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

Original Citation


This version is available at http://eprints.hud.ac.uk/19395/

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

• The authors, title and full bibliographic details is credited in any copy;
• A hyperlink and/or URL is included for the original metadata page; and
• The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: E.mailbox@hud.ac.uk.

http://eprints.hud.ac.uk/
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.

\[ f_{\text{BCF}} = \frac{N_b f_a}{2} \left[ 1 + \frac{D_p}{D_b} \cos \theta \right] \]  \hspace{1cm} (1)

- Outer race fault frequency \[ f_{\text{ORF}} = \frac{N_b f_a}{2} \left[ 1 - \frac{D_p}{D_b} \cos \theta \right] \]  \hspace{1cm} (2)

Where
- \( N_b \) number of balls.
- \( f_a \) shaft rotational frequency (Hz)
- \( D_b \) ball diameter (mm)
- \( D_p \) Pitch circle diameter (mm)
- \( \theta \) contact angle between inner and outer races – 0° (because there is no axial load).

<table>
<thead>
<tr>
<th>No</th>
<th>Load</th>
<th>Shaft Speed (Hz)</th>
<th>Inner Race (Hz)</th>
<th>Outer Race (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>24.9341</td>
<td>135.2487</td>
<td>89.1582</td>
</tr>
</tbody>
</table>

Test Facilities and Bearing Faults
1. Flexible Couplings
2. Bearing house
3. Vertical Sensor
4. Horizontal Sensor
5. Load gauge

Conclusion
- The initial result shows that the envelope analysis spectrum is powerful method to detect, diagnosis and prognosis faults on the bearing.
- 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 is 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)).