Mihăilescu Sorin, *Assoc.Prof.Eng. PhD, University of Petroşani*
Praporgescu Gabriel, *Assoc.Prof.Eng. PhD, University of Petroşani*

ABOUT MALFUNCTION OF THE BELT CONVEYORS ROLLER

ABSTRACT: Making the most of a roller is possible only when its lifetime is approximately equal to the life time of all its other elements. The experience of more than 30 years of service of the existing types of rollers has showed that they have an operating lifetime of approximately 4000...5000 hours, aspect that requires very high costs for the concerned mines in their efforts of replacing those prematurely decommissioned due to malfunctions arisen on their constituents.

1. INTRODUCTION

The share held by the transport costs affecting the cost of production for one ton of useful mineral can reach up to 60%.

Improving the design of belt conveyors has been particularly stimulated by the requirements of the coal industry because the need was felt here more than anywhere else, that there should be a continuous transport, able to circulate massive amounts of useful minerals mined by the high yields continuous cutting excavation equipment.

The attention that has to be paid to the rollers (Fig. 1) of belt conveyors results both from their quantitative aspect and especially the percentage of 25%, value they enter into the purchase price of the conveyor. Customizing the above said aspects, a conveyor with distance between centres of 1,000 m comprises about 3,100 rollers.

2. ROLLERS TO SUPPORT THE BELT OF THE CONVEYOR

The rollers of belt conveyors are used for moving and supporting of the rubber conveyor belt with minimum friction. The roller of the belt is one of the most important parts of the conveyor, being subjected to continuous stress both during operation and in stopping periods. Besides, the supporting rollers of the belt conveyor are crucial on the safety of operation of the facility they are built in and on the life of the belt conveyor which is the most expensive element of the equipment.

The high-capacity belt conveyors may comprise the following forms of constructive roller:

- strip rollers A symbol (Fig. 2) - used along route to the top of the conveyor belt, with a supporting and adjustment role;

Fig. 1. Rollers

Fig. 2.
Cross-section of A type strip roller

- rollers with rubber disc B symbol - used to transport to the bottom of the conveyor belt acting as cleaning elements;
- strip rollers AB symbol - used as component elements of the type B rollers and support the lower branch of the conveyor belt;
- C type rollers – damping rollers are used in the loading areas;
- AC rollers – used as component elements of the C type rollers are similar to AB rollers;

The sealing elements of a roller comprise the following:

- The bearing is protected both front and back with one elastic polyethylene gasket that serves as a grease deposit, while preventing dirt ingress and the egress of the grease from inside the bearing;
- Outside the roller, the seal is supplemented with covers, one of rubber and one of polyethylene that prevent water and impurities ingress from the outside;
- A safety steel ring of polyethylene is fitted before the cover preventing axial displacement of the sealing elements and of the bearing;
- Behind the polyethylene cover there is fitted a rubber spacer ring to prevent axial displacement of the sealing elements of the bearing;
- Behind the polyethylene cover a rubber spacer ring is fitted with to prevent axial displacement of the flexible polyethylene gasket;
- The rotation of the roller is achieved through two bearings mounted in the two enclosures and shaft ends of the roller.

3. FAULTS THAT MAY OCCUR DURING THE OPERATION OF ROLLERS

The constructive way of rollers and their influence on safety in the

ISSN 2311-0368 (Print)
ISSN 2409-1049 (Online)

operation of belt conveyors is felt by:

- bed and manufacturing of rollers;
- external dimensions of the rollers;
- their resistance to pressure and energy consumption;
- failure rate of rollers and expenses covering the operation period.

Failure rate, whose analysis involves the possible damage of a roller, is determined by the specific characteristics and by a number of occurrences and damages of the components such as:

- failures of bearings;
- failures of the sealing gaskets;
- failures due to decreased lubrication capacity;
- failures due to the supporting system for joints and suspensions;
- failures caused by wear and deformation, failures occurring in metallic jacket and the axis of the roller.

Several occurrences are on the basis of these failures but the main blameful one is the phenomenon of fatigue. Researches in this area demonstrate that failures due to fatigue display the weight percentage shown in Figure 3.

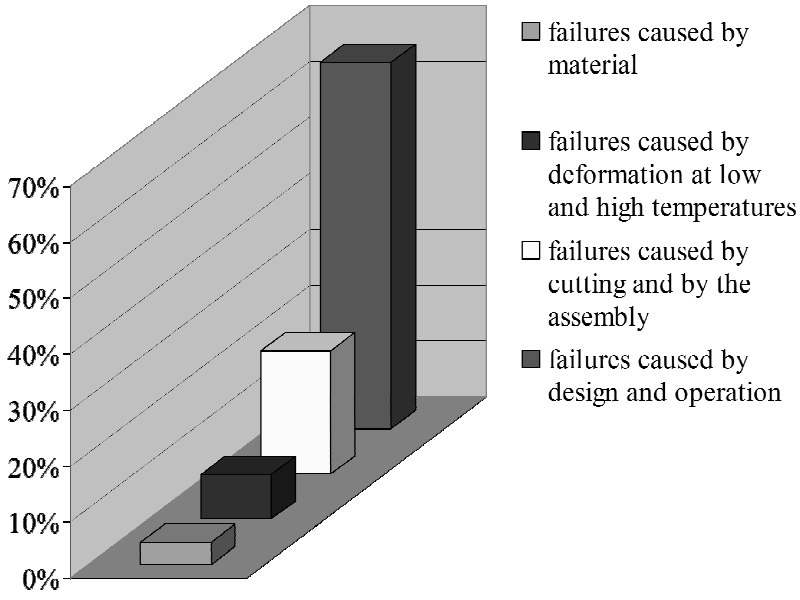

Fig. 3. Causes and weight percentage of failures due to fatigue

A large number of roller removed from service due to the support bearings.

For these reasons, it is particularly important to know the causes leading to the failure of bearings and limiting the duration of their use.

3.1. Failures produced by the bearings to the rollers

For the case of rollers, the lifetime during which the bearings remain fit for operation from a dimensional point of view depend on two aspects:

- the wearing of the material used for the manufacturing of rolling rings and bodies;
- the wearing of pathways of rings, of the rolling bodies (balls) and of cages.

The wearing process of bearings shall lead in many cases to jamming or forced tearing, with particularly serious effects on the surrounding parts or over the belt of conveyors and which put them out of operation in many cases of this kind is.

There shall be considered a coefficient of the operating length corresponding to the rated lifetime of 4,3…4,6 during the sizing of roller bearings on the high capacity belt conveyors. This value corresponds to fatigue lifecycle calculated at 50,000 hours and 40,000 hours, respectively.

After dismounting of a number of rollers 100, it was found that they ceased their functional due to wear of bearings and the main cause were impurities entering the bearing. If the ball bearing had still worked, the wear of bearings would accelerate and soon they would have reached the upper limit of their operating capacity.

Also, after examining the bearings on the 100 dismounted rollers, after running for about 4000 hours, it was noticed an increase of the radial clearance, due to wear of rolling bodies (balls) and of the pathways.

Consequently, one can conclude that the operation period of bearings used with the rollers in the belt conveyors, depends solely on the size of wear occurring in inside rolling bodies of and on the pathways as a result of impurities entering the bearings.

The literature states that the life of the bearings is closely related to operating conditions and to the environment in which they operate.

The research conducted on the bearings of rollers, have showed that at present they can reach a lifetime of 40,000 hours if they are well - protected against the ingress of moisture, water and impurities in their housing.

3.2. Failures produced by the sealing system

The main shortcoming of the sealing system with contact is that rubber and polyethylene gaskets and sleeves forming sealing system, permanently in operation and in contact functional displays a wear trend with the increasing number of operating hours. As a consequence of aging,

there is the loss of the good sealing effect in most cases during the initial phase as a result of (initially) permanently elastic contact between the sealing elements. As wearing level of the sealing elements in contact increases, there also increases the axial margin of the roller above the minimum limit required by design and execution of 2 mm, thereby eliminating grease from the bearing casing outside the roller, as well water, moisture and dirt ingress into the bearings of rollers .

All these phenomena were noticed when 100 rollers were dismounted.

If the current rollers have made a good seal at the external part, the sealing on the inside is limited only to a polyethylene gasket to protect against grease removal within the roller.

Research and tests on the batch of 100 rollers have highlighted the need to achieve a sealing system within the roller similar or as effective as the external one. The following arguments are on the basis of this statement:

- the existence inside roller of about 10...15 g lubricant removed from the casing of the bearing during operation of the roller due to lack of sealing on the inside;
- the presence of rust particles in the grease left on the bearing as well on its pathway coming from inside of the roller due to variations in temperature;
- lack of malleability of grease and loss of lubrication as a result of dirt ingress from the outside or inside the roller.

3.3. Failures produced by the diminished lubrication capability

Both the quality and reduced validity of the grease used on ball bearings of the rollers are another cause leading to a diminished the lifetime of the rolls.

The grease used for lubricating the bearings of rollers, which is done once by wrapping on the assembly line, has the following functions:

- performs the lubrication of bearings;
- performs the function of sealing by fixing dirt and air.

Grease must remain malleable throughout the operating period in the sealing system and keep its lubricating property throughout the period of use.

The analysis done after dismantling of rollers brought for repairing operations, rollers that worked about 3500 hours, showed that grease on bearings completely lost its lubricating capability. Consequently, many bearings were replaced as it was considered they were worn out. According to the specifications on the manufacturing of rollers, specifications drawn up

by local manufacturers, it resulted that the grease warranty period is only 12 months. According to the foreign literature (Germany), it results that the use period of grease is all through the lifetime of the roller, over five years.

3.4. Studies and achievements worldwide

Proving as the optimal for the conveyance of the mining mass in quarries, belt conveyors and belt conveyors and their subassemblies have been the subject of wide domain of researches and articles published on this subject. Scientific meetings held in countries such as Germany and Japan on the improvement of functional design of the various parts of belt conveyors highlight once again the attention to paid to these transportation means. Among the main measures to improve the design of the rollers there can enumerate the following ones:

- the use non-contact type labyrinth seal;
- sealing with preliminary grease room;
- improving the quality and duration of use of greases;
- improving the quality of raw materials used for making gaskets;
- increasing the service life of bearings;
- increase the static and dynamic balancing.

The general trend is to eliminate the contact sealing system, its place being taken by non-contact sealing. Figures 4 and 5 show the sealing systems of the Romanian company Doras PRODCOM.

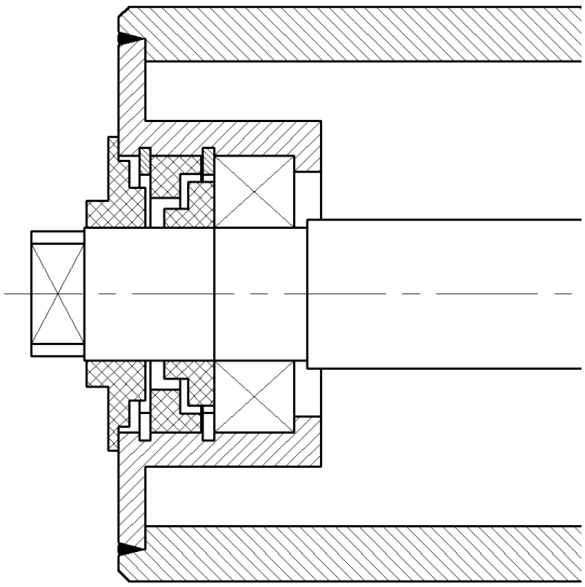

Fig. 4. Sealing system with simple labyrinth

ISSN 2311-0368 (Print)
ISSN 2409-1049 (Online)

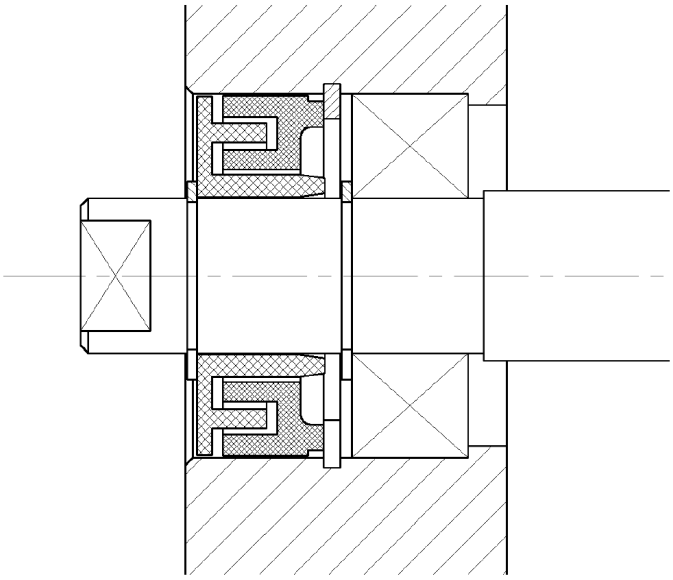

Fig. 5. Sealing system with double labyrinth

Constructive production of the sealing gaskets is highly differentiated. The highest sealing effect, yet with the largest constructive volume, is displayed by the systems with sealing inside the roller, too (Fig. 6).

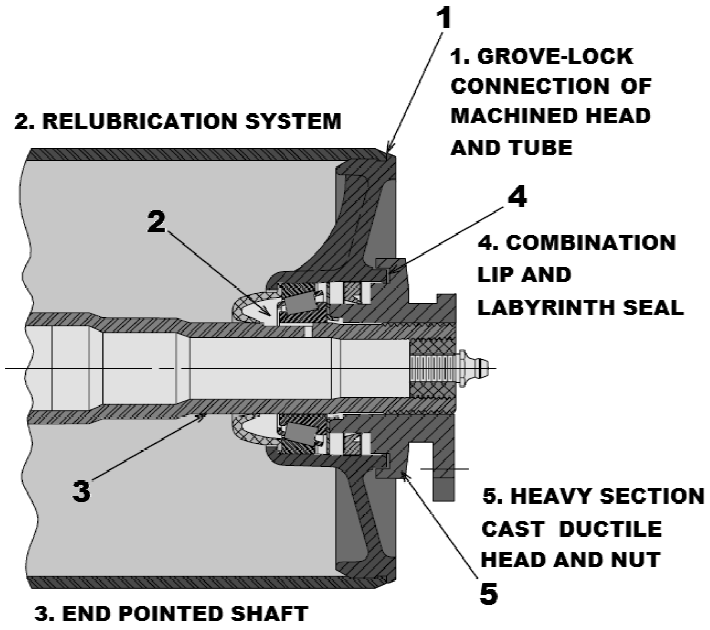

Fig. 6. SDX-Plus sealing system from Joy Mining Machinery

CONCLUSIONS

A proper seal shall provide a long time normal operation of bearings by protecting them against the ingress of harmful elements.

Non-contact seals have the advantage of not producing practically any wear or friction, allowing their use on assemblies working at high temperatures and velocities, their sustainability being considered unlimited.

The seal effect on labyrinth seals is achieved through a maze-shaped space between rotating and stationary parts of seals. This area should be minimal, without allowing any casual or permanent partial contact between rotating and fixed parts. By increasing the number of slots, the efficiency increases greatly. Slots in a labyrinth must be filled with calcium soap based grease to prevent water penetration. To avoid pumping outside or inside the case lubricant, radial beating of surfaces forming the slot should be minimal. To prevent this occurrence, the surfaces of the sealing labyrinth should be processed by cutting with a roughness $R_a > 1.25$ μm. A second sealing labyrinth shall increases the life of the rollers from 1 year to 5 years.

The sealing with two labyrinth rings have the disadvantage that requires a particular type of grease, i.e. a calcium soap - based grease. Introducing another type of grease shall not guarantee the same good sealing. The labyrinth ring also requires additional processing to ensure full sealing.

Therefore, the option with a labyrinth ring and bearing inside housing shall provide direct benefits compared to the first option. Also, a considerable advantage is that the sealing by bearing protection no longer depends on the space within the labyrinth where grease penetrates, space that must meet certain conditions without which it cannot ensure proper sealing.

By placing a unilaterally protected bearing there is also removed the occurrence of failures during the mounting stage, as it is known they hold a considerable share of 15% of the total failures occurring during operation of rollers.

Both versions must take account of the grease provided; it should have an operating period of guarantee for five years.

All these requirements imply the use of rollers that are so well design and produced an as long as possible lifetime. During this period, rollers don’t have to be repaired, and at the end of this period all components of rollers must display approximately a similar wear. At the end of this period, the existence in operation a large number of rollers represents a concrete result of the design efforts of the experts focused on improving

their functional design, so that these elements have the longest possible lifetime.

REFERENCES

1. Fodor, D., *Exploatări miniere la zi*, Editura Tehnică, Bucureşti, 1998
2. Marian, I., *Utilaje de încărcare şi transport minier*, Editura Didactică şi pedagogică, Bucureşti, 1984
3. Poiană, L., Mihăilescu, S., *Study on the Failures that May Occur in the Operation of the Rollers Supporting Belt Conveyors*, Lucrările ştiinţifice ale simpozionului internaţional multidisciplinar "Universitaria SIMPRO" 2010, Technological Machines and Equipments Technology; Mechanisms and Machines, Mechanics and Resistance, Petroşani, Editura UNIVERSITAS, ISSN 1842-4449, (pag. 93-96)
4. Ungureanu, N., Ungureanu, M., Mihăilescu, S., *Transportoare cu bandă pe role*, Editura RISOPRINT, Cluj-Napoca 2004;
5. ***, Prospecte şi cărţi tehnice ale firmelor şi uzinelor constructoare
6. ***, Studii şi proiecte de specialitate
7. ***, Îndrumător pentru construcţia lagărelor cu rulmenţi, 1970
8. http://www.continentalconveyor.com/CCC/catalogs/CCC_SDX_Series.pdf
9. http://www.componenteindustriale.ro/ro/produse/Role-transportoare-pentru-benzi-transportoare-171.html
10. http://www.dorasprodcom.ro/download/catalog%202008.pdf