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ANALYSIS OF THE LAWS OF CHANGES OF THE ANGULAR VELOCITIES OF BELT CONVEYOR DRUMS AND THE TORQUE OF THE DRIVE SHAFT AT DIFFERENT TECHNOLOGICAL RESISTANCE VALUES

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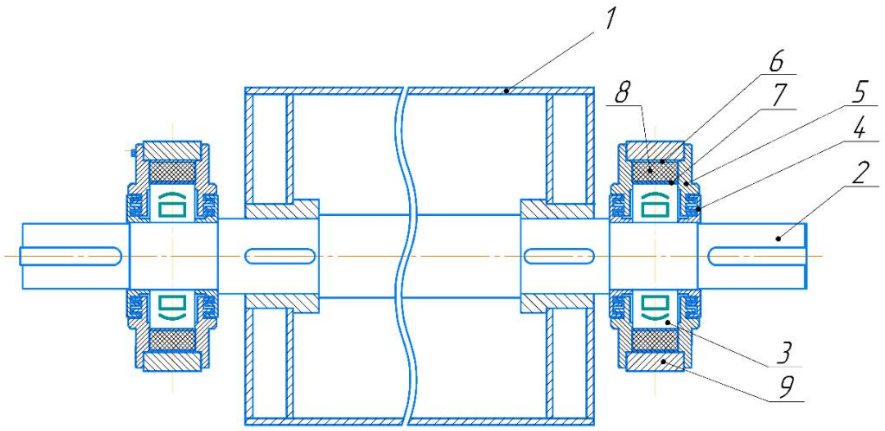
Abstract. The article presents ideas about the reliability and durability of belt conveyors in mining enterprises today, as well as the constantly increasing requirements for equipment. In order to increase the service life of the bearing supports of the belt conveyor leading and driven drums, it was found that it is possible to increase the service life of the drums by using rubber bushings on the outer side of the bearing. According to this, the analysis of scientific studies has been carried out that when bushings with belt elements are used in drums, it is possible to increase the UVK compared to the traditional one due to the reduction of the amplitude of vibrations in it.

Keywords. Conveyor, drum. belt element, deformation, loading, transportation, amplitude, vibration, technology.

Belt conveyors are widely used in mining enterprises, because the introduction of continuous transportation technology in open and closed quarries becomes important by increasing the technical level and economic efficiency of production. The specific trend of the development of belt conveyors in our republic and foreign countries in accordance with the needs of the times is explained by the fact that the continuous delivery of minerals over long distances significantly increases the work picture. At the same time, the reliability and durability of belt conveyors and the requirements for equipment are constantly increasing. In belt conveyors, the leading and leading drums are the mechanisms with a high level of loading. Loads on long conveyor drums can reach 1000 *kN* or more. Premature repair of drum components as a result of high loads and external shocks remains one of the urgent tasks.

The results of the conducted scientific and practical research show that one of the reasons for the failure of the drums is the premature failure of the bearings, the part that provides the basic rotational movement in the mechanism as a result of high loading and external shocks. This, in turn, leads to large economic costs in industrial enterprises, because the repair of the drum takes a long time [1, 2].

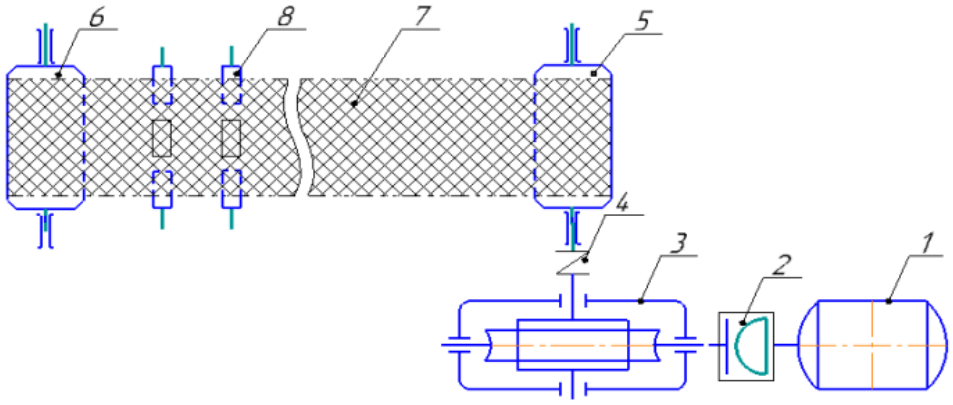
The research analysis showed that in order to increase the service life of the bearing supports of the belt conveyor leading and driven drums, it was found that it is possible to increase the service life of the drums by using rubber bushings on the outer side of the bearing. Because, when bushings with belt elements are used in the drum, it is possible to increase the UVK compared to the traditional one due to the reduction of the amplitude of vibrations in it.



1 – bearing, 2 – axle, 3 – bearing, 4 – labyrinth cover 1, 5 – labyrinth cover 2, 6 – outer ring, 7 – inner ring, 8 – elastic element (rubber)

Figure 1. Drum construction (Belt conveyor)

Figure 2 shows the kinematic scheme of the belt conveyor. This belt conveyor works in the following order: the motion is transmitted from the 5AM250M4 electric drive 1 through the clutch 2 to the reducer 3. After that, the movement is transmitted from the reducer 3 through the coupling 4 to the leading drum 5 using the belt 7 to the leading drum 6. During the transportation of minerals, rollers 8 are used to provide support and tension in the belt [3, 4].

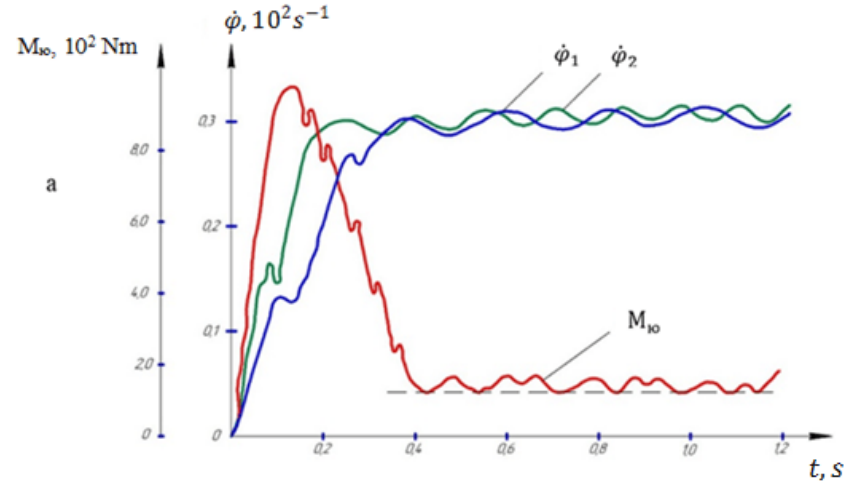


1- engine, 2, 4- coupling, 3- reducer (with worm), 5- leading drum, 6- leading drum, 7- belt, 8- roller.

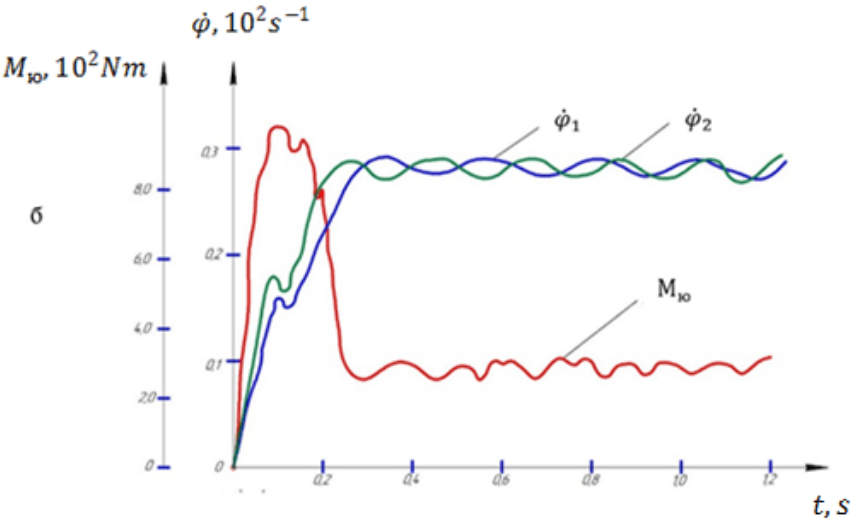
Figure 2. Belt conveyor kinematic scheme

In theoretical studies, it is important to study the law of motion of the conveyor drums, determine the limits of the change of angular speeds, recommend the optimal values as a result of studying the effects of loading and changing the parameters of technological resistance and inertia on the dissipative-cohesion properties of the belt [5, 6].

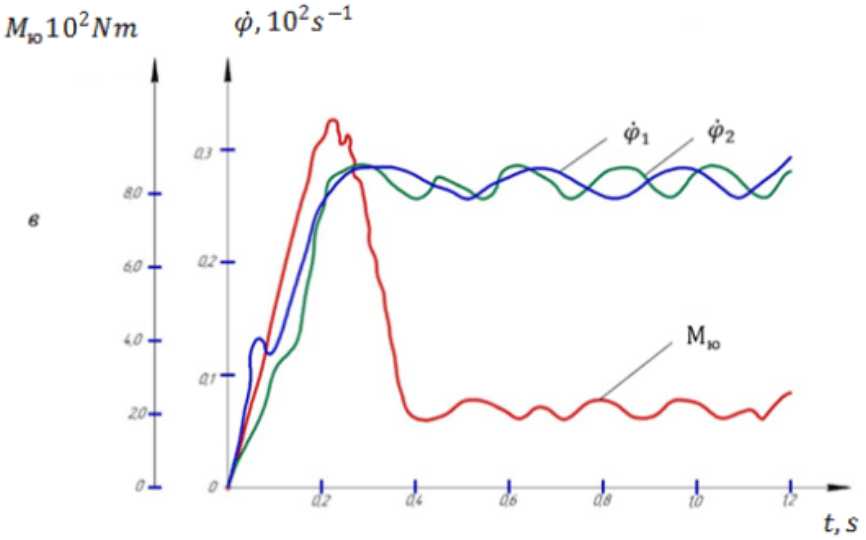
Samples of the variation patterns of the angular velocities of the drums and the torque on the electric drive shaft at different values of mineral transported on the belt conveyor are presented in Fig. 3. From them, it can be seen that the average values of $\dot{\varphi}_1$ and $\dot{\varphi}_2$ are around 28.23 s^{-1} when the technological resistance is 1.0□10^2 Nm, and the vibration coverage values are in the range of (0.6 ÷ 1.0) s^{-1} for $\dot{\varphi}_1$, for $\dot{\varphi}_2$, it is in the range of (0.8 ÷ 1.2) s^{-1}. The reason that the values of $\Delta\dot{\varphi}_2$ are reduced compared to $\Delta\ddot{\varphi}_2$ is due to the effect of the rotational stiffness of the belt transmission. The larger this rotation is, the closer the values of $\dot{\varphi}_1$ and $\dot{\varphi}_2$ are to each other. When the technological resistance values are doubled, the average values of $\dot{\varphi}_1$ and $\dot{\varphi}_2$ decrease to $\dot{\varphi}_1$ and 26.86 s^{-1}, respectively, and their vibration coverage values also increase, $\dot{\varphi}_2$ values reach (2.5 ÷ 3.5) s^{-1} (Fig. 3, graph $\dot{\varphi}_1$). Based on the processing of the obtained motion laws of the drums, connection graphs were obtained.



$M_{res}+M_{fric} = 1.0 \square 10^2\ Nm + (8 \div 10)\ Sin\ \omega t Nm \pm (1.5 \div 20)\ Nm$



$M_{res}+M_{fric} = 1.5 \square 10^2\ Nm + (11 \div 13)\ Sin\ \omega t Nm \pm (2.0 \div 2.5)\ Nm$



$M_{res}+M_{fric} = 2.0 \square 10^2\ Nm + (13 \div 15)\ Sin\ \omega t Nm \pm (2.5 \div 3.5)\ Nm$

Figure 3. Patterns of variation of angular velocities of belt conveyor drums and torque on the drive shaft at different values of technological resistance

According to the results of studies of technological resistance and the effect of the moment of friction forces on the law of change of the angular speed of the belt conveyor drums, the value of the angular speed of the vibration range of the leading drum is in the range of $\Delta\dot{\varphi}_2 \leq (0.21 \div 0.25)$

10 s^{-1} to ensure that $c_2 \leq (260 \div 300)$ Nm/rad, it was determined that the friction force moment decreases due to the deformation of the rubber bushing as a result of obtaining the technological and friction force torque from the transported ore using the formula.

The analysis of the graphs of the dependence of the angular speed of the belt conveyor drums on the variation of the vibration range and the load on the conveyor on the change of the belt stiffness coefficient was considered. As a result, the angular velocities of the leading and leading drums are close to each other, and the vibration ranges are within certain intervals. is recommended.

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