

## CMM – SYSTEM FOR CONTINUOUS CONTROL OF BEARINGS FROM THE MINING MECHANIZATION

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**ABSTRACT.** The article considers a system for continuous control, based on one of the methods of shock pulses, and namely dBm/dBc method. Described are the possibilities provided by the method, as well as the required equipment for the diagnostic needs of open-pit mining mechanization. Comments are made on the diagnostic parameters and their criterion sufficiency for the various types of mechanic damages subject to non-destructive control.

### CMM - СИСТЕМА ЗА НЕПРЕКЪСНАТ КОНТРОЛ НА СЪСТОЯНИЕТО НА ТЪРКАЛЯЩИ ЛАГЕРИ ОТ МИННАТА МЕХАНИЗАЦИЯ

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**РЕЗЮМЕ.** В статията се разглежда система за непрекъснат контрол, базираща се на метода на ударните импулси, а именно метод dBm / dBc. Описани са възможностите които предоставят метода, както и необходимото апаратно осигуряване за нуждите на диагностиката на минната механизация от открития възгледобив. Направен е коментар на диагностичните параметри и тяхната информативност за различните видове механични повреди, подлежащи на безразрушителен контрол.

### Introduction

The continuous technological process in the mining industry sets high security and reliability requirements to the mining mechanization. Past experience shows that the main reasons for emergencies are linked in the first place to damages in the roll bearings. The statistical analysis of damages in roll bearings reveals the main reasons leading to emergencies.

- 45% - deteriorated lubrication;
- 25% - incorrect mounting, most often overtightening;
- 20% - misalignment;
- 10% reach their limit life, i.e. they damage because of material fatigue.

This statistics predetermines also the main directions for improvement of the technical servicing of roll bearings – and namely, to create prerequisites for the larger part of bearings to damage because of material fatigue, i.e. to reach their limit exploitation life, through effective control of the lubrication condition and the quality of mounting. Past practice in the use of portable instruments and on-line systems proves that the specifics of the mining mechanization is best suited by the methods and apparatuses of SPM Instrument.

### Theoretical argumentation

The instruments and systems of SPM Instrument use the **Shock Pulse Method (SPM)**, which was established more than 30 years ago and is the most specialized and informative method for analysis of the condition of roll bearings, presently used in the industry. The main fundamental difference, distinguishing it from the methods of other firms that are based on vibration measurements, is that in measuring and analyzing the vibrations there can only be registered damages that have already appeared in the roll bearing, while with the SPM method - by controlling the lubrication – dry friction and thereby mechanical damage of the bearing can be repeatedly prevented.

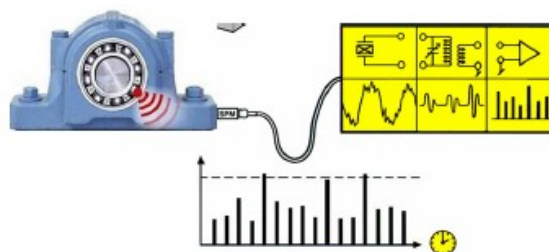


Fig.1

The "secret" of the SPM method is hidden in the specialized piezoelectric SPM transducer, which is mechanically and electrically adjusted to register the shock pulses in a very narrow range. The frequency range (32 kHz) is not accidentally

selected, considering that the upper limit of attenuation of the mechanical vibrations is around 27 kHz. In this way the SPM transducer registers low-energetic shock pulses, intensifying them 5-7 times stronger compared to the standard vibration transducer. The signal thus obtained passes through electric filters, after which a series of analogue pulses (Fig.1) enter the analyzing part of the measuring module. In this sense, the SPM method does not use “filtering method” for measuring of the bearings, unlike the “Envelope” equipment, and it is wrong to identify it with the vibration control methods. There exist 2 variants of the SPM method, which use the same SPM transducers, but differ in the evaluation and analysis of the shock pulses. As of present, “Maritza-Iztok” Mines has been using only one of them for diagnostic purposes, and namely the dBm/dBc method. Control there is realized on the basis of information about two limit parameters dBm and dBc, which illustrate the momentary condition of the bearing. dBm is a maximal level for a small number of shock pulses which are with high amplitude. It is an indicator for a damage in the bearing. dBc is a bottom level for many in number, but weaker shock pulses (around 200 pulses/second). It is an indicator for the lubrication condition. The two values are measured by a normalized decibel scale, which means that the scale is adjusted individually for every bearing after having entered the data thereof.

The bearing's details required for calculation of the initial level dB<sub>i</sub>, in relation to which reading of the two limit levels is done, are: diameter of the shaft (d) and frequency of rotation (rpm). In this way, after measurement, the dBm and dBc values are already evaluated and show the actual condition of the bearing by means of an arrow orientated opposite the respective zone of the condition scale (Fig.2):

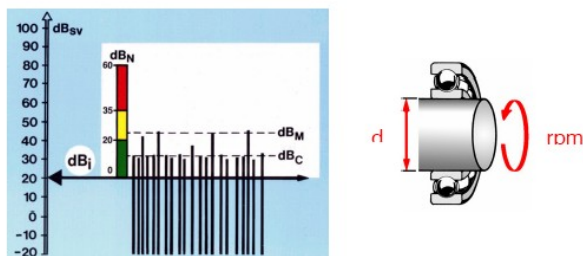


Fig.2

For a bearing in good condition the graph of the shock pulses corresponds to Fig.3, and for a bearing subject to replacement – Fig.4.

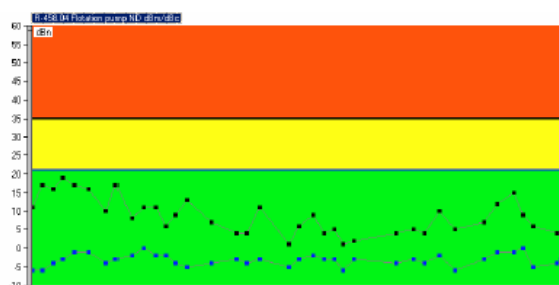


Fig.3

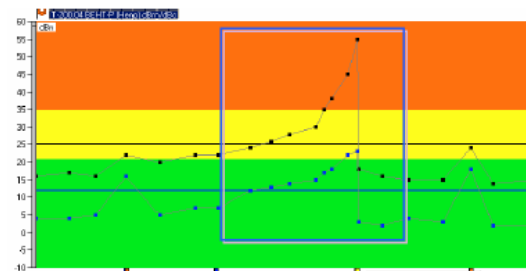


Fig.4

The method dBm/dBc is used for evaluation of the condition of roll bearings with Tester T30 and Module system SMM. System SMM (Fig.5) consists of single-channel and double-channel modules, which convert the signals from the transducers of shock pulses (SPM) and the vibration transducers in a universal current signal 4-20 mA. It is designed for:

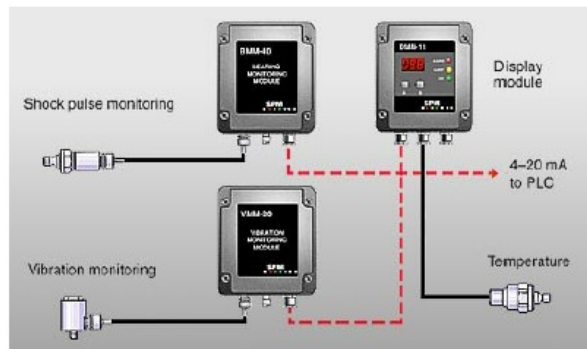


Fig.5

- Continuous monitoring of the condition of roll bearings by the SPM method dBm/dBc;
  - Measuring the level of vibrations according to ISO 10816;
  - Measuring the temperature and analogue signals.
- The measured signals can be analyzed in 2 ways:
- By the display modules DMM10, disposing with a color diode indication. They can be mounted in the operator's cabin of the drive station or in the excavator's cabin;
  - By sending the outgoing analogue signals 4-20 mA from the converting modules to the PLC system.

## Experimental investigations

A monitoring system of the SMM type for monitoring of the heavily loaded bearings has been installed on a drive station of a belt conveyor in Troyanovo-3 mine of “Mines Maritza-Iztok” EAD. The system has been built up to the level of display modules DMM10, with alarm signalization upon damage and possibility for connection to a PLC system. Thus structured, the system SMM operates together with the existing programs Condmaster®Pro 46, Version 1.11, Tester T30 and Analyzer A2011 in the mine. By way of information on the condition of each bearing, the screen of the display modules shows in digital form the controlled levels dBm/dBc, and upon eventual subsequent inclusion of the modules to the PLC system on a computer screen in the diagnostic laboratory of the mine there

would be obtained solely the graph of the level dBm (Fig.6). By the trend of the maximal level of the shock pulses we judge of a developing damage in the bearing. A shortcoming of this variant is the lack of information on the bearing's lubrication. This information can be obtained by periodical manual measurement of the levels dBm/dBc by means of Tester T 30 or analyzer A2010, after which the results from the periodical control are entered into a computer and processed with the program for diagnostics and evaluation of the bearings Condmaster PRO. The presence of a big number of measuring points does not permit conductance of effective diagnostic control. Therefore, at the present moment, the diagnostic control of the bearings is reduced to evaluation of their condition only in the periods preceding capital repair of the machine. On the other hand, it is not possible with the available equipment to do forestalling diagnostics and respectively – timely repair intervention to prolong the life of the bearing.

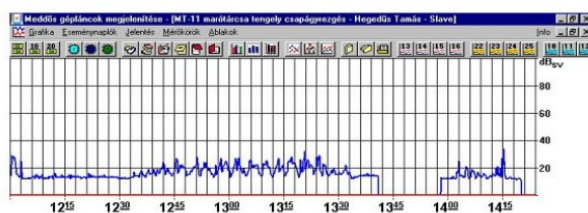


Fig.6

These negative circumstances can be overcome by implementing a system for continuous monitoring of the technical condition with automatic evaluation of the measuring results of the CMS type. Up to 250 measuring modules with total points number up to 4000 can be connected in a CMS system. In this way the system is extremely flexible and permits, after initial installation of a certain number of measuring points, a stage-by-stage expansion by adding new measuring channels. CMS ensures on-line connection between the analysing software and the measuring points from each machine. Through this connection measurement data are obtained and instructions are sent to the measuring modules.

For this purpose, two programs are used by the CMS System: Communication program CMS and analysing program Condmaster®Pro.

## Conclusions

1. The many years of experience with the control of bearings from open-pit coal-mining mechanization has unmistakably confirmed the shock-pulse method as the most effective method for diagnostics and control of their condition.
2. Based on the specifics of the equipment in open pits, to ensure reliable protection of heavily loaded rotor mechanisms on excavators, spreaders, drive stations, etc., the most expedient would be to build up a System for continuous monitoring of the technical condition with automatic evaluation of measurement results of the CMS type.

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