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# OPTIMIZATION OF TRANSPORT AT DEEP COAL MINES

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## ABSTRACT
*Optimization of underground mining transport enables the growth of productivity, profitability and others economic parameters of mine company production. It enables also save electric energy, materials and to improve machinery service life. The main aim of the run transport operative control is then ensuring the greatest continuity of the haulage as possible with minimization of idle time, especially the non-technological ones, and minimization of cost. The paper presents basic principles of these profits, namely the rationalization of belt conveyer automated control systems and the system of coal valorization in a way of selective haulage and homogenisation.*
**Keywords:** underground transport, optimization, simulation models

## 1. INTRODUCTION
The deep coal mine transport system ensures horizontal (section and central) transport and vertical transport by skip hoist system. Horizontal transport ensuring haulage of mined coal may be implemented using belt conveyers lines or underground locomotive transport. Another transport at deep coal mine is reverse transport - transport of materials and mine equipment to individual mine positions. Transport at deep coal mines has to ensure the perfect compliance among the all components of the haulage process. The increasing demands on underground transport lead often to critical states. The main aim of the run transport operative control is then ensuring the greatest continuity of the haulage as possible with minimization of idle time, especially the non-technological ones, and minimization of costs. There are four ways how to optimize the transport at deep coal mines:

- using rationalization of automated tandem conveyer control systems,
- operative control of material transport to working places per simulation models [1 ],
- operative control of locomotive coal haulage by means of simulation models and projecting programs of the underground railway systems [2 ],
- using effective valorization of mined coal in a way of selective haulage and homogenization.

## 2. AUTOMATION OF HAULAGE SYSTEMS AT UNDERGROUND MINE
The automation of haulage system for the deep coal mines deals with the problems of tandem conveyors automation, automated haulage system of coal per underground locomotive transport, vertical transportation and the systems of rationalization of automated conveyer lines. On the figure 1 is shown an example of the typical coal haulage system in a deep mine in OKD district. Here the longwall faces are market by the letters c.f. and roadway headings by the abbreviation r.h. The coal

from working places is transported to coal bunkers by the network of belt conveyer lines. Underground coal bunker No.5 is interconnected with bunker No.3 by the railway transport.

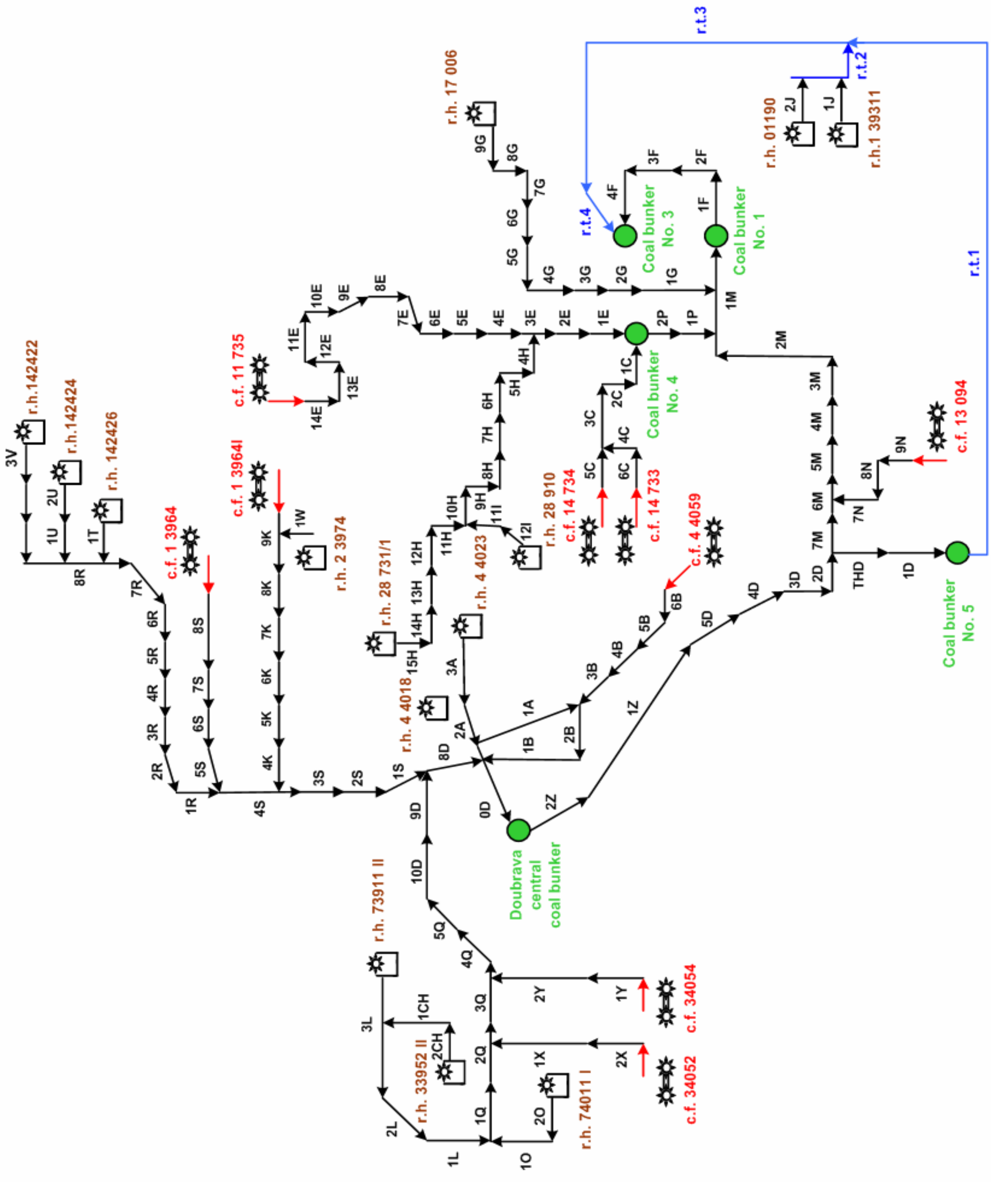


*Figure 1. An example of haulage system at deep coal mine*

## 2.1. Rationalization of automated tandem conveyer control systems

This deals with a higher level in the automated control of conveyers lines. The systems enable the saving of energy (electrical and respectively pneumatic), and also of conveyor materials. At the same time they increase the service live of conveyers and their drives. If for some reason the stope or face can not be mined, then the conveyer line is not in operation. If stopes and faces are then prepared for repeated activity, the conveyors are put into operation either automatically, or through remote control from the stope or face, respectively. The automatic start – up of conveyors is derived from the sensor information from the shearer or another machinery. This signal is transferred by help of transfer equipment on evaluating equipment, which controls an electrical pneumatic valve enabling the supply of the first conveyor in tandem. In OKR coal district a number of these rationalization systems were developed.

## 3. PROCESS OF THE COAL PRODUCED VALORIZATION

The process of the optimum mined coal valorization in a selective way or by homogenization follows from the basic condition of the contemporaneous occurrence coal seams existence. These coal seams have significantly different qualitative parameters (calorific value, ash content, volatile matters content, sulfur content, capability for cooking, etc.). Further basic presupposition for the valorization of mined coal is the existence of underground coal bunkers in the coal fields enabling the homogenization of different types of the coal blends, which correspond with various classification classes. These all background processes have to be solved as a complex and the whole process of the coal produced valorization has to be managed. The implementation of simulation models on computer and the possibility variants testing for the purpose of optimization and prediction are then the base for the management system. On the figure 2 is depicted the classification of hard coal from the viewpoint of its possible utilization for coking purposes.

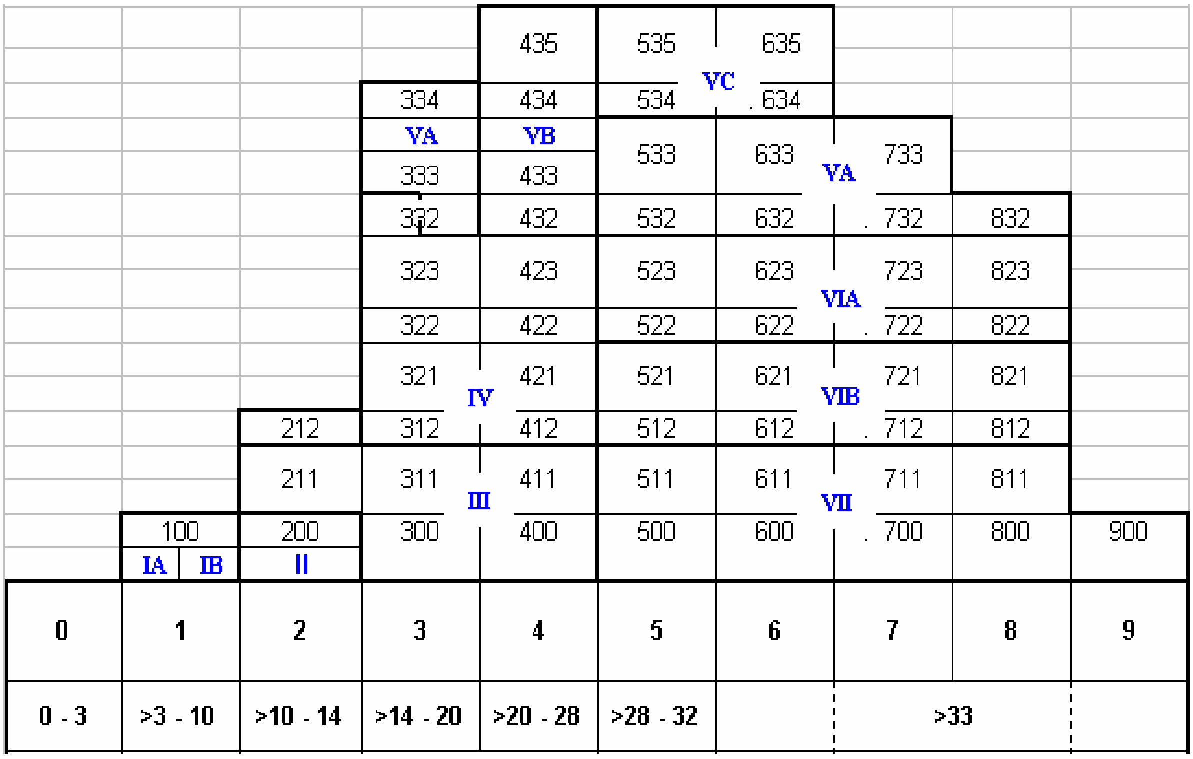


*Figure 2. Hard coal trade groups classification.*

Here, the coal is divided into the classes expressed by code numbers from 100 up to 900. The first code digit (degree of coalification) expresses the coal classification according to the percent of volatile inflammable matter in dry substance and is given in the lower part of the figure 2.

The second code digit determines the baking characteristics of coal, which is presented in the table 1.

*Table 1. Baking characteristic of coal.*

| **Coal characteristics** | Strongly baking | Medium baking | Weakly baking | Non-baking |
|---|---|---|---|---|
| **Swelling index** | 4.5 - 9 | 2.5 - 4 | 1 - 2 | 0 – 0.5 |
| **2$^{nd}$ code digit** | 3 | 2 | 1 | 0 |

The third code digit expresses the coking characteristics of coal, from very weakly coking one up to the excessively coking (see table 2).

*Table 2. Coking characteristic of coal*

| **Coal characteristics** | Excessively coking | Well coking | Medium coking | Weakly coking | Very weakly coking |
|---|---|---|---|---|---|
| **Dilation** | > 140 | > 50 - 140 | 0 - 50 | < 0 | none |
| **3rd code digit** | 5 | 4 | 3 | 2 | 1 |

On the basis of these given coal characteristics the trade groups were created, which are identified by the Roman digits from I up to VIII and the subgroups are identified with letters A, B, C and D.

### 3.1. The optimization criterion

The optimization criterion is the maximum profit: **P → max,** from the coal sale and has to respect the binding limits as: ensuring of sufficient space for mining from the longwall coal faces and ensuring the sufficient coal reserve in the underground coal bunkers so that the continuity of the coal preparation plant would not be impaired.

### 3.2. An example of grater valorization

The greater valorization of the mined coal by the methods of selective mining and homogenization is given on the following example. If a mine, for example, produces the coal of three trade groups as: V, VI and VII, then it is disadvantageous to sell the coal in the trade group number VII. One of the variants of more effective valorization of the mined coal is to haul the coal seams with significantly different qualitative parameters and to homogenize the rest of the coal mined. For instance, to haul the coal of higher trade group from a deep mine in a selective way and to concentrate it for the possibility to valorization in the more expensive price group.

### 3.3. Simulation models

Simulation models implemented on a computer represent a fundamental research area in solution of the whole problems. To resolve this task efficiently it is necessary to use the methodology of computer models creation with subsequent simulation of alternatives for comprehensive optimization of deep coal mine transport system design [3]. Development of simulation models has to be based on analyses of particular transport conditions in given mine, mathematic formalization and implementation of computer models using a suitable simulation program [1,2,3]. The simulation itself shall use the optimization methods for efficient transport system design in order to reach the best economic parameters of the mining company possible.

## 4. CONCLUSION

The deep mine transport system represents the most problematic element of the management. It has to ensure the complete harmony between mining and on the other hand coal preparation. Every cost-saving organizational arrangement is beneficial at the present time, when mining companies encounter a pressure to reduce costs (energy and materials) and increase profits due to competition. Owing to the fact that the transport is a fundamental element of the mine management, each progressive provision will prove advantageous to even bigger extent. Optimization of the transport logistics management will bring significant economic contributions for every mining company.

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