XXIII Conference of PhD Students and Young Scientists

Interdisciplinary topics in Mining, Geology and Geomatics

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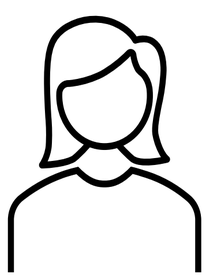
Assessment of energy efficiency of belt conveyors working in open pit mine



Natalia Suchorab-Matuszewska[1] **Piotr Bortnowski[1]** **Maksymilian Ozdoba[1]**

[1] Faculty of Geoengineering, Mining and Geology, Wrocław University of Science and Technology, Wyb. Wyspiańskiego 27, 50-370 Wrocław, Poland

Energy efficiency

Estimates indicate that the energy consumption of the mining industry is slightly more than 6% of the total energy produced in the world, of which 24\% is consumed by transport [1]. One of the most popular methods of transportation are belt conveyors (BCs) which are widely used for bulk material handling in the raw material industry. Although being considered the most efficient and economical means of transport they still consume significant amounts of energy [2,3]. Thus, there is a clear necessity of belt conveyors' energy performance improvement. Based on [4] energy efficient initiatives are divided into four components: equipment, operation, technology, and performance.

Contemporary solutions devoted to increasing the efficiency of the belt conveyor transportation process and lowering its energy use concern mainly equipment, technology and operation levels [5]. It means that there is still a space to consider the performance level of energy efficiency, that means to develop tools which can be useful for describing and assesing the energy efficiency.

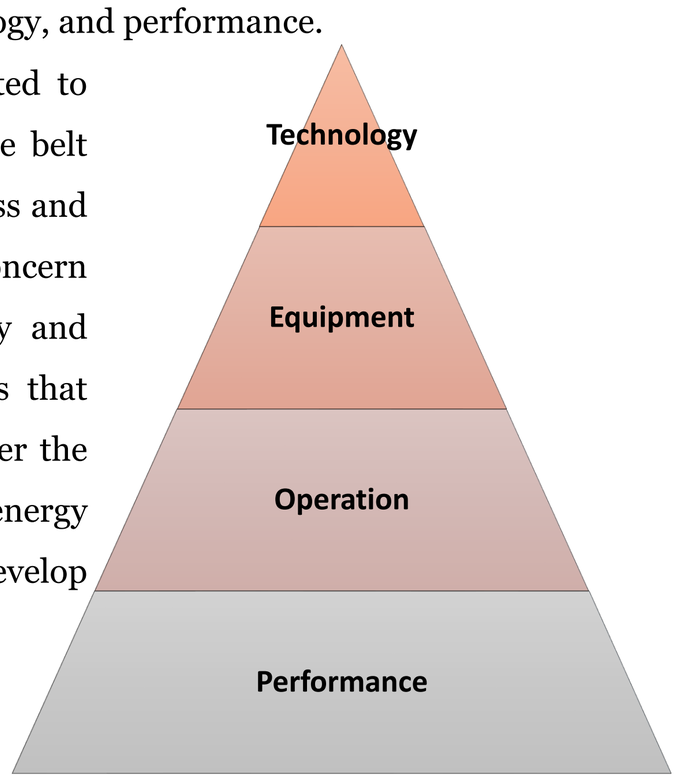


Figure 1. POET prespective of energy efficiency of belt conveyors

Specific Energy Consumption (SEC)

The indicator that can describe the energy performance of belt conveyors is named as speciefic energy consumption (SEC). SEC values describes how much energy is needed to transport 1 kg of material over 1 km during 1 s.

$$SEC = \frac{RTM}{\sum M \cdot \eta}, \frac{N}{kg}$$

$$SEC = \frac{N}{M_s \cdot L}, \frac{W \cdot s}{kg \cdot m}$$

- Capacity of BC
- Velocity of belt
- Length and Inclination angle
- Parameters of BC's elements

M_s – actual mass capacity, $\frac{kg}{s}$,
N – electric power of the drive delivered to the conveyor, W
L – length of the conveyor route, m
RTM – motion resistances, N
$\sum M$ – total mass of the transported bulk material, kg
η – drive unit efficiency, -

Data analysis

Using Monte Carlo simulation, data that represents different working states of belt conveyors and their energy efficiency was generated. Then based on the quartiles value of specific energy consumption indictator, dataset was divided into energy efficiency classes (A-F). That values were treated as reference values for specific classes. Finally, the real dataset was classified with the use od referenced value (Fig. 2). Eventually, it was possible to chek how long specific belt conveyor worked in a specific energy class (Fig. 3).

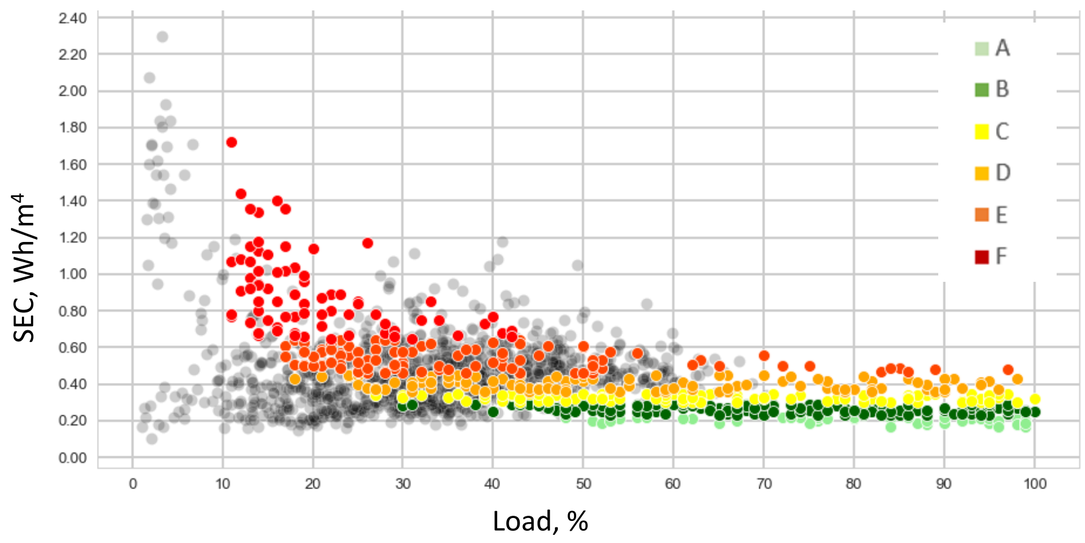


Figure 2. The relationship between specific energy consumption and load, where points in grey color show simulated data and colored points represent classified real dataset.

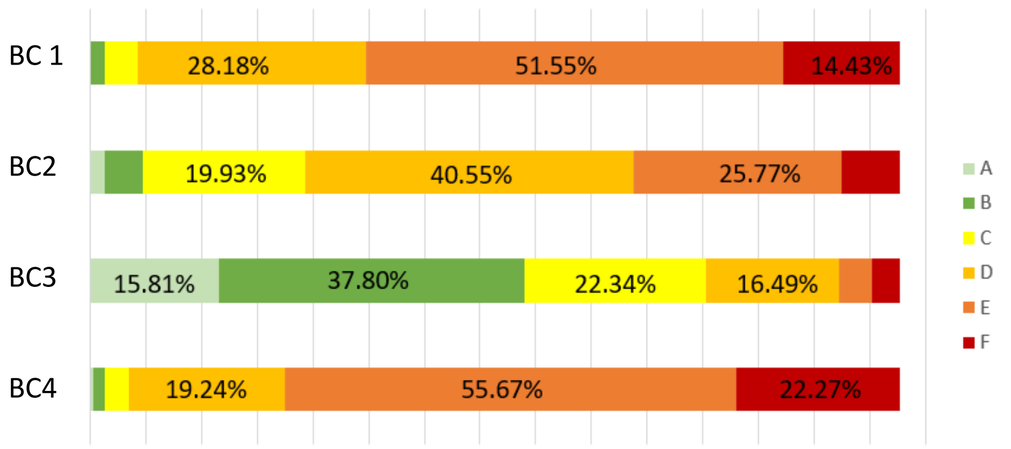


Figure 3. Percentage share of energy efficiency classes in the total belt conveyors' operating time

Conclusions

- Multiple-directional analyses of conveyor performance were carried out in the transportation system, indicating significant variations in their energy efficiency.
- For the arbitrarily selected range of efficient conveyor performance (25% - 75%) and calculated energy efficiency indicators (SEC), limits of energy efficiency classes (A - F) were established.
- The recorded operational results of the analyzed transportation system's conveyors were assigned to the created energy efficiency classes.
- The introduced classification of conveyor performance allows for distinguishing between less and more efficient objects, facilitating the identification of reasons for lower efficiency in specific cases.

Literature

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