1.7.6. IDENTIFICATION OF PROPAGATION OF CONTACT DAMAGE OF ROLLING BEARINGS USING ACOUSTIC EMISSION AND VIBRATION DIAGNOSTICS

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Introduction. Rolling bearings form an essential group of components of many machines and devices. The optimal and safe function of these devices depends just on the correct function of the bearings. An important reason of loss of decisive properties of all types of bearings is the inception of point contact damage, so called pitting, on some of its elements. Damage of surface layers causes inception of micro-cracks in places of maximum sheer stress. In the beginning, this fatigue damage results in decrease of functional properties of the damaged part; however, emerged surface hole may gradually create a centre of fatigue crack, which successively enlarges to the whole section of the part (fig. 1).

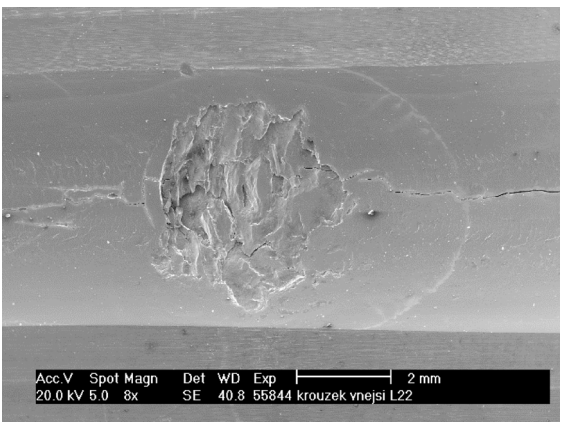

Fig. 1. Point contact damage with crack – outer bearing ring

Defects in bearings rolling element can occur on the rolling elements, raceways, cage, or any combination [1]. During the bearing lifetime, all of these defects types generate unique vibration signals. In most cases the actual degree of bearings damage is detected by vibrations sensing of the whole device. Despite the use of modern mathematical procedures of processing and evaluation of the signals obtained, a need of more detailed diagnostics of damage origin has emerged. Acoustic emission (AE) seems to be a very promising possibility for such purpose.

Basic results. This paper compares recent possibilities of AE method application in the area of identification and evaluation of early stages of rolling bearings damage. The overview of current state of the art in this area forms the first part of the paper and the experimental part is concerned with recent results of AE method application in the course of durability tests of axial and radial bearings which were implemented in the contact fatigue laboratories of Brno University of Technology.

Most recent group of our experiments was carried out on testing stations for tests of durability of radial bearings. Sensing of AE signal on these devices is complicated also by position of the tested bearing inside the testing station, so it is not possible to place the AE sensors to its direct vicinity. In this case we use waveguides, whose one end touches the outer ring of the bearing and the other end is connected to the sensor. Another sensors are placed on the surface of the testing station. Despite these complications with AE signal sensing, we have managed to find optimal setting of the measuring chain and process some record of high-quality and damaged radial bearings.

Examples of basic AE signal records of rolling bearing are depicted on next figures. Fig. 2 shows a record of bearing test from standard type analyzer Dakel Xedo. Fig. 3 shows the possibilities of the new generation of AE analysers Dakel IPL. These devices allow for continuous AE signal sensing. In the full version of the paper, we will further show records from simplified single-purpose equipments Dakel Abem, which were constructed for continuous evaluation of damage degree and whose functionality we are testing at the moment.

Discussion of results. From our results we can conclude that it is possible to detect different types of damage in rolling bearings by measuring AE and that the detective capacity of the AE method is better than that of the vibration within the range of present measurement. As a basic parameter we use RMS value evaluation, which quite reliably indicates the state of contact damage. Further suitable parameters will be possible to find after detailed analysis of the full signal from IPL analysers – f.e. observation of suitable frequency characteristics of the sensed events, etc.

Conclusion. Bearing condition monitoring technique based on processing of the acoustic emission signal of the monitored bearing system was investigated. The development and application of the monitoring technique was carried out on real axial and radial bearings. Our results proved the AE technique enables reliable recognition of running-in period, stabilised run and definition of stage of surface damage origin. It has been shown that the AE method is applicable to predict bearing defects and at least it can suitably complement traditional vibration bearing condition monitoring.

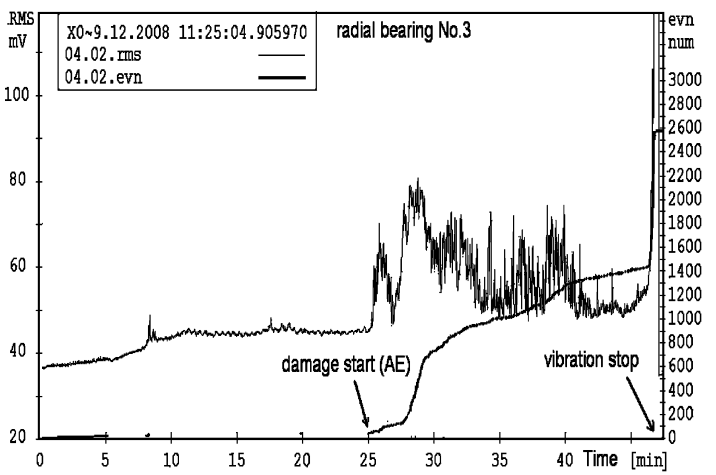

Fig. 2. RMS and events summation – destruction test of radial bearing (Dakel Xedo)

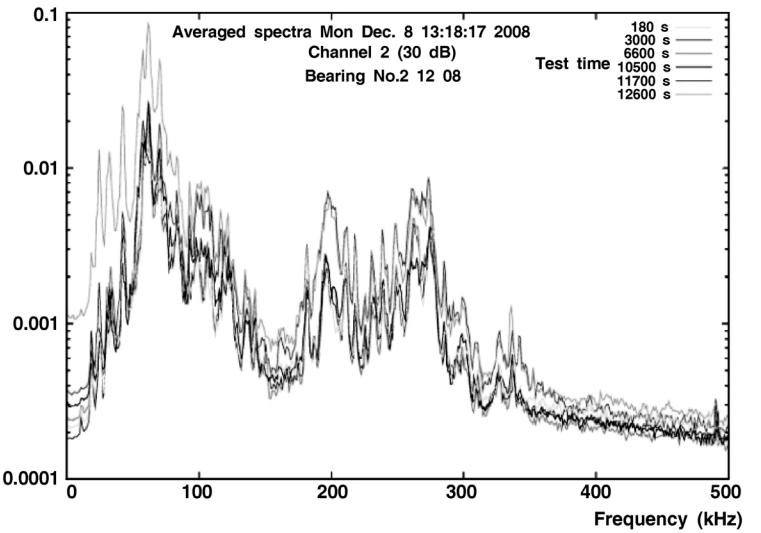

Fig. 3. Frequency spectrum of AE events in selected times of bearing destruction test [2]

Before use in industrial practice, it is however necessary to solve some of the "traditional" problems of AE method application, because monitoring of bearings contact damage is relatively complicated, as there is always mutual contact of many bodies. In case of development of contact damage, AE signal contains not only "standard information" about the activity of the defect itself. Taking into account the change of quality of contact surface, the vibrations of the system grow and, of course, noise in the testing equipment grows as well; all this is reflected in the scanned signal. Also the quality and changes of lubrication play a very important role in these measurements. With respect to sensitivity of AE method, the importance of quality of setting is apparent – choice of parameters, sensors, signal amplification, sensors location, quality of contact between sensor and surface etc.

Above mentioned results are created as a part of the solution of the project of FRVS CR No. G1/1616/ 2009 Online monitoring of contact damage.

References:

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2. **Mazar P., Hort F., Drab M., Slunecko T.**: Some possibilities of AE signal Treatment at Contact Damage Tests of Materials and Bearings // Journal of AE. – 2009. – Vo. 26. – No. 1. – p. 189 – 198. – ISSN 0730-0050.