Motor Electrical Fluting

Using Vibration Analysis to Detect & Prevent
Outline

- Introduction
- Cause & Effect
- Identifying the Problem
- Bearing life
- Bearing examples
- Protection Methods
Janelle Hammes

- Electric Motor and Repair, Inc
- West Columbia, SC
- Originally from Rockford, IL
- In the motor business for 2 years
Vibration Description
Cause & Effect

- VFD Induced Shaft Voltage
- Higher Carrier Frequency
- Constant Speed Operation
- Inadequate Grounding
- Excessive Loads/Over Heating
- Bearing Damage
- Insulation & Bearing Damage
- Bearing Damage
- Bearing Damage
- Bearing Damage
Identifying the Problems cont.
Identifying the Problems

- Vibration Analysis helpful in confirming bearing fluting (damage)
- Continuous monitoring/testing from installation on is recommended
- P.M is key
Identifying the Problems cont.

- Here are some examples of what to look for when you are performing a vibration analysis.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Vibration Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td><img src="image" alt="Normal Vibration" /></td>
</tr>
<tr>
<td>Rotor unbalance</td>
<td><img src="image" alt="Rotor Unbalance" /></td>
</tr>
<tr>
<td>Angular misalignment</td>
<td><img src="image" alt="Angular Misalignment" /></td>
</tr>
<tr>
<td>Parallel misalignment</td>
<td><img src="image" alt="Parallel Misalignment" /></td>
</tr>
<tr>
<td>Rotor bar broken</td>
<td><img src="image" alt="Rotor Bar Broken" /></td>
</tr>
<tr>
<td>Phase unbalance</td>
<td><img src="image" alt="Phase Unbalance" /></td>
</tr>
<tr>
<td>Bowed rotor</td>
<td><img src="image" alt="Bowed Rotor" /></td>
</tr>
<tr>
<td>Faulty bearing</td>
<td><img src="image" alt="Faulty Bearing" /></td>
</tr>
</tbody>
</table>

(a) Vibration signal
Identifying the Problems cont.

- Here is a good comparison of the good bearing vs the bad bearing. The difference is quite obvious.
Identifying the Problems cont.
Identifying the Problems cont.

- Voltage Analysis can be used to determine the likelihood of damage
- This method is not an exact science, however it is helpful
Half Cycle Voltage Waveform for a Typical PWM Inverter

Voltage

Time $1/T = f_{\text{switching}}$

$V_m$

dV

dt
Identifying the Problem cont.

- SKF Electrical Discharge Detector Pen
- Does not tell you what the problem is only a tool to assist in detection
Bearing life

\[ L_{10} = \frac{16700 \times \text{dynamic capacity x load rating}^3}{\text{rpm}} \]

\[ = \text{hours of life} \]

\[ B_{10h} = \frac{1000000}{60 \times \text{RPM}} \times \left( \frac{C}{P} \right)^p \]

Where

- \( B_{10h} = \) life of bearing in hours
- \( C = \) dynamic load rating (load at which at least 90% of identical bearings complete one million revolutions)
- \( P = \) equivalent dynamic bearing load
- \( p = \) exponent = (3 for ball bearing; 10/3 for roller bearing)
- \( \text{RPM} = \) revolutions per minute
Bearing Life
New Bearing Race

- New bearing race will be smooth
- Track will eventually form
Bearing Damage

- Pitting
- Early damage
Bearing Damage Cont.

- Birnelling
Bearing Damage cont.

- Fluting: “washboard” pattern.
- Vibration
- Noise
Bearing Damage cont.

- Rust damage / corrosion
Bearing Damage Cont.

- Excessive load / Overheating
- Brinelling and Discoloration
Protection Methods

- Shaft grounding
Protection Methods cont.

- Insulated/ceramic bearings or insulating the bearings
Protection Methods cont.

- Faraday Shield
Protection Methods cont.

- Sine wave filter
- Or DV/DT filter
Protection Methods cont.

- Conductive grease
- Can interfere with the performance of the shaft protector
Protection Methods cont.

- Bearing Protection Ring (SGR)
Bearing Installation Tips

- Handle with care
- Inspect shaft & housing
- Avoid overheating
- Use the same bearing that is replaced
- Use correct tools
- Pay attention

- Verify bearing ring & bearing seat
- Don’t clean new bearings
- Proper lubrication
- Rotate idle bearings
- Look for danger signs
- Find the cause of failure
Thank you