ACOUSTIC EMISSION AS AN AID TO UNDERSTANDING RACEWAY DAMAGE IN ROLLING ELEMENT BEARINGS

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ABSTRACT

Acoustic Emission (AE) sensors were used to detect signals arising from a cylindrical roller bearing with artificial defects seeded onto the outer raceway. High frequency analysis indicated the condition of the bearings through the determination of an increase in the structural resonances of the system as the size of an artificial defect was increased. As higher loads were applied, frequencies around 100kHz were excited, indicating the release of AE possibly attributed to friction and the plastic deformation as peaks, induced through engraving of the raceway, were over-rolled and worn down. Sensitivity of AE to this level in bearings indicates that detection of subsurface cracking may be possible in future work, providing early indication of incipient failure.

INTRODUCTION

Over recent years, Acoustic Emission (AE) has gained ground as a viable structural health-monitoring tool and has been proposed as a more sensitive technique to detect early-stage damage within tribological systems. Defined as a "transient wave generated by the rapid release of energy within a material" [1], AE is the detection of transient elastic waves caused by plastic deformation, crack tip growth, fluid flow, sharp impacts, and friction/rubbing fractures/dislocations of fibres and is commonly used to detect damage in static structures such as bridges and pressure vessels. For bearings it is thought that AE is induced through subsurface cracking, friction and plastic deformation of surface asperities during the running in phase and rolling fatigue failure, and as such can provide valuable insight into bearing condition [2].

METHOD

The test bearing, a SKF N204ECP single row roller bearing was placed between two, double-row tapered roller support bearings (Type SKF 22202/20E) and subjected to incremental loading of 0.29, 0.79, 1.29 and 1.89kN (L1-L4 respectively) at a speed of 5800rpm (Figure 1). Mistras Group Ltd. (MGL) Nano30 AE sensors were placed on the front face of the bearing housings and four wave streams (raw sensor output) were recorded for each load at a sampling frequency of 2MHz on a MGL PCI-2 system. Using an engraver, defects were artificially seeded into the outer raceway of the test bearing and were characterised using a Taylor Hobson Talysurf surface profilometer before and after being tested.

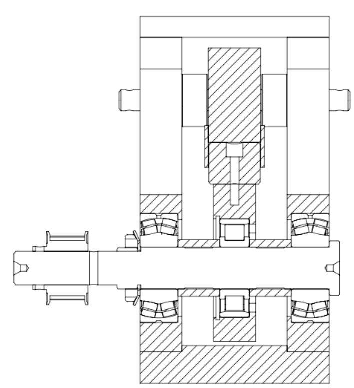

Figure 1) Test Head Schematic

RESULTS

Figure 2 is a stacked Fast Fourier Transform (FFT) used to illustrate the increase in frequency amplitude for a bearing with a 0.6x0.7mm defect seeded into the centre of the outer raceway to an approximate depth of 12µm. Comparison of pre and post-test surface profiles have led to the increase in frequency amplitude at approximately 100kHz being considered to be due to the plastic deformation of small peaks situated around the defect, induced through the engraving process, as they are flattened. Similar behavior was noted for a range of defect sizes tested in this work. Although not truly representative of natural bearing defects, the seeded defects used in this experiment have demonstrated the sensitivity of AE as a tool for gaining understanding of rolling element bearing failure and it is hoped further insight will be achieved through bearing life tests.

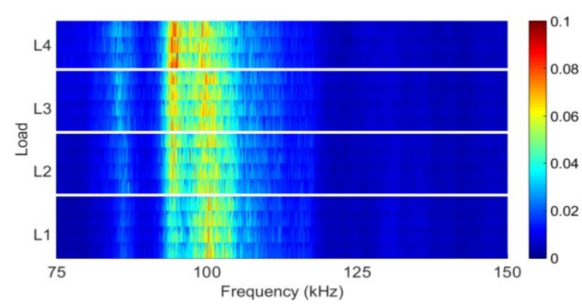

Figure 2) High Frequency Stacked FFT

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REFERENCES

[1] Mistras Group Limited 2015 Available at: http://www.mistrasgroup.co.uk
[2] Lees A W, Quiney Z, Ganji A and Murray B 2011 *J. Phys. Conf. Series* **305** 012074