

STUDY OF FAULT DIAGNOSIS ON INNER SURFACE OF OUTER RACE OF ROLLER BEARING USING ACOUSTIC EMISSION

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Abstract - This paper deals with acoustic emission method to predict defect on outer race of roller bearing element. In rolling element vibration based fault diagnosis methods are very popular but this method is more significant in rolling element fault diagnosis. The peaks rising by acoustic emission method have more clarity than vibration analysis. A test rig has been prepared to perform experimentation on roller bearing without defect and with defect on inner face of outer race. The faults of different sizes were prepared and experimentation was performed by varying speed. The contact type acoustic sensor was interfaced with PAK software to record the results. The amplitude of acoustic for varying speed was compared.

Key Words: Acoustic Emission, Fault Diagnosis, Fast Fourier Transform (FFT), Muller BBM Vibro-acoustic PAK Software, Roller Bearing

1. INTRODUCTION

Acoustic emissions are defined as transient elastic waves generated from a rapid release of strain energy caused by a deformation on the surface of material. Acoustic emissions are high frequent, transient sound waves emitted when rapid local stress redistributions occur in a material. The stress redistributions are normally caused by the generation of structural changes in a material under a general loading condition. Examples of structural changes are crack growth, phase transformations, corrosion, wear and loading. The Acoustic Emission non destructive testing technique is based on the detection and conversion of these high frequency elastic waves to electrical signals. This is accomplished by directly coupling piezoelectric transducers on the surface of the structure under test and loading the structure. Sensors are coupled to the structure by means of a fluid couplant and are secured with tape, adhesive bonds or magnetic hold downs. The output of each piezoelectric sensor is amplified through a low-noise preamplifier, filtered to remove any extraneous noise and furthered processed by suitable electronic equipment.

1.1 Experimental Setup

A test rig was designed to simulate early stage of bearing defects as shown in Fig- 1. The test-rig consists of a shaft coupled with loading disc. The Shaft was supported by two bearings and connected to a dimmer-stat speed controlled

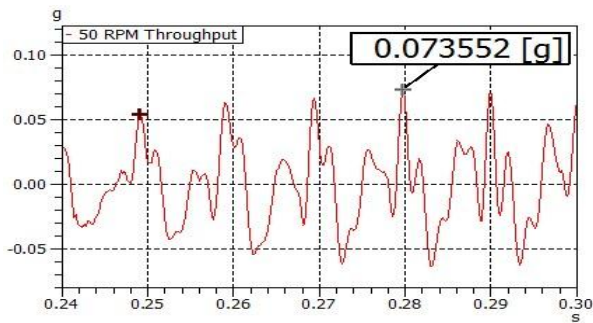
induction motor through a flexible coupling. A set up consists of single phase permanent magnet 1 HP, 1500 rpm DC induction motor. Two bearing were mounted on the shaft. The shaft was ground and hardened. At one end there was self-aligning roller bearing and at the other end there was roller bearing which is to be tested. The disc was coupled to the shaft by two grub screws, radially on the disc. An arrangement of spring balance with leather belt was done to apply radial load. The piezoelectric transducer was mounted on bearing housing which was interfaced to PAK software through FFT.



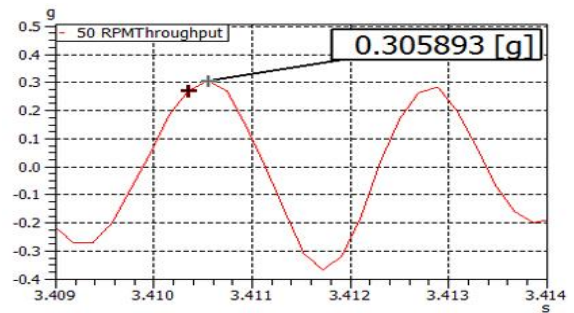
Fig- 1: Experimental Setup

1.2 Experimental Procedure

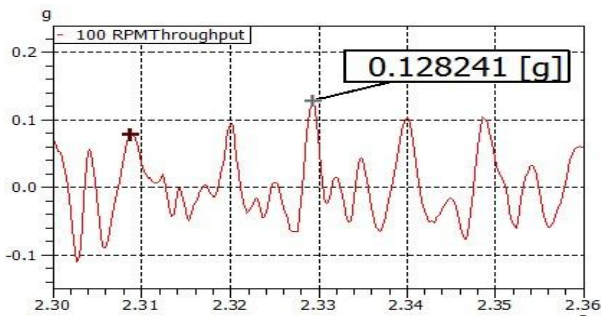
Initially a healthy roller bearing N203M was mounted on bearing housing. The test rig was run at 50 RPM using dimmer. The piezoelectric transducer was fixed on bearing housing which was interfaced with Muller BBM vibro-acoustic PAK software through FFT. The readings of amplitude of acoustic emission as acceleration vs time for 50, 100, 150 and 200 RPM were noted. The defective bearings of lateral crack on inner face of outer race of roller bearing were created by Electrical Discharge Machining (EDM). The lateral crack on inner face of outer race of roller bearing was of 0.6 mm, 0.8 mm, 1.0 mm and 1.2 mm. The healthy bearing was replaced by each defective bearing and amplitude of acoustic emission was noted for various speed conditions through Muller BBM vibro-acoustic PAK software.



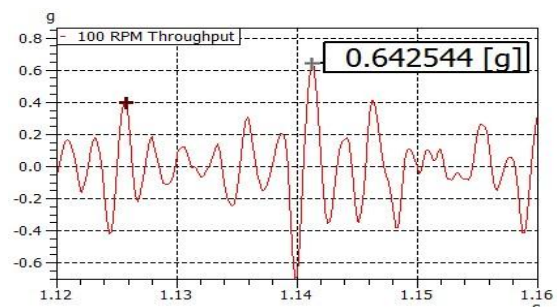
Acoustic Emissions of Healthy Bearing at 50 RPM Without Load



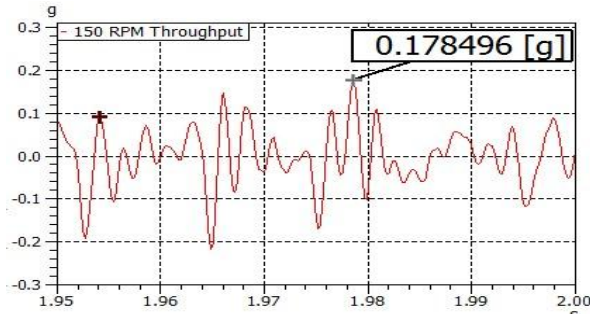
Acoustic Emissions of Bearing with 0.6 mm Crack at 50 RPM Without Load



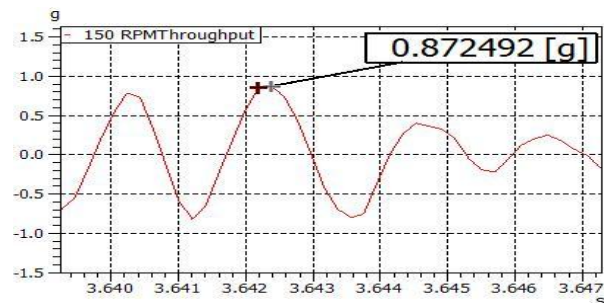
Acoustic Emissions of Healthy Bearing at 100 RPM Without Load



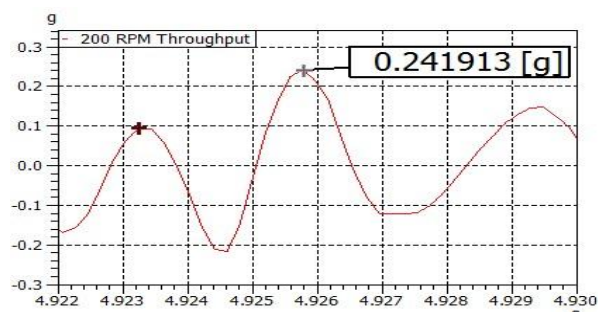
Acoustic Emissions of Bearing with 0.6 mm Crack at 100 RPM Without Load



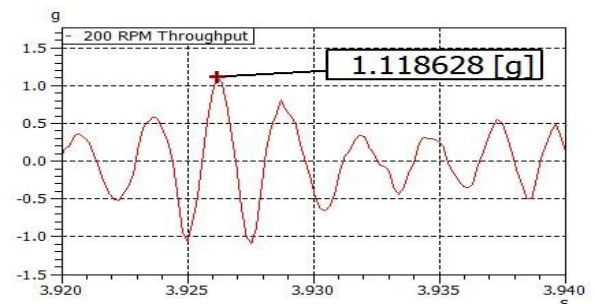
Acoustic Emissions of Healthy Bearing at 150 RPM Without Load



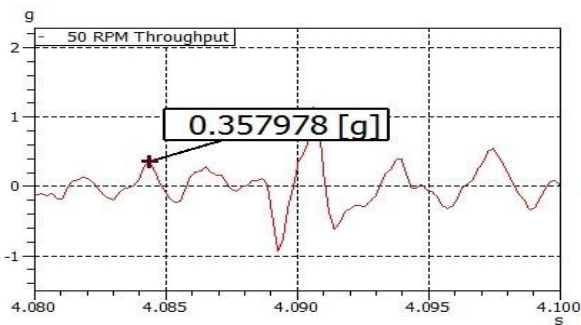
Acoustic Emissions of Bearing with 0.6 mm Crack at 150 RPM Without Load



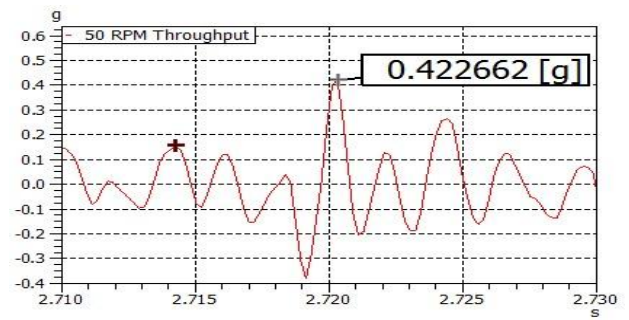
Acoustic Emissions of Healthy Bearing at 200 RPM Without Load



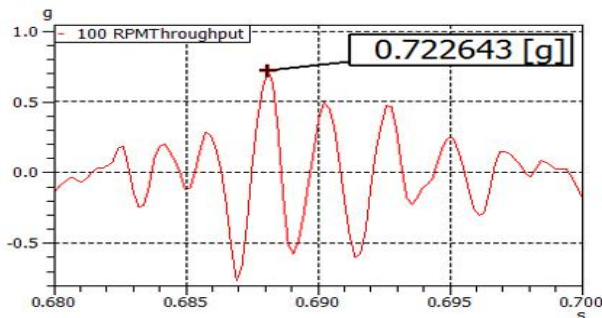
Acoustic Emissions of Bearing with 0.6 mm Crack at 200 RPM Without Load



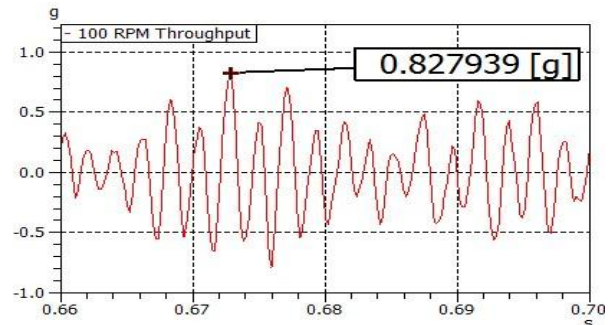
Acoustic Emissions of Bearing with 0.8 mm Crack at 50 RPM Without Load



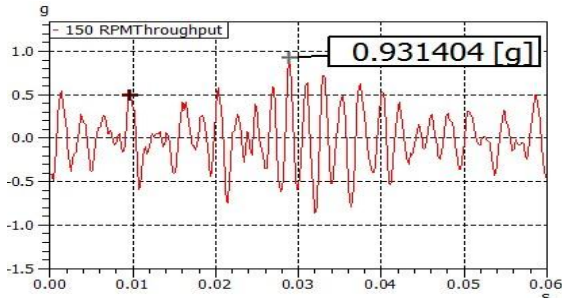
Acoustic Emissions of Bearing with 1.00 mm Crack at 50 RPM Without Load



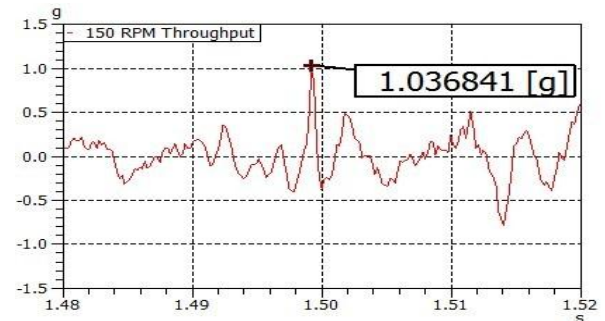
Acoustic Emissions of Bearing with 0.8 mm Crack at 100 RPM Without Load



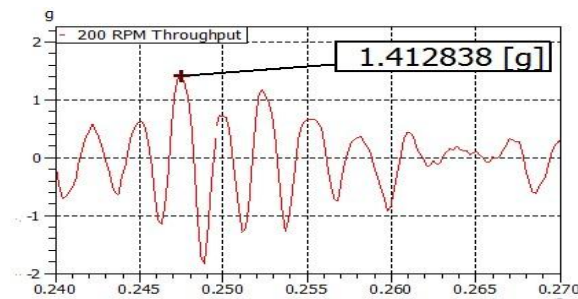
Acoustic Emissions of Bearing with 1.00 mm Crack at 100 RPM Without Load



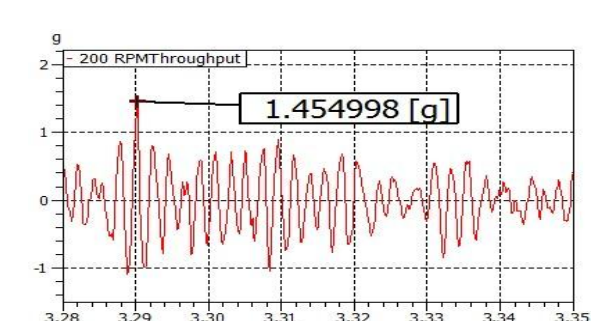
Acoustic Emissions of Bearing with 0.8 mm Crack at 150 RPM Without Load



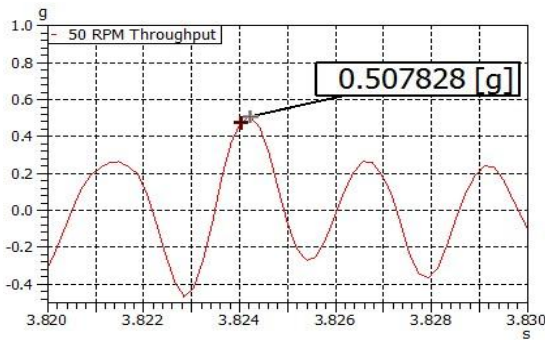
Acoustic Emissions of Bearing with 1.00 mm Crack at 150 RPM Without Load



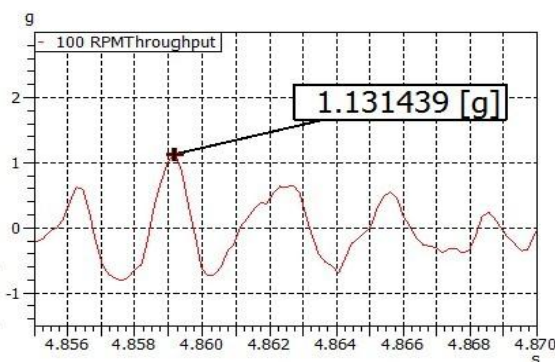
Acoustic Emissions of Bearing with 0.8 mm Crack at 200 RPM Without Load



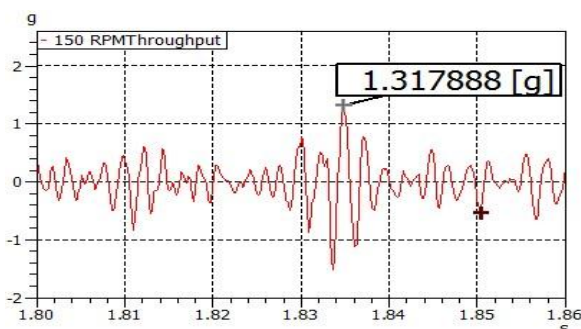
Acoustic Emissions of Bearing with 1.00 mm Crack at 200 RPM Without Load



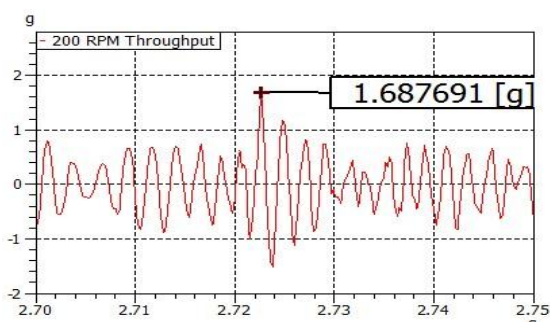
Acoustic Emissions of Bearing with 1.2 mm Crack at 50 RPM Without Load



Acoustic Emissions of Bearing with 1.2 mm Crack at 100 RPM Without Load



Acoustic Emissions of Bearing with 1.2 mm Crack at 150 RPM Without Load



Acoustic Emissions of Bearing with 1.2 mm Crack at 200 RPM Without Load

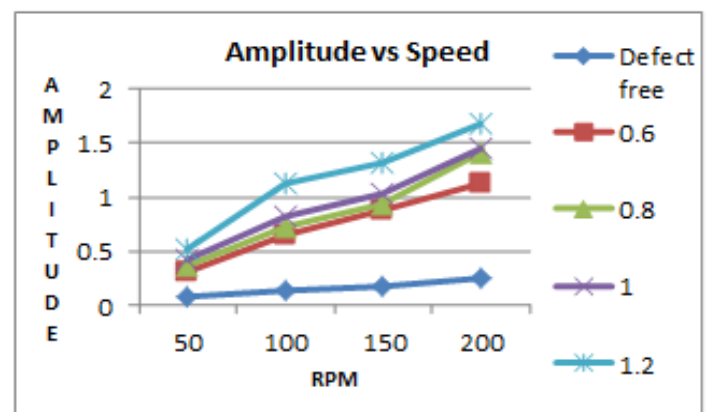
2. RESULTS AND DISCUSSION

Acoustic emission amplitude for roller bearing N203M with and without defect is tabulated in Table 1. It is observed that from the graph that amplitude is not significant but in defective bearing increase in acoustic amplitude is significant.

Table- 1: Amplitude at Various Defects

| Speed (RPM) | Defect Size | | | | |
|-------------|-------------|--------|--------|--------|--------|
| | Healthy | 0.6 mm | 0.8 mm | 1.0 mm | 1.2 mm |
| 50 | 0.0735 | 0.3058 | 0.3579 | 0.4226 | 0.5078 |
| 100 | 0.1282 | 0.6425 | 0.7226 | 0.8279 | 1.1314 |
| 150 | 0.1784 | 0.8724 | 0.9311 | 1.0368 | 1.3178 |
| 200 | 0.2419 | 1.1186 | 1.4128 | 1.4549 | 1.6876 |

Graph-1. Comparison of Amplitude of Acoustic Emission at Varying Speeds



3. CONCLUSIONS

Bearing with defect and without defect on inner face of outer race was analyzed by using acoustic emission technique. There is a significant difference in acoustic emission amplitude between healthy and faulty bearing. An acoustic emission spectrum clearly shows that as the defect size increases acoustic emission amplitude also increases. Hence from experimental investigation it is revealed that the acoustic emission technique gives better result to diagnose the defect with inner face of outer race of roller bearing.

REFERENCES

[1] Mao Kunli, Wu Yunxin, "Fault Diagnosis of Rolling Element Bearing based on Vibration Frequency Analysis", Third International Conference on Measuring Technology and Mechatronics Automation, 2011

- [2] Hasan Ocak, Smet Bayram, H. Metin, "Vibration analysis based localized bearing fault diagnosis under different load conditions", September 15-16th 2011.
- [3] Elforjani and Mba, "Accelerated natural fault diagnosis in slow speed bearings with Acoustic Emission", Engineering Fracture Mechanics, Vol.77, pp.112-127, 2010
- [4] Ravindra, Srinivasa and Krishnamurthy, "Acoustic emission for tool condition monitoring in metal cutting", Wear, Vol.212, pp.78-84, 1997.
- [5] James Li and Li, "Acoustic emission analysis for bearing condition monitoring", Wear, Vol.185, pp.67-74, 1995
- [6] Mr. Avinash V. Patil, Dr. Bimlesh Kumar, Dr. R.B.Barjibhe, "An Extensive Review on the use of Acoustic Emission Technoque for Continuous Monitoring", International Research Journal of Engineering and Technology, Vol. 03, Issue 02, pp 137-140, 2016