INTRODUCTION

Vibratory separation is effective in various industries both in the primary stages of production, and in the finishing operations. This leads, on the one hand, to intensive introduction vibratory separators in the industry. On the other hand it requires the methods developing for the complex dynamic systems analysis of vibratory separators; it needs the development of theoretical and experimental methods of technological processes vibration [1,7]. That’s why is important to investigate the impact of physical - mechanical characteristics, including elastic properties, density, velocity and amplitude - frequency characteristics of loose environment in the process of separation. For this purpose to built the mathematical models motion of the load layer [4-6], that will more fully consider the full range of internal and external factors that affect the separation. The main external factors include layouts and characteristics of vibration exciter, working container, etc...

In contemporary literature the loose environment movement was seen on the basis of some hypotheses, such as the motion of a particle in various forms vibrating plane [2], motion of the medium as a system of material points [3], that in some way interact with each other and the walls of the container, the layered motion loose environment [1,7]. However, these hypotheses describe the motion of loose environment only within certain assumptions, so it is appropriate to further its study.

Based on the above it is suggested to construct a mathematical model of loose medium on the basis of consideration of it as layers of elastic - plastic beams flat that interact elastically, tough, or as hinged.

MATHEMATICAL MODEL

To construct a mathematical model of loose environments movement the design scheme of vibration separator with only vertical oscillation sieves is considered.

Figure 1 Design scheme of vibratory separator

In this scheme eccentric 6 provides to housing 1 backward - forward movement along directed rollers 7. During the vibratory separation, loose environment 2 carries transverse movement along the sieve 4 under a certain angle to the horizon. The structure of environment changes along its movement on work surface. There are the periodic thickening and thinning factions, that causing the changing of its physical - mechanical properties. The velocity of the loose environment governed by tilting the sieve to the horizon is carried out by adjusting slats 5. In this case in different areas the speed of loose environment is different. So in the upper layers of loose medium speed is
The Influence of the Loose Medium Parameters on the Process of Vibratory Separation

Stotsko Z., Topilnytskyj V, Rebot D

The greatest and decreases towards lower loading layers. This is achieved by the power pulses that act between the particles. In general, the thinner the layer loading is the faster separation. But this is a characteristic only to a certain limit, after which the intensity of the process of separation decreases. The velocity of the loose medium also depends from the amplitude and frequency of loose medium which increase depending from the increasing of the amplitude and frequency of hull oscillations.

Generally speed and quality of separation depends greatly on factors such as:
- conveyor speed (download speed of loose medium);
- kinematic parameters of vibration separators container (its amplitude and frequency of oscillations);
- physical properties of loaded factions (their mass, density, size, elastic properties).

To build a model of the load layers movement, we assume that it satisfies the following statements: 1) The granular medium is a solid homogeneous material, considered as layers of flat elastic - plastic girders, the thickness of which is much smaller than the length and which contacts with the walls of the container elastic, tough or as a hinged girder; 2) the granular medium is moving like a layers, as a result its physical - mechanical properties are variables along the length of the sieve; 3) its material satisfies the linear law of elasticity:

\[ \sigma = E \varepsilon^{v+1} \]  

In this ratio the dynamic modulus of elasticity is variable along the environmental function, i.e.:

\[ E = E(x) \]  

Variables are also loose density environment. This is because the structure of the medium is changed in the process of separation by rarefaction and compaction.

Considering the environment as the stratification of plane elastic - plastic beams in contact with the walls of the container tough elastic or as hinged beams, write their boundary conditions as:

\[ u(x, t)|_{x=j} = \frac{\partial^2 u(x,t)}{\partial x^2} |_{x=j} = 0, \quad j = 0, 1 \]  

From the boundary conditions (3) the basic idea of perturbation methods [6] is using. According to it, unperturbed equation will have the form Eq (4). With a further review of equation (4), considering (2) and (3) the following equation for the amplitude - frequency characteristics of loose medium layer can be obtained as Eq (5) and Eq (6).

Based on equation (5,6) the influence of amplitude - frequency characteristics on the effectiveness of the vibration separation was studying. The loose medium was taken like a circular plate of insulating glass with different diameters, used in the manufacture of energy saving lamps. In the process of loading they were submitted to a vibration separator in a single continuous plate. Later this plate crushed by rolls and allocated plates. They were divided from wastes and by size. To further investigate we provide them and vibratory separators container following physical - mechanical characteristics: sieve inclination angle \( \beta = 45^\circ \); lengthhandwidthof the sieves respectively \( a = 1.2 \, m; b = 0.65 \, m; \) the density of loose medium \( \rho = 1500 \, kg/m^3; \) particles diameter \( d = 0.5 \ldots 1.0 \, mm; \) elastic modulus \( E = 70 \, GPa. \)

Figure 2 Changing the efficiency of separation in dependence of the amplitude of separators container for different values of the speed of downloading material.

1. \( V = 0.9 \, m/s; \) 2. \( V = 0.7 \, m/s; \) 3. \( V = 0.5 \, m/s; \) 4. \( V = 0.2 \, m/s; \)

Figure 3 Changing the frequency of oscillation loose medium in dependence of the speed of downloading material at different values of the amplitude of container.

1. \( A = 1.5 \, cm; \) 2. \( A = 1.0 \, cm; \) 3. \( A = 0.8 \, cm \)

Analysing the graphs it can be noted that the increase in the amplitude and frequency of vibrations container positively affects the productivity of the process of separation. Also the significant impact on separation has conveyor loading speed, i.e. loading speed of loose medium. In particular, a substantial its
increasing leads to a decrease in the oscillation frequency of loose medium and as a result to reduce the productivity of separation.

**CONCLUSION AND FUTURE DIRECTION OF RESEARCH**

The investigated method makes it possible to determine the impact of a wide range of parameters on the dynamics of vibratory separations process. In particular: a) the influence of loading speed on its own oscillation frequency of loose medium; b) the influence of the containers amplitude on its own oscillation frequency of the load layer. Obtained in the work results may be the basis for the study of more complicated cases of vibratory separations dynamics.

**REFERENCES**


