IMPROVEMENT AND STRUCTURAL ANALYSIS CONSTRUCTION OF DETAILS OF ROLLER MECHANISMS BELT CONVEYOR

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Abstract: On a belt conveyor, the mechanism that performs the base rotational motion is a roller; the part of which that performs a flat rotational motion is the use of a part that acts as a rotating sliding base instead of a rolling bearing. This means that a constant increase in dust and moisture in the place where the conveyor is installed will cause the machine to stop due to the hardening of the rolling bearings. To solve this important problem, instead of a rolling bearing on a guide roller mechanism, which acts as a base rotary motion on a belt conveyor, it is recommended to use plastic and composite flexible materials that are resistant to abrasion, friction, acting as a sliding base. To this end, the constructive design work of this detail is carried out, and according to the results of scientific research, it is recommended as an important innovation in production.

Keywords: mechanism, roller, support, technology, experiment, elastic, friction, analysis, tape, plastic, sliding

I. INTRODUCTION

Currently, belt conveyors are widely used in the mining industry because they have the highest performance with significantly lower cost when transporting minerals under certain conditions compared to other modes

of transport. In addition, this transport is characterized by a high degree of interaction with other types of technological machinery and equipment, as the introduction of different types of belt conveyors has a positive impact on improving the technical level of a particular connection in the production cycle. One of the key components of a conveyor that determines the efficiency of a conveyor belt, and especially the service life of a belt, are these guide roller mechanisms. The nature of the load (with or without impact) depends on the durability and reliability of the belt conveyor roller mechanisms; physical and mechanical properties of the load; design of a new design of the parts of the guide roller mechanism; factors such as the conditions of their use.

II. LITERATURE REVIEW

A. Analysis of the problem

Depending on the operating conditions, several types of belt conveyors have been developed, which are designed according to the following characteristics [1]:

– on the slope of the conveyor installation;

– by type of conveyor line (straight or curved);

– by type of tape (width and length);

– on the number of guide roller mechanisms;

– on the location of the guide roller mechanism (angle and distance);

– by type of cargo;

– according to the location of the load-bearing network of the belt;

– cross-section of the load-bearing network of the belt.

The main components of belt conveyors are the guide roller mechanism, the guide drum and the belt that surrounds them. (Figure 1). The conveyor also includes the following parts: belt compression and cleaning devices, handles, special roller mechanisms, elements that provide automatic control and belt movement.

Figure. 2. Belt Conveyor

The guide roller mechanism performs two different functions on a belt conveyor: for transporting cargo; conveyor guide roller mechanisms designed to hold the belt in the empty network will be installed. In mining plants, the guide roller mechanisms on the belt conveyor line are located at the same distance, and the bending angle of the side rollers at 200, 300, 360, 450 degrees relative to each other of the three rollers in each interval consists of guide roller mechanisms of the same length (Figure 2).

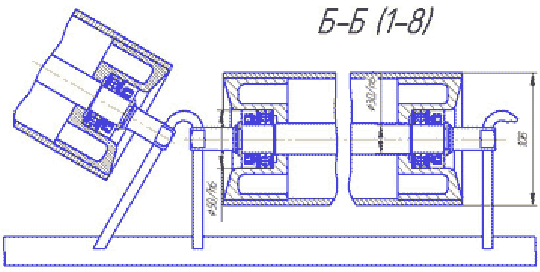
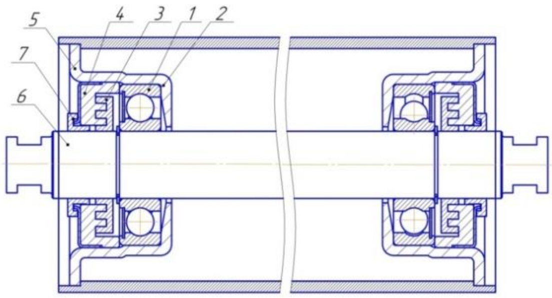


Figure. 2. Guide roller base

(Belt conveyor)

Depending on the operating conditions of the belt conveyor, the guide roller mechanisms are usually divided into light, medium and heavy series. Heavy-duty conveyor roller mechanisms are often used in underground mines and open pits.

This is because the heavy-duty guide roller mechanism is a mechanism that is reliable in terms of construction that can withstand heavy loads. The main difference between the guide roller mechanisms is that they are distinguished by the degree of protection of the protective caps used to protect the bearing from the external environment (dust, moisture and abrasive particles) (Figure. 3).



1- rolling bearing, 2- stupitsa, 3- Labyrinth cover[1], 4- Labyrinth cover[2], 5- cover, 6- bullet, 7- labyrinth cover

Figure 3. Guide roller mechanism

(Belt conveyor)

As mentioned above, in the design of guide roller mechanisms: special lubricated sandpaper, a set of labyrinth covers, contact and rubber sleeve protective coatings are used to protect the bearing from the external environment (dust, moisture and abrasive particles) in the guide roller mechanism. Depending on the operating conditions of the belt conveyor, these protective devices are used and it is confirmed during the operation that they also have a number of advantages and disadvantages. In general, the protective caps of the guide roller mechanism can be divided into contact, non-contact, or slotted and combined parts. The cover and sealing devices that protect the bearing of the belt conveyor roller mechanisms from the external environment (moisture and abrasive particles) shown [2].

B. The effect of the external environment on the guide roller mechanism

In the mining industry, the conveyor roller mechanisms of belt conveyors are part of the bearings that perform a smooth rotary motion. The periodicity and durability of conveyor mechanisms are important as they are determined by the location and temperature at which the equipment is installed. Constant dust and abrasive sand particles in open pits, and a constant increase in moisture in underground mines will inevitably have a negative effect on the parts of the guide roller mechanism. For example, bearings that provide a smooth rotational motion in the mechanism, the external and internal rings of the detail occur as a result of external influences. In turn, there are cases of bearing stiffness, as a result of which the guide roller mechanism stops rotating. This situation also affects other parts of the conveyor. For example, the friction of the belts increases the resistance of the conveyor to rotation and the risk of equipment failure. Today, it is important to improve the mining industry, in particular, the application of energy and resource-saving, high-speed equipment and technologies in production, expanding the range of products and increasing competitiveness. At the same time, one of the important tasks is to create new designs of resource-efficient belt conveyors, to develop calculation methods.

III. RESEARCH METHODS

A. Improving the design and development of parameters of belt conveyor roller mechanisms

Carrying out large-scale research work on the creation of new designs of belt conveyors and parts that meet modern requirements, synthesis, development of methods of structural, kinematic and dynamic analysis to justify the parameters and techniques and technologies to ensure quality execution of production processes in the mining industry being carried out. In this direction, the development of belt conveyors and their parts with high efficiency and technological performance is of great importance. At the same time, in order to optimize the mode and performance of mining equipment, including the improvement of the quality of belt conveyors, it is necessary to develop working bodies of guide roller mechanisms and new designs of transmission mechanisms.

The design of belt conveyor roller mechanisms involves a radical change of its parts. It should be noted that today the constructive design of machinery involves the production of quality products that are relatively compact, lightweight and highly durable. In order to prevent the above-mentioned situations in the belt conveyor roller mechanism, it is recommended to use a sliding support function using high-strength plastic (graphytocaprolone) and composite flexible materials instead of bearings that perform a flat rotary motion in the mechanism [3].

To do this, several types of structures are designed, which serve as a sliding base. On the inner surface of the part, which acts as a sliding base, a two-trapezoidal groove opens around the circumference (Figure 4). Purpose: the mechanism reduces friction during start-up; reduces the coefficient of friction of oil products between the bullet and the detail; high efficiency; compact overall dimensions in the direction of the arrow; causes ease of replacement and maintenance of parts.

When designing a sliding bearing structure, its efficiency is taken into account in many respects, such as the structure, the accuracy of the surface design of the parts, the current load, the type of lubrication and the conditions of use. One of the main causes of failure of a part acting as a sliding support mounted on a guide roller mechanism is the erosion of the friction surfaces (inner surface) as a result of constant and variable impact of the weight of the load being transported. In rare cases, it is the ingress of abrasive sand particles between the bullet and the detail that acts as a sliding base. Due to the above factors, it occurs as a result of premature repair and misuse of the guide roller mechanisms.

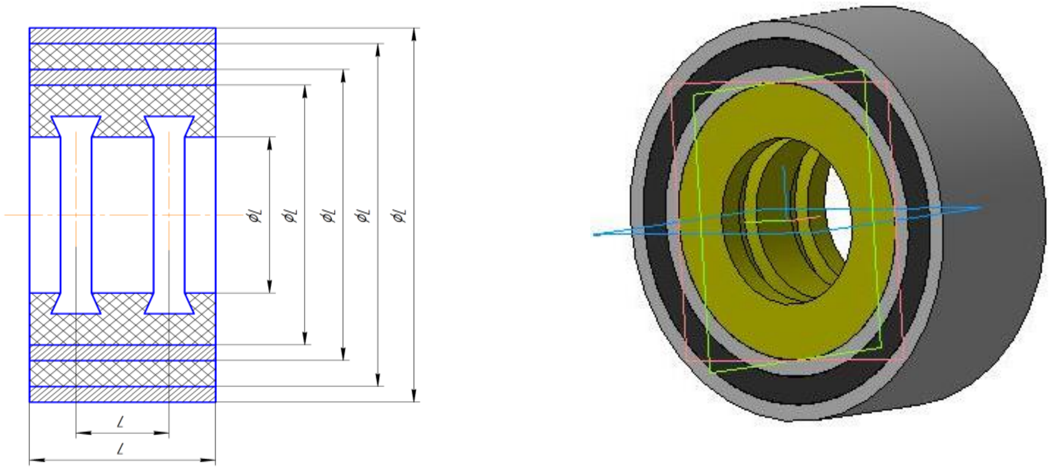


Figure 4. Sliding base (Guide roller)

In addition, the detail that acts as a sliding base is the formation of radial voids as a result of wear of the friction surfaces. Since the operation of belt conveyor guide roller mechanisms in mining enterprises is characterized by high radial loading, it can be assumed that when the parts acting as a sliding support slip or mixed slip occurs.

IV. EXPERIMENTAL AND THEORETICAL RESEARCH

A. Calculation of dynamic loads of belt conveyor roller mechanisms

The rotation and loading of the designed parts in the new design, mounted on the guide roller mechanism of the belt conveyor, is determined taking into account a number of factors:

- Alternating period of constant load current and current change period in belt conveyor operation. Therefore, the design should take into account the exact operating time of the belt conveyor.

- its level fluctuates during periods of constant load flow. The characteristic oscillation time of the continuous load current, according to experimental data [4], is always significantly higher than 5 seconds. The implementation of the corresponding random process is usually compared to a step function, the values of which obey the law of normal distribution, and the time between successive changes of values corresponds to Poisson's law. The parameters of Poisson's law are called the computational speed in the process under consideration.

- In addition to the small component of the load flow, large parts of the load fall on the belt conveyor, which causes dynamic loads on the guide roller mechanisms. The characteristic period of variability of these loads does not exceed the time during which part of the load passes through the gap between the guide roller mechanisms and part of the second. In fact, the exposure time of most of the transported material to the belt conveyor guide roller mechanisms is much shorter.

Much of the experimental and theoretical work has focused on the calculation of dynamic loads on conveyor belts carrying large pieces in mining enterprises, resulting in two approaches to addressing the causes of dynamic loads [5]. In the first approach, impact is considered as the main mechanism of impact of large load parts on the rollers due to the direction of the velocity vector at the point where the load vector is deposited on the guide roller mechanisms and the tangent does not coincide with the roller surface. A number of research studies have shown that at sufficiently high values of belt tension (from 110 N for 1 mm of belt width), the interaction force between the load pieces and the guide roller mechanisms depends on the magnitude of the belt tension. This means that another mechanism of basic interaction is the impulse mechanism. This approach considers the interaction of the

conveyor belt compression zones that occur under the belt contact areas of the load section. When these zones are close to each other, from a certain distance between the centers of the contact area (equal to the thickness of the tape 1-2), a sharp contraction of the contacts occurs, which is manifested as a pulse from the outside [6].

In addition to the vibration contact-repair of the part, which acts as a sliding base on which the belt conveyor roller mechanisms are mounted, there are also types of abrasive and friction-repair. This type of surface wear is predominant for details that act as a sliding support for guide roller mechanisms operating on a belt conveyor.

These types of wear are determined by the technical source of the part that serves as the sliding base. The reason for this phenomenon is the poor quality production of protective covers and sealing elements of the guide roller mechanism. However, belt conveyor roller mechanisms are such a mass product that perhaps the cost savings of the protective cover elements justify themselves, so it is necessary to take into account the type of wear that is not specific to the details that serve as a sliding base.

Many factors are known for the rapid repair of parts that act as a sliding support in a guide roller mechanism. For example, studies have shown that quartz particles enter the bearing block as a result of wear or tear of the protective caps. In these cases, it is observed that the service life of the guide roller mechanisms is often 350-600 hours. It is characterized by the amount of abrasive dust accumulated in the oil, not as the number of revolutions of the guide roller mechanisms as a result of the increase in high levels of dust and moisture. Dustiness of oil is expressed as a percentage of the weight of dust particles in the oil (%). In addition, a regressive dependence of the oil dust content on the test time is given:

$$m = pt^{u}M^{K}, \%p \quad (1)$$

where t – is time, hour; M – air dust, kg/m^3; $p, u, k -$ are empirical constants that depend on the constructive performance of the part acting as a sliding base.

The radial clearance of the inner surface of the part acting as a sliding base is determined by the following formula.

$$\Delta = \delta_0 + 12{,}23 \cdot 10^{-6} m, \quad (2)$$

where δ_0– is the initial working radial clearance for parts with an internal diameter $d = 30\ mm, \delta_0 \approx 10\ mkm$ and a test sliding base with a load of 100 N.

Dust of the external environment M: $M = (0{,}5 - 3{,}4) \cdot 10^{-3}$ *кг–м*^{3}.

If we generalize formulas (1.2) and (1.3) and the experimental studies take into account the rotational speed of the differential roller mechanisms, we get (1.4).

$$\Delta \cong \delta_0 + \frac{12{,}23 \cdot 10^{-6}(1+d/8}{700^{u} \cdot 4{,}75} pt^{u}M^{k}n^{u}. \quad (3)$$

However, the experimental studies take into account that the guide roller mechanisms, which are identical to the actual detail used in production conditions, are conducted at rotational speeds and that contaminants entering through the protective caps are closely related to the value of belt rotation speed [7].

V. CONCLUSIONS

The operating conditions and characteristics of belt conveyors of mining enterprises were considered, special requirements were set for the design of their main components. Constructions of belt

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