IMPROVEMENT OF THE DESIGN AND JUSTIFICATION OF THE PARAMETERS OF MECHANISMS OF COMPOSITE GUIDE ROLLERS OF BELT CONVEYORS

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Abstract. This article presents a recommended structural scheme and operating principle of a **belt conveyor equipped with composite guide rollers incorporating elastic shock absorbers**. Based on comprehensive studies, the motion patterns of the system parameters and operating modes were determined. Experimental investigations were carried out to identify the laws of motion of the belt conveyor drums, rotational resistance, vibration behavior, and load characteristics of the composite guide roller. As a result of full-scale experimental tests, the optimal parameters of the guide roller were established.

Keywords. Belt conveyor, guide roller, composite roller, elastic element, vibration

Annotatsiya. Mazkur maqolada elastik amortizatorlar bilan jihozlangan yig‘ma yo‘naltiruvchi roliklarga ega tasmali konveyer konstruksiyasining tavsiya etilgan sxemasi va ishlash prinsipi yoritilgan. Kompleks tadqiqotlar asosida tizim elementlarining harakat qonuniyatlari hamda ularning ishlash rejimlari aniqlangan. Tajribaviy izlanishlar natijasida tasmali konveyer barabanlarining harakat qonunlari, aylanishga qarshilik kuchlari, yig‘ma yo‘naltiruvchi rolikning tebranishlari va yuklanish xususiyatlari o‘rganilgan hamda ularning optimal parametrlari to‘liq eksperimental sinovlar asosida belgilangan.

Kalit so‘zlar. Tasmali konveyer, yo‘naltiruvchi rolik, yig‘ma rolik, elastik element, tebranish

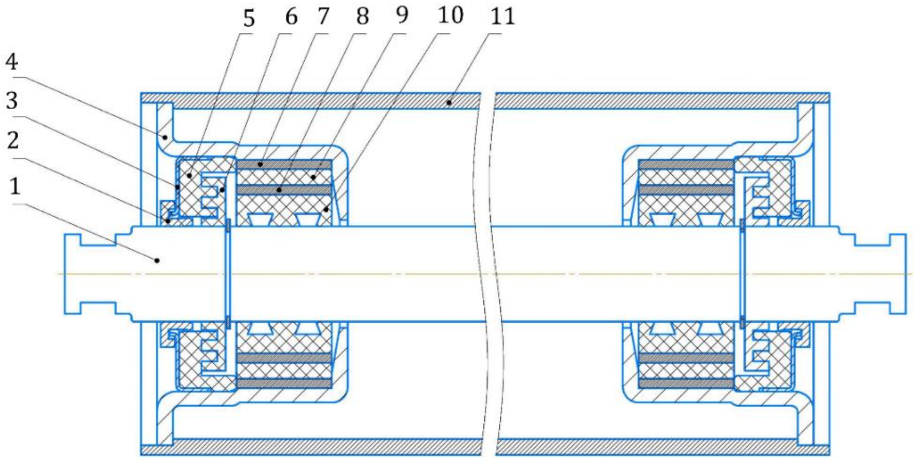
Аннотация. В статей приводится рекомендуемая схеме и приказан работы конструкции ленточного конвейера с составными направляющими роликами с упругими амортизаторами. На основе комплексных исследований определены закономерности движения составных параметров и режимы движения. На основе экспериментальных исследований определение законов движения барабанов ленточного конвейера, сопротивления вращению, законов колебаний и нагрузок составного направляющего ролика и их оптимальных параметров в результате полноценных опытов.

Ключевые слова. Ленточный конвейер, направляющий ролик, составной, упругий элемент, колебание

Improving the competitiveness of machine mechanisms is crucial to improving the global mining industry, particularly the use of resource-saving and durable machinery and technologies with high productivity. Considering that 40-70% of the total cost of transporting minerals from quarries worldwide is spent on transportation, the development and implementation of new, improved designs of high-performance belt conveyors is essential for mining companies. Belt conveyors ensure the continuous movement of minerals over long distances. Therefore, the widespread use of belt conveyors with low energy consumption, high productivity, and technological characteristics is crucial in the mining industry.

However, when developing resource-saving belt conveyors and performing their dynamic analysis, variable parameters and lubrication theory were not adequately considered. Scientific research, such as the influence of lubricant properties on the operation of composite guide roller mechanisms for belt conveyors used in the mining industry, was not taken into account. Designs for composite guide roller mechanisms for belt conveyors with an elastic element were developed, their parameters and operating modes were substantiated based on the results of comprehensive theoretical and applied research, and conveyor efficiency testing was conducted [1].

Based on a review of the operating conditions and characteristics of belt conveyors in mining operations, specific design requirements for their main components were established. Based on an analysis of the design of belt conveyor roller mechanisms, a composite design scheme for the flexible elements of the roller mechanisms was proposed. Figure 1 shows an efficient design scheme for a conveyor with friction bearings and a new roller mechanism with flexible elements, based on research into the operation and maintenance of belt conveyors in the mining industry and an analysis of existing belt conveyor designs [2].



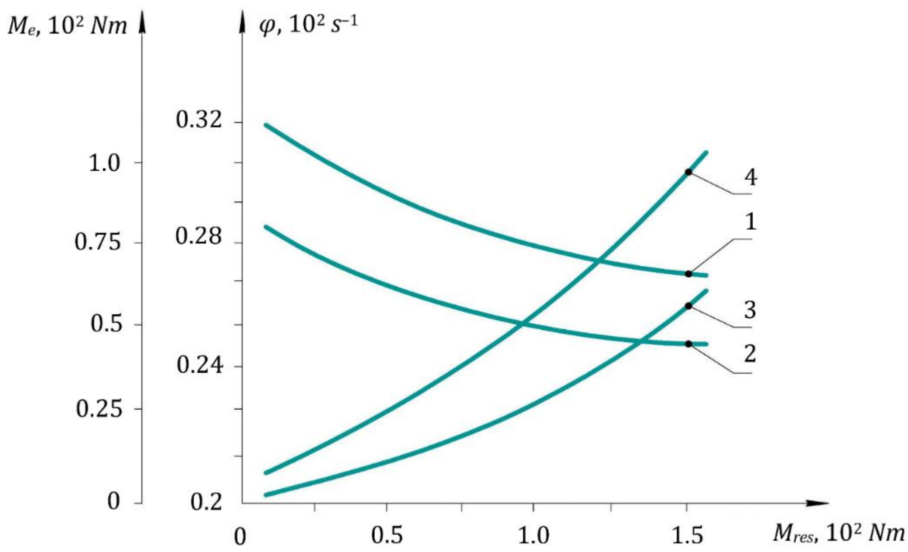
1-shaft, 2-labyrinth cover, 3-metal cover, 4-hub, 5-labyrinth protective cover1, 6-labyrinth protective cover2, 7-ring1, 8-ring2, 9-flexible element, 10-sliding bushing base (graphite-caprolon), 11-shell

FIGURE 1. Structural diagram of the proposed belt conveyor with a composite elastic element of the guide roller mechanism

Today, the key to the successful operation of all mining enterprises remains, first and foremost, the need for additional energy resulting from defects and problems in the belt conveyor and its components, and the mutual coordination of all departments to ensure reliable and trouble-free operation of the equipment. All of this has been analyzed in research conducted to develop new, improved designs for maintenance mechanisms, reliability diagnostics, and timely equipment repair.

Theoretical studies were mainly based on the study of the law of motion of conveyor drums, determination of the limits of change in angular velocities, dissipative-primary properties of the belt, the influence of changes in process resistances and inertial parameters on the load [3].

According to the analysis of the obtained graphs of the laws of motion and adhesion, with a change in the values of M_{res} from $0.15 \cdot 10^2$ Nm to $1.5 \cdot 10^2$ Nm, the torque on the electric drive shaft increases from 0.17 · 10^2 Nm to 0.86 · 10^2 Nm, and the friction torque, it can be seen, reaches from 0.11 · 10^2 Nm to 0.41 · 10^2 Nm. It is evident that the difference in the angular velocities of the drums decreases with an increase in process resistance. The main reason for this is that the change intervals are small, even if the belt deformation values are large under heavy loads (Fig. 2).



1 – $\dot{\varphi}_1 = f\,(M_{res})$; 2 – $\dot{\varphi}_2 = f\,(M_{res})$; 3, 4 – $\dot{\varphi}_1 = f\,(M_{res})$

FIGURE 2. Graph of the dependence of angular velocities and changes in the drive load of the drive and guide drums with a flexible element containing the recommended support of the belt conveyor on the process resistance

It should be noted that the reduction in belt vibration due to the composite roller damper also results in a reduction in the angular velocity of the drums. However, ensuring that the belt vibrates only as much as necessary ensures that the transported ore remains flat. Therefore, it is recommended that process resistance values not exceed (1.3 ÷ 1.6) 10^2 Nm [4].

Based on the results of experimental studies, it is recommended that the angular velocity of the lead drum be in the range of $\Delta\dot{\varphi}_2 \leq (0.21 \div 0.25)$ 10 s^{-1} in the presence of process resistance $c_2 \leq (260 \div 0.25)$ Nm/rad of the transported ore to ensure that the magnitude of the vibration coating is in the range of $\Delta\dot{\varphi}_2 \leq (0.21 \div 0.25)$ 10 s^{-1}. As noted above, an increase in the rotational rigidity of the belt leads to a decrease in the angular velocities of the drums by $\Delta\dot{\varphi}_1$ and $\Delta\dot{\varphi}_2$, respectively [2].

Based on the experiments, it was found that the best indicator for the part and Litol-24 oils made of rubber (7B-54MBC, 7IRP13-46, 7IRP13-48) and plastics (PVC, fluoroplastic, garfitokaprolon) with a load of F_r = 130 N, 190 N, 270 N and a rotational speed of f = 150 *rpm*, 300 *rpm*, 450 *rpm*, which depends on the rotational resistance of the belt conveyor guide roller mechanism, load F_r = 130 N, rotational speed f = 150 *rpm*. Litol-24 indicators of change in temperature coefficient relative to the rotational resistance of the mechanism are determined from the formula $k(t) = 1 – 0.16 (t + 30)$, the upper and lower values of the temperature coefficient were considered in the range from 0.27 to 0.021.

It follows that the belt conveyor roller mechanism is recommended for use at ambient temperatures ranging from – 30 to + 30 °C, provided that the temperature coefficient is $k(t) = 0.16$ and takes the form $t \geq 30$ °C. This value can be concluded to be the best. The friction force between the graphite-caprolon material and the bearing axis was also determined using Litol-24 oil. In this case, the rotating resistance of the composite roller was minimal [5, 6].

During testing, the guide roller mechanism installed on the belt conveyor ensured uniform rotational motion. Analysis was conducted in the plant's quality control department and research laboratory. Test results showed that the operating frequency of the plain bearing, instead of the rolling bearing performing both support and rotational motion, increased by 4.5%, mechanical damage to the roller mechanism decreased by 5.6%, external damage decreased by 4.99%, and productivity increased by up to 15%. Based on an extended cost-benefit calculation, the payback period is 3.6 years; the return on investment is 28%.

The design of mechanisms for composite guide rollers of belt conveyors with an elastic element has been developed, and the parameters and modes of their operation have been substantiated based on the results of comprehensive theoretical and applied research, as well as testing.

REFERENCES

[1]. Jumaev, A., Istablaev, F., Dustova, M. Development of the theory of calculation of constructive and rational parameters of belt conveyor roller mechanisms. *AIP Conference Proceedings*, 2022, 2467, 060025.
https://api.scienceweb.uz/storage/publication_files/9737/26397/666af69e34968.

[2]. Djuraev, A., Jumaev, A.S., Abduraxmanova, M.M.. Analysis of the results of physical and mechanical experimental studies of the modernized belt conveyor. *Journal of Physics: Conference Series*, 2023, 2573(1), 012012.
https://iopscience.iop.org/article/10.1088/1742-6596/2573/1/012012

[3]. Djuraev, A., Jumaev, A.S., Ibragimova, N.I., Turdaliyeva, M.Y. Analysis of the dynamics of a belt conveyor with composite guide rollers and elastic elements. *Journal of Physics: Conference Series*, 2023, 2573(1), 012026.
https://api.scienceweb.uz/storage/publication_files/9737/26378/666ad94ba5c1b

[4]. Abduvaliev, U., Jumaev, A., Nurullaev, R., Ashirov, A., Abdurafikov, B. Influence of the Sectional Shape of the Grabbing Element of a Screw Composite Spindle on Agricultural Performance and Stability of Operation of a Cotton-Picking Machine. *Lecture Notes in Networks and Systems*, 2024, 1129. https://link.springer.com/chapter/10.1007/978-3-031-70670-7_25

[5]. Tilabov, B., Jumaev, A., Sherbutaev, J., Normurodov, U., Salimov, G. Testing of heat-treated surfaced samples and machine parts for hardness and wear resistance. *E3S Web of Conferences*, 2024, 548, 03014.
https://www.e3s-conferences.org/articles/e3sconf/abs/2024/78/e3sconf_agritech-x_03014/e3sconf_agritech-x_03014.html

[6]. Abduvaliev, U., Jumaev, A., Nurullaev, R., Jakhonov, S., Jurakulov, I. Investigation of the process of the influence of winding spindles with cotton fiber on the performance of a cotton picker. *E3S Web of Conferences*, 2024, 548, 04013. https://www.e3s-conferences.org/articles/e3sconf/abs/2024/78/e3sconf_agritech-x_04013/e3sconf_agritech-x_04013.html.