CONDITION MONITORING OF ROTATING ELEMENTS USING ACOUSTIC EMISSION: INDIAN SCENARIO

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INTRODUCTION

The first experimental study in the world on the phenomenon of generation of Acoustic Emission dates back to the 1950's when Josef Kaiser heard these emissions during metal failure. But unfortunately, the work could not get impetus because of the limited means of sensing high frequency waves and the lack of knowledge dissemination. In the 1970's, the electronic instrumentation improved resulting in the increased activity centers of AE. At that time, Rao initiated work in this area at the Indian Institute of Science, Banglore for the first time in India. With the pioneering efforts of his group at IISc, new vistas were opened in this field. As a consequence of it, the first paper from India on this phenomenon was published in 1977 by Eshwar, et al. [1]. The paper dealt with the study of the form of AE observed on the cracking/breaking of plywood with prepared defects.

Since then, research activity in AE has been conducted to study the phenomena in different materials such as iron, aluminium, copper, brass, wood, concrete, etc. Some of the works have been related to Signal analysis [2,3], Noise suppression [4], Fatigue [5], Machine tool wear [6], Composites [7,8,9], etc. The major stress was laid on the generation of emissions during the failure of austinitic steel [10], which accounts for most of the structural problems in the Nuclear Industry. Department of Atomic Energy, realizing its potential collaborated with Academic Institutions for further research in AE Technique. In 1984, Acoustic Emission Working Group of Indian, AEWG (I) was formed with the idea of advancing this technology through timely exchange of technical information and promoting standardized terminology in acoustic emission documentation. This led to a steep increase in the awareness and utility of this technique.

Today, in India, there are over 40 organizations conducting AE research in areas like fracture, stress-corrosion cracking, leak detection, structural integrity, composites, weld monitoring and condition monitoring of rotating components, etc.

Rotating machineries in any industry constitute a major portion of the infrastructure. Their failures, if not monitored periodically, can

lead to large down-time, thus affecting the productivity. At present, conventional condition monitoring techniques like Temperature Shock Pulse and Vibration level Monitoring are used to prognosticate the useful life of the machinery. Hence, a study on the use of Acoustic Emission as a condition monitoring technique was sponsored by Aeronautical Research & Development Board (AR&DB), Ministry of Defence, GOI and Indian Institute of Technology, Delhi.

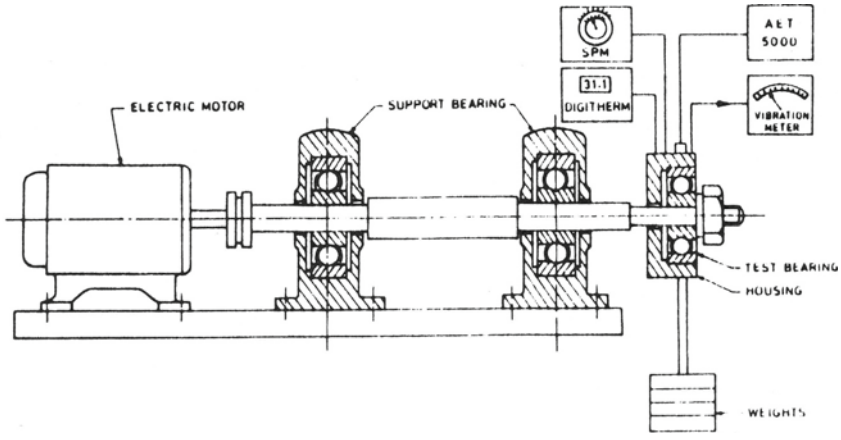

Fig. 1. Bearing test rig and instrumentation.

One of the typical features in the Indian Industries is the failure of bearings. The root cause lies in the recirculation of the discarded bearings after their reconditioning. These bearings, thus, do not meet the standards and fail prematurely. This problem was chosen as a test case for checking the efficacy of the Acoustic Emission as a Condition-Inspection technique.

Experiments were devised to test two categories of bearings-standard and reconditioned. A special rig (Fig. 1) was designed and set up for easy removal and fitment of bearings. It has provisions for loading the bearing (Fig. 2) and mounting different sensors. All the condition monitoring techniques listed above were utilized and a comparative study was carried out on the basis of the experimental data.

Figures 3, 4, and 5 display the bearing condition parameters like temperature rise, shock-pulse value and vibration level respectively during 10 minute runs under lubricated condition. It is seen that while SPM has a definite difference for the two categories, the other two techniques fail to identify bearing condition at no-load condition.

Acoustic Emission Peak-amplitude graphs displaying the bearing condition are shown in Figures 6 and 7. The statistical analysis of the data has led to a few interesting results in favor of this technique [11,12].

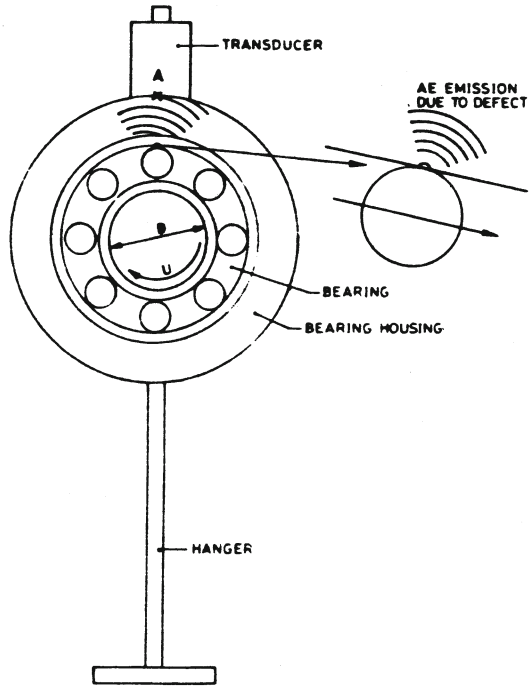

Fig. 2. Bearing loading and sensor location.

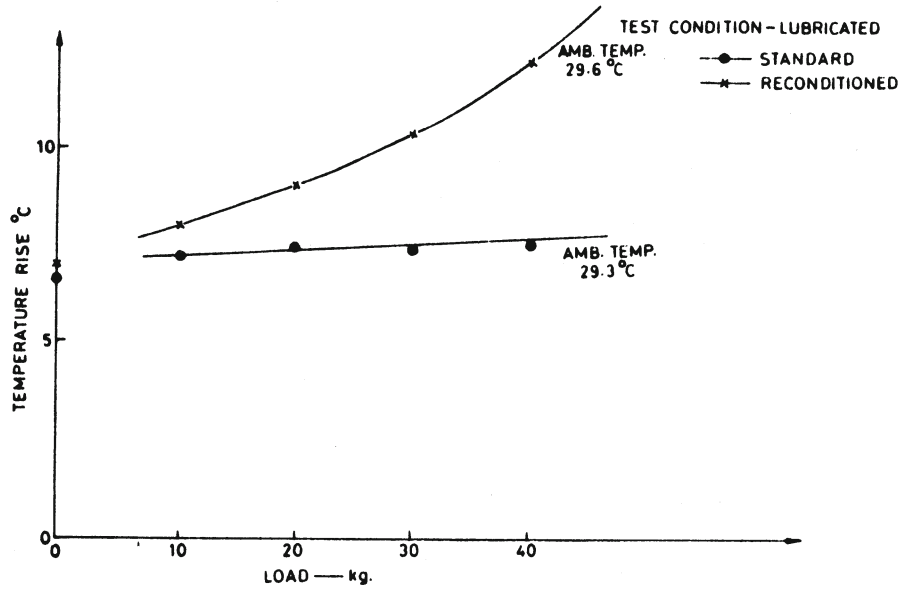

Fig. 3. Rise in temperature with load.

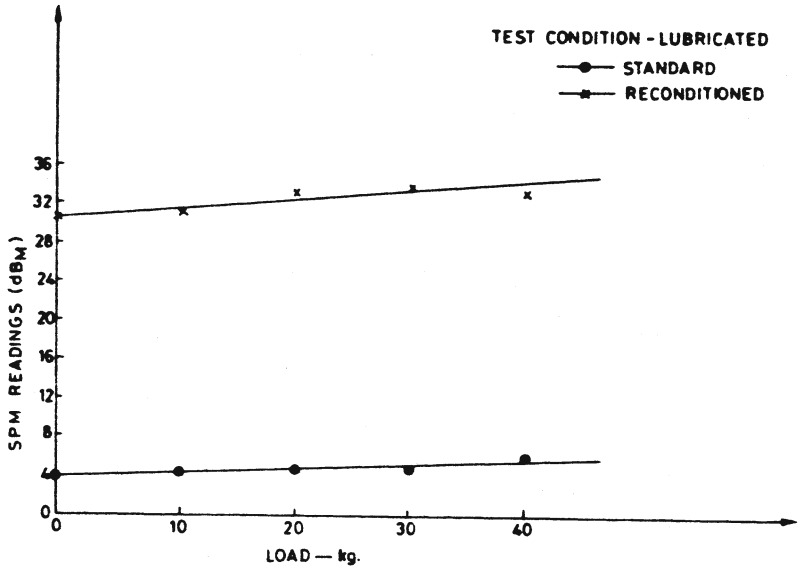

Fig. 4. Variation in SPM readings with load.

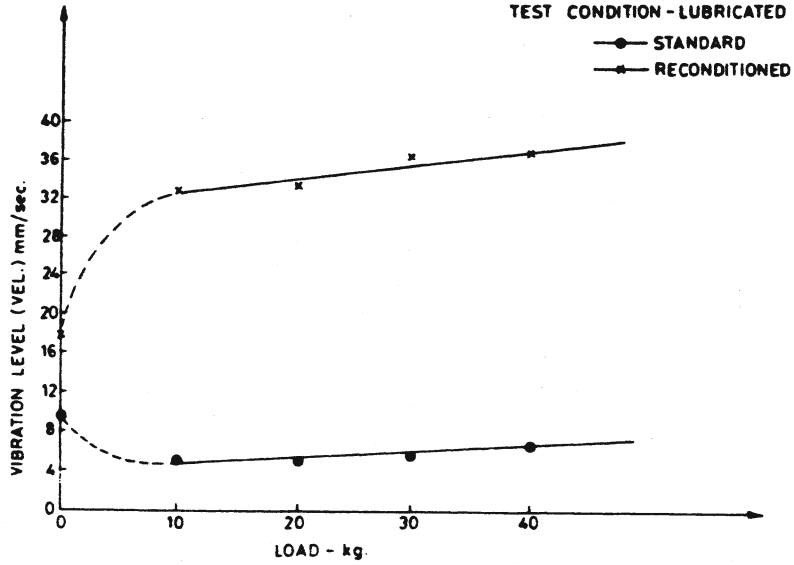

Fig. 5. Variation in vibration levels with load.

Based on the positive results of AET as a Condition-Inspection technique, further work is being conducted in understanding and quantifying the behavior of the interaction of mechanical elements involved in any rotating component.

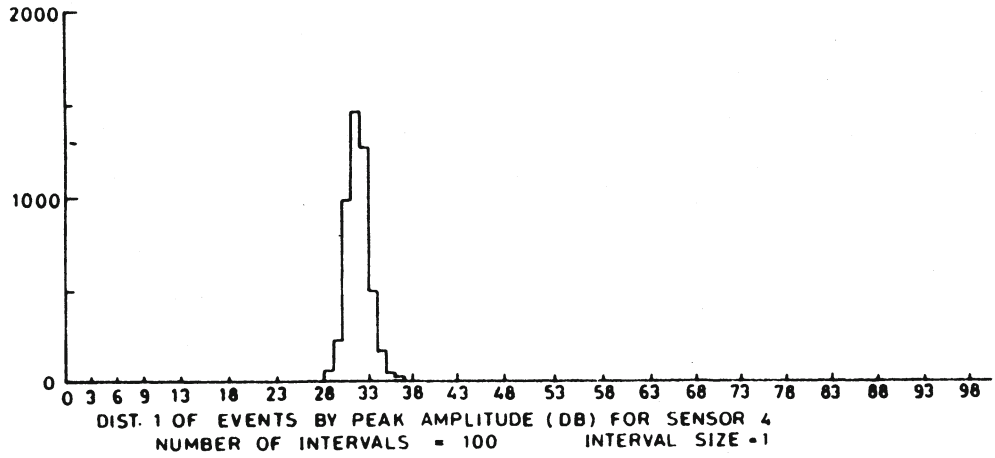

Fig. 6. AE peak amplitude for Standard bearing.

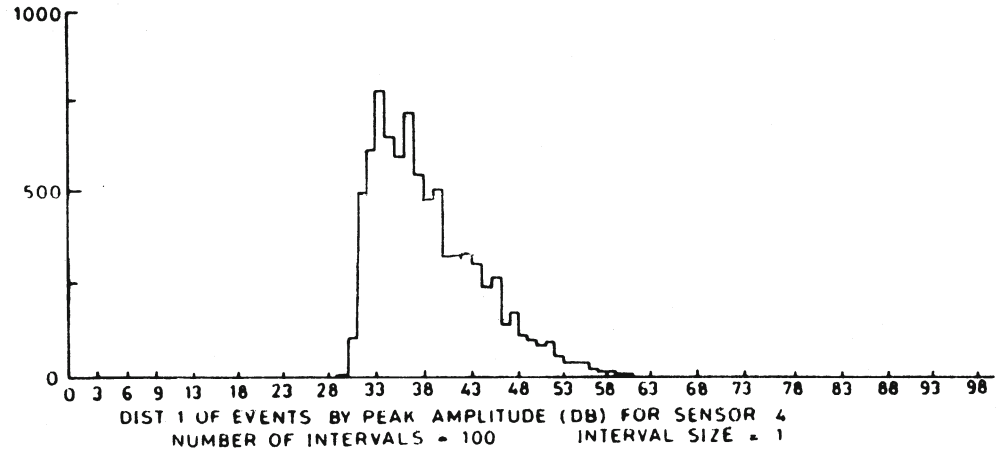

Fig. 7. AE peak amplitude for Reconditioned bearing.

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