

**ANALYSIS OF SPECIFIC VERTICAL AND ANGLE VIBRATIONS
OF A SCREW CONVEYOR SHAFT MOUNTED ON SLEEVE
BEARING SUPPORTS**

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Abstract: This paper presents an analysis of the natural vertical and inclined vibrations of a screw conveyor shaft mounted on elastic bearing supports. The performance of the proposed double-flight screw conveyor is mainly determined by the screw parameters, including diameter, rotational speed, length, screw pitch, as well as the amplitude and frequency of waves in each screw flight. The study investigates the influence of these parameters on the vibration characteristics and proposes scientific and technical solutions aimed at ensuring stable and efficient operation of the conveyor. The obtained results are of practical importance for the design and performance improvement of screw conveyor systems.

Keywords: screw conveyor, screw, elastic element, bearing, shaft, vibration frequency, vertical vibrations, inclined vibrations, performance, parameter, wave amplitude, frequency, dynamics

Annotatsiya: Ushbu maqolada qayishqoq podshipnikli tayanchlarga oʻrnatilgan vintli konveyer valining xususiy vertikal va ogʻma tebranishlari tahlil qilingan. Tavsiya etilgan ikki kirimli vintli konveyerning ish unumdorligi asosan vintning geometrik va kinematik parametrlariga bogʻliq boʻlib, ularga vint diametri, aylanish chastotasi, uzunligi, vint qadami hamda har bir vint kirimidagi toʻlqinlar amplitudasi va chastotasi kiradi. Tadqiqot jarayonida ushbu parametrlarning tebranish xarakteristikalariga taʼsiri oʻrganilgan hamda konveyerning barqaror ishlashini taʼminlashga qaratilgan ilmiy-texnik yechimlar taklif etilgan. Olingan natijalar vintli konveyerlarni loyihalash va ularning samaradorligini oshirishda muhim ahamiyat kasb etadi.

Kalit soʻzlar. vintli konveyer, vint, qayishqoq element, podshipnik, val, tebranish chastotasi, vertikal tebranish, ogʻma tebranish, ish unumdorligi, parametr, toʻlqin amplitudasi, chastota, dinamika

Аннотация: В данной статье проведён анализ собственных вертикальных и наклонных колебаний вала винтового конвейера, установленного на опорах с упругими подшипниками. Производительность предлагаемого двухзаходного винтового конвейера в основном определяется параметрами винта, такими как диаметр, частота вращения, длина, шаг винта, а также амплитуда и частота волн в каждом заходе винта. В ходе исследования изучено влияние указанных параметров на динамические характеристики колебаний и предложены научно-технические решения, направленные на обеспечение устойчивой работы конвейера. Полученные результаты могут быть использованы при проектировании и повышении эффективности винтовых конвейеров.

Ключевые слова: винтовой конвейер, винт, упругий элемент, подшипник, вал, частота колебаний, вертикальные колебания, наклонные колебания, производительность, параметр, амплитуда волны, частота, динамика

At the stage of development of mechanical engineering, along with all areas, it is of great importance to intensively apply in production of equipment and technologies that ensure resource efficiency and high productivity in the transportation of products in production, and to further increase the quality and competitiveness of products. “Transportation costs play an important role in reducing the cost of production, that is, in mechanical engineering, 5-6%, in the food industry 10-12% and even more costs are incurred for transportation”, which requires the development of new designs of screw conveyors for transportation and their implementation in practice in order to improve the technical and economic performance of production [1]. In this regard, great attention is paid to the use of screw conveyors with wide technological capabilities in the transportation, loading and unloading of products at manufacturing enterprises.

The efficiency of the proposed double-inlet screw conveyor mainly depends on the screw parameters, diameter, rotation frequency, length, screw pitch, and the amplitude and frequency of the waves in each screw inlet. The angle of deviation of the screw from the horizontal plane also plays an important role. When the transported load rises to a certain height, the effect of the screw on the bearing and belt elements is different. In particular, the bearing and belt bushing located below is deformed more than the one above. Also, when the load is transported along the horizontal axis, the deformations of the bearing and belt bushings with different stiffness coefficients are also different. In this case, the screw also experiences deflection vibrations within a certain angle range along its axis [2, 3].

Depending on the value of the vibrations, the vertical displacements of the screw at the inlet and outlet also differ. This, in turn, leads to a change in the gap between the

screw surface and the conveyor. Depending on the physical and mechanical properties of the transported material and the technological requirements for its use, it is possible to determine the pattern in which the gap between the screw surface and the shell changes in the direction of movement. Therefore, it is important to choose the dimensions of the bearings and belt bushings. Taking the above into account, a calculation scheme for a screw conveyor was developed (Fig. 1).

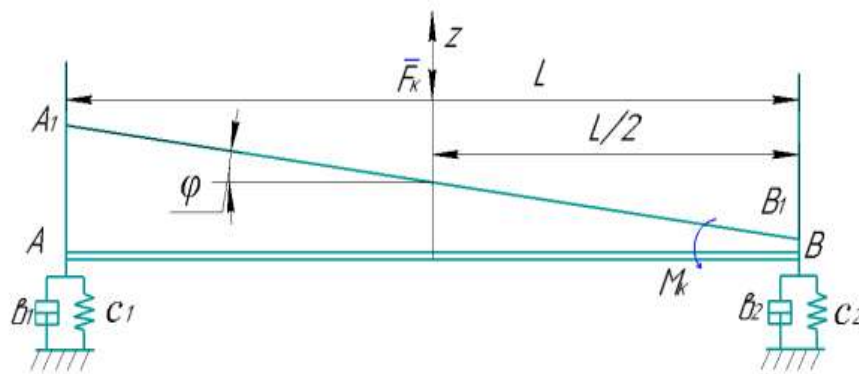


Figure 1. Calculation scheme for determining vertical and oblique vibrations of the propeller shaft

It should be noted that when compiling the calculation scheme, the deflection of the propeller shaft is taken into account, since the deflection is very small compared to the deformation of the flexible bushings. The forces that cause the vertical displacement and deflection of the propeller shaft are: weight, the rigidity of the flexible bushings, and the dissipation and inertia forces. To derive a system of differential equations describing the vibrations of the propeller, the Lagrange second-order equation was used [4, 5];

$$\frac{d}{dt} \left(\frac{\partial T}{\partial \dot{q}_i} \right) - \frac{\partial T}{\partial q_i} + \frac{\partial \Phi}{\partial \dot{q}_i} + \frac{\partial \Pi}{\partial q_i} = Q(q_i), \quad (1)$$

where q_i -system generalized coordinates, T , P – system kinetic and potential energies; Φ – Rayleigh dissipative function; $Q(q_i)$ – forces corresponding to generalized coordinates.

Based on the calculation scheme in Figure 1, two generalized coordinates of vertical and oblique vibrations of the screw conveyor were taken as z – vertical displacement and φ -screw axis deviation angle. Taking into account these generalized coordinates, we determine the corresponding integrals of Lagrange’s II-order equations. Accordingly, the kinetic, potential energies of the system are [6]:

$$\Pi = \frac{c_1 \left(z - \frac{\varphi l}{z} \right)^2}{2} + \frac{c_2 \left(z + \frac{\varphi l}{z} \right)^2}{2}, \quad T = \frac{m\dot{z}^2}{2} + \frac{J\dot{\varphi}^2}{2}, \quad (2)$$

where m is the mass of the screw; c_1, c_2 are the coefficients of rigidity of the rubber bushings with elastic elements; l is the length of the screw; J is the moment of inertia of the screw.

It is known that elastic elements absorb a certain amount of energy during movement. To express this absorption, the dissipative properties of elastic elements are taken into account. 4 elastic elements are used in the machine unit under consideration. The absorption in them significantly changes the law of screw motion.

Considering that when using the proposed double-entry and wavy-surface screw, the conveyor shell is filled with $(0.3 \div 0.5)$ % of the transported material, the vertical and oblique vibrations of the screw allow for sufficient mixing and transportation. It should be noted that this is especially applicable in cases of product deviations of up to $(20^\circ \div 35^\circ)$.

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