New product introduction  
FDB ( Fluid Dynamic Bearing )  
Presentation to customer
Content

1. Comparison of individual types of bearing
2. FDB introduction
3. FDB performance / reliability
4. Summary of FDB
5. Appendix
1. Comparison of individual types of bearing

1-1 Bearing types JARO provides

(1) Sleeve bearing;

(2) Dual ball bearing;

(3) 1 Ball, 1 Sleeve bearing;

(4) FDB (new product in 2004Q2)
### 1. Comparison of individual types of bearing

#### 1-2 The comparison analysis table

<table>
<thead>
<tr>
<th></th>
<th>Sleeve</th>
<th>Hypro</th>
<th>1B1S</th>
<th>2BB</th>
<th>FDB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Range</strong></td>
<td>Lowest</td>
<td>Lower</td>
<td>Middle</td>
<td>Higher</td>
<td>Higher</td>
</tr>
<tr>
<td><strong>Noise (Only Rotor /AD9225 / 3100 rpm / 0.3m)</strong></td>
<td>Higher 26dB(A)</td>
<td>Middle 25dB(A)</td>
<td>Highest 27dB(A)</td>
<td>Lower 24.4dB(A)</td>
<td>Lowest &amp; Stable 21.3dB(A)</td>
</tr>
<tr>
<td><strong>Life Expectancy (Hours/L10/ 40℃)</strong></td>
<td>31,000</td>
<td>40,000</td>
<td>50,000</td>
<td>50,000</td>
<td>60,000</td>
</tr>
<tr>
<td><strong>Operation Temperature</strong></td>
<td>Under 70℃</td>
<td>Under 70℃</td>
<td>Under 70℃</td>
<td>Under 90℃</td>
<td>Under 90℃</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>Easy to Oil Leakage</td>
<td>Easy to Oil leakage It should be protected by protective structure.</td>
<td>Noisy</td>
<td></td>
<td>Replace 2BB</td>
</tr>
<tr>
<td><strong>Apply to</strong></td>
<td>Power Supply, Case fan</td>
<td>N/B, Case Fan, VGA cooler</td>
<td>N/B, Hub, CPU cooler, Projector</td>
<td>N/B, Projector, PDP-TV, VGA cooler, Server</td>
<td>PDP-TV, N/B, Projector</td>
</tr>
</tbody>
</table>
1. Comparison of individual types of bearing

1-3 Before Burn-in Test
[Type: AD0612- FDB/2BB]

FDB fan performs the better performance by air flow, pressure, noise, power consumption before 7 days of burn-in (90 degreeC)
1. Comparison of individual types of bearing

1-3 After Burn-in Test
[Type 0612- FDB/2BB]

FDB fan performs the better performance by air flow, pressure, noise, power consumption after 7 days of burn-in (90 degreeC)

Air flow  ➔  Pressure  ➔  Noise  ➔  Current

Better
2. FDB introduction

2-1 Design concept

- **FDB**: Fluid Dynamic Bearing

- Bearing can endure high temperature
- No mechanical contact during revolution
- No oil reduction
- No oil quality change
- No oil leakage structure
Our FDB performs longer life by no metal contact with shaft to bearing.
2. FDB introduction

2-3 Types of FDB structure

(A) Open type

(B) Closed type

Our FDB is (B) Closed type. On case of using material of FDB by powder(with hole), it is not Occur of oil flew out. Then it can keep long term life.
2. FDB introduction

2-4 The comparison analysis table

<table>
<thead>
<tr>
<th></th>
<th>Life</th>
<th>Contact</th>
<th>Contact Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLEEVE Bearing</td>
<td>× 31,000 Hours @ 40 °C / 65%</td>
<td>Slide</td>
<td>Oil to Metal</td>
</tr>
<tr>
<td>BALL Bearing</td>
<td>○ 50,000 Hours @ 40 °C / 65%</td>
<td>Rolling</td>
<td>Grease</td>
</tr>
<tr>
<td>FDB</td>
<td>○ 60,000 Hours @ 40 °C / 65%</td>
<td>Oil with high pressure to Shaft float up</td>
<td>Oil</td>
</tr>
<tr>
<td>description</td>
<td></td>
<td>3700RPM,AB0612</td>
<td></td>
</tr>
</tbody>
</table>

Our FDB can support the long term life thru no metal contact with shaft to bearing.
2. FDB introduction

2-5 Motor design of conventional bearing and FDB

(A) Conventional:

(B) New Technology : FDB
2. FDB introduction

2-6 FDB structure with fan other components

Remark: Oil seal structure (repellent material) is not shown
2. FDB introduction

2-7 FDB Features

Major advantages over conventional bearings

Design:

- **Dynamic pressure built-up centering the shaft**
  - lubricating oil pressure gained by the shaft rotation

- **No metal surface contact**
  - lubricating oil between shaft and bearing
  - no metal-to-metal contact
  - lower noise
  - longer operating life
2. FDB introduction

2-7 FDB Features

Major advantages over conventional bearings

Design:

- **Vacuum impregnating oil**
  - no air bubbles
  - no oil leakage due to air pressure variation
  - higher level non-operational shock resistance
2. FDB introduction

2-7 FDB Features

Major advantages over conventional bearings

Design:

- **Capillary seal structure**
  - Lubricating oil leakage protection
  - Reliable even at higher temperature condition
  - Complete seal, not affected by mechanical position change
  - Less than 1% oil evaporation under 60°C, 30000Hrs aging test
2. FDB introduction

2-7 FDB Features

Major advantages over conventional bearings

Design:

- **FDB module**
  - More reliable manufacturing
  - Smart enabling technology
  - Easily adopted to various fan sizes
  - Less components (no washer)
3. FDB life test / reliability

3-1 Fan motor speed vs Time(Hr)

Less than 3% fan speed change after 145 days

Remark: Test condition: temperature 80℃; Start/stop cycle mode 0→8000rpm, 60X60X12mm blower
3. FDB life test / reliability

3-2 Fan operating current & Time(Hr)

Less than 2% fan operating current change after 145 days

Remark: Test condition: temperature 80°C; Start/stop cycle mode 0→8000rpm, 60X60X12mm blower
3. FDB life test / reliability

3-4 Performance of Life Expectancy (L10/40 degree C)

- Product: AB0605HF E03(SA01)
- AD0712MF-D93, AD0812MF-A71GL
- Fluid Dynamic Bearing
- Test by JARO lab
- Result - attachments
3. FDB life test / reliability

3-4 Performance of Life Expectancy

MTTF & L10 - AB0605HF-E03(SA01)
3. FDB life test / reliability

3-4 Performance of Life Expectancy

MTTF & L10 - AD0712MF-D93

<table>
<thead>
<tr>
<th>Hours (hrs)</th>
<th>MTTF</th>
<th>L10</th>
</tr>
</thead>
<tbody>
<tr>
<td>100000</td>
<td>623035</td>
<td></td>
</tr>
<tr>
<td>200000</td>
<td>298619</td>
<td></td>
</tr>
<tr>
<td>300000</td>
<td>150091</td>
<td></td>
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<td>400000</td>
<td>78173</td>
<td></td>
</tr>
<tr>
<td>500000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>700000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Temperatures: 40°C, 50°C, 60°C, 70°C
3. FDB life test / reliability

3-4 Performance of Life Expectancy

MTTF & L10 - AD0812MF-A70GL
3. FDB life test / reliability

3-5 Performance of Air flow/Static pressure/Noise level

- Product: AB0605HF-E03(SA01), AD0712MF-D93, AD0812MF-A71GL
- Fluid Dynamic Bearing
- Test by JARO lab
- Result - attachments
4. Summary of FDB fan

JARO FDB fan can perform:

- Long operating life [ >60,000 hours/40°C, 65%]
- High reliability
- Low power consumption
- Good performance after 7 days of burn-in test (90 °C)

JARO FDB fan size (till Dec-01-2004)

- AB6012, AD6015, AD7015, AD8025, AD9225, AD12025
4. Summary of FDB fan

4-2 Current customers already used FDB fan
- Japan SONY Notebook
- Japan Fujitsu Notebook
- Korea Sung-Ju CPU Cooler
- Japan SONY PDP TV
- Japan SONY RPTV

On-hand customers to approve
- Korea Samsung PDP TV

Potential customers to contact/approach
- USA Dell system fan
- USA HP system fan
Question & Answer