Calculation Of The Torque Of The Rotary Shaft

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ABSTRACT

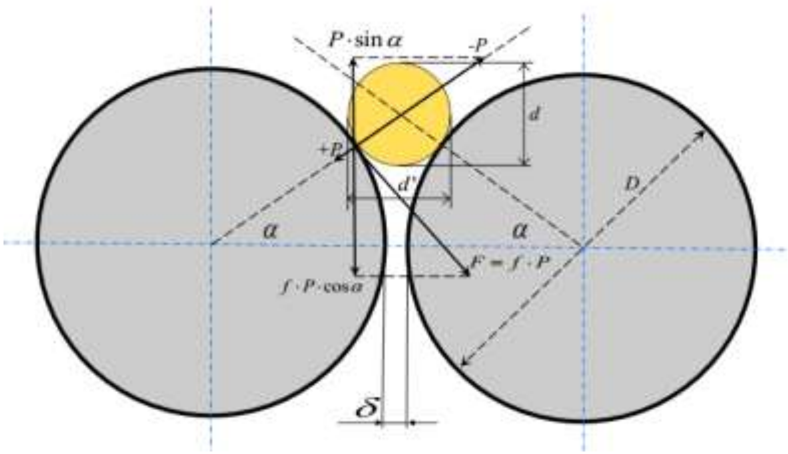
The principle of grinding the core on rolls lies in the peculiarities of the interaction of a particle with a pair of rolls rotating towards each other

Keywords:

The principle of grinding the core on rolls lies in the peculiarities of the interaction of a particle with a pair of rolls rotating towards each other. First, when the relative (to the diameter of the roll) particle size is small enough, it is drawn into the narrowing gap between the rolls. Secondly, the particle, passing through the narrowing gap, is deformed, and with sufficiently large compressive forces of the rolls, this causes high stresses in the particle, exceeding the tensile strength and causing grinding of the particle.

Let us consider the condition for the passage of a particle between the rolls (Fig. 1). The equation for the balance of forces acting on a particle

$$2P\sin\alpha = 2fP\cos\alpha$$



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Rice. 5.1. On the derivation of the equation that determines the conditions for the passage of a particle between rolls

$$2P\sin\alpha < 2fP\cos\alpha$$

Hence

$$f > \frac{\sin\alpha}{\cos\alpha} = tg\alpha$$

Since $f = tg\alpha$, the capture condition $tg\alpha < tg\varphi$ or $\alpha < \varphi$.

This condition is of practical importance in determining the diameter of the rolls. Figure 5.1 shows that the center-to-center distance between the rolls

$$D + \delta = D\cos\alpha + d^{'}$$

Hence the minimum diameter of the roll (m)

$$D = \frac{d^{'} - \delta}{1 - \cos\alpha}$$

Since the angle a is small, then

$$d^{'} = d\cos\alpha \cong d$$

Taking into account that $1 - \cos\alpha = 2\sin^2(\frac{\alpha}{2})$

Get $D = \frac{d - \delta}{2\sin\left(\frac{\alpha}{2}\right)}$

By entering the grinding ratio $k = \frac{d^{'}}{\delta}$, respectively, $\delta = \frac{d^{'}}{k}$ after substitution, we get:

$$D = \frac{d - \frac{d}{k}}{2\sin^2\left(\frac{\alpha}{2}\right)} = \frac{d\frac{k-1}{k}}{2\sin^2\left(\frac{\alpha}{2}\right)}$$

Indicate

$$D > \frac{d\frac{k-1}{k}}{2\sin^2\left(\frac{\varphi}{2}\right)}$$

$$\lambda = \frac{1}{2\sin^2\left(\frac{\varphi}{2}\right)}$$

Get

$$D > \lambda \cdot d \cdot \frac{k-1}{k}$$

For the angle of friction of the soft on the smooth surface of the rolls, cp = 10÷12e and X = 65.8÷45.5. For horizontal rolls, X = 60 is recommended, and for vertical rolls, X = 80.

The calculation of the productivity of roller machines is possible on the basis of the idea of the movement of material in the gap between two rolls as a sheet with a thickness of 6 (m) and a width of L (m) with a linear velocity v = L Dn / 60 (D is the diameter of the roll (m), n is the number of revolutions (rpm).

$$Q = \frac{\pi n}{60} \cdot D \cdot L \cdot \delta \cdot \rho \cdot C$$

where, Q is the productivity (kg/s), ρ is the volumetric mass of the crushed material (kg/m3); C = f (type of material, degree of grinding, machine design). For roller machines with an unregulated clearance, a number of quantities are difficult to determine, and therefore they are combined together with the known numerical values l / 60 into an experimentally determined coefficient A (for sunflower seeds A = 0.0095), and the performance equation takes the form

$$Q = A \cdot D \cdot L \cdot n$$

When determining the ways to intensify the work of the rollers, it is necessary to take into account the limitations of a number of the following factors on the speed of rotation (n) of the rolls:

- the influence of centrifugal force (v = 3.2 m/s - the limit, if more, then the particles are separated from the roll);
- the effect of friction work (it grows n, turns into heat, increases the wear of the rolls);
- the influence of the technological scheme (a thin, strong plate is obtained with reduced p).

The degree of grinding was studied experimentally on a roller machine VS-5 with free-lying rolls.

The following dependence of the particle size (average diameter d4, m) is established

$$d = (0.987 + 0.0495 \cdot z^2 - 0.426 \cdot z + 0.395 \cdot q)10^{-3}$$

where, q = Q/L is the specific (per unit length of the roll) productivity of the rollers, kg/(s•m); z is the number of the roller pair in the sequence of passes on the machine.

The energy characteristics of the roller machine can be determined on the basis of the theory of rolling powdered materials.

$$P_x = P_{\max}\left(\frac{h_л}{h_x}\right)^{\frac{f}{\varphi}}$$

The specific pressure on the material to be crushed in the rolling zone is described by an expression of the form:

where, P_x the distribution of the contact normal stress in the crushed material in the rolling zone up to the output of the crushed material (kg/mm2), the maximum contact normal stress (kg/mm2 $P_{\max}$), the rolling thickness (approximately equal to the size of the crushed particles) $h_л$ (mm), the variable gap between the pair of rolls in the rolling zone (mm), h_x f the coefficient of external friction of the material on the metal; cp = (ar + y) / 2 is the angle of inclination of the chord to the direction of rolling, y is the angle of the neutral section (this angle during grinding is small: y = 0.1 ar).

$$P_{\max} = \frac{G}{L\left[\frac{h_л - h_p \varepsilon^{\frac{f}{\varphi}}}{2(f-\varphi)} + \frac{R h_л(\gamma + \alpha_{-c})}{h_л + fR(\gamma + \alpha_{-c})}\right]}$$

The maximum contact voltage can be determined by the equation:

where, G is the force acting in the grinding zone (for the case of a machine with free-lying rolls, this is the weight of the overlying rolls, for the case of a machine with an adjustable gap, this is the elastic force of the roll fixation system with the appropriate deformation) (kg), L is the length of the roll (mm), ASJ is the compression angle (for grinding ASJ * 0).

To calculate the coefficient of external friction of oilseed material on metal, taking into account the sliding velocity, a dependence is proposed:

$$f = f_0 + 0.8 \cdot P \cdot v^{0.8}$$

where, fo = 0.05 + (5.6 • 10^{-3+} 1.2-10~4 L)P is the coefficient of friction in statics; P - pressure, MPa; v = (iDn/60) - (Q/Ld4p) - sliding velocity of the particles of the crushed material in the gap of the roller pair, m/s; L-oilseed material, %.

$$\overline{P} = \frac{1}{d_н - d_к} \int_{d_к}^{d_н} P_x \cdot d \cdot h$$

The average pressure per particle passing between rolls is determined by the integration of the ratio in a certain range of particle size changes

By determining the average pressure, it is possible to calculate the torque on the grinding roll and the grinding power.

The rolling moment (N • m) for both two-drive rolls and single-drive rolls is determined by the formula

$$M_{np} = \overline{P} \cdot D \cdot \psi \cdot \alpha_p$$

where, P = 0.33 + (y - ASJ) / 3ar is the coefficient of the leverage of the rolling moment. Power (W) is related to the torque ratio

$$N = M_{np} \cdot 2 \cdot \pi \cdot n$$

where, n is the speed of rotation of the roll, s^{-1}.

The calculation of power is determined for each roll according to the formula, and then summed up.

The analysis shows a significant effect of the roll diameter on power. Therefore, when designing roller machines, the smallest possible diameter should be selected. The required design power also increases with the increase in the speed of the rolls.

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