Thruster Experience -

Seal Issues

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Topics

- Basic technologies
- Problems
- Solutions
- Table for technical specification for seals
Azimuth Thrusters

- Low Pressure-applications (propeller shaft draught less than 7m)
- High Pressure-applications (propeller shaft draught more than 7m)
Low Pressure applications

- Tugboats
- Contaz-units
Low Pressure applications

- Face-seal + 2 x lip-seal
- Lip-seal package
High Pressure applications

- Face-seal + 2 x lip-seal
- Flushing line
High Pressure applications / UUC type DP-thruster
High Pressure applications / UUC type DP-thruster
Problems

- oil leakage out
- water leakage in
- oil leakage between gravity-chamber and gearbox
- pumping effect
- swelling
- shrinking
- face material wear
- housing fracture (composite)
- seat material corrosion
Solutions

• change of seat material NiResist => SiC
• increasing gravity pressure (tank height+pressurization)
• yard’s involvement: corrections to tank installation and pipeline (correct slope, cleanliness)
• change of housing material composite => stainless steel on face side, bronze on seat side
• change of seal type on low pressure applications face => lip seal package (axial pumping)
Common understanding

• Problems in both categories
• mostly due to:
  in some cases: insufficient knowledge of products/applications
  (example: vibration effects)
  too many suppliers within one sealing solution
  in some cases: insufficient specifications to seal suppliers
Future vision

- way of thinking: close co-operation with seal suppliers
- better control of the design
- common table for technical specification
- lip seal packages in low pressure applications
- possible “anti-pollution” seals in high pressure applications
## Common table for specification

<table>
<thead>
<tr>
<th>Specification of Requirements</th>
<th>Given Value</th>
<th>Calculated Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seals UUC 505 OUTER SEAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Basic Values
- Shaft diameter: 480 mm
- Shaft rotational speed: 148 RPM
- Static pressure difference (max. over one seal): 1 bar

| Line velocity | 3.71965 m/s |
| Static PV-value | 3.71965 bar m/s |

### Mechanical Vibrations
- Dynamic axial movement: 0.1 mm
- Dynamic radial movement: 0.1 mm
- Axial frequency: 9.87 Hz
- Radial frequency: 9.87 Hz

| Axial amplitude | 0.05 mm |
| Radial amplitude | 0.05 mm |

| Axial vibration speed (MAX) | 3.10075 m/s |
| Radial vibration speed (MAX) | 3.10075 m/s |
| Axial vibration speed (RMS) | 2.19256 m/s |
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| Axial vibration acceleration (MAX) | 192.293 mm/s² |
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| Axial vibration acceleration (RMS) | 135.972 mm/s² |
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### Maximum Static Displacements (shaft related to surroundings, from 0-position to other end)
- Axial Displacement: 0.4 mm
- Radial Displacement: 0.4 mm

### Lubrication (media)
- Lubricant: Mineral Gear Oil
- Viscosity at 40 deg: 150 cSt
- Viscosity at 100 deg: 15 cSt
- Operating temperature: 50 deg

### Lifetime
- Required lifetime without change of components: 5 years with 7000 h / year

### Operational profile
- Time share PV / PVmax:
  - 80 %: 100 %
  - 10 %: 50 %
  - 10 %: 25 %

### Corrosion protection
- Corrosion protection required on seal

### Acceptable level of leakage
- In: 0 ml/h
- Out: 5 ml/h
Time for ?