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POSSIBILITIES FOR ENVIRONMENTAL PROTECTION APPLICATION OF BELT CONVEYORS WITH HORIZONTAL CURVES IN THE MINES OF COAL

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Abstract:
The paper deals with application of conveyor belt that is placed with a horizontal curves, in order to avoid a number of transportation units during transport waste from the pit to the dump. Reducing the number of carriers reduces the vulnerability of the environment of increased dust and increases system reliability.

1. Introduction

The atmosphere pollution due to dustiness represents the greatest harmfulness which occurs in transporting mineral raw materials by belt conveyors. Such harmfulness is reduced along the conveyor route by introducing mechanical protection of the environment from the contact with the material on the conveyor, by wetting the transported load, by creating artificial barriers in order to mitigate the effect of wind etc.

The largest sources of atmosphere pollution in the transportation by continuous conveyor systems are loading/unloading points. Air protection from dust pollution, which is thereby generated, is achieved using the wet or dry procedure. Nevertheless, the best results can be achieved by a preventive action, i.e. by reducing and eliminating the source of pollution.

The objective of this paper is to indicate the advantages of reducing the number of unloading points on belt conveyor systems in coal mines. On that occasion, initial results of the analysis, in respect f possibilities for applying these solutions in Serbian coal mines, were also presented.

2. Possibilities of applying curvilinear belt conveyors

In order to solve, or mitigate, the issue of reliability of conveyance systems and to improve the level of the environmental protection on those, a preliminary analysis was carried out in respect of reducing the number of conveyors in coal mines. Thereat, the economic capacity of a mine was taken into account, i.e. the possibilities to invest in the modernization of conveyance systems.

Open-cast coal mines in Serbia are distinctive by a great number of belt conveyors. In 7 open-cast coal mines, the production amounting to about 35 million tons of coal and 82 million tons of tailings is transported by 108 conveyors with total length of about 95 km. The average number of transporting units in a system is approximately 4.7. Such a large number of conveyors with average lengths lower than 1000m indicate that there are prerequisites for the rationalization of the number of conveyors by introducing long conveyors with horizontal bends.

Underground coal mines in Serbia pertain to the group of small mines, but it is typical for them that they have a large number of transporting units in the system. In 8 coal mines there are on the average 46 belt conveyors, on broken conveyance routes, with an average length of 240m.

An unsuitable terrain is often the reason for setting up a large number of conveyors, linearly arranged, which may have the following negative effects:

- More power stations are needed which requires higher investments, a more complex power supply system and a more complicated organization of maintenance,

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- More operators of power stations and more surveillance and maintenance employees are needed,
- The reliability and throughput of a conveyance system is reduced due to a larger number of transporting units,
- Environmental pollution is higher, especially at loading/unloading points, due to the spillage of material and dust generation, etc.

If PS_{sv} is the throughput of a conveyance system from n conveyors, k_{bri} mathematical coefficient of the time usage of each conveyor, then the mathematical throughput of single-conveyor system in bends PS_{sk} will be:

$$PS_{sk} = \frac{1}{\prod_{i=1}^{n} k_{bri}} \cdot PS_{sv} \tag{1}$$

If there are n conveyors in a conveyance system, with same capacity and same throughputs the above formula may be written as follows:

$$PS_{sk} = \frac{1}{k_{bri}^{n}} \cdot PS_{sv} \tag{2}$$

From the environmental protection point of view, the reduction in the number of conveyors has the following advantages:

- The environmental pollution is reduced at loading/unloading points,
- The perturbation of the appearance of the environment due to the construction of power plants for the start-up of a number of conveyors,
- By-passing of populated places and protected environments,
- The contact of load with the atmosphere is reduced etc.

One of the most acceptable solutions for the reduction of harmful consequences of the existence of a number of conveyors in the system is the application of curvilinear belt conveyors The application of these conveyors would bring in the following advantages:

- Enhancement of the reliability of a conveyance system
- Decrease in the power consumption in comparison to a multi-conveyor system,
- Reduction of needs for manpower,
- Reduction of power plants along the route,
- Bypassing natural and artificial barriers without loading/unloading points
- Reduction of specific costs of conveyance etc.

In addition to the indisputable advantages of applying curvilinear belt conveyors systems, this method of conveyance has also the following weaknesses:

- Very precise identification of the parameters in designing and constructing the conveyors,
- Increased surveillance and maintenance
- Investment in a higher level of automation,
- Higher initial investments in means of conveyance etc.

The analysis of the possibilities of applying curvilinear belt conveyors involved 4 open-cast coal mines, 4 underground coal mines and 5 largest open-pit clay mines. In addition, only conveyance systems passing outside the limits of the pits themselves were analyzed on this occasion (main and external conveyance systems) with 18 conveyors. A typical layout of the system where curvilinear belt conveyors may be introduced is given in Fig. 1.

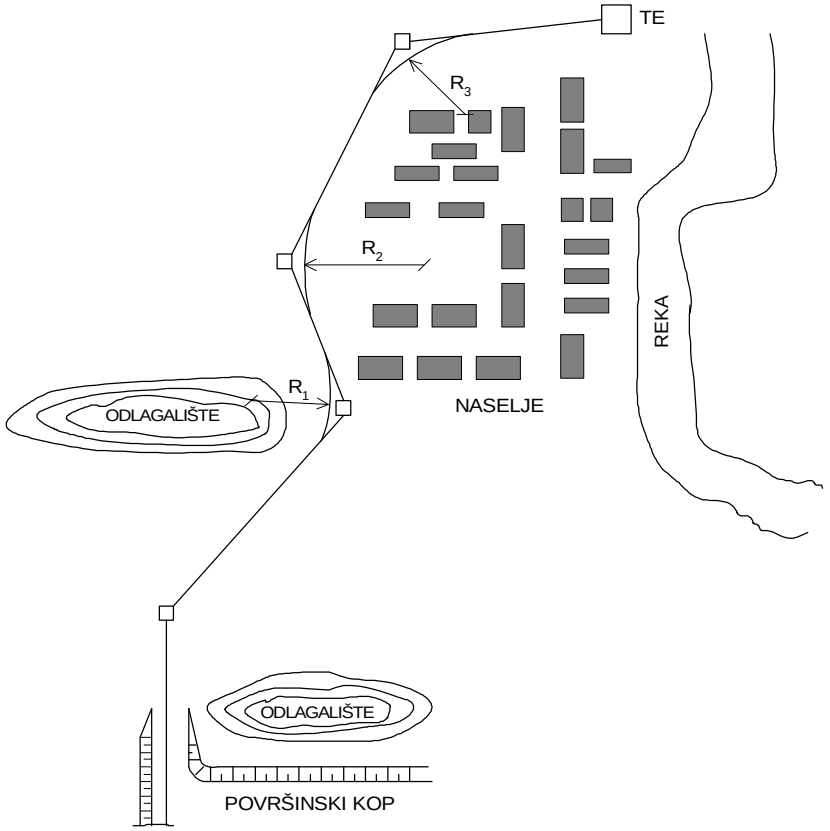

Fig. 1 *Diagram of possibilities for applying horizontal bend conveyors for the transportation of coal from an open-pit mine to the power plant*

In underground coal mines, the application of curvilinear belt conveyors is limited by the existence of already constructed underground mining workings. However, in the reconstruction of conveyance systems in underground coal mines, it is necessary to consider reconstructions of underground workings too. Introducing bend conveyors leads to increasing the investments in conveyors, but costs of maintenance of underground workings and manpower are reduced.

To install curvilinear belt conveyors in conditions of underground mining, to begin with, it is necessary to carry out certain mining operations in order to adjust the crossings or deviations to the construction of the curvature (Fig. 2). The scope of these operations depends on the length of the curve arc and on the deviation angle θ.

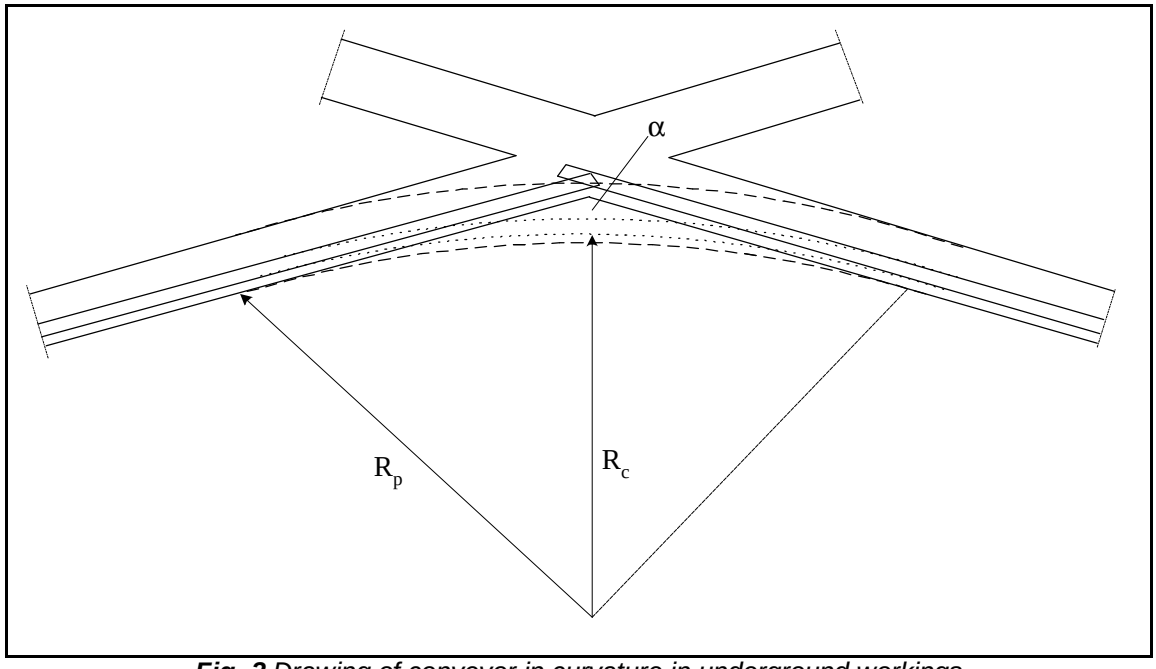

Fig. 2 *Drawing of conveyor in curvature in underground workings*

The level of investments for the installation of one curvature may be determined applying the following expression:

$$I_k = R_c \cdot \pi \left(1 - \frac{\alpha}{180} \right) \left(I_p + I_t + I_{at} \right) \quad (3)$$

where:
α -the angle made by two conveyors,
I_p-the investments made in mining operation in order to adapt the underground workings,
I_t-the investments made for the construction of curvilinear conveyors,
I_{at}-the investment made for the adaptation of the new conveyor.

By comparing the specific transportation costs before and after the installation of curvilinear belt conveyors it is possible to estimate if such an activity is economically justified.

After analyzing the current situation in coal mines, and on the basis of previous consideration, it may be stated that there are real conditions to install 6 curvilinear belt conveyors in main transportation spaces. The curve radius ranges from 650 to 1300 m which secures a stable operation of the system. Deviation angles do not exceed 12° while the length of curve arc ranges from 57 to 228 m.

In addition to coal mines, some conveyance systems in open-pit clay mines were also analyzed. The Fig. 3 shows the diagram of possible clay haulage by curvilinear belt conveyors from the open-pit mine to the tile factory in Kanjiža.

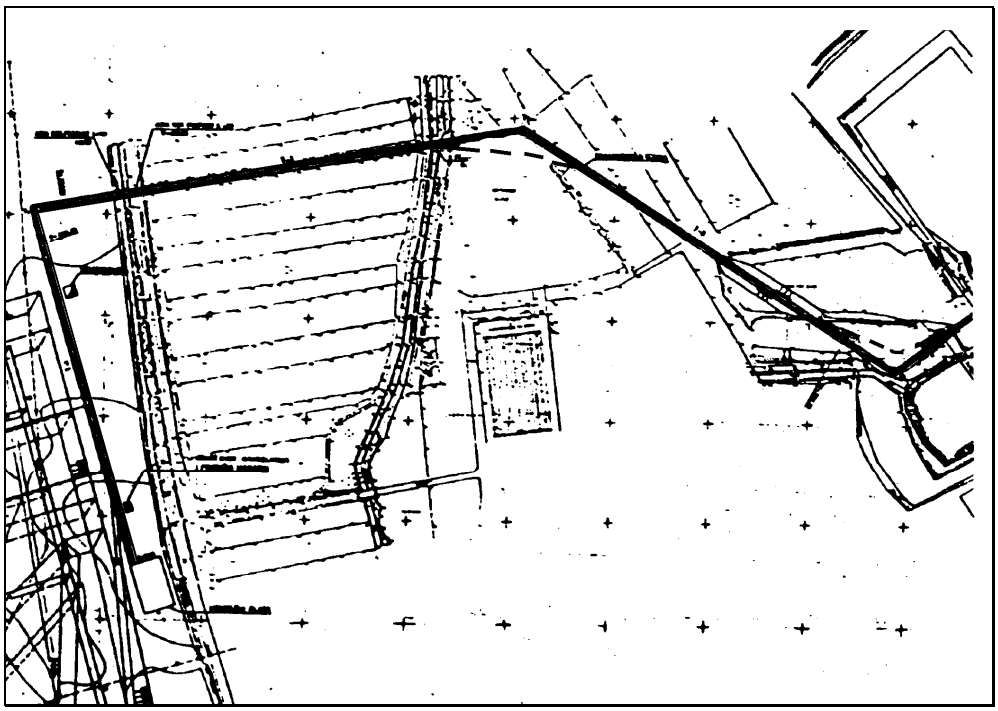

Fig. 3 *The possibilities of applying curvilinear belt conveyors in clay haulage*

The environmental protection in haulage systems with a number of belt conveyors is significantly enhanced if curvilinear belt conveyors are applied. The expenses for reducing dustiness at loading/unloading points proportionally decrease as the number of reloading points decreases. Other advantages have also positive impact on the efficiency, reliability and, on long-term basis, the cost-effectiveness of the conveyance.

3. Conclusion

The existence of a large number of conveyors in the transportation of coal and other mineral raw materials has quite a number of noxious consequences, which influence on the reliability, effectiveness of the operation and on the environmental pollution. Introducing curvilinear belt conveyors reduces the number of loading/unloading points and enhances many parameters of the conveyance system, especially those related to the environment. However, the installation of this type

of conveyors requires a more comprehensive analysis and the proper selection of all parameters of conveyance.

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