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Theoretical Analysis Of The Motion Of Raw Cotton With Uniform Feeder In A Cotton Cleaner

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ABSTRACT

In this scientific work, a theoretical analysis of the movement of raw cotton with a uniform feed of the feeder is considered, the cleaning machines used at the cotton ginning plant.

KEYWORDS

The Cotton, Saw Gin, Seed, Fiber, Saw, Roll Box, Seed Roll, Quality, Efficiency, Productivity, Density, Accelerator.

INTRODUCTION

The main elements of the cleaners are feeding devices, cleaning sections and bunkers for collecting trash and feeding them into pneumatic or mechanical transport. The purpose of the feeding devices is the continuous and uniform supply of raw cotton to the cleaning section of the machine in the amount required to achieve the specified performance and cleaning effect.The feeding devices (Fig. 1) consist of a storage shaft 1, feed rollers 2, a power regulator 3 and transmission gears 4.

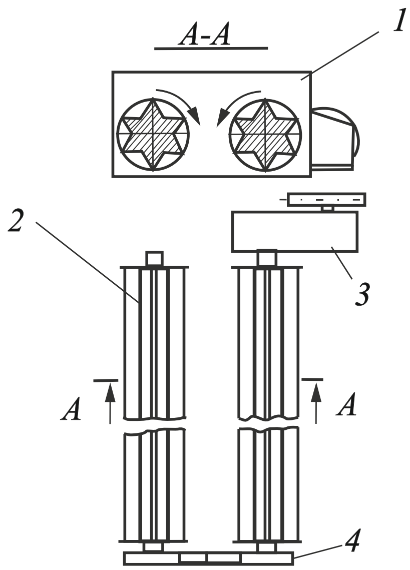

Figure:1. Feeder of the cotton gin:1-storage shaft,2-feed rollers,3-powerregulator,4-transfer gears.

In existing feeders, the gap between the feed rolls is constant and the feed rolls performance is controlled by changing the number of their revolutions.In the gap between the rollers, the raw cotton should have a density that does not damage the seeds.Feeding rollers pick up raw cotton from the storage shaft and feed it to the inlet section of the cleaner. During the passage of raw cotton between the rollers, the seeds and fibers should not be damaged. To quickly change the performance of the cleaner, the feed rollers must have a mechanism for regulating their rotation speed and work without fraction.Let us carry out a theoretical analysis of the movement of raw cotton with a uniform supply of the cotton cleaner feeder.We consider raw cotton to be a compressible medium;the process is stationary; therefore, we assume that the cells (space) between the blades are filled with material. Select an element from the mass of raw cotton *dx* and compose the equation of motion of this elemenσt.

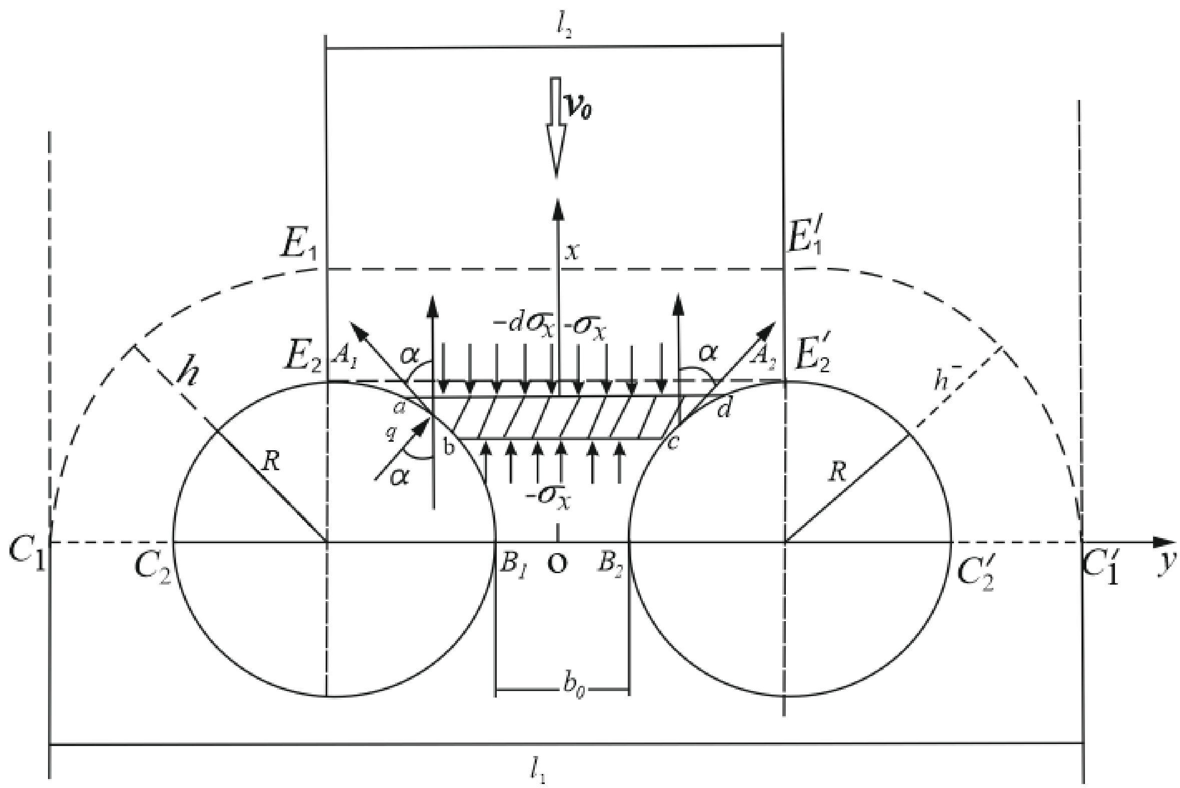

Fig. 2. Flow pattern of raw cotton between rollers with pegs

Denote by $\sigma_x = -p$ pressure on the arc point slip A_1B_1 (A_2B_2) in this case, the side pressure force acts on the element kp with projection $kp\sin\alpha$ and friction force with projection $\theta fkp\cos\alpha$ (k_0- side pressure coefficient f - coefficient of friction between layers of raw cotton and rollers $\theta = \pm 1$ sign θ before the coefficient of friction *f* selected depending on the direction of cross-sectional velocity). The equation of motion of the selected element is written in the form [1]

$$\rho bv\frac{dv}{dx} = -\frac{d}{dx}(pb) + pk_0(\sin\alpha + \theta f\cos\alpha) - \rho gb$$

where *v*-element speed α – angle between tangent to circular arc *ab* (*cd*)axis ox The width of the feeder is determined by the formula:

$b = b(\alpha) = 2R(1-\cos\alpha) + b_0$, Equation (1) contains three unknowns: pressure $p(x)$, density $\rho = \rho(x)$ and speed $v = v(x)$ We believe that the law of compressibility of raw cotton is known.

$$\rho = \rho_0\{1 + A(p - p_0)\}$$

Where: ρ_0, p_0 - known density and pressure in the cross section of the raw material entering the feeder zone *A* - compliance coefficient (reciprocal of the bulk compressibility moduli of raw cotton). Denote by Q the volume of material per unit length of the feeder, then from the law of conservation of mass at $A <<!$ follows dependence for speed

$$v = \frac{Q}{\rho Lb(\alpha)} = \frac{Q}{\rho_0 Lb(\alpha)[1 + A(p - p_0]} = \frac{Q}{\rho_0 Lb(\alpha)}[1 - A(p - p_0)]$$

Given the dependence on the surface of the roller : $x = R\sin\alpha$ equation (1) is written in the variable

$$\frac{Q}{L}\frac{dv}{d\alpha} = -\frac{d(pb)}{d\alpha} + pkR\cos\alpha(\sin\alpha + \theta f\cos\alpha) - \rho gRb\cos\alpha$$

Using dependences (3) and (4), we exclude the density from equation (5) $\rho(\alpha)$ and speed $v(\alpha)$

$$\frac{dp}{d\alpha} = pF_1(\alpha) + F_2(\alpha), \text{Where } \frac{dp}{d\alpha} = pF_1(\alpha) + F_2(\alpha),$$

$$F_2 = \frac{1}{Ac(\alpha)}\{Ap_0F_0(\alpha) + [1 - c(\alpha)]b' - \rho_0 gRbA\cos\alpha\}$$

$$F_0 = [1 - c(\alpha)]b' + \rho_0 gRab\cos\alpha, c(\alpha) = 1 - \frac{Q^2 A}{\rho_0 L^2 b^2}$$

Equality (6) is a first order differential equation for pressure p ,which integrates at a given pressure $p = p_h$ at $\alpha = \pi/2$.To select the sign for f we will carry out a qualitative analysis of the movement of the mass of raw cotton in the area of the feeder. Section Point Speed $x = 0$ ($\alpha = 0$) greater than the peripheral velocity of the particles along the circular are ACB ωR (ω–angular speed of the ring) relative speed $v - \omega R$ positive and therefore, the friction force has the direction of the positive part of the axis 0x and therefore, in the area adjacent to this section, the sign at *f* take positive. Points of a different section $x = R$ $(\alpha = \pi/2)$ has a speed less than has a speed less than ωR those. the relative speed of the raw cotton particles in the feeder zone is negative (pulling of the strip of raw materials), and, therefore, in the area adjacent to the cross section $x = R$ friction is directed in the negative direction of the axis OXin this section follows the sign at *f* choose minus In this section, the rollers (pegs) drag the mass towards the feeder, and the friction force will be active, and directed downward opposite the axis 0x In another section adjacent to the section $x = 0$, the friction force resists the motion of the mass (tends to keep the moving flow), therefore it is directed upward along

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the axis. $0x$ .Some cross section $x = c$ ($\alpha_c = \arcsin(c/R)$) $(0 < c < R)$, having a speed equal to the linear velocity of the particles of raw cotton along the arc of a circle of OCB serve as a section of the above sites. If at the borders $x = 0$, and $x = R$ pressures equal respectively $p = 0$ and $p = p_h$, then to determine $p(x)$)inside the plot $(0 < x < R)$, equation (6) should be integrated over $x > 0$, choosing a plus sign with the coefficient f on condition $p(0) = 0$ and a flat minus sign with f location on $x < R$ on condition $p(\pi/2) = p_h$.If for a given $p(\alpha)$ mass movement in the feeder is possible, from the condition that the voltage in the section is equal $x = c$ it follows that the curves $p_1(\alpha)$ $(x > 0)$ $p_2(\alpha)$ $x < R$ intersect at the point with the abscissa $x = c$ .This point is the boundary of both sections. If this point is found, then from the relation $\omega R = \frac{Q}{b(\alpha_c)\rho(\alpha_c)L}$, we find the necessary speed of rotation of the pegs to obtain a given feeder performance. To calculate the power consumed by the feeder, you need to calculate the pressure p along the border, the contact between the circle and the strip. Knowing the pressure p as functions α, we determine the circumferential force by the formula $T = f\left[\int_0^{\varepsilon_c} p_1(x)dx - \int_{\alpha_c}^{\pi/2} p_2(x)dx\right]$After that, the power used to feed the raw material through the feeder can be calculated by the formula $W = L(\omega RT + p_h \frac{Q}{\rho_0 Lb(\pi/2)}) + W_f$, Where W_f - the power spent to overcome friction on the working part of the feeder Denote by $p_1(\alpha)$ and $p_2(\alpha)$ remote areas $0 < \alpha < \arcsin(c/R)$, $\arcsin c/R < \alpha < \pi/2$ respectively, and consider the site $\alpha > 0$ according to the above conditions, the solutions of equation (6) for each zone are written as

$$p_1 = \exp[F_{11}(\alpha)]\int_0^{\alpha} F_2(t)\exp[-F_{11}(t)]dt$$

$$p_2 = \exp[F_{12}(\alpha)]\{p_h \exp[-F_{12}(\pi/2) - \int_{\alpha}^{\pi/2} F_2(t)\exp[-F_{12}(t)]dt\}$$

$$F_{11} = \frac{-b' + kR\cos\alpha(\sin\alpha + f\cos\alpha) - F_0(\alpha)}{bc(\alpha)}$$

$$F_{12} = \frac{-b' + kR\cos\alpha(\sin\alpha - f\cos\alpha) - F_0(\alpha)}{bc(\alpha)}$$

Land border $\alpha_c = \arcsin\frac{c}{R}$ are determined from the condition $p_1(\alpha_c) = p_2(\alpha_c)$, Which gives

$$\exp[F_{11}(\alpha_c)]\int_0^{\alpha_c} F_2(t)\exp[-F_{11}(t)]dt =$$

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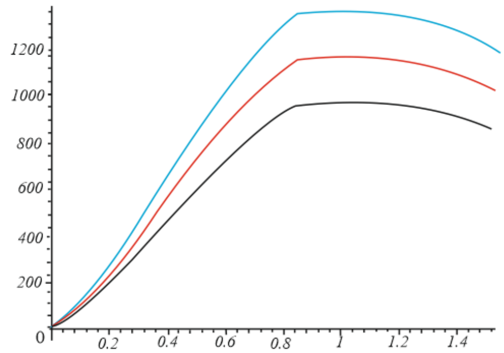
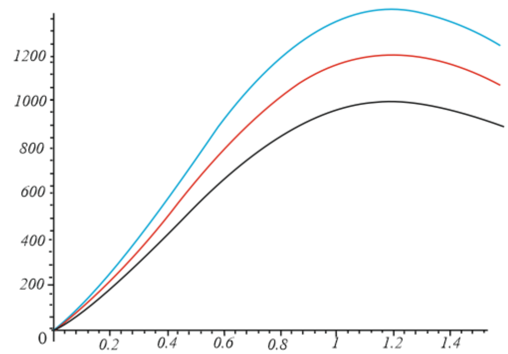
$$\exp[F_{12}(\alpha_c)]\{p_h \exp[-F_{12}(\pi/2) - \int_{\alpha_c}^{\pi/2} F_2(t)\exp[-F_{12}(t)]dt\}$$

Figure 2 shows the compression stress distribution curve. $p = -\sigma_x = -P/b(\alpha)$ for various parameter values $n = 2V_1/V_2$ and $\bar{k}$. Calculations were performed for the following values of the source data: $R = 0.07м$, $b = 0.1м$, $\rho = 60кг/м^3$; $L = 1{,}9м$; α

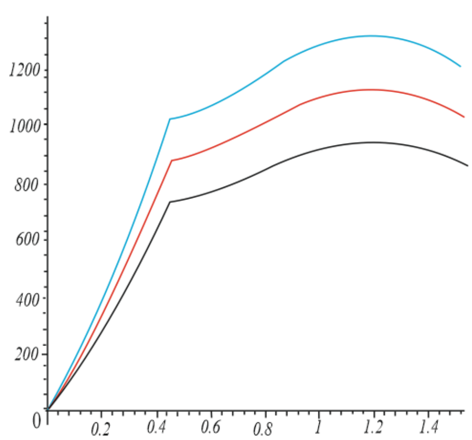


$\bar{k} = 40$ $\bar{k} = 45$



$\vec{k} = 80$

$\bar{k} = 60$



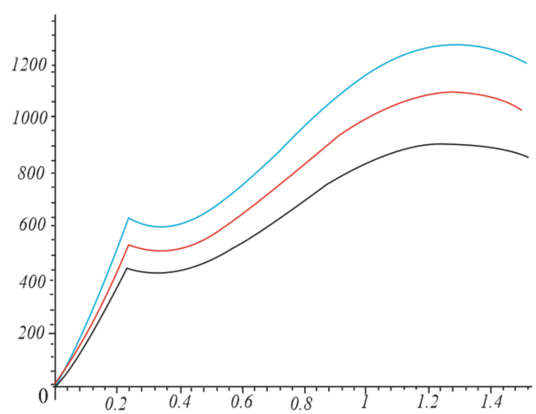


Fig. 3: Compression stress distribution $p(Па)$ **height of the sealing zonemasses of raw cotton for various parameter values** n **and** $\bar{k}$ **:**

$1-n=0$, $2-n=0.2$, $3-n=0.4$

CONCLUSIONS

In this case, the voltage in the lower part of the drive shaft is calculated by the formula $\sigma_x=\rho_0 gH=840\Pi a$, the coordinate of the section,where the speed of movement of the raw material coincides with the speed of the drum, will be equal to $c=0.9126R=0.06363м$. The speed of rotation

$$\omega=\frac{Q}{\rho_0 Rb(c)}=1.58c^{-1}=15.8об/мин.$$

The of the roller is equal to $v_в=R\omega=0.11м./c$, analysis of the obtained curves shows that the speed of movement of raw cotton varies from the minimum $v_{\min}=0.025м/c$. in cross section $x=0$ o to the maximum value $v_{\max}=1.176м/c$.

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