

REVIEW OF THE NEWEST NDT EQUIPMENT FOR CONVEYOR BELT DIAGNOSTICS

Ryszard BŁAŻEJ

Wroclaw University of Technology, Machinery Systems Division
Pl. Teatralny 2, 50-051 Wroclaw, Poland, e-mail: ryszard.blazej@pwr.wroc.pl

Summary

The length of steel cord conveyor belts successively increases in Polish brown coal mines [1]. Essential, emerging issue is the belt life and failure-free operation of the whole transport system. Changes in mine management rules cause that all service or maintenance activities related with machinery for muck hauling are carried out, more frequently by contractors. This in turn causes the problems with quality control and the scope of work ordered by the mine. Very helpful here is the diagnostic equipment, which apart from its basic functions may check and verify the quality of service activities. The paper will present the newest NDT equipment for belt conveyors diagnostics as well as potential of its application in Polish lignite mines.

Key words: conveyor belt, non-destructive testing, diagnosis, automatic detection.

PRZEGLĄD NAJNOWSZYCH URZĄDZEŃ NDT DO DIAGNOSTYKI TAŚM PRZENOŚNIKOWYCH

Streszczenie

W polskich kopalniach węglowych systematycznie rośnie długość taśm z linkami stalowymi instalowanych na przenośnikach taśmowych. Istotnym, pojawiającym się zagadnieniem jest trwałość taśmy oraz bezawaryjna praca całego systemu transportowego. Zmiany zachodzące w zarządzaniu kopalniami powodują, iż wszelkie czynności obsługowe czy konserwacyjne związane z urządzeniami do transportu urobku (coraz częściej) realizowane są przez firmy zewnętrzne. Taki stan rzeczy sprawia, że powstaje problem kontroli jakości i zakresu prac realizowanych na zlecenie kopalni. Z pomocą przychodzą tu urządzenia diagnostyczne, które oprócz swoich podstawowych zadań realizować będą funkcje sprawdzające i weryfikujące jakość wykonywanych usług. W artykule przedstawione zostaną najnowsze urządzenia do diagnostyki NDT taśm przenośnikowych oraz możliwości ich zastosowania w Polskich kopalniach.

Słowa kluczowe: diagnostyka NDT, automatyczna detekcja uszkodzeń, taśma przenośnikowa.

INTRODUCTION

In the biggest Polish open pit mines, the average of 200 to 250 kilometers of conveyor belts are installed. The share of steel cord belts is almost 75 % of the whole length of operating belts. Every year each mine replaces the substantial number of belts, which were simply worn out during their operation or because they were seriously damaged [2]. Annually, the mines replace the average of 30 to 50 kilometers of belts (fig. 1).

The increase the average belt life by one month reduces by 0.5 kilometer the length of annually replaced belts, what is essential from the point of variable costs of mine. Main damages of belts surface or their core are fractures, local cuts, perforations and longitudinal cuts [3]. Most of those damages occur after the long time of operation, thus there is a possibility to evaluate them and to repair the belt if necessary. Some damages such as longitudinal cuts are very serious and cause extreme financial losses, concerning both the belt conveyor and the whole mining system. One of the method of effective prevention is using the NDT – nondestructive diagnostics.

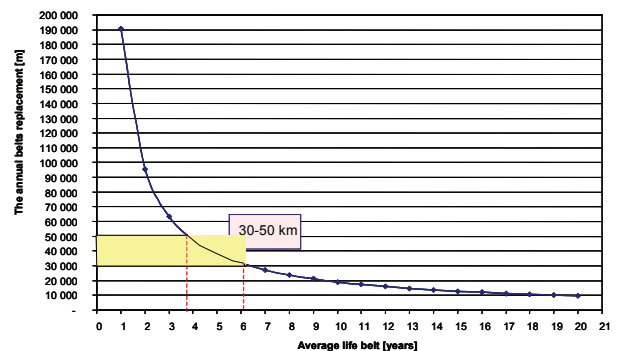


Fig. 1. Effect of average life belts on the amount of the annual exchange

1. REVIEW OF THE EQUIPMENT FOR STEEL CORD BELT CORE DIAGNOSTICS

The companies offering the St belt core scanners together with the relevant services exist on the market already from 30 years. Their newest equipment is the result of long term experience in conveyor belts diagnostics. The most important systems and their main characteristics are presented below:

- Beltscan Pty Ltd (Australia) –Belt Guard™ system. This system has several variants including the one with belt core scanning, measurement of covers thickness and longitudinal cuts preventing system. It is the only producer offering the high resolution system i.e. 200 channels for the 2500 mm wide belt (fig.2).

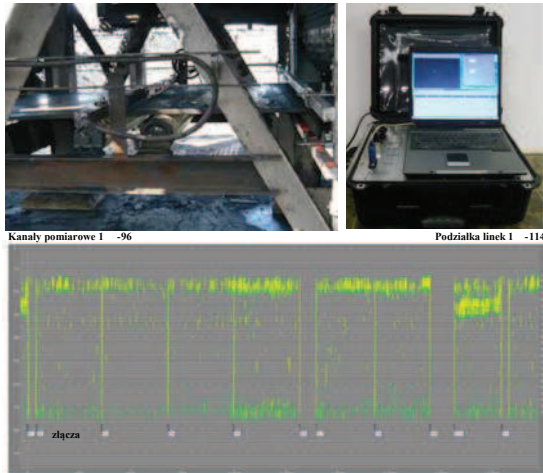


Fig. 2. The Belt Guard system, and the image after belt scanning (belt conveyor ST2200, 2307m x 1500mm) [www.beltscan.com.]

- **CBM Conveyor Belt Monitoring** (Australia) – The system apart the damages detection offers also the forecast the operation life based on the velocity of covers abrasion (fig.3). Unfortunately the picture of *St* belt cores condition, like in case of almost all such systems, is difficult to understand and to interpret. Thus the analysis of damages and belt condition is made by CBM engineers from the long distance, what in turn substantially increases the cost of system utilization.

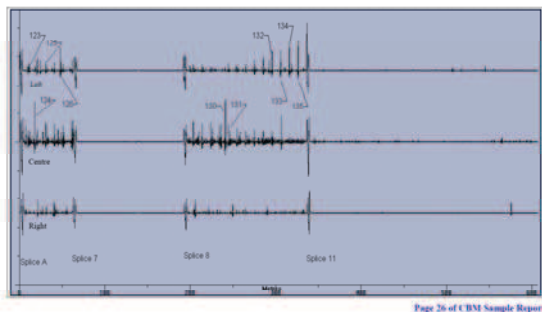


Fig. 3. Example image of belt damages after scanning [www.cbmi.com.au.]

- **CBT Conveyor Belt Technology** (USA) - The company offers *C.A.T.MDR™* system which has four components. The main element is a scanning head placed over the one side of belt. It has several 66 cm wide modules (from 1 to 4), which can be connected to cover the whole belt width. System of data collection for 2.64 m wide and moving with the speed of 7 m/sec

belt, gathers 750,000 samples per second. Classification of damages in *C.A.T.™ MDR* system. Picture of the belt is a white band (rubber is transparent) and colors inform about damages and anomalies (fig.4). Red color indicates the decrease of weight in steel cord while green says about the increase of weight.

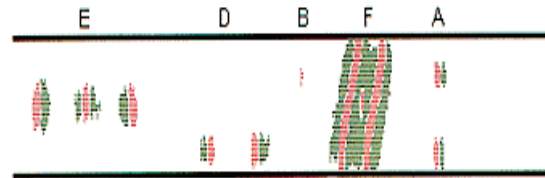


Fig. 4. A graphic image of defects in the system BELT CAT™ [http://www.cbtech.cl]

- **Conveyor Technologies** (CT Colorado and CT Pty. NSW Australia) Advanced opportunities for signals analysis allow for the remote access to all sensors in real time using the telephone wires. Special algorithm processing the measured values allow to select the splices between the belt sections, define their type and evaluate the damage level if it occurs. After finding the place of damage, the stress concentration rates are also calculated using the analysis of finite variances model (fig.5). Client receives the recommendations how to recover the belt strength and the previous level of safety factor.

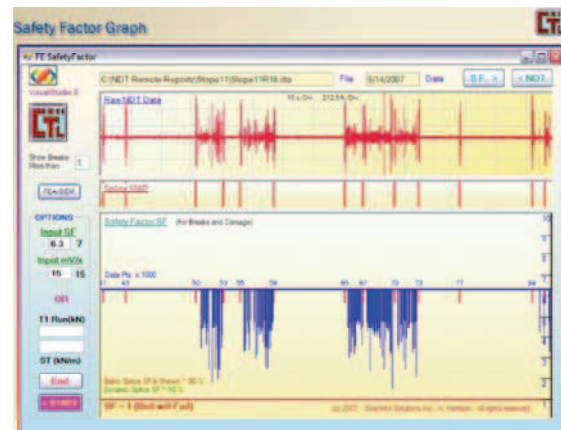


Fig. 5. Damages diagram of the tested belt (red) and the safety factor (blue) [www.conveyorscience.com]

- **Intron** (Russia) – **Introcon system**. It allows to monitor the 4 m wide belts, moving with the speed of up to 7 m/sec. Scanner may have 1-3 eddy-current modules and it is placed below or over the belt (10-20mm, fig.6). It is lighter than the equipment for magnetic field analysis. Measure values are transferred by cable to the field computer, and then to computer in the office. The device detects the damage or lack

of 1 cord, corrosion, belt splices, and breaks between cords in splices.

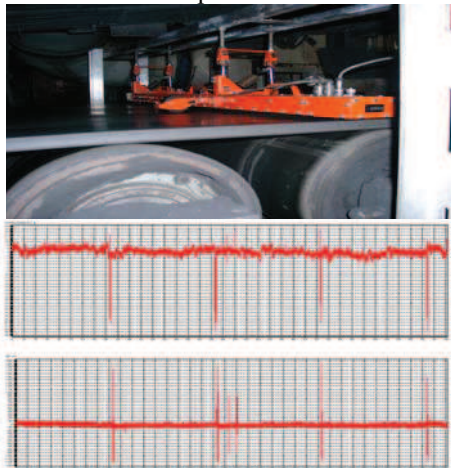


Fig. 6. Eddy current head mounted on belt conveyor and sample measurement result. [www.intron-plus.com]

- **TCK (China) - TCK Steel Cord Conveyor Belt Online Automatic Inspection System.** TCK is a big company producing the equipment and testing the conditions of steel ropes, covering the 80 % of Chinese market. It employs the advanced technology of weak magnetic fields inspection using the unique sensors. The device may examine the belts from 600 to ~2400 mm wide. The accurate qualitative (98%) and locational (1mm) identification of cord damages: cord cuts and corrosion as well as slices integrity is provided at the distance between the head and belt form 70 to 110 mm.



Fig. 7.

View of the device and belt scan sample [www.tck-cn.com].

- **Veyance Technologies (GoodYear) Cord Guard™** system. System identifies the damages of single steel cord with location accuracy of +/- 15mm. System has widely developed additional functions such as notice

about the damage by sms or e-mail, or at any time on demand the report about the current status in the form of PDF. The detailed list of damages location (length of belt, location of splices and damages) is generated as well as critical and no-critical alerts about the levels determined by the user. High resolution magnetic pictures of damages and splices do not need the expert to be interpreted (fig.8).

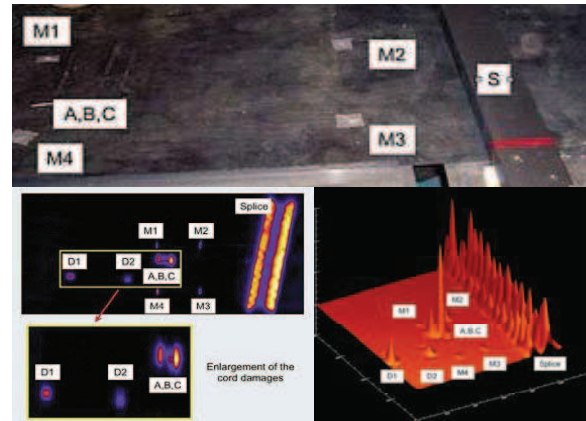


Fig. 8. Verification of visual damages of belt and splices illustrated in the Cord Guard system in 3D image [www.goodyear.com]

2. NEW POSSIBILITIES FOR NDT EQUIPMENT USE

Costs optimization and simplification of the organizational structure are the reasons of changes in companies in Polish mine and power industry. They in turn result in commissioning, much more frequently, the maintenance and service operations concerning the transport equipment to the contractors. This situation causes the problems with quality control and the scope of work ordered by the mine. Diagnostic equipment is very helpful there. Apart from its basic task it can check and verify the quality of the service (fig.9).

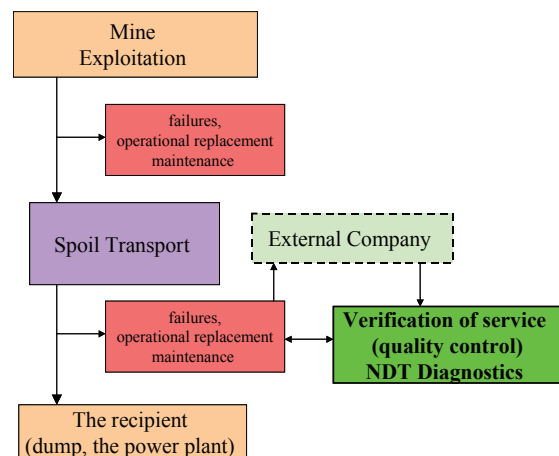


Fig. 9. Scheme to verify the quality of services provided by external companies

3. SUMMARY

Currently many companies are making the substantial changes in technologies applied and in equipment being offered. Some suppliers base on checked but old technology like Intron with Eddy-current technology or TCK with weak magnetic fields method. The offered equipment have different resolution in damages identification, differ in results displaying and in damages interpretation simplicity. The systems have also different prices. The prices of the cheapest systems without measuring the covers thickness or cut preventing option start from \$40 000. This systems, however, despite of their advantages, have one main disadvantage – they do not offer the automatic evaluation of belt condition. The evaluation of belt scanning results is still made by the experienced diagnosis specialist in mine, or specialized team of experts in the companies delivering the equipment. It makes the costs of diagnostic much higher and widen the scope of the service [4]. Newly developed equipment should follow many additional criteria, such as:

- Automatic evaluation of belt condition directly on the conveyor, based on real time and historical data stored in the equipment memory
- Legible report and results visualization adjusted to the needs of the particular user (mine, power plant)
- Mobility, easy assembly, easy operation not requiring the high qualified personnel
- Low reasonable price, allowing to buy several devices by one client
- construction and software opened for modifications allowing for quick adjustment to new, changing needs of the user.

Meeting these requirements should enable the wider usage of NDT method for conveyor belts diagnostics, affecting positively on belts life and reduction of transport costs in mines. Possibility of adjusting the user interface to new, changing needs and requirements of users may be conducive while making the decision about its purchase and widespread usage.

REFERENCES

- [1] Kawalec W. 2009. *Long-range belt conveyors for lignite transport* (in Polish). *Transport Przemysłowy i Maszyny Robocze*. 2009, nr 1.
- [2] Jurdziak Leszek, Błażej Ryszard: *Conveyor belts maintenance costs Estimating in a mine using different strategies to belts replacements and method of their damage detection* (in Polish). *Cuprum*. 2010, nr 4, s. 5-18
- [3] Jurdziak Leszek: ” *Steel cord and textile belts damage analysis in the "Turow" . open*

pit mine (in Polish). *Transport Przemysłowy* 2002r, nr 1, s. 22-26.

- [4] Błażej Ryszard, Jurdziak Leszek, Zimroz Radosław: *The need to develop their own diagnostic tools for automatic assesment of conveyor belts in surface mines*. (in Polish). *Górnictwo i Geoinżynieria*. 2011r. R. 35, s. 63-71.



Dr. Ryszard BŁAŻEJ graduated from Wroclaw University of Technology (Faculty of Mining, MSc 2001, PhD 2001). His work is related to belt experimental testing with regard to the belt and belt' joints properties analysis. He is an author of many papers and technical reports for industry. In recent years his area of interest has been extended to diagnostics of belts.