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Research Article

SUBSTANTIATION OF AN EFFICIENT VARIANT OF THE MAIN CONVEYOR IN THE CONDITIONS OF DAUGIZTAU QUARRY

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ABSTRACT

The article discusses the periodic flow technological scheme in the conditions of Daugiztau mine. The problem of increasing the efficiency, reliability, low power and transport distance of the main conveyor is considered. An efficient periodic flow technological scheme will be developed.

KEYWORDS

Conveyor, belt, roller, periodic flow technological scheme.

INTRODUCTION

The rapid development of the mining industry in the world and the growing development of the mining industry require modernization, re-equipment, improvement and repair of mining equipment and machinery in the mining and transportation of minerals and rocks. The use of modern belt conveyors in the transportation of minerals and rocks in open pits will lead to increased productivity, reduced distances in the transportation of rocks and reduced overall costs. Quarry trucks are designed to transport minerals and cladding rocks as well as the main loads in quarries.

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As quarries deepen, the demand for conveyor transport, which is characterized by high economic efficiency and environmental friendliness and high productivity, will increase. Important conditions for the normal operation of belt conveyors are their correct installation (assembly), proper loading and unloading, as well as careful and constant monitoring and timely repair of the belt, rollers, drums and the entire conveyor. In addition, one of the main aspects to be considered is that the correlation of parameters in the installation of the conveyor is carried out on the basis of calculations. When calculating the conveyor load, we need to determine the drive force of the belt conveyor. In determining load currents and conveyor drive, A.V. Andreev, V.A.Dyakov, V.G. Dmitriev, I.V. Zapenin, E.E. Sheshko, V.I. Galkin, V.P. Dyachenko and others contributed. We see in the example of the main conveyor of the Daugiztau deposit, which belongs to NMMC, the normalization of load flows, energy-efficient and economical installation of the conveyor.

Adequate efficiency of the main conveyor is not used because of the low energy consumption.

Determining the resistances acting on the conveyor.

According to the general equation of motion, the force of conveyor drive is used to overcome the forces of resistance to motion.

The resistance in the straight-line section of the conveyor is due to the friction between the rollers, the movement of the belt along the rollers; is formed by gravitational forces forming longitudinally on inclined conveyors. [2]

For horizontally mounted conveyor surface

$$W_{юклш} = (q + q_л + q_p')L\omega' = (114{,}6 + 45{,}6 + 47{,}5)600 \cdot 0{,}023 = 2866{,}99 \text{ кгк}$$

For the direction of conveyor load installed at an oblique angle, the forces of resistance to movement are determined by the following formula:

$$W_{юклш} = (q + q_л + q_p')L\omega' \cos\beta \pm (q + q_л)L\sin\beta =$$
$$= (114{,}6 + 45{,}6 + 47{,}5)600 \cdot 0{,}023 \cdot 0{,}99 + (114{,}6 + 45{,}6)600 \cdot 0{,}104 =$$
$$= 2837{,}6 + 9996{,}48 = 12834{,}08 \text{ кгк}$$

Resistance forces in the unloaded direction of the conveyor are calculated according to the following formulas:

$$W_{юксиз} = (q_л + q_p'')L\omega' = (45{,}6 + 13{,}3)600 \cdot 0{,}023 = 812{,}82 \text{ кгк} \quad (3)$$

$$W_{юксиз} = (q_л + q_p'')L\omega' \cos\beta \pm q_л L\sin\beta =$$
$$= (45{,}6 + 13{,}3)600 \cdot 0{,}023 \cdot 0{,}99 - 45{,}6 \cdot 600 \cdot 0{,}139 =$$
$$= 804{,}69 - 2845{,}44 = -2040{,}75 \text{ кгк}$$

here.

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L - conveyor length, m;

β - slope angle of the conveyor, grad;

$q = \frac{Q_Э}{3,6V} = \frac{1230}{3,6 \cdot 2,98} = 114,6$ 1 m conveyor length weight, kgk/m;

$q_л$ - weight of 1 m long strip, kgk/m;

q_p' - weight of moving parts of rollers in the load network, corresponding to the length of the conveyor 1 m, kgk / m;

q_p'' - the weight of the moving parts of the rollers in the unloaded network, corresponding to the length of the conveyor 1 m, kgk/m;

ω' - coefficient of resistance of the conveyor belt.

Table 1 shows the weight of 1 m2 of tape. From the information in the table, the weight of a 1 m long strip can be calculated according to the formula:

$$q_л = G_л' \cdot B = 38 \cdot 1,2 = 45,6 \text{ , кгк}$$

here B is the band width, m.

Table 1.

Rubber-cloth straps		Rubber-cord straps	
Number of layers	Weight, kgs / m²	Type of tape	Weight, kgs / m²
4	18	РТЛ-1500	28
5	20	**РТЛ-2000**	**38**
6	22	РТЛ-3500	43
8	25	РТЛ-4000 РТЛ-5000 РТЛ-6000	48 55 65

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The weights of the moving parts of the rollers in the loaded and unloaded networks, corresponding to the length of the conveyor 1 m, are determined by the following formulas:

$$q_p' = \frac{G_p'}{l'} = \frac{57}{1,2} = 47,5\ , \quad \text{kgk/m} \qquad (4)$$

$$q_p'' = \frac{G_p''}{l''} = \frac{40}{3} = 13,3, \quad \text{kgk/m} \qquad (5)$$

here

Gp ’and Gp” - weight of rotating parts of roller bearings in loaded and unloaded directions, kgk;

l ' and *l* "- the distance between the roller supports in loaded and unloaded networks, usually *l*' = 0.8-1.2 m (a small number is obtained when transporting heavy and large pieces), *l*" = 2 - 4 m

The weight of the rollers and the resistance forces of their moving parts depend on the width of the belt, the diameter and structure of the rollers. Table 2 shows the values of the weights of the rotating parts of the roller bearings in the loaded (three-roller) and unloaded (single-roller) networks of conveyors.

Table 2

The weight of the rotating parts of the roller bearings

Tape width, mm	Three-roller roller bearings				A roller	
	Normal		Heavy			
	Roller diameters, mm	Weight, kgs	Roller diameters, mm	Weight, kgs	Roller diameters, mm	Weight, kgs
1000	127	25	159	50	127	21,5
1200	127	29	**159**	**57**	127	26
1400	159	50	194	108	159	**40**
1600	-	60	194	116	-	-
1800	-	82	194	122	159	47
2000	-	-	219	190	-	-

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The measurement of the coefficient of resistance to conveyor belt movement depends on many factors: roller quality, conveyor assembly, belt thickness, load size, etc.

The values of the standards are determined as follows, depending on the condition of the conveyor:

very good 0.18-0.02
good 0.02-0.022

The straight linearity of the stave is not high-precision and is strongly contaminated 0.023-0.027

The power of the conveyor device drive can be determined by the point method along the rotational contour of the belt. The contour formed by the conveyor belt is divided into straight and curved sections (Fig. 1). From the point of exit of the belt from the driving drum, all points of reorientation are numbered. Then, the voltages and driving forces of the incoming and outgoing networks in series along the contour rotation are determined.

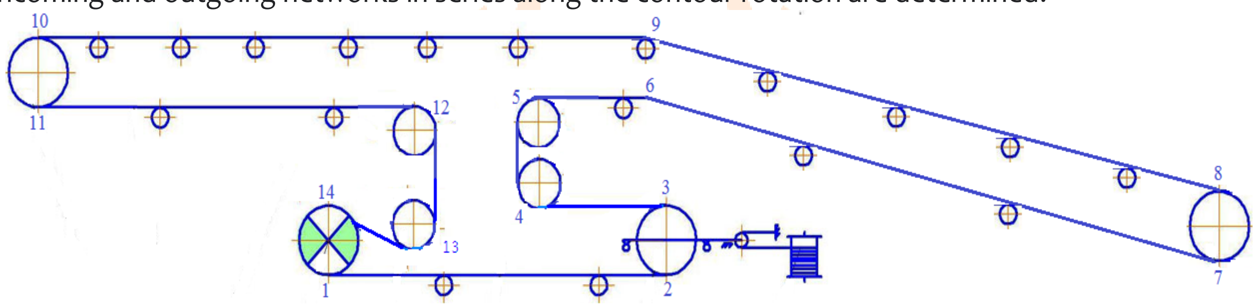

Figure 1. Scheme of calculation of the conveyor "by contour"

The rule for calculating tension is as follows: the tension of a traction body at a given point is found by the sum of the resistance forces on the section to the tension at the previous point (the resistances between the two points).

$$S_i = S_{i-1} + W_{(i-1)-i} \text{ , кгк} \quad (8)$$

According to the scheme shown in Figure 1, the tension at the exit point of the belt from the drive drum is equal to S1.

The tension at point 2 is

$$S_2 = S_1 \text{, кгк} \quad (9)$$

Tension at point 3

$$S_3 = 1{,}06 S_2 = 1{,}06 \cdot 2474{,}07 = 2622{,}51 \text{ , кгк} \quad (10)$$

Tension at point 4

$$S_4 = S_3 = 2622{,}51, \text{ кгк} \quad (11)$$

Tension at point 5

$$S_5 = S_4 = 2622{,}51, \text{ кгк} \quad (12)$$

Tension at point 6

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$$S_6 = 1{,}04 S_5 = 1{,}04 \cdot 2622{,}51 = 2727{,}41 \text{ кгк} \qquad (13)$$

Tension at point 7

$$S_7 = S_6 + W_{юкcuз} = 2727{,}41 - 2040{,}75 = 686{,}66 \text{ кгк} \qquad (14)$$

Tension at point 8

$$S_8 = 1{,}06 S_7 = 1{,}06 \cdot 686{,}66 = 727{,}86 \text{ кгк} \qquad (15)$$

Tension at point 9

$$S_9 = S_8 + W_{юклu} = 727{,}86 + 12834{,}08 = 13561{,}94 \text{ кгк} \qquad (16)$$

Tension at point 10

$$S_{10} = S_9 + W_{юклu} = 13561{,}94 + 2866{,}99 = 16428{,}93 \text{ кгк} \qquad (17)$$

Tension at point 11

$$S_{11} = 1{,}06 S_{10} = 1{,}06 \cdot 16428{,}93 = 17414{,}66 \text{ кгк} \qquad (18)$$

Tension at point 12

$$S_{12} = S_{11} + W_{юкcuз} = 17414{,}66 + 812{,}82 = 18227{,}48 \text{ кгк} \qquad (19)$$

Tension at point 13

$$S_{13} = S_{12} \text{ кгк} \qquad (20)$$

Tension at point14

$$S_{14} = 1{,}04 S_{13} = 1{,}04 \cdot 18227{,}48 = 18956{,}58 \text{ кгк} \qquad (21)$$

On the other hand, there is a connection between the tensions of points 14 and 1 (at the points of entry and exit of the belt to the drum) as follows

$$S_{14} = S_1 \cdot e^{\mu\alpha} = S_1 \cdot 2.71^{0.35 \cdot 5.34} \qquad \textbf{(22)}$$

here μ - the adhesion between the belt and the drum surface is a coefficient whose value is the conveyor operating conditions and the surface of the drum related;
α - the angle of rotation of the belt on the driving drum, degrees.

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The gravitational force on the conveyor drive is determined by the following expression.

$$W_0 = S_{нб} - S_{сб} = S_{14} - S_1 = 18956{,}58 - 2474{,}07 = 16482{,}51, \text{ кгк} \quad (23)$$

The electric drive power is determined by the following expression.

$$N = K_M \frac{W_0' \cdot V}{102 \cdot \eta} = 1.1 \frac{16482{,}51 \cdot 2.98}{102 \cdot 0.85} = 623{,}18, \text{ квт} \quad (24)$$

We determine the number of electric drives as follows

$$n = \frac{N_A}{N_D} = \frac{623{,}18}{337.5} \approx 2 \text{ driving will be required}$$

OFFERED OPTION

The resistance in the straight-line section of the conveyor is due to the friction between the rollers, the movement of the belt along the rollers; is formed by gravitational forces forming longitudinally on inclined conveyors. [2]
For the direction of conveyor load installed at an oblique angle, the forces of resistance to movement are determined by the following formula:

$$\begin{aligned} W_{юклш} &= (q + q_л + q_p')L\omega'\cos\beta \pm (q + q_л)L\sin\beta = \\ &= (107{,}44 + 45{,}6 + 47{,}5) \cdot 600 \cdot 0{,}023 \cdot 0{,}99 + \\ &+ (107{,}44 + 45{,}6) \cdot 600 \cdot 0{,}104 = 12289{,}46 \end{aligned} \text{ кгк} \quad (1)$$

Resistance forces in the unloaded direction of the conveyor are calculated according to the following formulas:

$$\begin{aligned} W_{юксиз} &= (q_л + q_p'')L\omega'\cos\beta \pm q_л L\sin\beta = \\ &= (45{,}6 + 13{,}3) \cdot 600 \cdot 0{,}023 \cdot 0{,}99 - 45{,}6 \cdot 600 \cdot 0{,}104 = \\ &= 804{,}69 - 2845.44 = -2040.75 \end{aligned} \text{ кгк} \quad (2)$$

The forces of resistance to movement in the load direction of a horizontally mounted conveyor are calculated according to the following formulas:

$$W_{юклш} = (q + q_л + q_p')L\omega' = (107{,}44 + 45{,}6 + 47{,}5) \cdot 900 \cdot 0{,}023 = 4151{,}17 \text{ кгк} \quad (3)$$

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The forces of resistance to movement in the unloaded direction of a horizontally mounted conveyor are calculated according to the following formulas:

$$W_{юксиз} = (q + q_p^{"})L\omega^{'} = (45{,}6 + 47{,}5) \cdot 900 \cdot 0{,}023 = 1219{,}23 \text{ кгк} \quad (4)$$

here

$q = \dfrac{Q_Э}{3{,}6V}$; -1 m conveyor length weight, kgk/m;

$q_л$ -Weight of 1 m long strip, kgk/m;

The power of the conveyor device drive can be determined by the point method along the rotational contour of the belt. The contour formed by the conveyor belt is divided into straight and curved sections (Fig. 2). From the point of exit of the belt from the driving drum, all points of reorientation are numbered. Then, the voltages and driving forces of the incoming and outgoing networks in series along the contour rotation are determined.

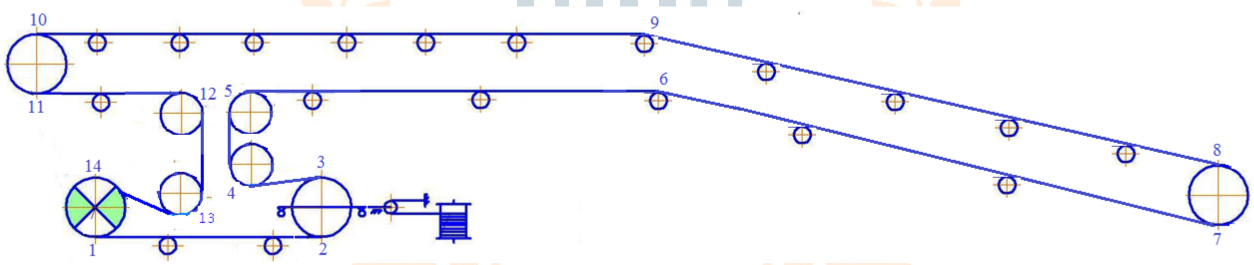

Figure 2. Scheme of calculation of the conveyor "by contour"

The rule for calculating tension is as follows: the tension of a traction body at a given point is found by the sum of the resistance forces on the section to the tension at the previous point.

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S_1	S_2	S_3	S_4	S_5	S_6	S_7
2711,55	2711,55	2820,012	2820,012	2820,012	4039,24	1998,49

S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}
2078,43	14367,9	18519,06	18889,44	18889,44	18889,44	19267,21

The gravitational force on the conveyor drive is determined by the following expression.

$$W_0 = S_{нб} - S_{сб} = S_{14} - S_1 = 19267{,}21 - 2711{,}55 = 16555{,}66 \text{ кгк} \quad (5)$$

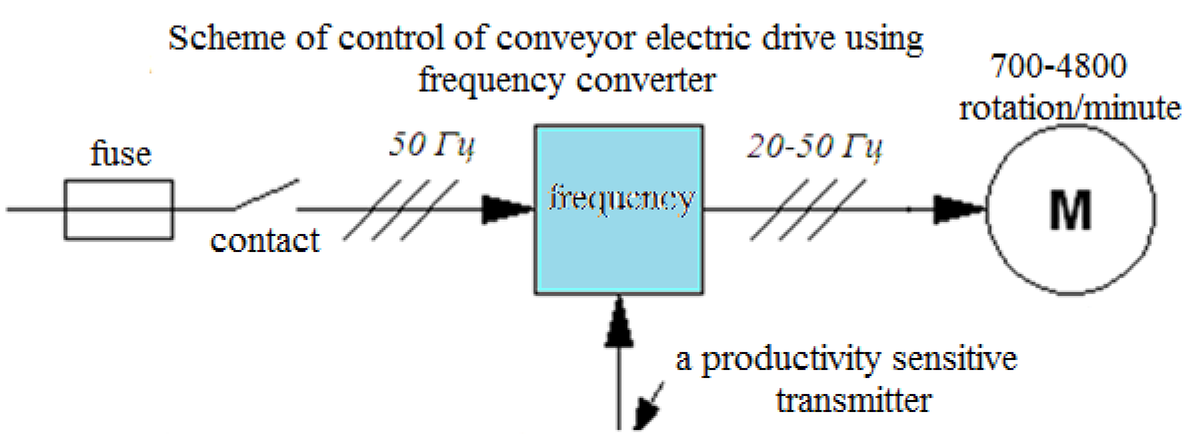
The electric drive power is determined by the following expression.

$$N = K_M \frac{W_0' \cdot V}{102 \cdot \eta} = 1.1 \frac{16555{,}66 \cdot 3{,}18}{102 \cdot 0.9} = 630 \text{ кВт} \quad (6)$$

Electric drive AK313-62-8 is selected.

N=630 кВт, n=740 rotation/minute, U=6 кВ.

According to the proposed option, the transport distance, service life and productivity of conveyor equipment will be significantly increased.



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A frequency converter is used to convert three-phase or single-phase alternating current with a frequency of 50 (60) Gts from 1 Gts to 50 Gts or from 50 Gts to 1 Gts. When the frequency converter is placed on the main conveyor, the cross-section of the conveyor belt can be fully used when the density of the target rock is less than r = 1.5 t / m^3 and when transporting light-weight rocks. When the density of the rock is greater than r = 1.5 t / m^3 and when transporting heavy rocks, the rated current of the conveyor drive can be used efficiently.

CONCLUSION

Two electric drives and two reducers from 337.5 kW are installed on the main conveyor with a carrying distance of 1200 meters. In the proposed variant, on the main conveyor with a carrying distance of 1,500 meters, with the installation of a single 630 kW electric drive, the use of frequency converters will achieve energy efficiency.

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