Diagnostics of Technical Condition of Gear Units of Belt Conveyors for the Aggregate of Methods of Nondestructive Testing

Evgeny G Kuzin 1,2, Boris L Gerike 2, Yuriy V Drozdenko 2, Michael G Lupiy 1, Natalya V Grigoryeva 1

1 Regional Campus of Kuzbass State Technical University after T. F. Gorbachev, 653039, Russia, Prokopievsk, Nogradskaya str. 19a.
2 Kuzbass State Technical University after T. F. Gorbachev, 650000, Russia, Kemerovo, Vesennyaya str. 28

E-mail: a kuzinevgen@gmail.com

Abstract: The article reviews the issues of complex use of methods of technical diagnostics of gearboxes for belt conveyors, with the aim of creating an effective system of maintenance. The article is showing the results of the evaluation of the technical condition of the drives of belt conveyors based on vibration monitoring and thermal parameters, and analysis of lubricating oil.

Introduction.

Transportation of coal from the coalface to the surface is an important process, the cost of which ranges from 70 to 80% of the total costs of production.

Thus, on one hand the spent time on non-productive pauses in the transportation chain should be kept to a minimum, and on the other hand it should be minimizing energy costs.

The quality of the work conveyor transportation to a large extent depends on the reliability and efficiency of drive units and control equipment.

Technical diagnostics allows to estimate and predict the state change of mining equipment, timely maintenance, and to more effective plan repairs. In addition an aggregate diagnosis of diagnostic characteristics allows to reveal defects at an early stage and to prolong the service life of equipment due to proactive (proactive) maintenance [1].

Statement of the problem and research methods choices.

Today vibration analysis is the strongest and most common method of detecting and determining fault in gears of the gearbox [2]. It should be noted that fluctuations related to the defect of the rolling bearing have a much lower amplitude than the variations associated with many other lesions, such as imbalance, misalignment or defective gear. A large variety of bearing designs and usage conditions, operation speeds and loads makes it very difficult to use the total allowable level of vibration, which would have worked satisfactory in most cases [3, 5, 6].

These observations determined the set of technical diagnostics methods for gearboxes of coal mine belt conveyors in the parameters of vibration, lubricants and thermal control by infrared thermography.

In order to diagnose drives mine belt conveyors the results of the monitoring of vibration parameters, lubricants and thermal control were used. The studies were conducted periodically starting with from the time of installation of conveyor lines. The drive station is equipped with gearboxes Moventas

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Santasalo, Morley motors of 500 kW and a frequency Converter station, which provides smooth starting, torque control and speed of the motors.

The vibro-diagnostics specifics that vibration alerts almost instantly react to changes in the condition of the equipment. Analysis of vibration parameters allows to determine the imbalance of the ligament of the engine to the gearbox, the weakening of the landing bearings, defective gears, bearings and defects attaching to the foundation [4, 7, 8]. Thus, reducing the speed of the tape significantly reduces the level of vibration.

The analysis of the parameters of the lubricating oil in addition to accumulation speed wear and General degradation of the oil helps to assess which elements of the gear wear in the first place.

Thermal control of drive components by infrared thermography complements, enhances the diagnostic abilities and allows to reveal defects of cooling systems including mechanical and electrical parts of transmission stations.

Results.

Fig. 1. The change of iron content in oil of gearbox from the time in operating

This paper describes the monitoring results of parameters of the lubricating oil, vibration, and thermal control gearboxes Moventas Santasalo mining belt conveyors LL1600. Fig. 1. shows the result of the iron accumulation, [g/t] in the oil for exactly the same gear from the moment of installation until 21800 hours are reached. The results differ from the minimum accumulation of iron about 150 [g/t] in the drive P22 to a maximum of about 780 [g/t] in the drive P23. The maximum allowed iron content in the lubrication oil should be not exceed 200 [g/t].
Fig. 2. The change in the content of chromium in oil of gearbox from the time in operating

Fig. 3. The change in the content of tin in oil of gearbox from the time in operating
After the analyzing the parameters of the oil, it can be concluded that more viscous oil (like in the gearbox P22) helps to reduce the accumulation of mechanical impurities. In the parameters of the lubricating oil reducer P22 that is in good condition, the gears P21 and P23 require oil changes.

Additionally monitoring of vibration parameters was performed. The effect of the overall RMS value of vibration velocity is shown in Fig. 5. The parameters of the vibration reducers P22 and P23 are in good condition, and satisfactory P21.

Fig. 4. The change in viscosity of the oil in a gearbox of a belt conveyor

Fig. 5. The change of vibration parameters from the time in operating
Spectral analysis helps to assess the condition of gearbox components. Fig. 6 shows the spectrum of velocity vibration in one of the feature points P21 reducer which increases the level of vibration at odd sub-harmonics of the reverse frequency. This range characterizes a certain stiffness of the system.

The amount and nature of vibration in the weakening of the rigidity depends on the degree of defect, the force excitation magnitude of (as a result it depends on a load to the actuator) and the properties of a particular unit of anisotrop and nonlinearity of the reference frame. The vibration signal of gears mounted on a jet-powered (no capital base) usually has a complex nature. It usually presents oscillations in a wide frequency range: vibration with excitation frequency, its harmonics and subharmonics, and sometimes in the other frequency components.

Fig. 6 Spectrum of the vibration velocity P21 point 3A appear odd sub-harmonics, which is the frequency of circulating

Thermal control of actuators via infrared thermography allows more accurate control of the faulty nodes, such as, to identify one local overheating of the bearing and failure of the cooling system. Fig. 7. presents the thermograms of gears having different temperature. This difference may be caused by the parameters of the oil and vibration and different load on the drive drums depending on their place of installation in the scheme of the pipeline.
a) reducer P21 the highest temperature 53 °C

b) reducer P22 highest temperature 58.2 °C

c) reducer P23 the highest temperature is 50.7 °C

Fig. 7. The thermograms of the respective gears at 15100 hours of operating
Conclusion
With decreasing oil viscosity the level of vibration increases and wear occurs more intensively. At higher oil temperature the evaporation of low boiling fractions and the viscosity slightly increases. At higher vibration it is recommended to increase the viscosity of the oil extending the life of the drives.

For reducer P21 it is recommended to inspect a mechanical fastener.
In reducer P23 it is necessary change the oil. In general the gearboxes are in a satisfactory technical condition and the projected life of these gearboxes is at least 20000 hours.

Systematic monitoring will allow to take measures in advance for repair preparation or replacement of defective gearbox, such as rewiring the equipment of the longwall next time. The results of the monitoring will help to create a database on the nature of the processes of wear and set proper evaluation criteria for the gears mentioned above.

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