GROOVE DESIGN AND O-RING INSTALLATION

Outline of Training

I. Description of common types of seals
   A. Static seals
   B. Dynamic seals

II. Groove dimensions and machining considerations
   A. General considerations
   B. Groove design
   C. Grooves for static vs. dynamic seals
   D. Example of determining groove dimensions

III. Determining Cross section
    A. Piston seal
    B. Face seal

IV. Installation
    A. Seal stretch
    B. Squeeze
    C. Installation over sharp edges
    D. Lubrication of seals for installation
3. Installation over sharp edges

Avoid forcing O-Rings over threads, sharp corners, slots or other sharp objects.

If design does not allow for this then use a cone or thimble or some type of support when installing the O-Ring.

4. Lubrication of seals for installation

It is very important to lubricate an O-Ring before it installation. The lubrication helps protect the O-Ring from damage by abrasion, cutting or pinching.

Lubrication is especially critical in dynamic seals.

Common lubricants for O-Rings are Petrolatum, Barium Grease, Celvacene and Silicone.
INSTALLATION

1. Seal Stretch

Generally, an O-Ring should not be stretched more than 100% during installation.

Once installed in a groove, an O-Ring should not be stretched more than 5%. Excessive stretch can lead to rapid deterioration, reduced cross section and flattening.

2. Squeeze

Squeeze is the diametrical compression of the O-Ring between the bottom surface of the groove and the surface of the other mating part in the gland assembly.

An O-Ring should be squeezed a minimum of .005 inch and a maximum of 30 % of the O-Ring cross section in most applications.
1. Quantify all factors that can reduce nominal squeeze on O-Ring cross section.

   → Maximum groove depth can vary from Nominal (.006"
   → Maximum distortion and flex between sealing surfaces
   → total squeeze reduction (.006" + .007")

2. Calculate minimum squeeze needed on O-Ring. Use value from step 1 multiplied by a safety factor of 4. (.013 x 4)

3. Calculate cross section for O-Ring to provide a squeeze of 25%, typical for a face seal.

4. Select closest standard cross section for O-Ring
1. Quantify all factors that can reduce nominal squeeze on O-Ring cross section.

   → Maximum nominal piston can shift off center from nominal bore \((1.250'' - 1.248'' \div 2)\) \(.001''\)

   → Maximum piston OD can vary from nominal \(.002'' \div 2\) \(.001''\)

   → Maximum bore can vary from nominal \(.002'' \div 2\) \(.001''\)

   → Maximum groove diameter can vary from nominal \(.002'' \div 2\) \(.001''\)

   → Maximum groove eccentricity (total indicator reading \div 2) \(.003'' \div 2\) \(.0015''\)

   → Total squeeze reduction \(.0055''\)

2. Calculate minimum squeeze needed on O-Ring. Use total value from step 1 multiplied by a safety factor of 4. \(.0055'' \times 4\) \(.022''\)

3. Calculate cross section for O-Ring to provide a Squeeze of 15%, typical for a piston seal. \(.146''\)

4. Select closest standard cross section for O-Ring \(.139''\)
GROOVE DIMENSIONS AND MACHINING CONSIDERATIONS

4. Example of Determining Groove Dimension

Determine the appropriate groove dimensions and tolerances for the following seal:

Reciprocating seal, OD sealing

Size 214 O-Ring

Solution:

\[
\text{A} = \underline{\text{_______}} \quad \text{G} = \underline{\text{_______}} \quad \text{B-1} = \underline{\text{_______}}
\]
GROOVE DIMENSIONS AND MACHINING CONSIDERATIONS

3. Grooves for Static vs. Dynamic Seals

A. Static seal grooves are normally designed to have Between 15%-25% squeeze on the O-Ring. Static seals can tolerate higher volume swell of the O-Ring than dynamic seals.

B. Dynamic seal grooves are normally designed to have about 15% squeeze on the O-Ring. Less squeeze increases probability of leakage while more squeeze increases friction and probability of spiral failure. Dynamic seals can tolerate less volume change than static seals.

C. Different design guidelines should be used for groove dimensions for static and dynamic seals.
2. Groove Design

Industrial Static and Dynamic Seal Glands

<table>
<thead>
<tr>
<th>O-Ring Cross Section</th>
<th>Static &quot;F&quot; Gland Depth</th>
<th>Static Squeeze Actual %</th>
<th>Standard Groove Width</th>
<th>Dynamic &quot;F&quot; Gland Depth</th>
<th>Dynamic Squeeze Actual %</th>
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<tr>
<td>.040</td>
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<td>.007-.014</td>
<td>16-38</td>
<td>.063</td>
<td>.031/.032</td>
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<td>.036/.037</td>
<td>.010-.017</td>
<td>19-32</td>
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<td>.044/.045</td>
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<td>.020-.032</td>
<td>15-22</td>
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<td>.228/.234</td>
<td>.035-.063</td>
<td>13-19</td>
<td>.375</td>
<td>.234/.240</td>
</tr>
</tbody>
</table>
GROOVE DIMENSIONS AND MACHINING CONSIDERATIONS

D. Chamfers

Chamfer Angle 15° to 30°
Chamfer to serve as "shoehorn" to facilitate assembly. X greater than Y

E. Bevels

Bore
Cross drilled port
Direction of installation
See preferred installation to eliminate this sharp edge
Prefered Installation
Undercut bore as indicated
GROOVE DIMENSIONS AND MACHINING CONSIDERATIONS

1. General considerations

A. Preferred metals for sealing surfaces
   (1) Chrome-plated steel
   (2) Ground steel
   (3) Ground and honed cast iron

B. Metals generally not recommended for sealing Surfaces (dynamic)
   (1) Aluminum
   (2) Bronze
   (3) Monel

C. Surface finishes
   (1) All sharp burrs and corners should be removed
   (2) Recommended finish for piston rod and cylinder bore is 8 to 16 micro-inches RMS
   (3) Recommended groove surface is 20 to 40 micro-inches RMS
DESCRIPTION OF COMMON TYPES OF SEALS

2. Dynamic seal (continued)

B. Rotary seal: A seal in which one part rotates continuously about its axis relative to the other part.

C. Oscillating seal: A seal in which one part rotates about its axis relative to the other part and then returns.
DESCRIPTION OF COMMON TYPES OF SEALS

2. **Dynamic seal**: A seal in which the restraining parts move relative to each other. The three main classifications of dynamic seals are reciprocating, rotary and oscillating.

   A. **Reciprocating seal**: A seal in which one part moves axially relative to the other part then returns.
DESCRIPTION OF COMMON TYPES OF SEALS

1. **Static seal**: A seal in which the restraining parts do not move relative to each other. Static seals are classified as either axial or radial squeeze.

   A. **Axial Squeeze**: Axial squeeze is the compression of the top and bottom of the seal.

   ![Axial Squeeze Diagram]

   B. **Radial Squeeze**: Radial squeeze is the compression of the ID and OD of the seal.

   ![Radial Squeeze Diagram]