

Chapter 7

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THE POSSIBILITY OF REGENERATION PROCESS IMPROVEMENT OF CONVEYOR BELTS

Abstract: The paper presents the results of research carried out in one of the national companies engaged inter alia regeneration of conveyor belts used in the mining industry. Characteristics of the conveyor belts made in terms of structure and their purpose. Based on the results obtained during the study includes recommendations that will serve the improvement of the existing process of regeneration of conveyor belts.

Key words: production process improvement, regeneration of conveyor belts

7.1. Characteristics and construction of conveyor belts used in mining

Transport conveyor in the opencast mines is a key solution to the transport effort earth from the excavation of the mining and transport of coal depriving him of excavators and transporting it to storage sites. Belt conveyors which, for example, work in the coal mines belong to the complex transport systems (up to several hundred kilometers in length). The basic element of the conveyor belt is a belt of conveyor. Depending on the mode of operation, operating conditions of the working environment followed by the selection of the tape construction, the strength, the tape width and tape length. The basic types of tape working during the operation of brown coal are strip widths of 1600 mm to 2600 mm. Tapes of the highest widths are working on basic machines, it is on the cutting drums coal excavators and chain bucket excavator forming

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overburden coal. Conveying will include a strip with a width of 2000 mm and 2250 mm. Additionally, tipping coal on the back are used for tape widths 1600 mm. Conveyor belts can be divided in terms of building the core of the tape on the tape with steel cord and strip sandwich. Basic parameters of the strength of tapes with steel cable to the strength of 4500 kN/m and a width of 2500 mm. Typical construction of the tape with steel cable is the core of the tape consists of steel cords and covers the core side of the carrier tape and the racing side. A typical cross section of the tape is shown in Fig. 7.1.

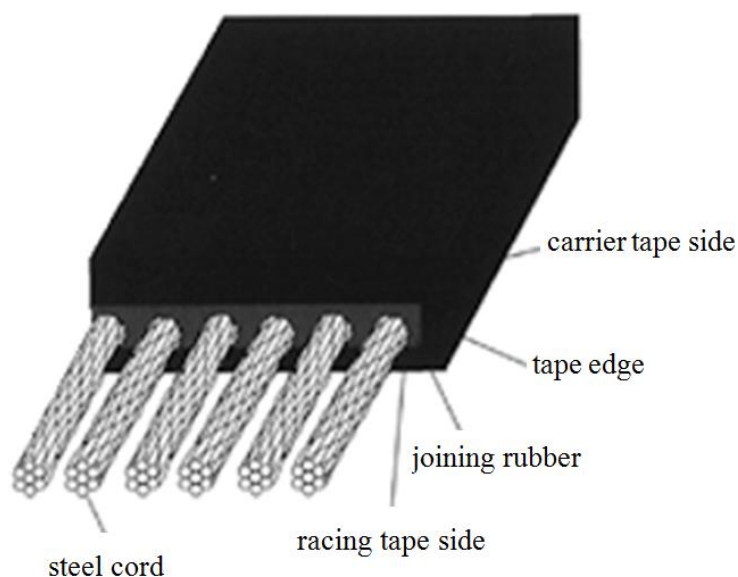


Fig. 7.1. Conveyor belt with steel cords cross - section

Source: Labor.pl 2013

In mines are three types of conveyor belts with a steel cord, depending on the nature of the work. These are tapes of steel cord for different strengths of general purpose where there are no fire hazards. For example, the transport effort to dumping grounds. The second type is

tapes with a steel cord flame retardant for coal transport in conditions of increased fire hazard. The third type is tapes with a steel cord flame-retardant one type is mainly used in underground mines, defined covers are approved by the Central Mining Office. For these tapes is used for standard admission PN-EN ISO 15236-2, which specifies the properties and physico-mechanical parameters. Another type strips are tapes of textile core interleaf. The spacer is technical fabric of a specified strength. Number of inserts used in the construction of tapes increases the strength and load output. Like the tapes of steel cord, cloth tape outside the core fabric has a rubber cover on the side of the carrier and the racing. A typical cross-section shown in Fig. 7.2.

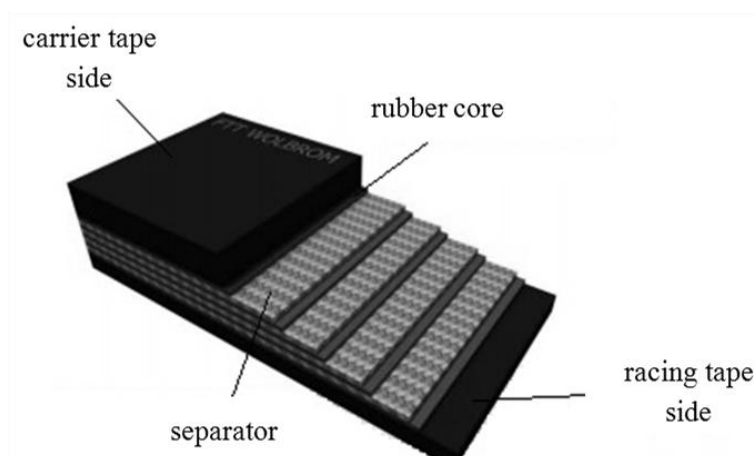


Fig. 7.2. Conveyor tape with fabric core cross - section

Source: ftwolbrom.com.pl

Conveyor belts with textile core mines due to load the tape, where the important thing is the strength of the used polyester-type fabric with the symbol [E], fabrics like polyamide [P] and fabric types of aromatic - aramid symbol [D]. This type of separators guarantees a strength of 2500-3500 kN/m. In order to increase the strength, so-called mixed type or

steel cord fabric with the technical core of tapes, where the tapes have not only high strength but also are resistant to punctures. A completely new solution conveyor belts in the mine are tapes where the core is made of steel wire rope and steel mesh. This type of tape is characterized by high strength, very low elongation, puncture resistance. Cross section of such a tapes shown in Fig. 7.3.

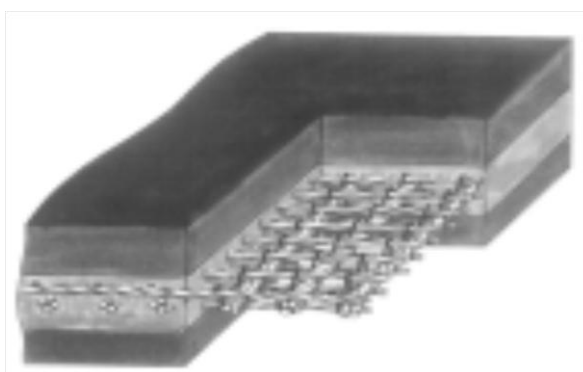


Fig. 7.3. Conveyor belt with steel mesh cross - section

Source: ftwolbrom.com.pl

All conveyor belts working in the mine during the transport of excavated material in the form of coal or effort have different service life and exploitation wear. Wear is defined as a natural or wiping the covers carrier and the racing tapes and wear an emergency caused by any damage to the tape. The third factor is the speed increase which results in an increased number of hinges, thereby causing numerous cracks accelerated wear process. Average use of tapes in the brown coal mine is a period of approximately 8 years. So the cycle of tapes depends on many elements of supplies and movement. Therefore, exploited tapes are evaluated for the possibility of further regeneration (PN-EN ISO 15236-2, BŁAŻEJ R., DOMAŃSKI L., JURDZIAK M., 2010, GŁADYSIEWICZ L., 2014, HARDYGÓRA M., ŻUR T., 1979).

7.2. The conveyor belts repair technology

In the analyzed company regeneration of conveyor belts is performed in the vertical production. The very process of regeneration takes place simultaneously on two production lines. Technological lines consist of milling machines (devices for removing coating tapes), then the tables confectionery where it is repairing tapes, curing presses, where the process of vulcanizing tapes after regeneration. The regeneration process starts with tapes at a working position in the mining industry work conveyor belt. There follows a review of tapes, a visual inspection and measurement of the thickness of the belt. Then decisions are made with reclaimed or disposed of tapes due to the damage, which do not qualify regeneration (extensive damage to the core tapes). After removing the tapes from the conveyor and rolling on special machines - coilers for tapes followed by transport to regeneration in the production hall. Provided tape is folded over the reel, and a process of cleaning, drying tapes, and then milling process by means of special milling head that takes the top rubber layer. Followed by milling of the carrier tape side, and then after turning the page the racing belt (Fig. 7.4). Milling process intended to compensate for wear of tapes coating rubber and the image in parallel to the tape core. This process is repeated along the tapes heads having a width of 150 - 350 mm wide band. After completion of the milling tapes carrier side and the racing side is performed to measure the thickness of tapes and measure the thickness of the cover tapes to the core wire with a multimeter to measure the thickness of the covers type of NGO - 3150K. The principle of operation is based on the reflection of electromagnetic waves from the steel core wire and registration of measuring this distance.



Fig. 7.4. The conveyor belt milling process at the head milling machine
Source: Own interpretation

Such measuring operation is performed on both sides of the belt to check and selection covers plates (Fig. 7.5).



Fig. 7.5. The measurement of the thickness of the covers lines using the apparatus type NGK - 3150K
Source: own interpretation

The choice of the thickness of the carrier plate is made on the basis of the difference in thickness between the actual dimension and the required. Dimension is required for the standard 14mm tapes. Thereafter, the method is the production of plates, meaning the difference between the actual dimension and the thickness from measurements. On the racing site are performed the same actions by choosing the thickness of the plate to the thickness of the actual 7 mm (Fig. 6).

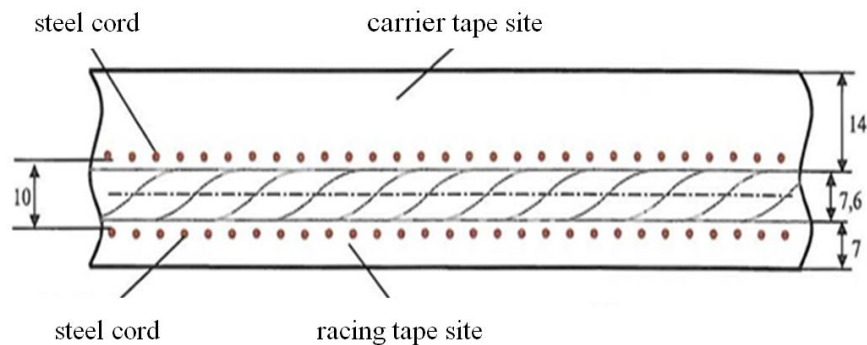


Fig. 7.6. Cross-section of a conveyor belt with a steel core in the form of steel cords

Source: own interpretation

After completion of the milling process of the conveyor belt is made to measure the thickness of the cover carrier and the racing side. After this occurs transporting tape on confection tables. Confection tables are used to repair the tapes after the milling process. Construction of the repair table means that they can repair the support side and at the same time the racing length of 15 m of the tape. The tape is given to the coiler located under the confection table and is pulled over the worktop top and the bottom of the table for repair. At the ends of the table are arranged to slide tapes reels. At the beginning of the upper table and the lower rollers are mounted on plates which are attached calendered to repair the carrier and the racing side. The thickness is set so as to overlap the tape. Plates to

the bearing site points of the upper table and the lower table plate for covering the racing tapes side. The next process after the administration of tapes on the table is a garment repair. Passing the tape is so designed, that is the side supporting the upper table, and the racing side is located on the lower table. Repair is to open cracks and check the condition of cords in the core of the tape. In the case of corrosion of cords they are cut and follows the so-called inset with links not damaged. It is understood as a micro connector. Cutting tapes cracks, mechanical damage, repair damage to the tape core, rebuilding margins of the tape. After completing these steps, followed by filling defects cut rubber compound with special pneumatic extruders. In the case of repairs core tape is used a mixture of core which cause the connection metal - rubber (steel cord - rubber). Used a mixture of repairs are blends that have the same physical - mechanical parameters. Tape cutting defects such as cracks and micro-cracks are executed to reduce the penetration of moisture and water into the core of the tape, because it causes corrosion of the core. After removing the defects in the form of corroded cables, making repairs and filling a mixture of core and cladding tape is the next stage. They are applied to the respective plate thickness prior selection of the thickness on the side of the carrier and the running tape. The carrier tape side is a site which transports the spoil, and is exposed to damage. They also use a thicker layer of the plate. The racing side has a smaller thickness of rubber, as it is in contact with the reel driving and reversing and the entire set of rollers located in the conveyor. Laying rubber slabs calendered with a specific thickness is prepared and repaired along the tape. Due to the width of the tape used in the plate are placed in parallel with each other on a small plant. Then covered with a film knurled to prevent possible sticking of the rubber slabs during coiling after the confection. After the repair, confection tape protects the foil knurled and coiled on the drum. The tape is transported by crane to the reel drive before the vulcanization press. Then, the programming of the vulcanization press on the desktop as a pressure which is approx. 290 bar, a temperature of 140°C, then sealed tape section between the two heating plates of the

press. The length of vulcanization section is 5m and vulcanization time was determined at 45 minutes for the tape thickness 30 mm. Before the vulcanization process, a process of venting in the press, it is an essential aim of downforce plates and rubber seals to eliminate air. Before the start of the vulcanization process in advance match is performed plates and heating to a temperature of approx. 80°C. Are then made withdrawal of the entrance to the press aim pierce any air bubbles enclosed in the packaging of confectionery on the tables. After this occurs re-entry to the press to press and begin the process of vulcanization section of the tape (Fig.7.7). These steps are repeated until the total vulcanizing tape. After the vulcanization is carried out a review of the tape by the quality control and collapse on the reel for the vulcanization press. After receipt by the Quality Control a process of identification marking and transfer to a warehouse for finished products.



Fig. 7.7. Vulcanization of the conveyor belt in the Wagener heating press
Source: own interpretation

7.3. The production system improving of conveyor belts regeneration

The main problem in the regeneration process is too long cooling press cycle after the vulcanization. This reduces the number of times the same work operation, and thus lower the productivity at the same fixed and variable costs. Additional elements is too large number of employees during tapes milling operations. Unjustified and poor work organization on the confectionery tables during the repair tape prior to vulcanization. Waste (SELEJDAK J., KLIMECKA - TATAR D., KNOP K. 2012) resulting from improper workstation ergonomics during the implementation of the tasks arising during the operation to remove the core cord tape and repair joints. The increased number of employees due to the need for additional cleaning operations of the tape after delivery from the mine. On the basis of the carried studies of the conveyor belts regeneration process proposed reducing the employees number on the confectionery tables in the repair tape. Reducing the number of workers introduced tools so-called strippers, which workers activities remove carrier tape site or the racing does not have to perform a duet. Reduced the number of employees milling machines with additional sensor regulates the movement of the regenerated tape during milling operations. Also it proposes to use additional tools in the form of pneumatic grinders and shears to remove the corroded part of the core, which should result in a reduction in the number of employees on the confectionery tables. However, the key solution is to use a new cooling system of heating oil vulcanizing presses. Factor causing the vulcanizing plate heating is heating oil. Currently the vulcanization process tape component together with the venting of the press is 45 - 50 minutes. Whereas the oil cooling process after the vulcanization process takes about 35 - 40 minutes. In the summer time due to high temperatures, this period is extended by about 20 minutes. To eliminate this process, use an automatic refrigeration cycle using a cold flow of heating oil to seek to reduce the cooling cycle to 15 minutes. The current cooler (Fig. 7.8) in the analyzed company has a capacity of 2000

l/h, a new solution WCH500 type (Fig. 7.9) has a 6200 l/h capacity flows through a cycle of the cooling chamber.



Fig. 7.8. Heating oil cooler of vulcanizing presses - present state

Source: own interpretation



Fig. 7.9. Heating oil cooler of vulcanizing presses - future state

Source: own interpretation

Reducing the time of cooling will increase in the number of cycles of the vulcanization process in the press in one shift and, consequently, the monthly productivity will be increased the vulcanization process of the conveyor belt for approx. 50 m.

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