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DETERMINING THE EXIT TIME OF BULK MATERIAL FROM THE PERFORATED DRUM

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Abstract

This article presents analytical expressions that make it possible to determine the exit time of dispersed materials from a perforated drum that sorts such materials. The expressions are derived based on the movement of the material along the length of the drum during the sorting process. The calculated results have been solved and analyzed numerically using Microsoft Excel.

Keywords: perforated drum, exit time, bulk material, angular velocity, drum length, inclination angle.

Introduction

In the search for efficient methods of sorting bulk materials, significant attention is given to the use of centrifugal separators. This is because, during the sorting process, the dispersed material is subjected to an inertial force greater than the force of gravity. When the bulk material is under the influence of centrifugal force, the sorting process becomes more intensive. This ensures continuous interaction between the particles of the dispersed material and the sorting surface, increasing the likelihood of particles falling through the perforations. Additionally, the higher movement velocity of the dispersed material contributes to an increase in the efficiency of the separator [1, 2].

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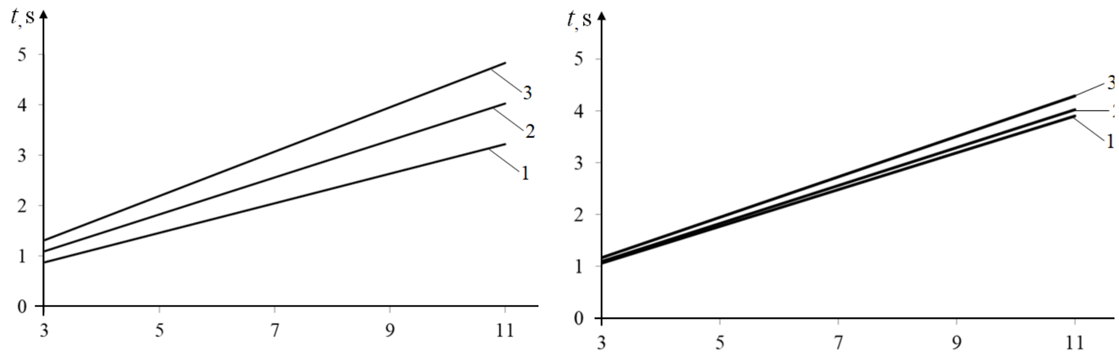
The exit time of bulk materials from a perforated drum—specifically, the time it takes for the material to travel along the length of the drum during axial movement—is of great importance for the analysis and optimization of the technological process. This time depends on the kinematic parameters of the drum, its inclination angle, length, and angular velocity.

The exit time of unsorted bulk material from the drum can be expressed as follows:

$$t(L) = \frac{(k\omega + \omega_0)L}{gtg(\beta)cos(\alpha)} . \qquad (1)$$

To determine the variation patterns of the exit times of dispersed material being sorted in a perforated drum along the drum axis, we solve equation (1) numerically using Microsoft Office Excel, with the following parameter values, that is e=2,7; k=0,8; g=9,81m/s^2, β=30°, α=(5°÷25°), ω=(2÷3) c^{-1}; L=(3÷11) m.



1-ω=2 c^{-1}; 2-ω=2,5 c^{-1}; *3*-ω=3 c^{-1} — *а*

1-α=5°; *2*-α=15°; *3*-α=25° — *б*

Figure 1. Graph of the variation of the falling time of bulk material depending on the drum length

Graphs constructed based on the numerical solution of expression (1) are presented in Figure 1. These curves show that the exit time of dispersed material from the drum increases linearly with the increase in drum length. Furthermore, as the angular velocity and inclination angle of the drum increase, the exit time of the dispersed material also increases.

For example, when the drum's angular velocity is ω = 2 s^{-1}, and the drum length increases from 3 m to 11 m, the exit time ranges from 0.88 to 3.22 seconds. At ω = 2.5 s^{-1}, the exit time ranges from 1.1 to 4.03 seconds over the same drum length range. At $\omega = 3\ s^{-1}$, the exit time ranges from 1.3 to 4.8 seconds.

In conclusion, it can be stated that the exit time of dispersed material from a perforated drum is one of the key factors directly affecting the efficiency of the technological process. By determining this time, it becomes possible to optimize the drum parameters, improve the quality of sorting, and enhance the overall performance of the machine.

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