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ANALYSIS OF ANGULAR VELOCITIES OF BELT CONVEYOR DRUMS AND CONVEYOR LOAD CHANGE DEPENDENCE ON TECHNOLOGICAL RESISTANCE

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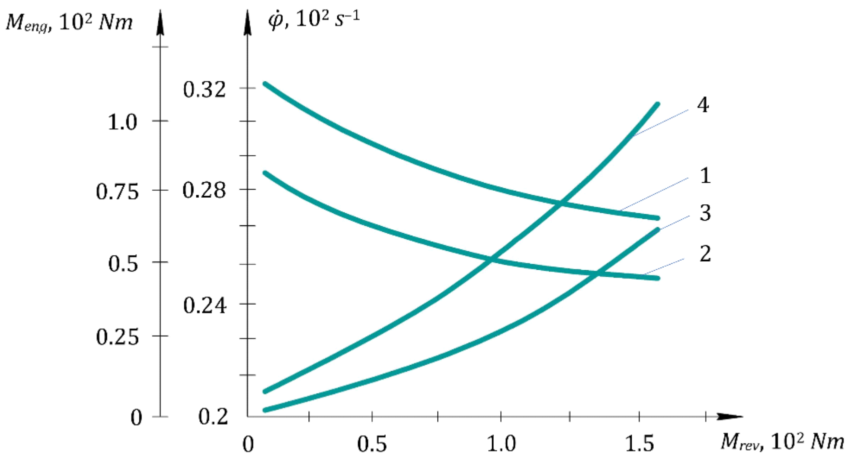
Abstract. The article presents ideas about the reliability and durability of belt conveyors in mining enterprises today, as well as the constantly increasing requirements for equipment. Graphs of the dependence of the angular speeds of the recommended belt conveyor drums and the change of the driver load on the technological resistance and the resistance moment of the friction force and the torque of the friction force are given and their recommended values are given. 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.

Today, belt conveyors are considered as a means of transport for the continuous supply of minerals in mining enterprises, modeling their activity taking into account economic efficiency indicators, studying the influence of parameters of open and closed quarries on the choice of technological schemes for the transportation of minerals. scientific research is being carried out. In this regard, one of the urgent tasks is to determine the optimal area of application of the technological schemes of transportation of mining mass using belt conveyors in the organization of continuous transportation of mineral resources in the horizons of deep pits, and to develop the optimal technological scheme of transportation of mining mass in the further development of deep quarries.

If mineral resources are mined from open quarries, when the depth of the quarry is more than 600 meters, the maximum movement volume of mineral extraction mass during one year and their transportation work will increase significantly. In this situation, the cost of transportation will be 60% and more as the quarry depth increases. For this reason, additional studies were conducted to determine the patterns of impact of the volumes of rocks extracted from the quarry on the mining machines. As a result, the main parameters of the quarry were selected for conducting scientific research, and belt conveyors were organized depending on the weight of the rocks and the depth of the quarry, which would allow the selection of transport machines for deep quarries [1, 2].

In theoretical research, it is important to study the law of motion of belt conveyor drums, to determine the limits of angular velocity changes, to recommend optimal values as a result of studying the effects of loading and changes in the dissipative-cohesion characteristics of the belt, technological resistance and inertial parameters on the law of motion [3, 4].

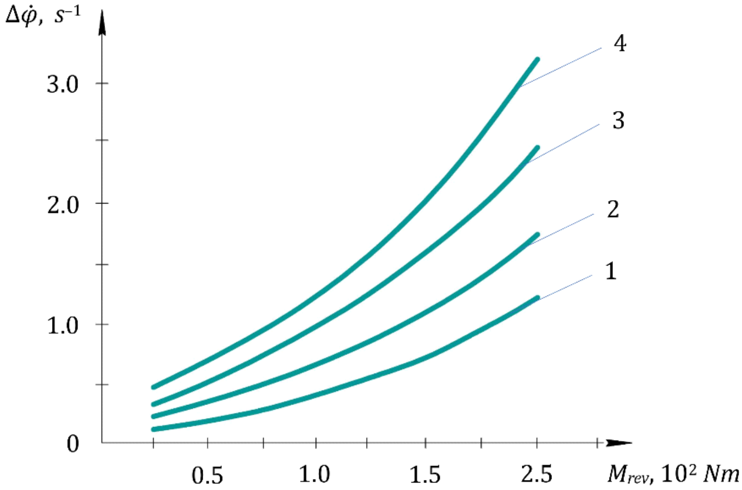
Fig. 1 shows graphs of dependence of the angular speeds of the leading and driven drums with the belt element of the proposed belt conveyor bearing and the change of the driver load on the technological resistance and the resistance torque of the friction force.



where, 1 – $\dot{\varphi}_1 = f(M_{res})$; 2 – $\dot{\varphi}_2 = f(M_{res})$; 3.4 – $M_{enj} = f(M_{res})$;
3 – $M_{fric} = 43$ *Nm*; 4 – $M_{fric} = 26$ *Nm*.

Figure 1. Graphs of angular velocities and conveyor load variations of the leading and driven drums with a belt element of the proposed belt conveyor bearing support and technological resistance dependence graphs

Based on the graphical connections, when the values of M_{res} change from $0.15 \cdot 10^2$ *Nm* to $1.5 \cdot 10^2$ *Nm*, the torque on the drive shaft increases from $0.17 \cdot 10^2$ *Nm* to $0.86 \cdot 10^2$ *Nm*, while the torque of the friction forces increases from $0.11 \cdot 10^2$ *Nm* It can be seen that it reaches $0.41 \cdot 10^2$ *Nm*. It can be seen that the difference between the angular velocities of the drums decreases as the technological resistance increases. The main reason for this is that even if the deformation values of the belt are large under a large load, the change intervals are small. In particular, it can be seen from the equation that when the values of M_{res} increase from $0.2 \cdot 10^2$ *Nm* to $1.5 \cdot 10^2$ *Nm*, the values decrease linearly from $0.305 \cdot 102$ s^{-1} to $0.274 \cdot 102$ s^{-1}, and the angular velocity of the leading drum decreases from $0.283 \cdot 102$ s^{-1} to $0.256 \cdot 102$ s^{-1} can be determined. The difference between the angular velocities, as we noted above, occurs due to the rotation of the conveyor belt, due to the change in friction, due to a sufficient level of sliding. It should be noted that the reduction of belt vibrations at the expense of the composite roller shock absorber also leads to a reduction of the angular speed fluctuations of the drums. However, by ensuring that the belt vibrates at the required level, it causes the transported ore to be level. Therefore, it is recommended to achieve the values of technological resistance $(1.3 \div 1.6)\ 10^2$ *Nm* from, and the torque of friction force does not exceed $(35 \div 40)$ *Nm*.

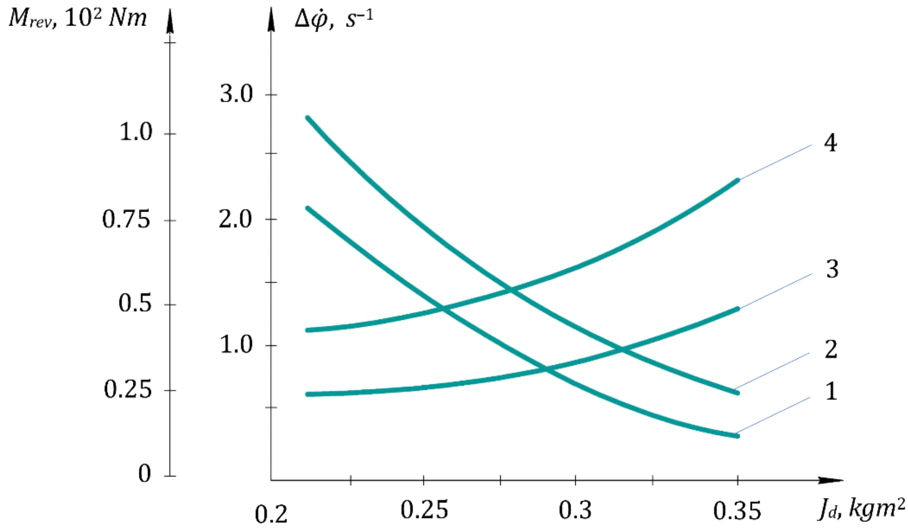


where, 1, 2 – $\Delta\dot{\varphi}_2 = f(M_{res})$; 3, 4 – $\Delta\dot{\varphi}_2 = f(M_{res})$; 1, 3 – c_2 = 380 *Nm*/*rad*;
2, 4 – c_2 = 260 *Nm*/*rad*

Figure 2. Graphs of dependence of angular speeds of belt conveyor drums on technological resistance

Figure 2 shows graphs of dependence of belt conveyor drums angular velocities, vibration range, technological resistance and friction moment. In this case, when the technological resistance and M_{res} incoming resistance increase from $0.25 \cdot 10^2$ *Nm* to $1.98 \cdot 10^2$ *Nm*, the angular velocity of the driving drum increases in a non-linear pattern from 0.46 s^{-1} to 2.95 s^{-1} when the vibration range is c_2 = 260 *Nm*/*rad*. can be achieved (Fig. 2, graph 4). Correspondingly, when the rotational speed coefficient of the conveyor belt increases to 320 *Nm*/*rad*, the range of oscillation of the angular velocity of the driving drum increases from 0.42 s^{-1} to 2.19 s^{-1}, and the values of $\Delta\dot{\varphi}_1$ only increase to 1.11 s^{-1}. In this case, the maximum difference between $\Delta\dot{\varphi}_1$ and $\Delta\dot{\varphi}_2$ reaches (1.0 ÷ 1.25) s^{-1} when $M_{res} + M_{fric} = 2.0 \cdot 10^2$ *Nm* (Fig. 2, graphs 2, 4). According to the results of experimental studies, to ensure that the angular velocity of the driving drum is within the range of $\Delta\dot{\varphi}_2 \leq$ (0.21 ÷ 0.25) 10 s^{-1}, $c_2 \leq$ (260 ÷ 300) *Nm*/*rad* coming from the transported ore and it is recommended that the torque of the friction force should be in the range of technological resistance $M_{res} + M_{fric}$ = (1.3 ÷ 1.6) *Nm*. As mentioned above, increasing the speed of belt rotation causes the angular velocities of the drums to converge and decrease $\Delta\dot{\varphi}_1$ and $\Delta\dot{\varphi}_2$.

Figure 3 shows graphs of the dependence of the angular speed of the belt conveyor drums on the vibration range and the load on the conveyor on the changes in the moments of inertia of the drums.



$1 - \Delta\dot{\varphi}_1 = f(J_{d1})$; $1 - \Delta\dot{\varphi}_1 = f(J_{d2})$; 3, 4 – $M_{ener} = f(J_{d1})$;
3 – $M_{res}+M_{fric} = 0.75 \cdot 10^2$ *Nm*; 4 – $M_{res}+M_{fric} = 1.25 \cdot 10^2$ *Nm*

Figure 3. Graphs of the dependence of the angular speed of the belt conveyor drums, the vibration range and the load change on the conveyor on the change of the moments of inertia of the drums

It is known that with the increase of moments of inertia in rotating joints, the motion becomes smooth. Therefore, in order to obtain the angular velocity unevenness coefficient within the desired limit, the moment of inertia values are chosen accordingly. It can be seen that when the moment of inertia values of belt conveyor drums are increased from 0.32 kgm^2 to 0.45 kgm^2, the values of $\Delta\dot{\varphi}_1$ decrease nonlinearly from 2.12 s^{-1} to 0.36 s^{-1}, and the angular velocity of the driving drum decreases from 2.9 s^{-1} to 0.82 s^{-1} can be seen (Fig. 3, graphs 1, 2). In order to keep $\Delta\dot{\varphi}_2$ in the desired range, it is recommended that $J_{b1} = (0.45 \div 0.52)$ kgm^2 and $J_{b2} = (0.42 \div 0.45)$ kgm^2. It should be noted that as the moment of inertia of the drums increases, the load on the electric conductor also increases. For example, when $J_{b1} = J_{b2} = 0.45$ kgm^2 increases to $M_{res} = 1.25 \cdot 102$ Nm, it can be seen that M_{ener} values increase from $0.46 \cdot 10^2$ *Nm* to $0.83 \cdot 10^2$ *Nm*, i.e. up to two times. Therefore, the moment of inertia of drums is limited.

Summary. In order to ensure uniform distribution of transported ore on the basis of vibrations of the belt, it is recommended to achieve values of technological resistance and friction moment not exceeding $(1.3 \div 1.7)$ 10^2 *N*. The effect of technological resistance and friction torque on the variation of the angular speed of the belt conveyor drums on the variation of the vibration range was studied, the angular speed of the leading drum was determined to be in the range of $\Delta\dot{\varphi}_2 \leq (0.21 \div 0.25)$ 10 s^{-1} to ensure $c_2 \leq (0.21 \div 0.25)$ *Nm/rad*, the formula for determining the technological and friction torque coming from the transported ore was obtained. In this case, it was found that the torque of the friction forces decreases due to the deformation of the rubber bushing.

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