DEVELOPMENT OF A METHOD TO ELIMINATE THE DISPLACEMENT OF THE ROLLER AXIS

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Abstract
Nowadays, the problems related to conveyer rollers in mining production enterprises occurring more often and therefore, it is really crucial to find address to these issues. The conducted studies show that the highest index of displacement caused by the method of installation of roller covers by using the method of roller construction with thread cover, the displacement on the axis of the roller was reduced, that is, the displacements were several times was reduced.

Keywords: conveyer rollers, ball bearing, axis, gravity forces, coefficient of friction, conveyer belt, the speed of conveyer belt, drum.

Introduction

Defects in the roller axes of belt conveyors have a negative impact on the equipment's performance, as well as cause rapid failure, non-performance of the bearings according to technical specifications, and several other negative consequences.

In mining production enterprises, the method of welding is widely used during the assembly of belt conveyor rollers, as mentioned above. When the roller axis is placed in the center based on the correct dimensions and welding of the covers is started, the axis escapes from the center is a process that always occurs. Defects during welding are part of the workflow. Picture 1 below shows the defects that occur during installation on the roller axle and covers.

Picture 1. Conveyor roller covers installed

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It is known from the given picture 1 that during welding, the axis is not always located in the same position according to the correct center and does not work according to the dimensions in the technical indicators of the axis, the excess loads that occur during welding on the outside do not affect the center of mass. changes by a certain amount and provides additional torque resistance.

Analyzes and Methods of References

In order to increase the level of accuracy of the results obtained in the experimental tests conducted on the conveyors at the mining enterprise, practical and theoretical research works were also carried out in the experimental device of the Department of "Mining Electrical Mechanics" of the Navoi State University of Mining and Technologies. It is designed to determine the dynamic and kinematic parameters of the roller axis and the bearing as a result of loading the equipment. The experimental device is shown in Pic. 2.

Picture 2. Roller tester

The experimental device shown in Pic. 2 is the bodywork 1, the roller under investigation 2, the roller force-acting device 3, the belt drive that delivers the movement in the electric drive 4, the device for changing the forces acting on the roller an additional load box 5, an electric drive that produces energy that provides movements in the equipment 6, a frequency converter that changes the frequency coming to the equipment 7, a lever that transmits the forces generated on the rollers to a measuring device 8 and a strain gauge that measures forces 9 consists of.

Main Body

The location and direction of the dynamic and kinematic parameters that appear in the schematic view of the roller testing device are given in Figure 3 below.

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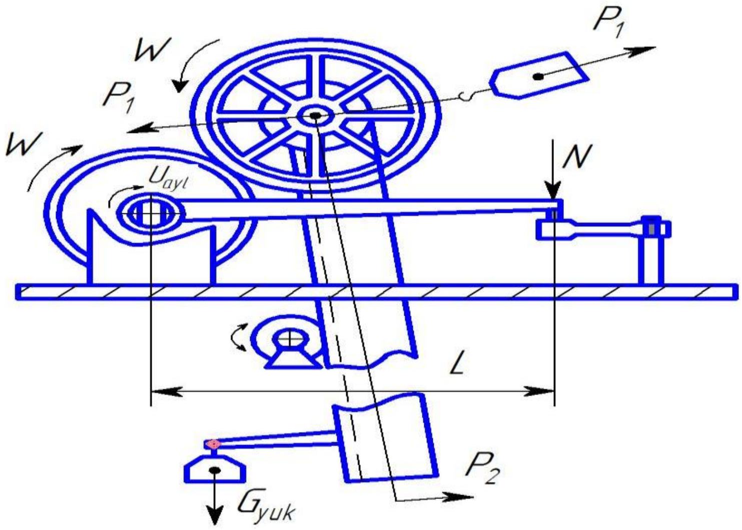

Picture 3. Schematic view of the experimental process

The traction force is transmitted to the continuous traction part of the conveyor due to the friction created on the surface of its driving drum. Analytical proof of this friction-based law was derived by Euler based on the condition of non-slipping on the surface of a cylinder that does not have weight, is absolutely flexible and inextensible. The mathematical expression of this law is as follows.

$$\frac{S1}{S2} \leq e^{\mu a} , \qquad (1)$$

here S_1 and S_2 - the value of the tension of the rubber fabric;

e=2.72 – the base of national logarifm;

μ - coefficient of friction:

α - angle of covering the cylinder with rubber fabric, rad.

For belt conveyors acting as motors, the Eyler expression looks like this:

$$\frac{S_k}{Sq} = e^{\mu a}, \qquad (2)$$

Here $S_к$ - the tension of the system of the conveyor belt to the driving drum N;

S_q - the tension of the idler system of the drum that drives the conveyor belt, N

μ - coefficient of friction between the tape and the surface of the drum:

α - the angle of covering the driving drum with the belt, rad.

The value of the traction force is determined by the difference in the tension of the belts coming (S_k) and away (S_q) from the driving drum.:

$$W_0 = S_k - S_q, \qquad (3)$$

The Euler expression for conveyors acting as a brake (generator) is written as follows:

$$\frac{Sq}{Sk} = e^{\mu a}, \qquad (4)$$

The condition of non-slipping on the drum driving the belt is written in the form of the following inequality.

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The engine of conveyer:

- when working as an engine $\frac{S_q}{S_k} < e^{\mu a}$, (5)

- when working as a generator $\frac{S_q}{S_k} < e^{\mu a}$, (6)

Thus, the threshold value of this condition is determined from expressions (5) and (6), respectively.

As can be seen from the above expressions, the normal operation of the conveyor belt without slipping depends on the tension of the belt, the coefficient of friction and the angle covered by the belt with the driving drum. Below is the method of determining these values on the test bench.

During the experimental work, the electric drive in the experimental equipment is activated and the roller starts to rotate. During operation, the roller loses its initial resistive forces, and the strain gauge begins to count this. The torque M_1 (N*m) caused by the displacement or escape of the roller axis from the center is determined by the following expression.

$$M_1 = U_{ayl} \cdot r_{o‘r} ,$$

Here U_{ayl} – force acting on ball bearing rotation, N; $r_{o'r}$ –the average diameter of ball bearing. mm.

When the roller reaches its nominal speed and begins to rotate, a moment M2 is created on the roller axis, which is affected by the force N (N) on the arm shoulder l (mm) and is determined as followed way

$M_2 = N \cdot l,$ (7)

If the dynamic moment is basically equal to Dalamber's principle in the range of instantaneous values based on the above conditions, the equilibrium moment is as follows.

$$\sum M_0(F_K) = 0,$$

When the equations are generalized to accept positive and negative values in return for the direction of rotation of the moments M_1 and M_2 being clockwise and counter-clockwise, the expression looks like this.

$$\sum M_0 (F_K) = M_1 - M_2 = 0,$$

$$U_{ayl} * r_{o'r} - N * l = 0,$$

$$U_{ayl=} \frac{N * l}{r_{o'r}}.$$

Based on the difference between the energies generated by the torque and the frictional force, based on the law of Lagranj's displacement principle, we can express the following equation and derive the dependence of time on the displacement distance.

$$\Delta A = M \cdot \Delta\varphi = F_{ISH} \cdot \Delta S \quad => \quad M\Delta\omega t = F_{ISH} \cdot \Delta vt \quad => \quad M\Delta\omega = F_{ISH}\Delta v \quad =$$

$$> \quad M2\pi n\Delta t = F_{ISH} \cdot \Delta r \quad => \quad \Delta t = \frac{F_{ISH} \cdot \Delta r}{2\pi nM},$$

$\Delta t = \frac{r_{o'r} * .F_{ISH} \cdot \Delta r}{N*l*2*\pi*n}$. (8)

here; F_{ISH}- frictional force generated on the surface (N), Δr-the length of movement (m), N-

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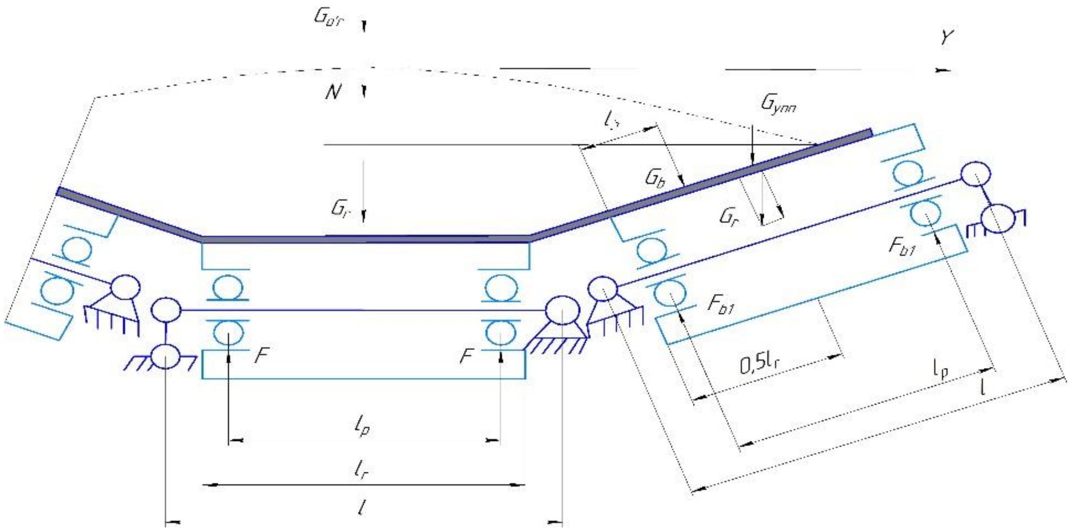
the reaction force generated on the roller, n- the number of roller revolutions (number).

In the above expression, all parameters can be determined, only the reaction force acting on the belt conveyor roller is unknown.

Determining the displacements in the axis caused by the loads falling on the belt conveyors, the dimensions of the roller, the angle of inclination in the installation of the side rollers, the material of the belt, the weight of the belt, the width of the belt, the height of the descent of the rock, the height of the rock It depends on the size and mass of the rock per meter. At the time of loading on the belt of the belt conveyor, the forces acting on the rocks and the belt in motion, namely, based on the Ritsa method, considering the rollers in a dynamic position, are considered at the expense of large pieces of rock falling on the belt. In Pic. 4, when the forces are projected along the x, y axes, the forces acting on the side and middle rollers of the conveyor are determined as follows.



Picture 4. The main parameters of rollers

The forces acting on the rollers and their supports, the roller reaction force RA is directed in its normal direction. Due to the fact that the gravity forces of the belt and load flow relative to the rollers are directed horizontally, the forces acting on them are projected relative to the axis as follows:

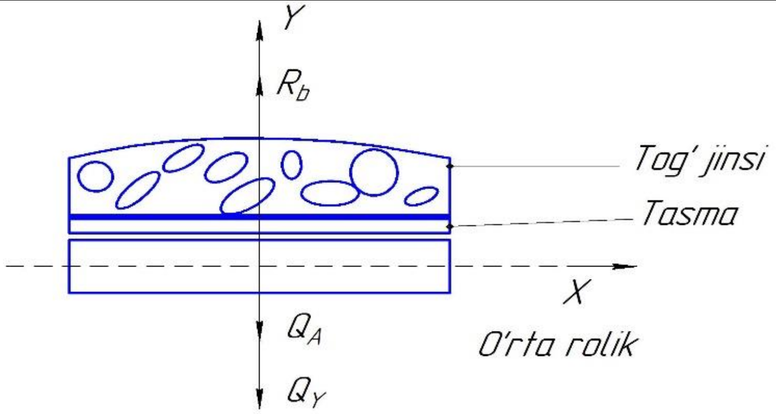
$\sum F_y = R_A \cdot cos\beta - Q_{yuk} \cdot g - Q_{tas} \cdot g = 0.$ (9)

The reaction force on the side roller located at the point of loading of belt conveyors is determined by the following expression:

$$R_A = \frac{k_t \cdot l \cdot h \cdot \sin(90-\beta) \cdot v \cdot \beta \cdot k_t + G_{tas} \cdot B}{cos\beta} \cdot g, \text{ kN.}$$

(10)

Picture 5 shows the reaction forces acting on the middle roller located at the loading point of belt conveyors. Through this image, we determine the reaction force acting on the middle roller.



Picture 5. Forces acting on the middle roller

The reaction force acting on the middle roller located at the loading point of belt conveyors is found using the following expression:

$$R_B = G_{tas} \cdot Bg + h \cdot l \cdot v \cdot \gamma \cdot k_t\ g, \text{kN}. \quad (11)$$

here, *Qyuk* – Weight of rock 1 m long, kg/m;
Qtas – Weight of 1 m long tape, kg/m;
υ -speed of the tape, m/s;
γ – rock density kg/m^3;
k_t – fullness coefficient;
G_{tas} –weight of the tape 1 m^2, kg/m^2;
B – conveyor belt width, m;
β – the angle between the side rollers;
l – roller length, m;
h - the height of the bedrock above the belt, m.

The tension distribution of belt conveyor roller lengths is found using the following expression:

$$l = \frac{G_{tas} \cdot B \cdot sin\beta}{k_t \cdot h \cdot cos\beta \cdot \gamma}, \text{ m.} \quad (12)$$

The fact that the load does not arrive evenly and evenly on belt conveyors is also a number of stops, due to the cover installed by welding causes displacements as a result of the axis escaping from the center, the length of the part of the rocks touching the belt surface located on the side rollers is found using the following expression:

$$l_r = 0.5 \cdot B \cdot (K_B - K_{prop}), \quad (13)$$

Here K_B –the coefficient of usage of the width of tape, $K_B = 0.9 - \frac{0.05}{B}$.

The length of the middle roller of the belt conveyor is found based on the given stress distribution using the following expression:

$$l_p = K_{prop} \cdot B - \frac{G_{tas} \cdot B \cdot sin\beta}{k_t \cdot h \cdot cos\beta \cdot \gamma}, \text{ m.} \quad (14)$$

By changing the design of the roller covers of the belt conveyor, the defect that occurs during welding on the roller axles, that is, the fact that the axle escapes from the center, significantly affects the productivity of the conveyor, is determined from the above expressions. a significant decrease in productivity caused by In conveyor rollers, the change in rotational speed caused

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by the axis running away from the center has a significant impact on the performance of the conveyor equipment, that is, it differs from the performance indicated in the technical indicators, the bearings fail due to different load drops and it also causes economic damage.
Before the belt conveyor roller axis is installed on the roller housing, it is checked for flatness by placing it on the device, and after correcting the defects, it is allowed to install the roller. Actions aimed at preventing conveyor roller axles from running away from the center are shown in Picture 6.

Picture 6. The process of checking the roller axis for flatness

Results

Despite the high level of inspection mentioned in the picture above, the centering of the belt conveyor roller axis occurs due to defects during welding. Therefore, the moment can be increased or decreased by avoiding the center of mass through the welding of the roller covers mentioned in the above section, so a small amount of mass can also dynamically cause a negative moment of inertia, by opening the grooved cover Scientific research has shown that installation is the solution to the problem.
By using a grooved cover design on the belt conveyor unloading rollers, a significant decrease in productivity caused by welding defects on the roller axles has also been avoided. In conveyor rollers, the change in rotational speed caused by the axis running away from the center has a significant impact on the performance of the conveyor equipment, that is, it differs from the performance indicated in the technical indicators, the bearings fail due to different load drops and it also causes economic damage.
After fixing the belt conveyor rollers by the grooved cap method, with the help of the Z162 locking device, the degree of problems related to the displacement of the shaft caused by the eccentricity of the rollers was reduced by a factor of 2, and these results were the same as the results obtained with the experimental equipment and the software. was determined. Picture 7 below shows the centering and checking of the roller axis after the threaded caps are installed on the belt conveyor roller.

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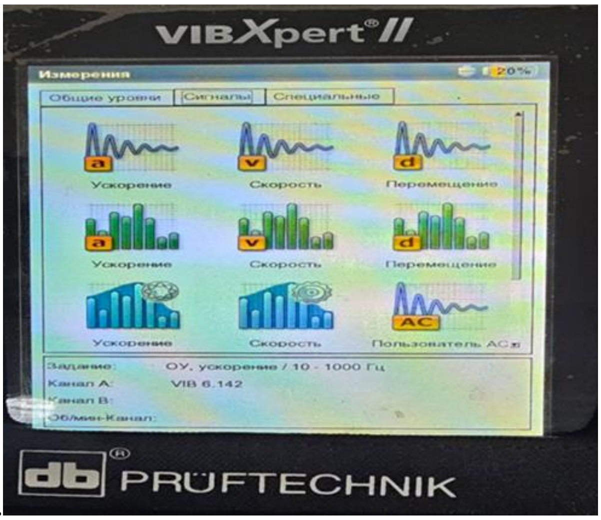
Picture 7. The process of checking the roller axis from center to displacement

Due to the fact that the roller with grooved cover has been tested and has given positive results, it is necessary to carry out experimental tests during the production of the roller. The results were obtained in axial, horizontal and vertical positions to ensure accuracy and reliability. Experimental work carried out at the mining enterprise is shown in Picture 8.

Picture 8. Trial process

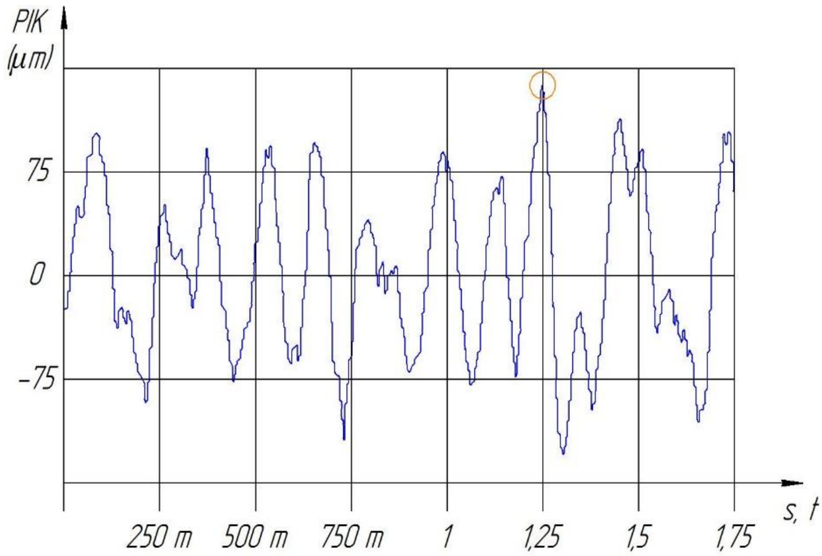
The results of the conducted experimental work were obtained on the modern VIBXpert// test device manufactured in Germany, which is widely used at the moment. analyzes the changes caused by displacement, acceleration, speed, number of revolutions and vibration in bearings and bearings. The VIBXpert// device is a device designed to obtain the results of experimental work, as a result of the welding of the side of the rollers and the installation of a grooved cover, the degree of sliding and non-slipping of the bullet was obtained (Pic. 9).

a.  b. 

Overview of the a-VIBXpert device and b-device performance functions

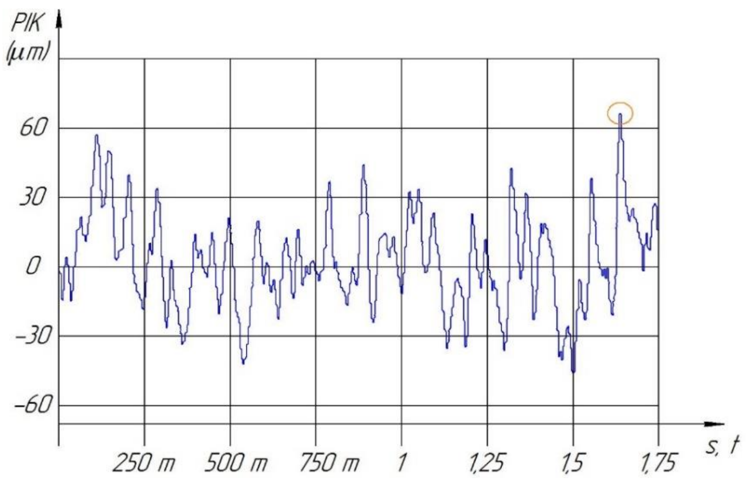
Picture 9. VIBXpert // experimental device

In order to eliminate such defects as the weight of the load falling on the rollers, the displacement of the axis during the rotation of the rollers, the displacement of the roller axis as a result of the defects caused by the installation of the rollers (welding of the cover), pilot-testing works using the VIBXpert// device in 2 different cases was carried out on the example of rollers. These are rollers at the point of loading onto the belt conveyor, rollers that are used using the welding method with operating parameters, and manufactured rollers with a grooved cover construction. The results obtained with the VIBXpert// device of the changes caused by the displacements of the belt conveyor roller axis are presented in pictures 10 and 11.



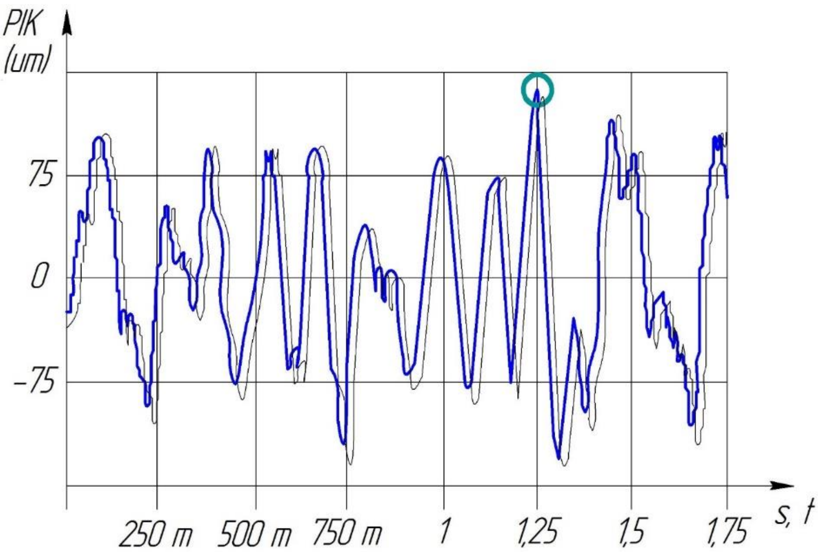
10 - picture. Graph of dependence on time shifts in the method of welding roller covers.

In this graph, the displacement of the roller axis when the load falls on the rollers in the loading areas of belt conveyors is considered based on the experimental test. As can be seen from the graph, the displacement of the roller axis located on the u axis was 142 mKm in the unit of time located on the x axis of the graph in 1.25 s. This shift has a negative effect on the operation of the roller and must be eliminated.

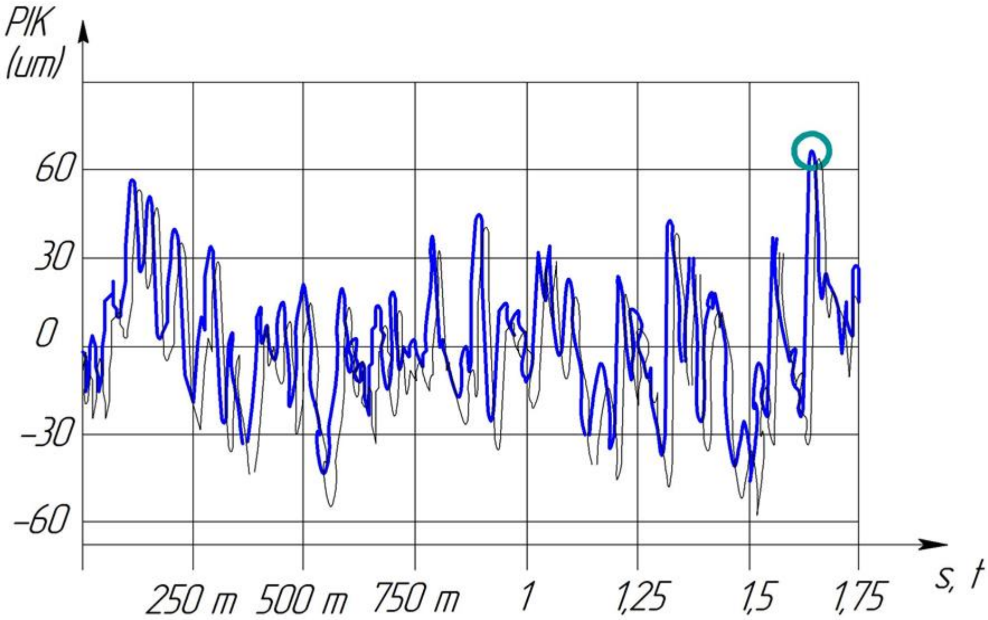


11 - picture. Graph of dependence of time displacements in the application of roller construction with groove cover.

In the graphs in picture 11, a graph of time displacements of the rollers in the loading areas of the belt conveyor during unloading (in the process of operation) with the use of the thread cover roller construction was obtained. In this graph, the displacement of the roller axis on the u axis was 63 mKm in 1.6 s per time unit when the roller axis is located along the x axis of the graph. The conducted studies show that the highest index of displacement caused by the method of installation of roller covers based on welding was 142 mKm, by using the method of roller construction with thread cover, the displacement on the axis of the roller was reduced to 63 mKm, that is, the displacements were 2.25 times was reduced. In addition, since the displacements on the roller axis are performed per unit of time, while the highest indicator of the displacement occurred in 1.25 s in the method of installing the roller covers based on welding, the displacement on the roller axis by using the grooved cover roller construction method The maximum shift rate was 1.6 s. This indicates a 22% increase in time.



12 - picture. Rolik's theory and practical graph related to time shifts in their treatment method.



13- picture. Theoretical and practical graph of the dependence on time displacements in the application of the grooved cover roller construction.

As a result of the theoretical analysis, the graph of the displacement distance generated by the inertial forces generated in the roller coating was drawn up in a time-dependent state. In this case, the axial shift, which reached the maximum value of 137 mKm, brought the coordinate closer to the limit of positive value, and this value was reached in 1.25 s. As a result of the experiment, we can observe in the graph that the value obtained using the VIBXpert// device reached the maximum value of 142 mKm in 1.25 s. As a result of comparing theoretical and experimental results, these values correspond to each other by 96.5%.

By using a grooved cover structure designed to reduce the time spent on preparing for the replacement of belt conveyor roller bearings, prevent the axis from running away from the center, and extend the service life of the roller, lighten the manual labor of roller maintenance personnel, the roller to reduce the time spent on taking the rollers to a special repair shop for replacing the bearings at the site where the conveyor is working, to prevent mistakes made during the welding of the covers, and in general to reduce the time spent on the repair of conveyor rollers by 10% reduction to 56% made it possible to reduce the displacements caused by the axis running away from the center.

Conclusions

1. Deviation of the belt conveyor device to a certain angle causes an increase in tension and reaction forces on the belt, rollers and their supports, rapid failure of roller bearings and deformation of their supports.
2. The decrease in operational productivity of the belt conveyor depends on the climate and conditions of use. Unfavorable climate and difficult working conditions increase the load on the electric drives along with the rapid failure of the roller, as a result of which the overall performance of belt conveyors has been found to decrease.

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3. The process of replacing roller bearings of a belt conveyor, that is, removing the roller from the support, opening the covers closed by welding, and replacing the failed bearing with a new one, takes a long time. With the help of the developed new construction, it was possible to reduce stoppages caused by friction between rollers and belts by 13-16%, and reduce the mechanical hours spent on repair work by 10-15%.
4. The application of the grooved cover structure has made it possible to ease the manual labor of roller maintenance personnel, to reduce the time spent on conveyor roller repair work by 10%, and to reduce the displacements caused by the axis running away from the center by 2.25 times.

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