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Fault Detection and Diagnosis of Ball Bearing Using Advanced Vibration Analysis Techniques

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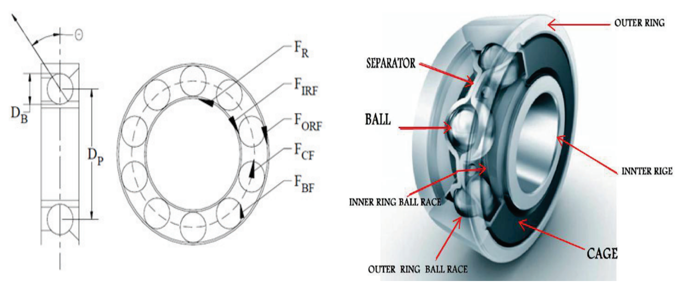
Introduction

The antifriction bearing vibration measurement is one of the major condition monitoring tools in regular use. By measuring the velocity, acceleration and frequencies emitted from a rolling bearing it is possible to tell its condition and the prospect of imminent failure.

Bearing Fault Characteristic Frequencies

The bearing characteristic defect frequency (BCF) depends on the geometry of the bearing.



Figure(1) Dimensions and Frequencies Related to the Characteristic Fault Frequencies .

- ➢ In this test the shaft rotational frequency calculated as in the table by using Matlab software. The signatures of failure appear in the vibration signals at frequencies named characteristic frequencies of bearing as in the equations below:

Outer race falut frequancy $f_{ORF} = \frac{N_b}{2} f_A \left[1 - \frac{D_B}{D_P} \cos\theta\right]$ (1)

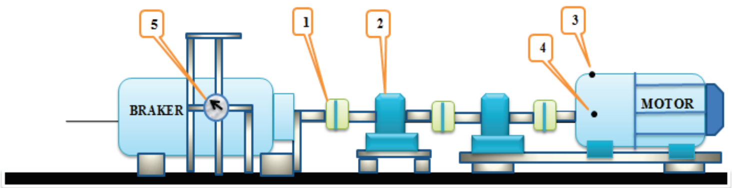
Inner race fault frequency $f_{IRF} = \frac{N_b}{2} f_A \left[1 + \frac{D_B}{D_P} \cos\theta\right]$ (2)

Where
$N_b$number of balls .
$f_A$shaft rotational frequency (Hz
D_B ball diameter (mm)
D_P Pitch circle diameter (mm)
θ contact angle between inner and outer races = 0º (because there is no axial load).

Nº	Load %	Shaft Speed (Hz)	Inner Race (Hz)	Outer Race (Hz)
1.	0	24.9341	135.2487	89.1582

Test Facilities and Bearing Faults

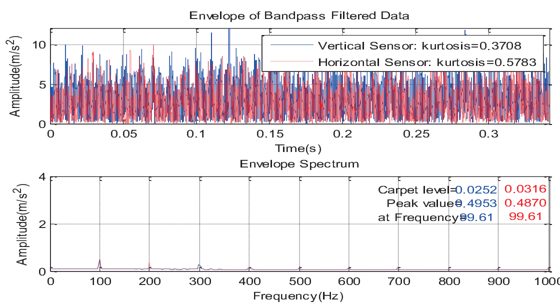
1- Flexible Couplings
2- Bearing house
3- Vertical Sensor
4- Horizontal Sensor
5-Load gauge



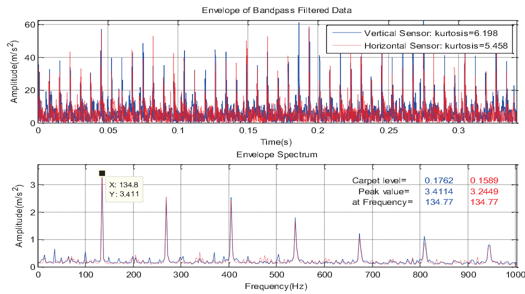
Figure(2) Schematic Diagram of Bearing Rig

Result

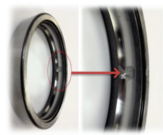
1--Healthy

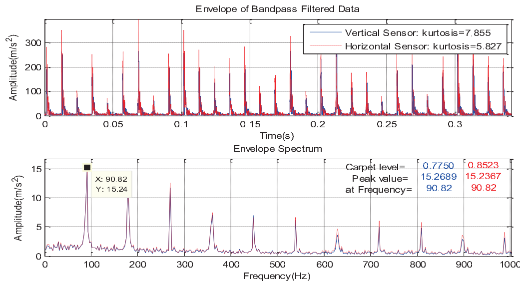


2-Inner race



3-Outer Race





Conclusion

- ➢ The initial result shows that, the envelope analysis spectrum is powerful method to detect, diagnosis and prognosis faults on the bearings.
- ➢ The bearing faults were significantly detected and diagnosed in both the inner race and outer race, which is the frequency value of the inner race fault are identified clearly at 134.8 Hz, Furthermore, this frequency value is very close to the calculated value at 135.2487Hz.
- ➢ The frequency value of the outer race fault are identified clearly at 90.08 Hz, furthermore, this frequency value is very close to the calculated value at 89.1582Hz.

Future Work

- ➢ Perform and carry out some further experiments to study and investigate the performance of vibration signal analysis.
- ➢ Study and understand signal processing method such as (Empirical Mode Decomposition (EMD) and Cyclic Autocorrelation Function (CAF)).

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