Bearing Design
WHY USE NYLON?

- Excellent Load Bearing Capacity
  - 15,000 psi at 10% deflection
  - 3500 psi bearing strength
- Corrosion Resistance
- Light Weight
  - 1/8 weight of steel
- Low co-efficient of friction
- Relatively low cost

- Excellent wear resistance
- Reduced wear on mating parts
- Available in many tube sizes
- Near Net Shape capability
- Insulator (good & bad)
- Easy to machine
OPERATING ENVIRONMENT

• Temperature (from -40 to 275° F)
• Moisture Considerations
• Surface Speed and Load (PV)
• Chemicals
BEARING DESIGN DIMENSIONS

• Outer Diameter - Press Fit

• Inner Diameter - Running Clearance
  • Shaft Allowance
  • Temperature Factor
  • Moisture Factor
  • Press Fit

• Finished Dimensions
PRESS FIT

• Bearing should be slightly larger than housing diameter
• Rule of thumb, multiply 0.005 to $\sqrt{\text{Housing Diameter}}$. The bearing should be larger by this amount.
• Example; for a 4 inch housing, the press fit is $0.005 \times \sqrt{4} = 0.010$. The bearing diameter should be machined to 4.010 inches
RUNNING CLEARANCE

There are four components that make up running clearance.

- Shaft Allowance
- Operating Temperature
- Moisture Factor
- Press Fit

Note: The single most common reason for nylon bearing failure is inadequate running clearance.
# SHAFT ALLOWANCE

**Shaft Allowance Chart**

<table>
<thead>
<tr>
<th>Shaft Size (Ds)</th>
<th>3/4</th>
<th>1</th>
<th>1 1/4</th>
<th>1 1/2</th>
<th>1 3/4</th>
<th>2</th>
<th>2 1/4</th>
<th>2 1/2</th>
<th>2 3/4</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft Allowance</td>
<td>0.004</td>
<td>0.005</td>
<td>0.006</td>
<td>0.007</td>
<td>0.008</td>
<td>0.009</td>
<td>0.01</td>
<td>0.011</td>
<td>0.012</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Note: For shafts larger than 3”, add 0.002” per inch to 0.013”. For example, a 5” diameter shaft would need 0.017” shaft allowance.
OPERATING TEMPERATURE

- Additional running clearance will be required to account for the ambient temperature.
- This additional clearance depends on the nominal wall thickness of the bearing as well as the temperature.

<table>
<thead>
<tr>
<th>Ambient temperature (in °F)</th>
<th>Wall Thickness Factor (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70°</td>
<td>0.013</td>
</tr>
<tr>
<td>100°</td>
<td>0.016</td>
</tr>
<tr>
<td>150°</td>
<td>0.019</td>
</tr>
<tr>
<td>200°</td>
<td>0.022</td>
</tr>
<tr>
<td>250°</td>
<td>0.025</td>
</tr>
<tr>
<td>300°</td>
<td>0.029</td>
</tr>
</tbody>
</table>

To calculate the additional running clearance, reference the ambient temperature and multiply the wall thickness factor to the nominal wall thickness of the bearing.

For example: A 2-1/4” dia housing with 1-1/2” shaft at 250°F would need an additional 0.009” running clearance (0.375” wall * 0.025).
**MOISTURE FACTOR**

For submerged applications, machine bushings to within 0.1” of the finished size and soak in water for 5 days. Then machine to size.

**Otherwise, use the chart to the right**

<table>
<thead>
<tr>
<th>Wall Thickness</th>
<th>Additional Running Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16”</td>
<td>0.018”</td>
</tr>
<tr>
<td>1/4”</td>
<td>0.022”</td>
</tr>
<tr>
<td>5/16”</td>
<td>0.025”</td>
</tr>
<tr>
<td>3/8”</td>
<td>0.027”</td>
</tr>
<tr>
<td>1/2”</td>
<td>0.030”</td>
</tr>
<tr>
<td>5/8”</td>
<td>0.032”</td>
</tr>
<tr>
<td>3/4”</td>
<td>0.033”</td>
</tr>
<tr>
<td>1” or Larger</td>
<td>0.034”</td>
</tr>
</tbody>
</table>
ADJUSTED BEARING SIZE

• Bearing OD = Housing ID + Press Fit
  • Example: 2.5” Housing requires a press fit of 0.008 (.005 x √2.5). Bearing OD then is 2.508”

• Bearing ID = Shaft OD + Shaft Allowance + temperature factor + moisture factor + Press fit
  • Example: 1.25” shaft operating at 200°F in a 2.5” housing (not submerged). Bearing ID = 1.25” + 0.006 + 0.014 + 0 + 0.008. The Bearing ID is 1.278”

• Tolerances
  • For bearings smaller than 5” OD, the OD tolerance should be +/-0.004 provided that it does not eliminate the press fit. The tolerance on the ID should be +0.005, -0.
• For busing or bearing applications, use a compressive strength of 3,500 psi
• The Load Bearing capability of the bushing is the contact area multiplied by 3,500 psi
• The contact area is **Inner Diameter** multiplied by the **Length**
  • **Example**: an ID of 1.5” and a length of 4”
  • Contact Area is 1.5” × 4” = 6 square inches
• In our example 6 square inches × 3,500 psi = 21,000 lbs
PRESSURE VELOCITY (PV) CALCULATION

- **PV** is the pressure on the nylon part multiplied by the surface speed
- **Common units for PV** is **psi-fpm**
- **Typically Known Information**
  - Load
  - Shaft or part speed in rpm
  - Shaft diameter
  - Contact length

- **Example:**
  - **Bearing** - 3” long on a 2” dia shaft carrying a 3,000lb load and rotating @ 55 rpm
  - **Pressure**: \( \frac{\text{Load}}{\text{Contact Area}} \)
    - \( \frac{3,000\text{lbs}}{3'' \times 2''} = 500 \text{ psi} \)
  - **Surface Speed** (in fpm)
    - 2” dia shaft @ 55 rpm
    - \( 2'' \times \pi \times 55\text{rpm} = 345.4 \text{ inches per minute} \)
    - \( 345.4 \div 12 \text{ (in/ft)} = 28.78 \text{ fpm} \)
  - **PV** is 500 psi \( \times \) 28.78 fpm or 14,390 psi-fpm
LIMITING PV VALUES

- **MD Nylon** is 3,000 psi-fpm
- **Oil Filled** and **MD-Oil Filled** is 5,500 psi-fpm
- **Nylatech SL** is 15,000 psi-fpm
- **Nylatech PVM** is 16,000 psi-fpm
SUMMARY

- Advantage of Nylatech Bearings
- Environmental Factors
- Press Fit
- Running Clearance
- Bearing Size
- Bearing load calculation
- PV Calculation

QUESTIONS?