TO THE QUESTION OF RESEARCH OF SCREW CONVEYORS

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Abstract: Research has been conducted on defining constructive and mode parameters of the spiral conveyers. Experimental findings have been conducted on different modes of the conveyors, data have been processed using the Gagen-Puazeyl method. As a result of research three options have been recommended for usage of the conveyors to transport different dispersed materials.

Keywords: Reynolds number, equivalent diameter, dispersed material, spiral channel.

In the cotton-cleaning chemical, food, medical and other industries, screw conveyors are used to move mainly dry, well-flowing goods (pulverized to small pieces).
Typically, screw conveyors are horizontal or gently inclined at an angle of up to 200 and vertical or steeply inclined. The advantages of screw conveyors are the simplicity of the device and the ease of maintenance, the largest overall dimensions, the convenience of intermediate unloading, tightness, etc. [1].
In order to use them more rationally, it is necessary to find the optimal design and operating parameters.
The paper considers a technique for determining the main parameters of the conveyor. An infinitesimal element [2] of a helical channel in a section perpendicular to its axis with an area of $dF1 = r * dr * d\varphi$ where r, φ- are the current coordinates of the element is taken as the object of study. In this case, the area of the free section of the flow of the transported material passing through this element will be
$dF = dF1 * \cos{(xv)}$, (1a)
where (xv) - is the angle between the channel axis and the flow velocity vector at a given point, the direction of which corresponds to the direction of the helical surfaces of the conveyor screw. And $\cos(xv) = sin\gamma$. Here γ is the angle of inclination of the helical surfaces to the plane perpendicular to the longitudinal axis of the channel. Then
$dF = r * dr * d\varphi * sin\gamma$ (1б)
Assuming that $tg\gamma = \frac{S}{2\pi * r}$, after a series of transformations, we have [2]

$$dF = \frac{S * r * dr * d\varphi}{2\pi\sqrt{r^2 + (\frac{S}{2\pi})2}}$$

whereat S – conveyor screw pitch. Next, we obtain the expression for the actual area of the free section of the channel with the screw.

$$F = \int_{r0}^{r1} \frac{S * r * dr * d\varphi}{2\pi\sqrt{r^2 + (\frac{S}{2\pi})2}} \qquad (2)$$

After integration, and taking into account

$F = S[\sqrt{r_1^2 + (\frac{S}{2\pi})^2} - \sqrt{r_1^2 + \left(\frac{S}{2\pi}\right)^2}] - 2\delta(r_1 - r_0),$ (3)

whereat r_0 and r_1 – respectively, the radii of the shaft and screw, δ- screw wall thickness. From this it can be seen that the actual area of the free section of the conveyor increases with an increase in the pitch of the screw S. In the case of S=∞, the actual open area approaches the cross-sectional area of the conveyor chute F_0.

The processing of the obtained experimental data for screw conveyors transporting dispersed materials was carried out using the Hagen-Poiseuille equation [3], which has the form

$\varepsilon = \frac{\varrho\partial}{\mathrm{Re}}$ (4)

where the friction coefficient ε and the Reynolds Re number were previously found using the following formulas

$\varepsilon = \frac{P/\Pi}{\rho * v^2/2 * l/d_э}$ (5)

$R_e = \frac{v * d * \rho}{\mu}$ (6)

Here P and П - power and productivity of the conveyor; ρ and v and, accordingly, the density and average speed of the transported material; *1*- screw channel length; μ- material dynamic viscosity; $d_э$- equivalent screw channel diameter;

Formula (4) expresses the relationship between the coefficient of friction and the Reynolds number, those. characterizes the capacity of the conveyor P at the transported material productivity П for length *1* in a screw channel with an equivalent diameter $d_э$ and at medium speed *v*.

Parameter P/П*1 is the specific energy consumption, those. the amount of energy consumed during the transportation of dispersed material by a conveyor with a capacity of 1 m3/s per length 1 m.

The dynamic viscosity of the transported material can be found by the expression

$\mu = c * t(\rho_ш - \rho_ж)$ (7)

where c is the bead constant of the device; t is the rolling time of the ball; $\rho_ш$ and $\rho_ж$ – respectively, the density of the ball and the investigated liquid.

The viscosity of the material moved along the conveyor chute depends on its physical and mechanical characteristics, design and operating parameters of the conveyor.

The average speed of the transported material can be found using the formula (2).

The equivalent diameter of the screw channel is determined by the formula $d_э = \frac{S(D-d)\sin\gamma}{S * \sin\gamma + \frac{D-d}{2}}$

(8)

where D and d – diameter of screw and shaft; γ- helical surface helix angle along the average diameter D screws, $D = \frac{D-d}{2}$.

When performing calculations in formulas (5) и (6) arithmetic mean values from three experimental data are substituted *P* and *П*.

Theoretical generalization was made taking into account the data of experimental studies of domestic (A.M. Grigorieva, H.J. Abdugaffarov) and foreign (A.Kh.Villisa, A.V.Robertsf and others.) scientists, as well as production data from different plants. At the same time, the choice of various design parameters of conveyors and various particles of dispersed materials (cotton seeds, superphosphate, oats, wheat, etc.) was carried out for conveyors with parameters D=0,05-0,4 m, *l*=0,7-10 m, *S*=0,03-0,32 m, *n*=50-1200 min-1.

Using experimental data, a graph of the dependence of the coefficient of friction was drawn up (resistance) ε on the Reynolds number Re, from which it follows that all experimental points are located along a straight line do not exceed 20-25%, and they are mainly associated with the sliding of the material along the machine of the chute and the screw of the conveyor.

Depending on the Reynolds number, three options can be recommended three options for using a screw conveyor:

In the first case ($Re < 10$)pipelines can be used c $n < 300$ min^{-1}, D=0,05-0,3 m and $K_s = \frac{S}{D} = 0{,}8 - 1{,}0$ for transporting powdery and fine-grained materials.

With the second option (Re=10-100)– conveyors c n=400-1200 min^{-1}, D=0,05-0,15 m and K_s=0,6-1,0 should be used to move any materials.

For the third option (Re>100)- conveyors c n=500-900 min^{-1}, D=0,1-0,2 m suitable for transporting easily moved materials with a low coefficient of sliding friction ε o groove and screw.

An analysis of experimental data shows that the Reynolds number has a significant effect on the speed of the propeller per minute n. A graph of the dependence of the Re number on n for various dispersed materials and screw pitches has been compiled.

The definition of the main parameters of the conveyor is as follows. Given a certain value of conveyor performance *П,* tentatively accept D, $K_s = \frac{S}{D}$, $K_d = \frac{d}{D}$. Then by formulas above find values (4), (5) and (6) define parameters Re, ε and P.

In conclusion, it should be noted that the work and analysis of experimental data confirm the possibility of applying the equation Hagen-Poiseuille for research transportation of dispersed materials, show the advantages of this method for calculating and selecting the main characteristics of a screw conveyor.

Literature

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