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Analysis And Calculation Of The Operating Time Of The Conveyor Transport For The Conditions Of The Angren Open Pit

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ABSTRACT

The article considers and solves the problem of determining the average operation period of belt conveyor rollers used for transporting overburdened rocks in the conditions of the Angren open pit. The main objective of the study is to determine the operation period of the conveyor belt rollers by considering statistical and dynamic loads on individual pieces of rock. A graph of the dependence of the service life of the belt conveyor rollers on the belt speed was obtained. Recommendations for increasing the service life of belt conveyor rollers are presented.

KEYWORDS

Cyclic Flow Technology, belt conveyor, bearings, operation period, dump conveyor.

INTRODUCTION

The purpose of this work is to calculate the operation period of the rollers of the belt conveyors of roller supports under the conditions of overburden operations using the Cyclic Flow Technology (CPT) at the Angrencoal mine.

The central heating centre at the overburden complex consists of the following technical units:

- Excavator (EKG-15) - 3 pcs .;
- A mobile crushing plant that accepts rock mass from an EKG-15 mining excavator with its subsequent loading onto a downhole inter-step reloader. Productivity 4000 t/h, delivery volume 3 pcs;

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- Bridge-type downhole cross-platform loader used as a link between the mobile crusher and the face conveyor;
- It transfers the crushed rock mass from the mobile crusher to the face belt conveyor. The height of the bench being worked out is 15 m, productivity is Q = 4000 t/h, the scope of delivery - 3 pcs.;
- Belt conveyor is used to transporting rock mass from a mobile crusher to a spreader. The total number of stripping belt conveyors is 14;
- Downhole crusher with a loading carriage, used as a connecting link between the crusher and the face conveyor. Quantity - 2 pcs.;
- Spreader - designed for dumping overburden into the inner dump, the length of the unloading boom is 60 meters, the total length is 110m, the productivity is Q = 12100 t/h, the number is 1 piece;

The sequence of work in the central heating centre is carried out as follows: The EKG-15 excavator loads the overburden into the bunker of the crushing plant, then the overburden from the bunker enters the plate conveyor, from there, through the feed hopper, it enters the two-roll crusher, which passes through itself the transported material with a size of 1100 mm at the output up to 300 mm. The overburden goes through the crusher's outlet chute onto a belt conveyor, which transports it to a mobile transfer loader. Further transportation of the rock mass is carried out by the main conveyor with a capacity of 12100 t/ h, followed by reloading onto a dump conveyor, from where the rock mass moves to a spreader, which forms internal dumps [1].

In this process, the maximum size of the transported rock is about 250-300 mm and the mass is 20-30 kg. This mass is 10% -20% of the total mass that is transported in conveyor transport.

In this case, studying the operation period of the roller support is a special aspect to determine the continuous operation of the conveyor transport.

ANALYSIS

Becoming a conveyor with roller supports is an important part of the belt conveyor, on the technical condition of which the reliability of the conveyor as a whole depends.

The reliability of the stave is determined by the reliability of the rollers of the roller supports since the reliability of the supporting metal structures is much higher.

The main indicator for assessing the reliability of a roller is its operation period, which depends on the type, parameters of rollers and operating conditions.

L. G. Shakhmeister, V. G. Dmitriev, V. F. Monastyrsky, A. I. Dodatko and other researchers were engaged in the task of determining the operation period of the belt conveyor rollers. In their works, it is shown that the main reason for the failure of the rollers is the failure of the bearing assembly, the loads on the rollers during the transportation of the rock mass are determined, and on the basis of this, formulas are proposed for calculating their operation

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period. In this case, the loads on the roller bearings arising from large pieces of load. Therefore, the operation period of one roller is determined by the operation period of the bearings.

CALCULATION METHOD

The durability or 90% operation period of rolling bearingsL_09, measured in hours, is determined according to [4]:

$$L_{09} = \left(\frac{\eth_n}{P_m} \right)^p \cdot \frac{10^6}{60n} k_E \qquad (1)$$

Where- C_n dynamic load capacity, N, (load at which the life is equal to 1 million revolutions, this value for each specific bearing is selected from the reference book); P_m- Equivalent dynamic load on the roller bearing, H; n - bearing rotation speed, $1/s$; p - power exponent (p = 3 for ball bearings and p = 10/3 for roller bearings); k_e-coefficient taking into account the operating conditions.

The average bearing life, according to [5], is determined from the ratio

$$t_a = 4,08 \cdot L_{09} \qquad (2)$$

The speed n is determined by the formula:

$$n = \frac{60 v_b}{2\pi r} \qquad (3)$$

wherev_b – is the speed of the conveyor belt, m/s;r – is the radius of the roller, m.

In our case, the bearing assembly of the roller is loaded with a load-flow, which creates a radial and axial load on the bearing. We neglect the axial load on the bearing because the impact of the load on the bearing is transferred through the metal cup and the axial component is small. Therefore, in the rollers of the conveyors under consideration, radial and radial thrust bearings are used. For radial and angular contact ball bearings and angular contact roller bearings, the dynamic radial load is calculated using the formula.

Based on this, the total dynamic radial load on the roller bearing is:

$$P_m = 1,2 \cdot F_r \qquad (4)$$

Where F_r is the radial load on the bearing; F_r- can be thought of as the average bearing load:

$$F_r = \frac{1}{2} M\left[x(t)\right], \qquad (5)$$

where M [x (t)] is the mathematical expectation of the load on the central roller of the roller support; x (t) -random function model of cargo traffic, which is considered in the form of a small fraction and large pieces located in it.

According to this work, M [x (t)] is determined by the formula

$$M\left[x(t)\right] = 0,5 \sum_i^s k_{di} \tau_k Q P_i + q_m l_r, \qquad (6)$$

where P_i-weight fractions of pieces of the i-th fraction in the total mass of the cargo entering the conveyor; Q-productivity of the conveyor, kg/s; k_{di}-dynamism coefficient when a piece of cargo of the i th – fraction interacts with roller support; l_r-distance between roller supports, m; τ_k-time of interaction of a piece of cargo with roller support, s; q_m-linear load on the bearing unit, N/m; gfree-fall acceleration, m/s^2, s-number of fractions.

A large piece interacts with the roller during two spans between the roller supports, therefore τ_k- is defined as

$$\tau_k = \frac{2 l_p}{v_л} \qquad (7)$$

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Load $q_m$taking into account the uneven load on the side and middle rollers is determined by the farm

$$q_m = 0,7k_d \cdot (q_m + q_b) + q_{r,} \quad (8)$$

where q_m – is the linear load on the belt from small fractions (i.e., excluding the percentage of large fractions considered separately), N/m; q_b – linear weight of the tape, N/m; $q_{r,}$ –weight of the rolling parts of the roller, N; k'_d – is the dynamic factor in the interaction of a small lump fraction with roller support.

In formula (8), the coefficient 0,7 takes into account the part of the load taken by the middle roller.

Conveyor performance Q, according to [I], is determined by the formula

$$Q = \frac{q_{m\vartheta_b}}{g} \quad (9)$$

where qg is the linear weight of the cargo, including small and large fractions, N/m.

When determining the load on the roller, the pieces of those fractions are taken into account for which the average distance between the pieces l_i – is greater than the distance between the roller supports $l_r (l_i > l_r)$, that is, it is assumed that at the moment only one large piece interacts with the roller support.

From formula (6) it can be seen that the average load on the roller of the roller supports depends on the dynamic coefficient k_{di} when interacting with a piece of each fraction and the granastava of the transported cargo. As studies have shown [8], k_{di}depends on the design of the roller supports and the parameters of the conveyor.

Substituting (4) into (1) taking into account (5) - (9), and then substituting the obtained expression for the resource L_{09} into (2), we finally determine the average bearing life.

The analysis showed that the operation period of the conveyor rollers depends on the running load, conveyor parameters, grain size distribution of the transported cargo, type and parameters of roller supports.

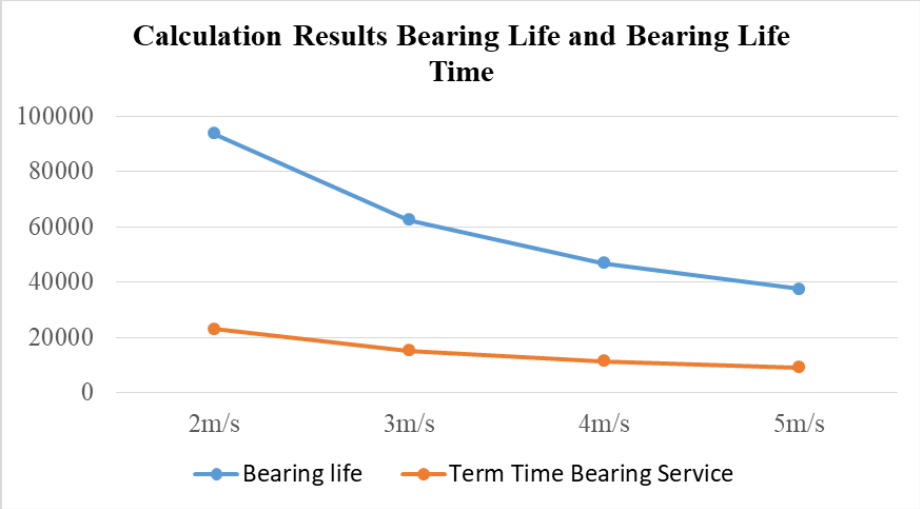

Figure 1. Results of the durability and operation period of the bearing calculation

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Calculation of the average operation period of the bearing of the conveyor rollers under the conditions of the Angren open pit mine.

We carry out the calculation for the conditions of transportation of the overburden of the Angrensky open pit, having determined that the hourly productivity of the conveyor is 4000 t/h, the distance between the roller support is 1 m, the weight fraction of the load is 20.

This calculation is performed to determine the average bearing life of the conveyor rollers versus the speed of the conveyor belt.

Figure 1 shows the dependences of the average operation period of the roller t_a and the operation period of the bearingL_{09}on the belt speed v_b for the types of roller supports suspended on a rope stand.

FINDINGS

1. The operation period and durability of the bearing of the conveyor rollers depends on the speed of the conveyor belt.
2. The operation period of the bearing of the conveyor rollers is 93575 hours, 62383 hours, 46787 hours, 37430 hours depending on the belt speed in accordance with 2 m/s, 3 m/s, 4 m/s, 5 m/s
3. It is recommended, according to the standard of maintaining the average bearing life, not to increase the weight fraction of a piece from 20.

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