Prospective Design of Conveyor Rollers

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Abstract: Operation of belt conveyors and vertical conveyor-elevators was considered and design of their support rollers was analyzed in this study. The study presents the results of the research work of belt conveyors and vertical conveyors, elevators and proposed new design support rollers. To increase productivity, they must meet certain requirements as reliability, durability, flexibility, light weight, etc. One of them increase the bearing capacity of the supporting rollers and the reliability of the sealing devices. In this study, attempts were made to extend the life of carrying rollers due to the new design of rollers providing a joint misalignment of the bearing rings under certain geometrical sizes.

Key words: Roller, conveyor, bearing, roller seal, design

INTRODUCTION

Belt conveyors are the most common type of continuous machines in industries. Besides, the cost of rollers amounts 25-30% of the total installation cost. Moreover, 40% of the total cost of upkeep is the share of rollers that determines efficiency, energy intensity of the belt conveyor and influences on the belt durability.

In recent years, greatly increased the required length of the transport conveyor belts (sometimes reaching a length of several kilometers), they have become more complex, it increased the amount of cargo transported per unit of time, much tougher environmental standards and safety. Downtime belt conveyors are unacceptable because they lead to a halt in all other mining equipment, causing serious economic losses in the mining operations. In this connection and significantly increased the requirements for the constituent elements of belt conveyors (this rollers, roller, conveyor belt, drive station), especially in the mining and mining heavy loads fall on the roller and roller loading units. It is in the download sites where there are shock loads most often observed failure of the roller carriages. Basic elements of general purpose standardized belt conveyors. The flexible endless belt conveyor belt bends around the drive drum and the tensioning drum and in the span between them based on a series of roller supports which are mounted at regular intervals on the frame. Thus, the roller are one of the main components of the belt conveyor. By roller supports high demands. They must be inexpensive, reliable; they should have a minimal resistance to rotation, they should ensure the centering of the tape; specify the required grooved belt and favorable conditions of work. Therefore, improving the reliability and durability of roller carriages conveyor systems is an important task.

In addition to belt conveyors, rollers are used in other Machines with Continuous Transport (MCT), for instance, for transportation and packages of piece goods in rolling conveyors and various kinds of storage silos where the cost of the rollers amounts 50-80% of the cost of continuous machines. Therefore, reliability enhancement and durability of rolling supports of conveyor systems is an urgent task.

Justification of the research direction: At present the lifetime of rolling supports working in hard conditions with a dusty environment and large-sized goods which is typical for the mining industry averages on linear sections 12-15 thousand hours and 5 thousand hours on loading sites. Allocation of failures is shown in Table 1. As it can be seen from the statistical data of operation of belt conveyors the major cause of failure of rolling supports in a dusty environment is clogging bearing assemblies with dust particles 5-30 μ in size and is abrasive damage of labyrinth seals and insufficiency of lubricant. Despite the

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Table 1: Statistical data of failures

Causes of failure	Failure frequency (%)	
	Upper branch of the conveyor	Lower branch of the conveyor
Clogged of bearings and their locking because of sealed dusts	38	12
Outflow and shortage of oil in bearing assemblies	37	36
Violation of bearing seat in case hubs	12	10
Violation of bearing seat on non-driving axle	3	3
Circumferential abrasion of shell at overloads	2	30
Unidentified factors in the operation	8	9

large number of research works and active inventive activity in the world the lifetime of the rollers of belt conveyor for dusty environment is heightened insignificantly. The reasons of this are technological and constructive. It is well known that permissible angle of obliquity of inner ring relative to bearing cup of (single-row) ball bearing is 0° and 6-8 min (Kolobov *et al.*, 1984). Considering inevitable obliquity of bearing rings after construction associated with manufacturing and assembly error the permitted angle of obliquity is reduced to 0° and 3-4 min depending on the length and diameter of the roller.

It can be concluded that the existing construction of rolling supports, the technology of their production abroad in Russia and Kazakhstan preliminary obliquities of racers are inevitable that substantially reduces their bearing capacity (Kuznetsov, 1986; Manezhanov *et al.*, 2014).

Most importantly, for dusty environments effective methods to protect bearing assemblies from falling dust particles were not developed (Reicks, 2012; Zhao, 2011; Sugumaran and Ramachandran, 2011; Gupta, 2013; Shaikhanova *et al.*, 2015).

The most significant technological factors affecting the carrying capacity of mechanical engineering components (which are the partsan droll) are the residual stresses, the anisotropy of the mechanical properties of the material, the state of the surface layer is largely dependent on the production technology. The choice of processing technology often depends durability of roller bearings, respectively the entirebeltas a whole.

The technology of manufacture of parts of rollers and original piece. For example, use as a preform in the manufacture of conventional tube shell quality beat variation in wall thickness of 1.5 and 1% of the outer diameter. When both the boreon both sides, on the horizontal multi-spindle trans fer machines with basing on the outersurface of the pipe, this led to a pre-pinching bodies rolling single row ball bearings type zero. Here, we have apre-skew roller bearing rings.

Also, for the manufacture of shells aligned rollers used electric-welded pipes is drawn to the inside diameter and having a run-out does not exceed 0.5% of the diameter. Seatings in the shell for steel hub handled

bilateral boring press fitted, followed by rolling the ends, however, it does not eliminate the distortions of the bearing rings (Ibraeva *et al.*, 2013; Kolobov *et al.*, 1984) Another way of producing shells, may be its manufacture from a sheet by bending dimensional sheets or strips on rollers or subsequent welding stamped and (Kuznetsov, 1986).

Considering the production of video technology components, we can not dwell on the machine tools. If the individual production is still possible to use the universal machine when a mass or aggregate increasingly using special machines that achieve desired handling qualities axis machined shells without significantly increasing downtimes. Recently, however, when working in a large range of manufactured products are increasingly using modern model of flexible manufacturing readj usted where extensive use of modern high-precision CNC machine tools provide high speed of production, the exact geometry and high quality of the parts.

However, in this study, we will consider only structural factors and technological factors affecting the quality of the manufacture of individual elements of the pipeline will be discussed in a separate study.

Of course, one cannot ignore the effect of loads on the rollers and their bearings during operation of pipelines. Pressures on the roller bearings must be divided by the weight of the external load, the belt and the rollers themselves and rotating parts inside, appearing as a result of manufacturing in accuracies and distortions of misalignment during installation of bearings.

MATERIALS AND METHODS

How is the load? The total load on the roller bearings during operation is determined by the equation:

$$F = F_{BK} + F_0 \cdot \cos \omega \cdot t_p \qquad (1)$$

Where:

$F_{BK} = F_{rp} + F_n + F_c$ = Radial load from the weight of the load, the belt and the rotating parts of its own weight roller in H

F_0 = Additional internal load on the rolling elements when misalignment

ω = Angular velocity roller 1/c

t_p = The duration of the internal load when skewed to the roller

$$t_p = \frac{\pi}{Z_w} \cdot \omega(c)$$

The additional load is cyclical in nature and has the signed. It should be noted that the rings appear skewed axial load in the bearing, creating resistance to rotation moment zaschemlyayuschy.
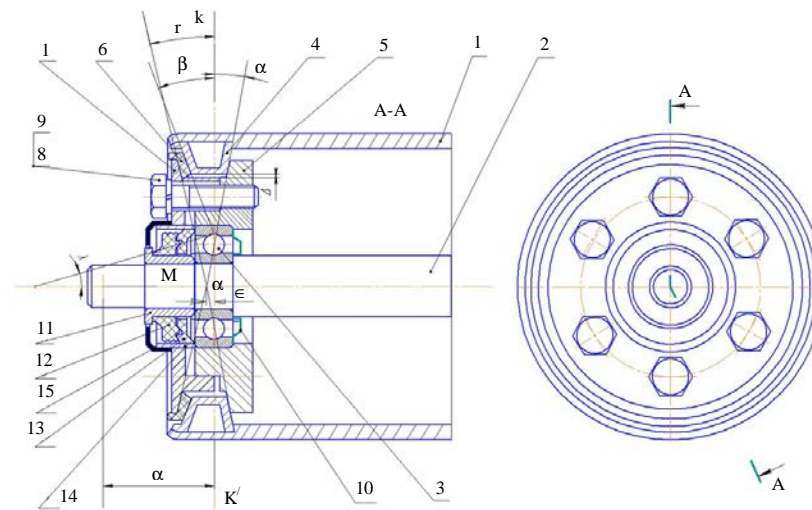
Fig. 1: The roller with amortized rolling support; 1: Shell; 2: Axis; 3:Bearing; 4: Thin-walled ring of keystone-shaped section; 5: Internal stepped disc; 6: Rubber gasket; 7: External disc; 8: Screw; 9: Spring washer; 10: Steel shield; 11: Internal sleeve; 12: External sealing element; 13: Internal sealing element; 14:External sleeve; 15:Protective housing

The question arises, how to get rid of internal loads in a warp? This is achieved at the same time ensuring the relative misalignment of the bearing rings with a common axis deformation in a plane passing through the point at the intersection of the axis of symmetry of the rolling element with the geometrical axis of rotation of the roller. It is inherent in the design submitted by the rollers, thus, is also very important, design of bearing units reliably protect against the ingress of dust particles and provides a centrifugal cleaning of the bearing assembly and the supply of bearing grease.

RESULTS AND DISCUSSION

In this research, the attempts were made to increase lifetime of rolling supports up to 30 thousand hours at the expense of new construction of bearing rollers providing combined obliquities of racers on certain geometric conditions.

In previous inventions (e.g., author certificate Republic of Kazakhstan No. 7 G10, 22585, 27735, 28128) developed on the principle of increasing the bearing capacity of the bearing assemblies, the forced obliquities are implemented at the expense of axial force but in the following two constructions it is done at the expense of radial load by itself, operating on rollers (Ibraeva *et al.*, 2013; Temirtasov *et al.*, 2014). The principle of operation of roller number 1 (Temirtasov *et al.*, 2009).

Figure 1 shows the roller with amortized rolling support that includes cylinder course 1 and axis 2,

bearing 3, thin-walled ring of keystone-shaped section 4, internal stepped disk 5, rubber gasket 6, external disc 7, screw 8, spring washer 9, steel shield 10, internal sleeve 11, external closure element 12, internal closure element 13, external sleeve 14, protective housing 15.

Such performance of the roller eliminates the appearance of relative obliquities of bearing rings as by axis deformation together with the internal racers obliquities of bearing cup occurs with assembled hub relatively to the cone in the neutral plane of the shell (e.g., NMN') that is perpendicular to the operating load. Incidentally the general plane K-K' is constant tangent to the trajectory of the point O_2 of axis-part. The principle of operation of roller number 2 (Temirtasov and Manezhanov, 2004).

The roller of second construction shown on Fig. 2 contains cylindrical shell 1, forming together with the end hubs 2 the case of roller.

The outer surfaces of the hubs 2 are spherical with a radius equal to the inner diameter of the shell with centers F and L located through inner surface of the shell at intersection points of a plane passing through symmetry points of the rolling elements of bearing. After installation of the hubs into end interior of the shell it makes performance of subsequent folding with creation by force of pressing of circular groove in the shell to restrict their movement inside.

The case of roller is mounted on the axis 3 by by the use of supports placed in the hub 2 of sealing washers 4, bearings 5 and labyrinth seals. The external seals 6,
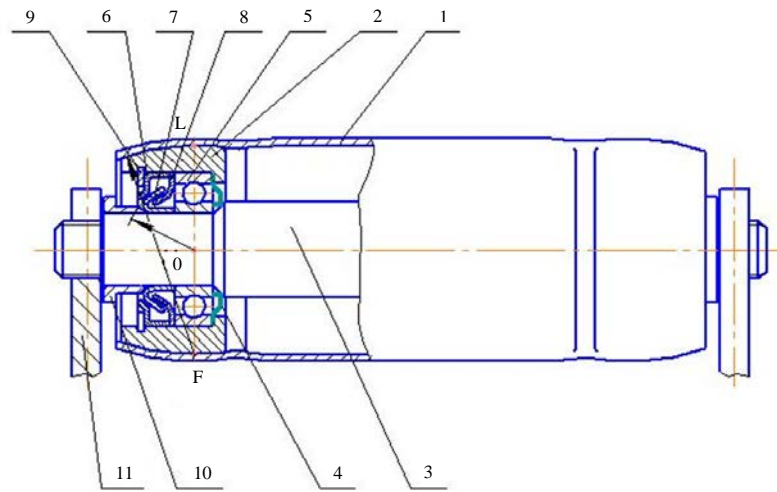
Fig. 2: The roller of second construction; 1: Shell; 2: End hub, 3: Axis; 4: Sealing washer; 5: Bearing; 6: External element of labyrinth seal; 7: Intermediate member of labyrinth seal; 8: Internal element of labyrinth seal; 9: Locking ring; 10: Bush; 11: Rack

intermediate 7 and internal 8 elements with end walls having spherical surfaces mounted concentrically to each other with common geometrical center in the point of the intersection of the plane passing through symmetry point, rolling elements with axis of roller rotation. The external element 6 presses the internal element 8 to the bearing cup 5 in the hole of the hub 2 and held by locking ring 9. The intermediate sealing element 7 placed on the axis 3 is pressed to the internal racer 5 and held by sleeve 10 pressed on the axis 3. The axis of the roller is mounted on the rack11 of fabricated metals of conveyor.

Design of all of fered roller shasgeneral principle of inner and outer bearing rings cooperative forced distortion by different methods. Investigation of these rollers, performed by methods of engineering forecast using patent sources, gives the grounds to assume that rollers have good perspective on condition of further construction development (Shayakhmetov *et al.*, 2015).

CONCLUSION

Thus in proposed constructions of rollers functional technical, constructional, ergonomic indicators are improved. There liability, unification and energy-efficient indices are increased too. It is expected the increase of life time of rolling supports up to 25-30 thousand hours that should compensate the increase of cost parameters at the expense of the use of science intensive technologies, materials of high quality and pipes with extra accuracy for shells of rollers. Its competitiveness for external and internal market will be provided with such data as high reliability and durability as well as lower levels of noise and vibration.

REFERENCES

Gupta, A., 2013. Safety Measures for reduction of failure in belt conveyor for thermal power plant. Int. J. Mechanical Eng. Robotics Res., 2: 214-220.

Ibraeva, D.T., O.T. Temirtasov and E.Y. Shayakhmetov, 2013. Dynamic loads at the nodes loading of belt conveyors. Bull. Semey State Univ. Shakarim, 2: 59-62.

Kolobov, L.N., O.T. Temirtasov and V. Graf, 1984. Gravitational mechanized warehouses for meat and dairy industries. TsNIITEI, Moscow, pp: 36.

Kuznetsov, A.A., 1986. Probabilistic skew angles bearing rings in the conveyor rollers. Bull. Univ. Eng., 7: 105-109.

Manezhanov, B.A., Y. Shayakhmetov, T.M. Mendebayev, O.T. Temirtasov and R.R. Ibragimova, 2014. Prospectivity of designing roller supports for conveyor systems operating in harsh conditions. Life Sci. J., 11: 273-277.

Reicks, A.V., 2012. Conveyer models as quantitative platforms for belt conveyor energy options. BulkSolids Eur., 48: 1-10.

Shaikhanova, A.K., A.D. Zolotov, E.M. Muhametov, M.P. Karpinski and D.O. Kozhahmetova, 2015. Evaluation of time complexity in investigation of methods of modular exponentiation. Res. J. Applied Sci., 10: 66-69.

Shayakhmetov, Y., B.A. Manezhanov, T.M. Mendebayev, O.T. Temirtasov, R.R. Ibragimova and Y.T. Abilmazhinov, 2015. Prediction of development prospects of roller support designs for conveyor systems. Int. J. Applied Eng. Res., 10: 38110-38115.

Sugumaran, V. and K.I. Ramachandran, 2011. Effect of number of features on classification of roller bearing faults using SVM and PSVM. Expert Syst. Applic., 38: 4088-4096.

Temirtasov, O.T. and B.A. Manezhanov, 2004. Conveyor system for vertical piece cargo. Patent 14719, Republic of Kazakhstan, B65G 13/00, B65G 17/00. Publ. 15.09. 2004, Bull. No. 9, pp: 9.

Temirtasov, O.T., R.R. Ibragimova, T.M. Mendebayev, B.A. Manezhanov and Y. Shayakhmetov, 2014. Investigation of the static stiffness of a chassis conveyor support rollers. Proceedings of the Fundamental and Applied Sciences Today-Conference Materials, April 2-5, 2014, North Charleston, USA.

Temirtasov, O.T., Y. Shayakhmetov and D.K. Temirtasov, 2009. Conveyor belt. Patent 21789, Republic of Kazakhstan, B65G 15/00, B65G 15/28. Publ. 15.10.2009, Bull. No. 10, pp: 12.

Zhao, L., 2011. Typical failure analysis and processing of belt conveyor. Procedia Eng., 26: 942-946.