

COMPREHENSIVE CHECK MEASUREMENT OF KEY PARAMETERS ON MODEL BELT CONVEYOR

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Abstract:

Complex measurements of characteristic parameters realised on a long distance model belt conveyor are described. The main objective was to complete and combine the regular measurements of electric power on drives of belt conveyors operated in Czech opencast mines with measurements of other physical quantities and to gain by this way an image of their mutual relations and relations of quantities derived from them. The paper includes a short description and results of the measurements on an experimental model conveyor with a closed material transport way.

Key words: belt conveyor, belt diagnostics, reliability, tensioning

INTRODUCTION

Presented article describes a measurement which is a part of MPO project No. FR-TI1/537 "Complex diagnostic system for belt conveyors" and it shows an access to quantify parameters and observation and evaluation technical state of a drive and belt. Results of the presented solution are used to verify the results of more up to date methods of measuring parameters of a transport belt and driving drum at the development of a diagnostic system of a belt conveyor [1, 2, 6]. They are also used to characteristic parameters of the drives in the system [4]. The system with added certified diagnostic services will be used as a part of equipment of a wide spectrum of belt conveyors, from small to large ones operated in quarries and open pit mines in Czech.

A series of in situ measurements on other belt conveyors preceded the measurement described in following text. The series ends with a long term measurement on belt conveyor with a closed material transport way constructed specially for this project, (see Figure 1).



Fig. 1 Model conveyor

MEASURING MECHANICAL VIBRATION

Mechanical vibration of drive was recorded on drives No. 1 and 2 of the model conveyor in the frame of complex measurement. The situation can be seen in Figure 2.

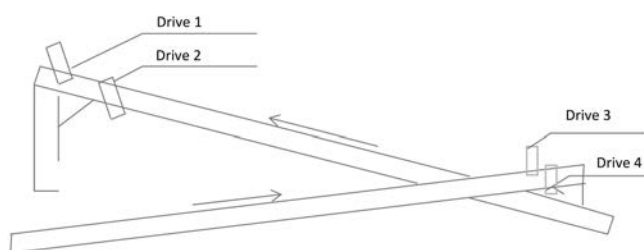


Fig. 2 Schema of deploying the drives on the model conveyor

Measuring points were chosen on a gear box coat at places of bearings of an output shaft [3]. Markings of the measuring points and oriented measurement directions see Figure 3.

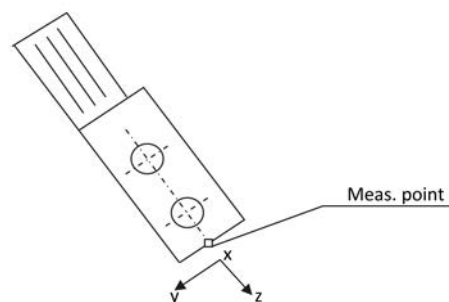


Fig. 3 Markings of the measuring points and oriented measurement directions

Vibration velocity v [$\text{m}\cdot\text{s}^{-1}$] and vibration acceleration a [$\text{m}\cdot\text{s}^{-2}$] in X, Y (perpendicular to motor axis) and Y (axial) direction were measured.

- RMS value of vibration speed was measured with MICROLOG CMVA 60 device with weighing filter in $10\div 1000$ Hz frequency range. The device also measured vibration speed spectra in the same frequency range. Vibration acceleration was measured with two systems: EMS DV 813 system in $0\div 350$ Hz frequency range and Brüel & Kjaer system in $100\div 1000$ Hz frequency range.

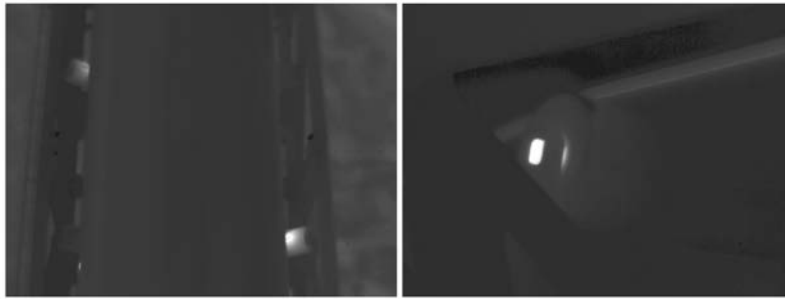


Fig. 4 Thermal imaging measurement of rollers

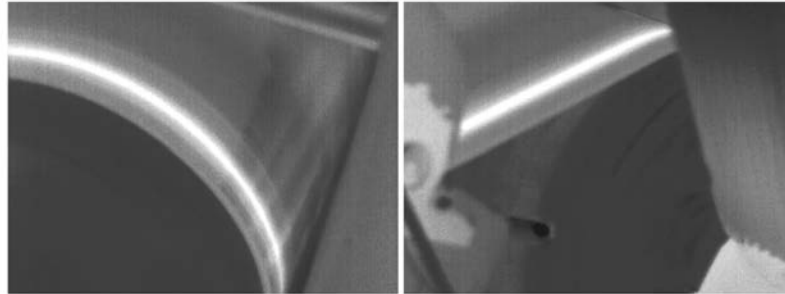


Fig. 5 Thermal imaging measurement of belt

EMS DV 813 system: sampling 200 S.s⁻¹ dynamic, 1 S.s⁻¹ static and Brüel & Kjaer system: sampling 4000 S.s⁻¹. Sample data were saved to the disk of collecting computer.

Totally 13 measurements were carried out with various values of tensioning of the belt from minimum to fully loaded belt.

Measured RMS values – Microlog CMVA 60 system – 10÷1000 Hz frequency range are as following:

DH-PH	Y	1.48 mm.s ⁻¹	1.43 m.s ⁻²
	X	2.78 mm.s ⁻¹	5.47 m.s ⁻²
	Z	1.52 mm.s ⁻¹	1.65 m.s ⁻²
DH-PD	Y	1.36 mm.s ⁻¹	2.52 m.s ⁻²
	X	2.90 mm.s ⁻¹	7.25 m.s ⁻²
	Z	1.56 mm.s ⁻¹	2.38 m.s ⁻²

Measured values of vibration exceed the limit value 2.3 mm.s⁻¹ according to the ČSN ISO 10816-3:2010 standard for drives in new machines:

- **lower** gear box vibration in drum axial direction 2.9 mm.s⁻¹.
- **upper** gear box vibration in drum axial direction 2.78 mm.s⁻¹.

TEMPERATURE MEASUREMENT

Rollers measurement

New rollers from three different producers were ordered and installed during construction of a new model belt conveyor (Fig. 4).

For simplification they are blue, red and yellow. Temperatures of roller bearings on the three sets were measured

with thermal imaging system Therma CAMTM PM 545 from FLIR Systems company at the conveyor operation with following results:

- blue rollers – max. temperature 82.7°C average temperature 35.2°C
- red rollers – max. temperature 22.5°C average temperature 19.9°C
- yellow rollers – max. temperature 20.6°C average temperature 19.6°C

Thus the worst results in operational temperature (friction) have the blue rollers, red and yellow rollers follow with a little difference.

Belt measurement

Belt surface temperature of both loops of the model conveyor was measured ca 30 minutes after start of run (Fig. 5). No anomalies were measured on a lower belt branch loop. Following temperature was measured on an upper belt branch loop:

- right edge of belt – max. temperature 56.7°C
- left edge of belt – max. temperature 21.2°C

The difference between temperatures in the belt was 35.5°C. The belt was loaded unevenly

Measurement of drives

Measurement of operational surface temperature of all drive and gear boxes started at 30 minutes after start and they ended with no finds (Fig. 6). Meteorological conditions were also recorded during noise measurement in outer space.

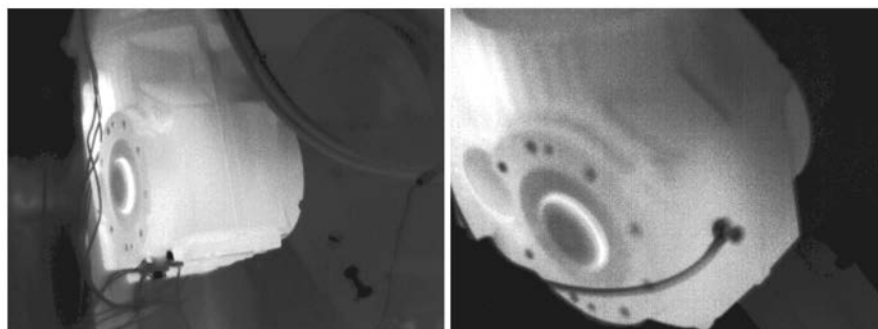


Fig. 6 Thermal imaging measurement of drives

MEASUREMENT OF NOISE

Acoustic pressure levels of the three roller sets were measured with B&K 2236 noise meter, B&K 4188 microphone and B&K 4231 calibrator in 1 and 5 m distance. Results are in the following Table 1.

Table 1
Acoustic pressure levels

Meas. point	Noise level L_A [dB(A)]					
	L_{Aeq}	L_{Amin}	L_{Amax}	L_{95}	L_{50}	L_{05}
blue rollers 1 m	77.9	74.8	80.8	26.5	29.5	40.5
red rollers 1 m	72.7	71.2	73.7	26.5	2.	32.5
yellow rollers 1 m	72.2	70.5	73.8	26.5	29.0	32.5
blue rollers 5 m	71.2	69.4	73.4	29.5	34.0	38.5
red rollers 5 m	68.1	67.1	70.0	26.5	29.5	41.5
yellow rollers 5 m	66.3	65.1	69.6	26.5	29.5	42.0

Blue rollers were the most noisy, red and yellow rollers follow with a little difference. The noise measuring results fully correspond with the temperature measuring results.

ELECTRIC DRIVE MEASUREMENT

Electric drives were also measured together with measurement described above. Measuring set consisting of ENA 500.22 analyser and its accessories was used to measure supplying voltages and currents, power factors and harmonics (Fig. 7). Active current loops with 3000 A range and

signal voltage cable with safety banana plugs are used for current and voltage measurement.

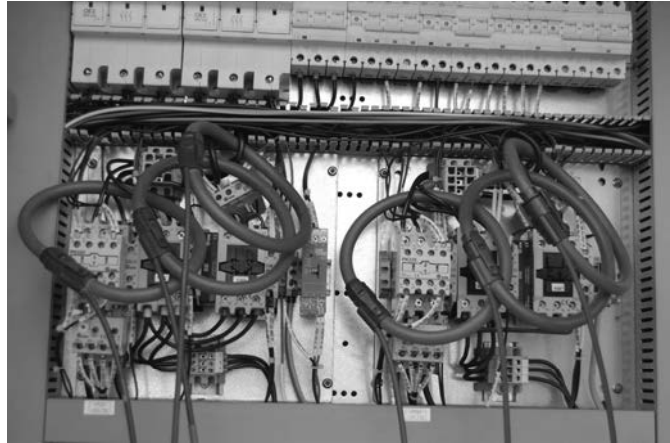


Fig. 7 Current loops of The ENA 500.22 analyser

The analyser includes two sets of voltage and current inputs and can be well used for simultaneous measurement of two three phase systems. Real power of each drive of the empty first conveyor is 3 kW, and 2.5 kW at the second one. The first conveyor is set with two 22 kW motors. No transducers are used, start up power peak is limited by switching neutral end tap changing and mesh connection. The second conveyor is set with two 15 kW motors with frequency control. Little differences in real power can be seen in Figure 8. Drive 1 is set with more power motors.

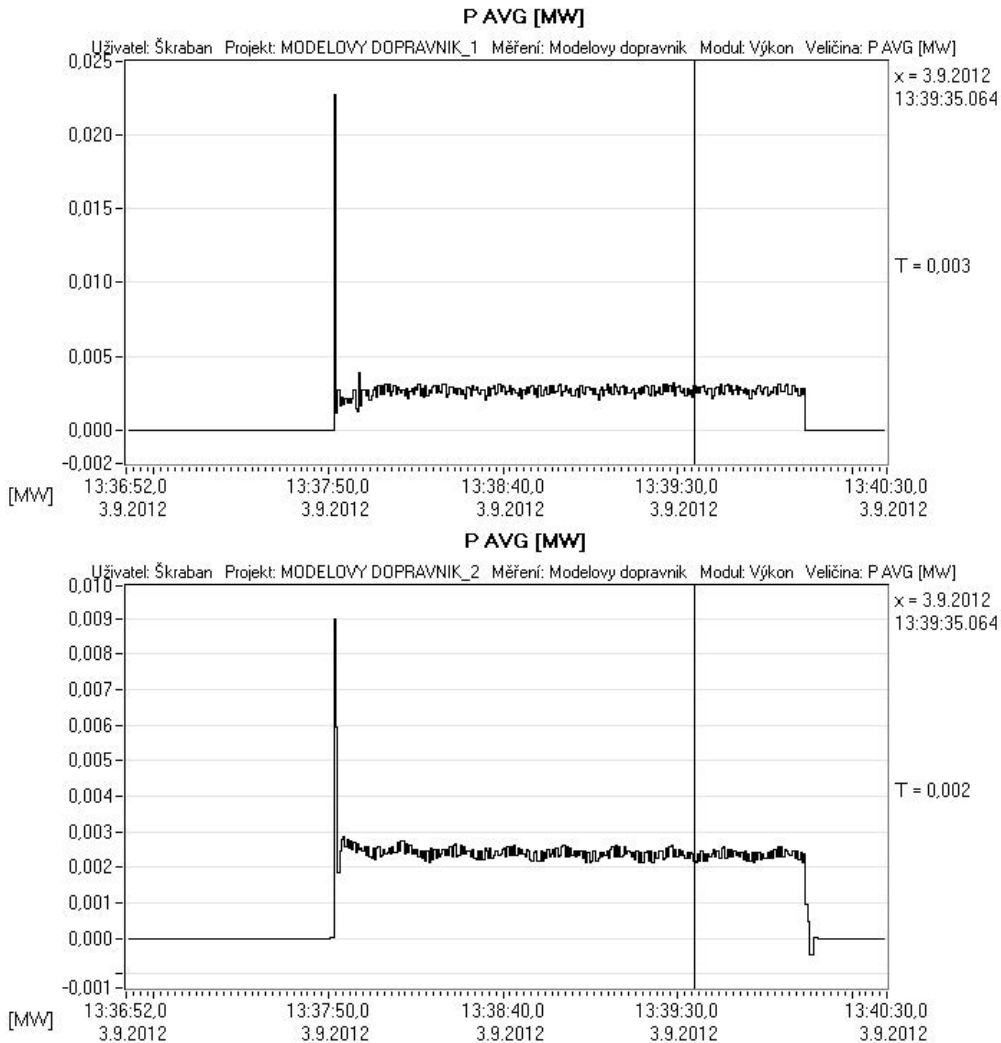


Fig. 8 Real power of drives 1 (without transd.) and 2 (with transd)

CONCLUSION

Presented complex measurement shows one off possible accesses to parameter quantification and observing and evaluation of technical state of drive and conveyor belt. The article may seem to repeat already known knowledge [5] but in fact it applies it to development of a relatively cheap, widely available diagnostic and controlling system for the needs of large spectrum of belt conveyors which is still missing in the Czech market.

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