Commercial production of the Sh5 feeder has been developed at the DW at a cost of 1765 rubles per unit.

CALCULATION OF THE CAPACITY OF A CONTINUOUSLY-ACTING CENTRIFUGE ALLOWING FOR THE RATE OF FEED OF THE SUSPENSION

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It is known [1, 2] that the actual throughput of a continuously-acting centrifuge \( V_a \) is smaller than the calculated throughput \( V_c \). The operating efficiency coefficient of the centrifuge \( \xi = V_a/V_c \) depends on many process parameters (the dispersity of the solids, the viscosity and density of the suspension, the throughput and the constructional characteristics of the centrifuge), and is determined experimentally. In design calculations it is usually assumed that \( \xi = 0.375 \) for tubular centrifuges and \( \xi = 0.55 \) for pan separators [1]. The large differences between the actual and calculated throughputs cannot be explained by the hindered deposition of the particles: taking this effect into account gives considerably smaller corrections even for very concentrated suspensions.

In our opinion, one of the important reasons for the difference between the actual and calculated throughputs lies in the incorrect assumption that the angular velocity \( \omega \) is constant over the cross section of the annular layer of liquid in the rotating drum (that \( \omega \) is independent of the radius \( r \)) [1, 2]. In fact, the angular rate of rotation of the annular layer of suspension (see Fig. 1, where the angular velocity is shown nominally in the plane of the drawing) must be taken (without making allowance for slippage) as being equal to the rate of rotation of the centrifuge drum \( (\omega_2) \) only at the outside radius of the annular layer \( R_2 \). However, it can be considerably smaller in the zone in which the initial suspension is fed into the centrifuge, i.e., at the inside radius of the annular layer \( R_1 \), where \( \omega_1 = uH/R_1 \approx 0 \). (Here \( uH \) is the circumferential component of the velocity of the suspension at the exit from the feed device; \( uH \approx 0 \).)

The calculations given below for the time of deposition of the particles and the capacity of the centrifuge are based on the assumption of viscous flow of the suspension in the centrifuge (the absence of information in the literature on the form of the function \( \omega = f(r) \) during turbulent flow of the stream makes it impossible to proceed with centrifuge calculations under these conditions). It is also assumed that the slurry is fed into the centrifuge over practically the entire length of the rotor, and that as a result of the interactions of the layers of liquid the angular velocity of the stream of suspension gradually increases from \( \omega_1 \) at the radius \( R_1 \) to \( \omega_2 \) at radius \( R_2 \) over the entire length of the rotor \( L \).

In the case of viscous flow, the rate of rotation of the liquid is given by [3]:

\[
\omega = \omega_2 R_2 \frac{r/R_1 - R_1/r}{R_2/R_1 - R_1/R_2}.
\]

From this it is easy to derive the relationship describing the change in the angular rate of rotation of the stream along the radius \( r \):
Fig. 1. Distribution of the angular rate of rotation over the cross section of the stream in a continuously acting centrifuge.

Fig. 2. Dependence of the time of deposition of a single particle on the velocity of the suspension $u_H$.

$$\omega = \frac{u}{r} = \omega_1 a \left(1 - \frac{R_1^2}{r^2}\right).$$

where $a = R_2^2 / (R_2^2 - R_1^2)$.

If it is assumed that when $u_H > 0$ the change in $\omega$ obeys an analogous relationship it is found (see Fig. 1) that

$$\omega = \omega_1 + (\omega_2 - \omega_1) a \left(1 - \frac{R_1^2}{r^2}\right). \quad (1)$$

From Eq. (1) it is seen that $\omega = \omega_1$ when $r = R_1$, and $\omega = \omega_2$ when $r = R_2$. The calculated radius $r = R_0$ corresponding to $\omega = 0$ is given by

$$R_0 = \sqrt[3]{\frac{R_1}{\omega_1 + (\omega_2 - \omega_1) a}}.$$

The time for deposition of a single particle is determined by using the formula of Todes for the rate of deposition $w_0$ after replacing the accelerating force of gravity $g$ in the Archimedes criterion [2] by the centrifugal force $m = \omega^2 r$:

$$\Delta t = \frac{\omega^2 r}{v^2} \frac{d^3 (\rho_r - \rho)}{\rho}.$$

where $d$ is the particle diameter, $m$; $v$ is the kinematic viscosity of the medium, $m^2$/sec; $\rho_r$, $\rho$ are the densities of the particle and medium, respectively, $kg/m^3$).

Using Eq. (1), the maximum time of deposition of a particle which is initially at the radius $R_1$ is

$$\tau = \int_{R_1}^{R_0} \frac{R_0 - R_1}{\omega_0} \frac{d r}{\omega_1 + (\omega_2 - \omega_1) a} \left(\frac{R_0^2}{R_1^2 - R_0^2} + \frac{2 R_1^2}{R_1^2 - R_0^2} \frac{V R_1 - V R_0}{V R_1 + V R_0} - \frac{2 (V R_1 - V R_0)}{2 \times} \right).$$

After integrating and rearranging this expression, it is found that:

$$\tau = \frac{9 \sqrt{\rho}}{d^2 (\rho_r - \rho)} \left[\frac{R_0^2 (R_1^2 - R_0^2)}{(R_1^2 - R_0^2) (R_2^2 - R_0^2)} + \ln \frac{R_2^2 - R_1^2}{R_2^2 - R_0^2}\right] + \frac{0.61 V R_0}{\sqrt{d} (\rho_r - \rho)} \left[\frac{2 (V R_1 - V R_0)}{2 \times} \right]$$

$$\times \left[\frac{(V R_1 - V R_0)}{(V R_1 + V R_0)} \left(V R_1 - V R_0\right) - \frac{\arctan \sqrt{\frac{R_0}{R_1}} - \arctan \sqrt{\frac{R_0}{R_0}}}{\frac{R_1}{R_0}}\right]. \quad (2)$$

For concentrated suspensions of porosity $\varepsilon$ the rate of deposition is reduced (or the time of deposition is increased) proportionally to $\varepsilon^{4.75}$ or $\varepsilon^{2.38}$ for the laminar or turbu-