqrt{1+f^2}\right)}{2f} - \frac{1}{2\omega^2(1+f^2}g\right] \cdot$$

$$\cdot\, e^{\omega t\left(f-\sqrt{1-f^2}\right)} + \frac{g}{\omega^2(1+f^2)}\left[f sin\omega t - \frac{(1-f^2)cos\omega t}{2}\right] + R - \frac{fKV_x^2}{m} \quad (1)$$

Here: **m** – mass of the cotton piece; **ω** – angular velocity of the spiked drum; **R** – internal rotation radius of the drum; **y** – displacement along the axis; **g** – acceleration due to gravity; **f** – coefficient of friction between the cotton piece and the curved spike; **α** – angle between the force of gravity and the **Y**-axis.

From the analysis of solution (1), it should be noted that during the initial transition phase, the values of the first two terms decrease over time. These values are much smaller compared to the subsequent terms that describe the forced motion, and thus they can be neglected.

At the same time, the cotton piece moves elementarily along the "Y" axis on the surface of the curved spike. It moves along the angle θ corresponding to the radius. Based on the schematic condition shown in Figure 2:

$$\theta = arcsin\frac{y}{r} \qquad (2)$$

Taking into account expression (19), expression (20) is derived in the following form. Here, the curvature radius of the spike is:

$$r = \frac{1}{\theta}\left[\frac{fKRV_x^2}{m\omega^2} + \frac{(1-f^2)g}{2\omega^2(1+f^2} - \frac{\left(R + \frac{(1-f^2)}{2\omega^2(1+f^2)}\right) - \frac{fKV_x^2}{m\omega^2}\left(f+\sqrt{1+f^2}\right)}{2f}\right] \cdot$$

$$\cdot\, e^{-\omega t\left(f+\sqrt{1+f^2}\right)} + \left[\frac{\left(R + \frac{(1-f^2)}{2\omega^2(1+f^2)}\right) - \frac{fKV_x^2}{m\omega^2}\left(f+\sqrt{1+f^2}\right)}{2f} - \frac{1}{2\omega^2(1+f^2}g\right] \cdot$$

$$\cdot\, e^{\omega t\left(f-\sqrt{1-f^2}\right)} + \frac{g}{\omega^2(1+f^2)}\left[f sin\omega t - \frac{(1-f^2)cos\omega t}{2}\right] + R - \frac{fKV_x^2}{m} \qquad (3)$$

The motion of a cotton piece on the surface of a curved spike of the cleaning drum and its capture and removal condition are studied based on the following parameter values: m = (0.15÷0.75)·10^{-3} kg; g = 9.8 m/s²; ω = (40÷45) s^{-1}; f = (0.15÷0.4); D=2R = (0.31÷0.35) m; K = (0.05÷0.07) kg/m; Vx = (1.2÷1.4) m/s; e = 2.72; n = 0.7·10^{-3} m.

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