Improving Bearing Life by Studying & Optimizing Tooling Design

#1 Mohan V. Kadam, #2 Suneeta V. Phadkule

1PG Student, Dept of Mech Engg, JSPM’S JSCOE, Hadapsar, Pune, India-411028
2Associate Professor, Dept of Mech Engg, JSPM’S JSCOE, Hadapsar, Pune, India-411028

ABSTRACT

One of the primary reasons for rejection of bearing is vibration. The increasing number of lobes in various bands results into increasing vibration. The bearing manufacturing process which consists of process parameters and toolings used for manufacturing determines the number of lobes. For this study one of the bearing types which was having high rejection in ‘M’ out of L, M, H band is analysed from various perspectives. Tooling for inner ring plays major role for ‘M’ band rejection. Tooling parameters analysed and modified for improving ‘M’ band. The bearing rejection due to above cause reduced from 8% to 0.5%. Quality level improved from Q66 to Q55 which is better.

Keywords— Lobe, band, quality level, micro centric

I. INTRODUCTION

Silent is one of the most demanding requirements for DGBB, mainly for small sizes (OD < 52mm), but also for medium sizes (OD ≥52mm). The scope of silent running is broad and covers several aspects such as:

- Vibration or air borne noise generated by bearing itself i.e. naked, while it rotates.
- Vibration or air borne noise generated by the application. The bearing is then part of a system & can act as an “exciter” of the structure or modify the system response depending on its rigidity for instance.

1.1 Vibration Causes in Bearing:

Vibrations in bearings are caused by time varying forces in bearing. The contact forces moved around the bearing giving rise to “perfect bearing vibration” in the outer ring. The geometric imperfections of raceways & balls such as:

- Waviness
- Roughness
- Form Error

Or the parameters such as:

- Cage Problem
- Local defects of balls & rings
- Dirt Particles
- Grease
- Radial Clearance

Are all changing the contact forces by which the bearing and the system coupled to it are excited. Each of these quality aspects of the raceways are coupled to the quality of the processes who made these components. Vibration plays major role in rotatinelements of m/c.
1.2 Types of Vibrations in Bearing

1.2.1 Waviness

The VKR or VKK is the evaluation of number and the size of the waves (Lobes):

On the race way for the rings on the Diameter for the rolling elements (for DGBB: balls):

For the rings the waviness is called VKR.

The VKR is split into 3 bands:
- Low band (L)
- Medium band (M)
- High band (H)

For the grinding process the L band is subdivided in 3 bands L1, L2, L3

For the rolling elements the waviness is called VKK.

The VKK is split into 3 bands:
- Low band (L)
- Medium band (M)
- High band (H)

or the grinding process the M band is subdivided in 2 bands M1, M2.

II. Vibrations

2.1 Types of Lobes Generated

The SKF concept

2.2 Measurement of Lobes in Vibration

MEASURING METHOD (AFBMA)

Anti-Friction Bearing Manufacturers Association, Inc. (ANSI/AFBMA)

Standards to cover the measurement of noise and vibration in bearings.

Focus on test conditions such as:
- Speed of rotation: 1800 rpm + / - 2%
- External forces: axial, radial loads...
- Mechanical unit: coupled masses etc.
- Point and direction of measurement
- Stabilized vibration level
- Lubrication
- Cleanliness of bearing and test environment
- Mechanical and electrical frequency response
- Time averaging method

- Test sequence: one or two sides . . .
- Size limitations
- Physical quantity: μm/s

Frequency range: 50-300-1800-10000 Hz

III. Case Study

3.1 Existing Condition

- 63/28HN3 IR is always having VKR bad after groove grinding.
- Many DOE’s done but unable to achieve 100% result.
- This was badly affecting order loss with additional losses of m/c adjustment & tooling changes.

1.2 63/28 IR MWA Report After Grinding

1.3 63/28IR MWA Report After Honing

1.4 Analysis of MWA Reports After Grinding

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (range)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta ±r</td>
<td>2.4~ 5.6 μm</td>
<td>Not ok</td>
</tr>
</tbody>
</table>
L1, L2, L3 Except L1 all above limit Not ok

| No of lobes error | 3~5 (4~6) | Consistently same |

3.5 Analysis of MWA Reports After Honing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta ±r</td>
<td>0.35~ 0.6 μm</td>
</tr>
<tr>
<td>L,M,H</td>
<td>Not within tolerance band.</td>
</tr>
<tr>
<td>No of lobes</td>
<td>3<del>5 (4</del>6)</td>
</tr>
</tbody>
</table>

IV. ROOT CAUSE ANALYSIS

- Lobe error dominant for 3~5 lobes.
- This is mainly caused by shoe holder geometry, micro centric value only. (Ref SKF Gr theory).

This parameter was zeroed as all other parameters & tooling/m/c condition’s viz. - Driving plate run-out, new shoe etc were checked & confirmed not affecting

To confirm the hypothesis that there is problem in shoe holder design & it is affecting only these lobes, it was decided as below –

i. Compare shoe holder design for all types on Ch01 SGP.
ii. Identify difference in design.
iii. Check other type rings processed &analyse on MWA.

Shoe holder design is same for all types on Ch01 SGP Confirmation done for 1838001, 6206& 63/28. All types have same lobe error.

V. ACTION PLAN

Option to correct this lobe error.

i. Change in shoe holder – Reduce or increase Included Angle.

As this was trial & error & more time consuming- This option was decided to be taken in later stage.

ii. Increase micro-centric offset.

This was taken forward & pin with 0.8mm offset was procured. Existing design was of 0.4mm offset.

VI. RESULT

1) MWA analysis for 63/28 type.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tolerance limit</th>
<th>Before value</th>
<th>After value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta ±r</td>
<td>0.2μ</td>
<td>0.772μ</td>
<td>0.372μ</td>
</tr>
<tr>
<td>L1,L2,L3</td>
<td>31.5,63,180</td>
<td>50,104,168</td>
<td>21,35,45.</td>
</tr>
<tr>
<td>L</td>
<td>90</td>
<td>66</td>
<td>42</td>
</tr>
<tr>
<td>M</td>
<td>32</td>
<td>59</td>
<td>33</td>
</tr>
<tr>
<td>H</td>
<td>11</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Lobe error</td>
<td>Max(3)-0.225μ</td>
<td>Max(3)-0.081μ</td>
<td></td>
</tr>
</tbody>
</table>

MWA report
These results were achieved in Jan 2013 batch. This was reconfirmed in Feb & Mar 13 batches & was confirmed partly (20%) batch successfully. This also helped to tune cycle time to 6.5 sec on SGP which is bottleneck. MWA analysis for 63/28 type was done during confirmation batch run in Jan 13. Batch setting on SGP m/c was done with 0.8 mm offset pin & confirmation was taken for random ring (ground as well as honed) picked from channel & checked on MWA.

VII. CONCLUSION.

- Any material with superfinishing or honing operation should be free from L & M Band (two or three point ovality).
- Product life can be improved by reducing vibration levels.
- Product quality level can be increased by increasing higher lobes means reducing amplitude of vibration.

REFERENCES