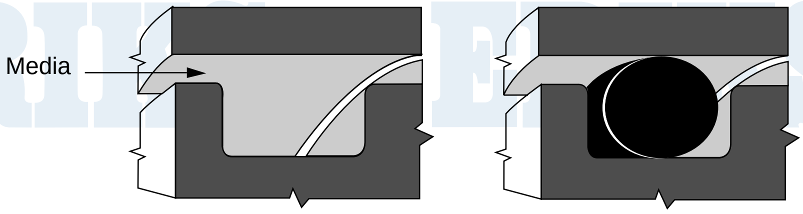
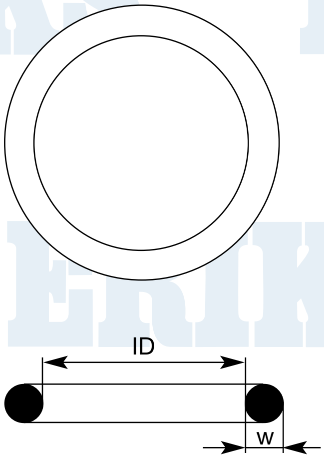
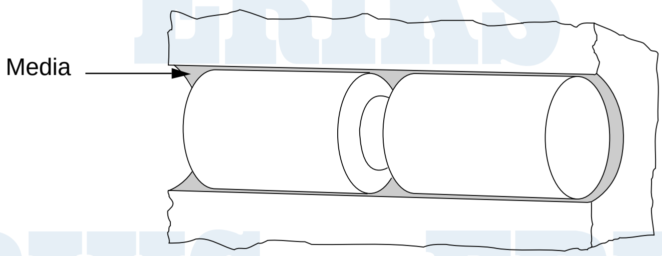
2. O-ring Sealing Principles

O-rings are bi-directional seals, circular in shape and cross section.
O-rings are generally made of an elastomeric material, but may be made of other materials such as PTFE or metal.
This handbook deals entirely with elastomeric O-rings and PTFE encapsulated elastomeric O-rings.
An O-ring seals through the deformation of the seal material by installation and media pressure to close off the gap between mating components.
Higher system pressures can cause deformation through the gap, known as extrusion, resulting in seal failure.
Choosing a harder seal material or installing back-up rings to support the O-ring may alleviate this problem.

ERIKS O-rings are precision seal components made from a variety of elastomeric compounds .
When you specify an O-ring we need to know the inside diameter (I.D.), the cross section diameter (W), and the compound (elastomer material) from which the O-ring is to be made.
All sealing applications fall into one of two categories - those in which the seal or sealed surface moves, and those in which the seal is stationary.







ID= O-ring inside diameter
w= O-ring cross section

2. O-ring Sealing Principles

A seal that does not move, except for pulsation caused by cycle pressure, is called a static seal. Those seals that are subjected to movement are dynamic seals. These are further defined as reciprocating (seals exposed to linear motion) and rotary (stationary seals exposed to a rotating shaft).

O-rings can be successfully used in static as well as dynamic applications. The rubber O-ring should be considered as an incompressible, viscous fluid having a very high surface tension. Whether by mechanical pressure from the surrounding geometry or by pressure transmitted through the hydraulic fluid or gas, this extremely viscous (elastomeric) fluid is forced to flow in the gland to produce zero clearance or a positive block to the flow of the media being sealed. The O-ring absorbs the stack-up of tolerances of the unit and its memory maintains a sealed condition.

Proper seal design begins with the careful consideration of the sealing application. Appropriate material hardness, for example, is determined by the friction and pressure to which the seal will be exposed, as well as the cross sectional dimensions of the seal. Other key factors include temperature range, adjacent surfaces, and media.

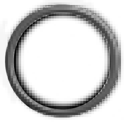
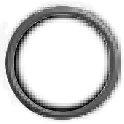
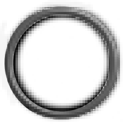
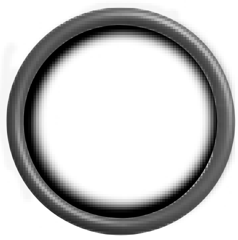
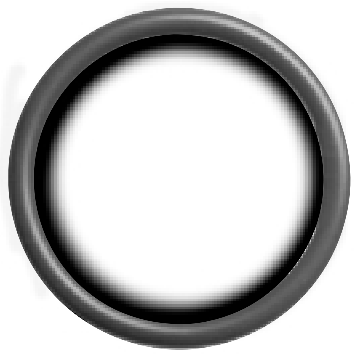
Dynamic O-rings may fail by abrasion against the cylinder or piston walls. Therefore, the contacting surfaces should be polished for long seal life. Moving O-rings that pass over ports or other surface irregularities while under pressure are quickly damaged.

In designing an O-ring seal, there are usually several standard cross sectional sizes available. Selecting the best cross section depends on the application. In a reciprocating application, the choice is automatically narrowed because the design tables do not include all the standard O-ring sizes. For any given piston or rod diameter, rings with smaller cross sections tend to twist in the groove while in motion. This leads to leakage and failure. The smaller cross sections for each inside diameter are therefore omitted in the reciprocating design tables. For dynamic applications, the largest cross sectional sizes available should be used to increase stability.

O-rings in reciprocating applications must be radial compressed between the bottom of the seal groove and the cylinder wall for proper sealing action. This compression or squeeze may cause the O-ring to roll slightly in its groove under certain conditions of motion, but the rolling action is not necessary for normal operation of the seal.

The shape of the groove is unimportant as long as it results in proper squeeze of the O-ring.

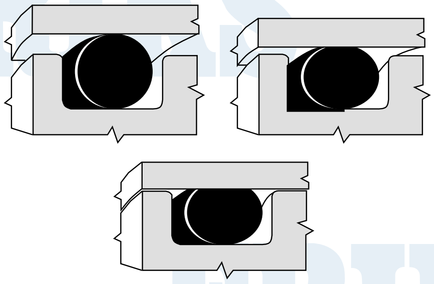
Groove dimensions are shown in the tables beginning on page 105. The groove depth is measured including the gap.

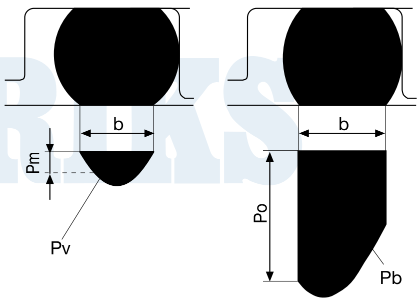
2. O-ring Sealing Principles

The tendency of an O-ring to return to its original shape when the cross section is deflected is the basic reason why O-rings make excellent seals. The squeeze or rate of compression is a major consideration in O-ring seal design. Elastomers may take up the stack-up of tolerances of the unit and its memory maintains a sealed condition. O-rings with smaller cross sections are squeezed by a higher percentage to overcome the relatively higher groove dimension tolerances.

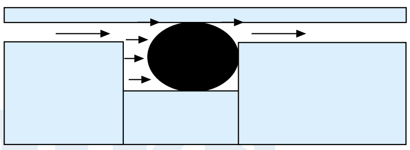
In static applications the recommended squeeze is usually between 15-30%. In some cases the very small cross sections can even be squeezed up to 30%.
In vacuum applications the squeeze can even be higher. Squeezing more than 30% induces additional stress which may contribute to early seal deterioration.
In dynamic applications the recommended squeeze is between 8-16%; due to friction and wear considerations,
smaller cross sections may be squeezed as much as 20%.



O-ring deformation



0-Ring Sealing Principle



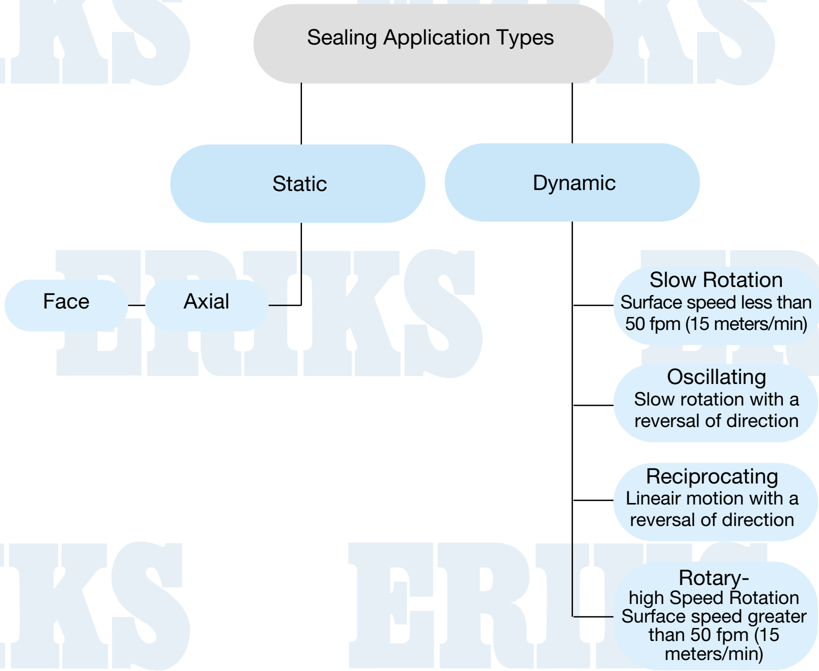
Leakage

(Leakage is possible due to permeability of rubber and roughness of the surface)

2. O-ring Sealing Principles

Identifying a sealing application type

Although sealing applications can be classified in many different ways.
A common method for classifying sealing applications is by the type of motion experienced by the application. The common application types are depicted in the graphic on the right.



Sealing tips

- Provide detailed seal installation and assembly instructions, especially if the unit could be serviced by the end-user of the product. When appropriate or required, specify the use of OEM sealing parts.
- Within reason, the larger the cross-section, the more effective the seal.
- Avoid sealing axially and radially at the same time with the same O-ring or Quad®-ring.
- Don’t use a seal as a bearing to support a load or center a shaft. This will eventually cause seal failure.

Selecting the seal material

When selecting the seal material for the application, carefully consider:

- The primary fluids which the O-ring or Quad®-ring will seal.
- Other fluids to which the seal will be exposed, such as cleaning fluids or lubricants.
- The suitability of the material for the application’s temperature extremes - hot and cold.
- The presence of abrasive external contaminants.
- Lubricating the seal and mating components with an appropriate lubricant before assembling the unit.
- Keeping the seal stationary in its groove - don’t let it spin with the rotating member.
- When using back-up rings, increasing the groove width by the maximum thickness of the back-up ring.
- With a face seal, don’t try to seal around a square corner. Corners must have a minimum radius of 4 times the seal cross section.