Ways of solving problems of abrasive effects of transported materials on technological lines for raw mineral processing

Jan Fiala¹, Milan Mikolas², Jan Fiala Junior¹, Miroslav Lapka³
¹K Potoku 243, Horoušánky 25082, Czech Republic
²17.listopadu 2172/15, Ostrava – Poruba 708 00, Czech Republic
³Vrbka 31, Postoloprty, 440 01, Czech Republic
j.fiala9@gmail.com

Abstract. The article analyzes systems of transport tracks on technological lines for processing of raw materials on selected quarries of the Czech Republic and the Slovak Republic. It deals with the functionality of the technological equipment in relation to the movement of raw material within these technological lines, it introduces and compares various systems of raw materials transferred to the long-distance transport of raw materials between the technological department softening organizations. It brings different views on how to deal with the negative effects on the lifetime of individual parts of technological units. It deals mainly with the problems of abrasion on raw materials transported and the problems of abrasive influences of fine particles in the process of extraction of individual nodes of the technological line. The article provides possibilities for more efficient maintenance of this equipment, financial savings in subsequent pairs and a view of the application of modern materials such as UHMW-PE, polyurethane, teflon, wear protection rubber. By combining the anti-abrasion protection systems of the technological equipment, significant savings can be made in the maintenance of aggregate processing technology.

1. Introduction

Many plants of mining organizations solve the problems with transfer of treated raw materials between individual stages of the technological line for the extraction of mineral resources.

Some smaller plants deal with insufficient equipment of individual technological parts and larger organizations operating across the Czech Republic solve the insufficient lifetime of used anti-abrasive materials. Our objective is to ensure the safe and, as far as possible, maintenance-free operation of the individual parts for the entire period between individual outages, which are usually planned once a year.

1.1. Part I

Our clients also include one smaller mining company operating on the Czech market, which seeks to resolve the issue of the non-existence of the coarse screen in their technological processing line. The current state is solved by means of a primary vibrating screen, which in ideal conditions tries to sort out the 0/32 fraction and use a conveyor belt with a width of 500 mm to deposit on the intermediate storage from which the material is then transported for final storage unless it is used as a source of profit. A disadvantage of the present state is that all of the recovered raw material passes through the
primary jaw crusher together with smaller fractions that could be sorted before entering the jaw 
crusher. The primary jaw crusher could be much more efficient, less stressed and would not be sealed 
during deteriorated climatic conditions that are more prevalent throughout the year than in other 
regions due to the high altitude. [1]

Our proposal calculates the necessity of incorporating a coarse screen into the technological line 
and we put it as a priority for the given operation. From the technical point of view, the primary jaw 
 crusher is moved about 2 m further from the primary hopper and the primary hopper is raised by about 
1 m. The coarse screener we selected would have a pair of sorting areas to ensure maximum relief of 
the primary jaw crusher. However, this system requires additional assembly of 3 new belt conveyors 
with a conveyor belt width of 500mm. One pair of 7.5 m and 22 m belt conveyors would serves to 
transport the 0/22 fraction to the interim dump and the third 5 m belt conveyor would serve to move 
the raw material from the interspace of coarse screen to the main belt conveyor connecting the primary 
crusher to the primary vibrating screen currently installed to the technological line. The following 
illustration shows our idea of how to solve the problem (Figure 1) Visualization of integration of 
integrated roughing sorter into the technology line

![Figure 1. Visualization of integration of integrated roughing sorter into the technology line](image)

1.2. Part II
Larger mining companies solves the problems of abrasion and sticking of transporting materials 
intended for processing on technological lines. This is mainly due to the much higher output of 
production and the fact that the individual parts of the technological line are relatively well and 
technologically solved.

Our intention is to increase the service life of individual parts of the technological line with regard 
to the transport of raw materials. In the first phase, these are belt conveyors, chutes, other
technological equipment. In the second phase, the systems for extracting fine dust particles from the transported raw material - one aspect is purely ecological and the other focuses on the quality of the final product.

2. First phase

2.1. Utilization of abrasion-resistant materials in the area of belt transport and associated equipment

Impact energy absorbing materials and increased abrasion resistance are the subjects of our investigation. These materials can be classified into 3 groups: NR/BR (rubber), PU (polyurethane), PE (polyethylene), PTFE (teflon).

We use the rubbers according to their technical properties determined mainly by their abrasion resistance. The second parameter is the hardness.

Wear Protection Rubbers with an abrasion value of more than 120 mm³ at 10N are suitable for direct contact with the conveyor belt surface and provide a long-lasting 100% seal when these skirt rubbers are used. In the case of direct and long-term contact with the rubber cover of the conveyor belt, it will not damage it. Many of our customers use old conveyor belts for this using with the idea of saving money for the purchase of quality rubber, but do not solve the damage to the conveyor belt when the rubber cover layer and the textile plies are abraded and the belt separates at the contact points. The cost of purchasing a new conveyor belt and replacing the old belt by the service company exceeds the value of buying high quality skirting rubbers.

Wear Protection Rubbers with an abrasion value of less than 90 mm³ at 10N are intended primarily as an anti-abrasive protection for machinery and chutes on a technological lines. For quarries, mainly wear protection rubbers with a hardness of around 60 ° ShA, for sand mining with a hardness of around 40 ° ShA, are intended. Most of the wear protection rubbers of these properties are provided on the underside with a contact layer intended for application by adhesives. The use of these rubbers can be found on vibrating screens, vibrating feeders, log washers, dewatering wheels, piping systems (water, air) and many others. The advantage of using these rubbers is the quick reparability of worn parts and easy handling. If we treat impact spaces and chutes, there is no need to replace heavy hardox and steel plates and the associated heavy physical work. In most cases, the lifetime of the treated areas is also extended to up to 2 times the life of the original steel plates with the same thickness. In addition, the system for repairing rubber lining will also allow local repairs of worn out areas and no need to replace entire areas. At the same time, rubber coating also serves as corrosion protection. Another great advantage is the reduction of noise.

PU (polyurethane) has the great advantage that we can make any shape and determine the properties of polyurethane. According to our design, we choose color, hardness and abrasion resistance. Hardness ranges from 60ShA to 95ShA, rubber is better in this respect. However, the abrasion resistance can be in the range of 60 mm 3 to 15 mm 3 at 10 N, which the rubber cannot achieve. Thanks to these properties, we are able to increase the lifetime of abrasion-resistant elements made of PU up to three times the lifetime of the same elements made of wear protection rubbers. Typical use is in the protection of chutes between belt conveyors or other equipment on the technological line (example of protection of the inner shutter in vibrating screen, etc.)

PE (polyethylene) uses the UHMW-PE form in the mining and energy industries. These are sheets of varying thickness, color, sizes. It has excellent abrasion-resistant properties and is suitable for use in large quantities. An example is the lining of underground coal storage and their chutes in the energy industry, where UHMW-PE is used with antistatic properties. The sheets are assembled by means of a screw connection. The disadvantage is wrong formability, so they are mainly used on flat surfaces. Basic types include PE1000 and PE8000. PE1000 is more resistant to impact, while PE8000 has better
anti-abrasive properties. The types of PE-sheets for a specific purpose are usually already mentioned in the technical documents of the equipment.

PTFE (Teflon) is mainly used in plants that work with large quantities of fine particles and which are prone to sticking. Teflon designed for lining of chutes provides excellent sliding properties, but is not applicable to abrasive raw materials.

2.2. The use of scraping technology in the area of belt transport

Scraping technology is extremely important for belt conveyor operation. In 90% of cases, the technological line cannot be operated without this equipment. The fine particles of the transported raw material remain adhered to the conveyor belt and gradually fall off the entire length of the conveyor, causing heavy contamination under the conveyor and destroying the lower conveyor rollers and disrupting the anti-corrosion protection of the conveyor structure. [2]

Basic classification of scrapers:

- According to the material used for scraping: carbide, polyurethane
- According to the type of tensioning: flexible (torsional or spring tensioners), fixed (screw tensioners use on reverting conveyor belts)
- According to the location: precleaner scrapers (directly on a drum), main scrapers (under the drum)
- According to the type of conveyor belt: Scrapers for straight conveyor belts, scrapers for profile conveyor belts

Each scraper must be carefully selected for the specific application with regard to the material being transported and with regard to the mounting location. Wrong selection will lead to malfunctioning of the entire conveyor system or inefficiency in terms of lifetime of the individual scraping elements. For sands and fine-grained materials, we choose carbide scraper’s blades, polyurethane scraper’s blades for clay and many sticky materials. The ideal combination is a pair of scrapers - the scraper on the drum, the main scraper under the drum. These combinations are suitable for coal power plants and mines. The choice of scraping technology is ideal to leave to specialized companies that guarantee the smooth operation of this equipment and provide quality and fast service in case of failure.

2.3. The use of centering technology in the area of belt transport

Centering technology is key to running and protecting the conveyor belts. The technological lines should be equipped with these accessories. If the conveyor belt runs out of its track, the conveyor belt itself may be damaged, the steel structure may be damaged due to friction between the conveyor belt and supporting steel construction and last but not least the problem of transporting the raw material, which may cause secondary damage to the conveyor belt accessories.

The centering technology can be divided into passive and active. The passive elements include belt guide rollers with the function of keeping the conveyor belt in the track. I like using the belt guide rollers with PU body. Active elements are centering stations located on the top or bottom of the conveyor, for example the Trac-Roller UP on the top side and the Trac-Roller RE on the bottom side. Both accessories for conveyors can move the conveyor belt to the designated track. For the right operation of these accessories is necessary to select a sufficient number of centering units on a particular conveyor belt (Figure 2) Centering technology for conveyor belts. [3]
3. **Second phase**

3.1. **Use of abrasion resistant materials in the area of exhaust of fine dust particles in quarries**

The pipelines, which provide for the removal of fine dust particles on the quarry production lines, are very often over-stressed by high airspeeds and excessive quantity of dust particles. This leads to a damage of the individual steel parts of the pipeline and the costs associated with replacing these parts are very high. Therefore, a few years ago, we started with an application of internal rubber lining of exposed places. Above all, there are pipe arcs where abrasion is the biggest problem. Due to the shape of the arcs, we use to wear protection rubbers or polyurethanes. The advantages and disadvantages of each material are already described in this article. In most cases, we use rubber as an anti-abrasive protection that is interesting in economic terms. However, when treating pipes, that we know to be excessively exposed, we use polyurethane, which has a significantly lower abrasion value and has better sliding properties. This will increase the lifetime of the internal surface to 3-4 times opposite the rubber. A disadvantage is the cost of these products and the associated limited application possibilities. This method of protection pipelines is primarily used by EUROVIA kamenolomy, a.s. and Českomoravský štěrk, a.s. in the Czech Republic. [4]

4. **Conclusion**

In conclusion, we would like to thank the organizations whose operating technologies we could test for possible system solutions to the individual issues of transporting the mined raw materials, and through which we can further explore this issue and try to find more ways to bring these solutions closer to other mining organizations.

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