ENERGY SAVING SOLUTIONS FOR BELT CONVEYORS IN LIGNITE SURFACE MINES

Ryszard BLAZEJ, Leszek JURDZIAK, Witold KAWALEC
Institute of Mining Eng., Wroclaw University of Technology, Na Grobli 15, 50-421 Wroclaw, Poland
ryszard.blazej@pwr.wroc.pl, witold.kawalec@pwr.wroc.pl

(1) Overview

Electric energy is consumed in large quantities by the power generation industry, especially in several mid-European countries where energy generated by lignite fuelled power plants contributes a substantial share of the total energy production. Savings of the energy consumption demanded by the EU (known as the "3 x 20" package) require significant improvements also in the industry that produces electric energy.

Continuous surface mining systems that are widely employed in lignite mines in Europe have utilized large belt conveyor transportation systems (the total length of belt conveyor routes in four operating Polish lignite mines exceeds some 260 kilometers) , which can consume up to some 40% of the total amount of electric energy needed for main mining operations: digging, transporting and overburden spreading. Though the biggest mining costs savings can only be achieved as a result of an optimized mine planning and pit design implemented by qualified mining engineers responsible on the whole process of designing the new mine since its pre-feasibility study to the detailed plans of pit advancing, the advantages of the modernized machinery equipment should not be neglected.

For high capacity belt conveyors used in lignite surface mines the combined idler rotational resistance and the indentation resistance (caused by the interaction between idlers and a running belt) share up to 70% of the total resistance force of a belt conveyor, therefore the biggest energy savings are expected there. These savings can be obtained as a result of implementation of new materials, improved belt conveyor equipment selection and more precise dimensioning of conveyor units with regard to modern maintenance methods.

(2) Methods

The energy saving solutions proposed for high capacity belt conveyors used in lignite surface mines, focused on decreasing the idler rotational resistance and the indentation resistance of a belt on idlers can be achieved due to:

- careful selection of a conveyor belt, with special regard to rubber mix parameters, chosen individually for the planned operational conditions at the users' site,
- new generation of modernized idlers with significantly reduced rotational resistance to motion,
- optimised dimensioning of conveyor elements (especially drive units and conveyor belt) which requires the use of advanced, computer assisted design tools.

Optimisation of the belt conveyor equipment selection and design is based upon the well proven algorithms of calculating the main resistance force components. In the Institute of Mining Engineering of the Wroclaw University of Technology theoretical and experimental (done both in the laboratory and in-situ) investigations in the field of belt conveyors main resistances to motion have been carried out for many years. The main resistance to motion components are calculated on the basis of the analysis of the energy dissipation processes in a conveyor belt and in the material load stream and the analysis of the interaction between the belt and idlers. These processes depend on a large set of technical, physical and operational data of a belt, transported bulk material, design characteristics of a conveyor and the terms of use of the conveyor (Gladysiewicz & Hardygora & Kawalec 2009).

For the exact calculations of belt conveyors the following assumptions can be done:

1. The rotational resistance to motion of idlers depends on temperature and (which is usually neglected) their radial loading (see fig.1) – the idler spacing can be adjusted to the expected operational capacity of a conveyor,
2. The belt safety factor used for setting the required belt strength is rather conservative due to the uncertainty of the actual strength of running belt and its joints; however, the use of recently developed diagnostic system allow to monitor the actual condition of a belt in order to check whether the required strength has been maintained (see fig.2),
3. The operating power requirement of a belt conveyor working in a surface lignite mine should be calculated according to the maximum averaged – not instantaneous maximum capacity of an excavator, averaged on the period of time necessary for loading the whole conveyor (see fig.3).

(3) Results

The exact results of energy savings can only be computed with regard to actual operating parameters of a given belt conveyor transporting lignite or overburden in a given location in a transportation system in a surface lignite mine. On the following figures the results of laboratory measurements (fig.1), developed belt condition diagnostic system (fig.2) and the results of the analysis of computation the required drive power of a given lignite belt conveyor (fig.3) have been presented.

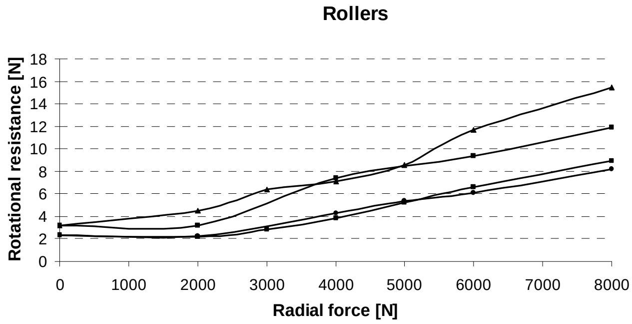

Fig. 1: Rotational resistance of rollers as a function of their radial loading (Bukowski et al. 2010)

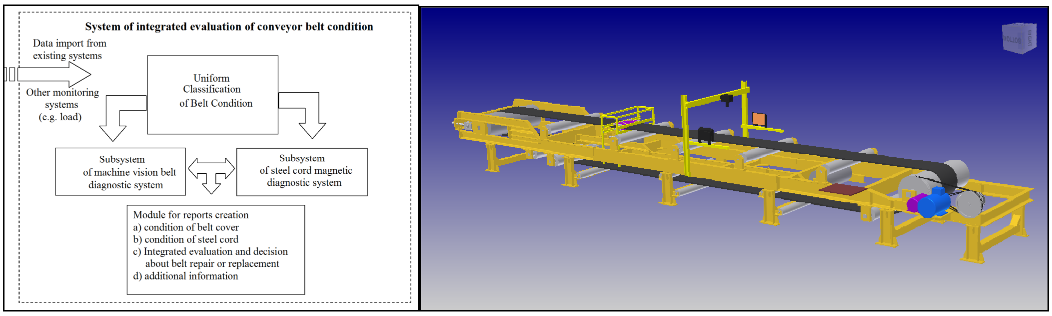

Fig. 2: Left: Integrated belt condition diagnostic system utilising information from magnetic and machine vision subsystems. Right: Special testing belt conveyor (Blazej & Jurdziak 2011)

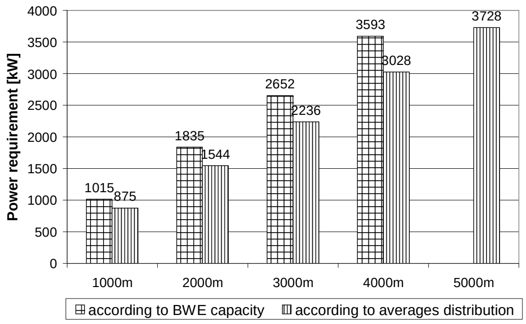

Fig. 3: The differences of required drive power between the standard driving force calculation (full bucket-wheel-excavator capacity) versus 97.5% quantile of averaged maximums (computed upon the recorded distribution of actual volume capacity of the BWE) (Gladysiewicz & Kawalec 2006)

(4) Conclusions

Belt conveyors used in surface lignite mines are strongly oversized and the combined implementation of available developments in the field of the use of new materials (belts), improved conveyor equipment assembling technology (idlers), accurate dimensioning of conveyor elements as well as optimization of chosen belt conveyor parameters (belt strength, idler spacing, belt troughing angle, main drive units installed power) can lower their specific energy consumption by up to 40% of the standard figures.

Acknowledgements

This paper was financially supported by Applied Research Programme (Program Badan Stosowanych) in the path A: “Intelligent system for automated testing and continuous diagnosis of the conveyor belt” (2012-2015)

References

Jedrzej Bukowski, Robert Krol, Lech Gladysiewicz (2010), “Tests of belt conveyor resistance to motion”, *Bulk Solids Europe 2010, International Conference on Storing, Handling and Transporting Bulk*, Glasgow, Scotland, September 9-10, 2010 Vogel Business Media, Institution of Mechanical Engineers

Lech Gladysiewicz, Monika Hardygóra, Witold Kawalec (2009), “Determining belt resistance”. *Bulk Handling Today*, 2009, No.5

Lech Gladysiewicz, Witold Kawalec (2006), “Optimised Selection Of A Belt Conveyor Loaded By A BWE”, *International Symposium “Continuous Surface Mining”*, Proceedings, RWTH Aachen 2006

Ryszard Blazej, Leszek Jurdziak (2011), “Integrated Diagnostic Device For Automatic Assessment Of Conveyor Belts Condition”, *Proceedings of World Mining Congress*, Istanbul, Turkey, 2011