Swagelok®

Leakage prevention about threads and seals

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Introduction Swagelok

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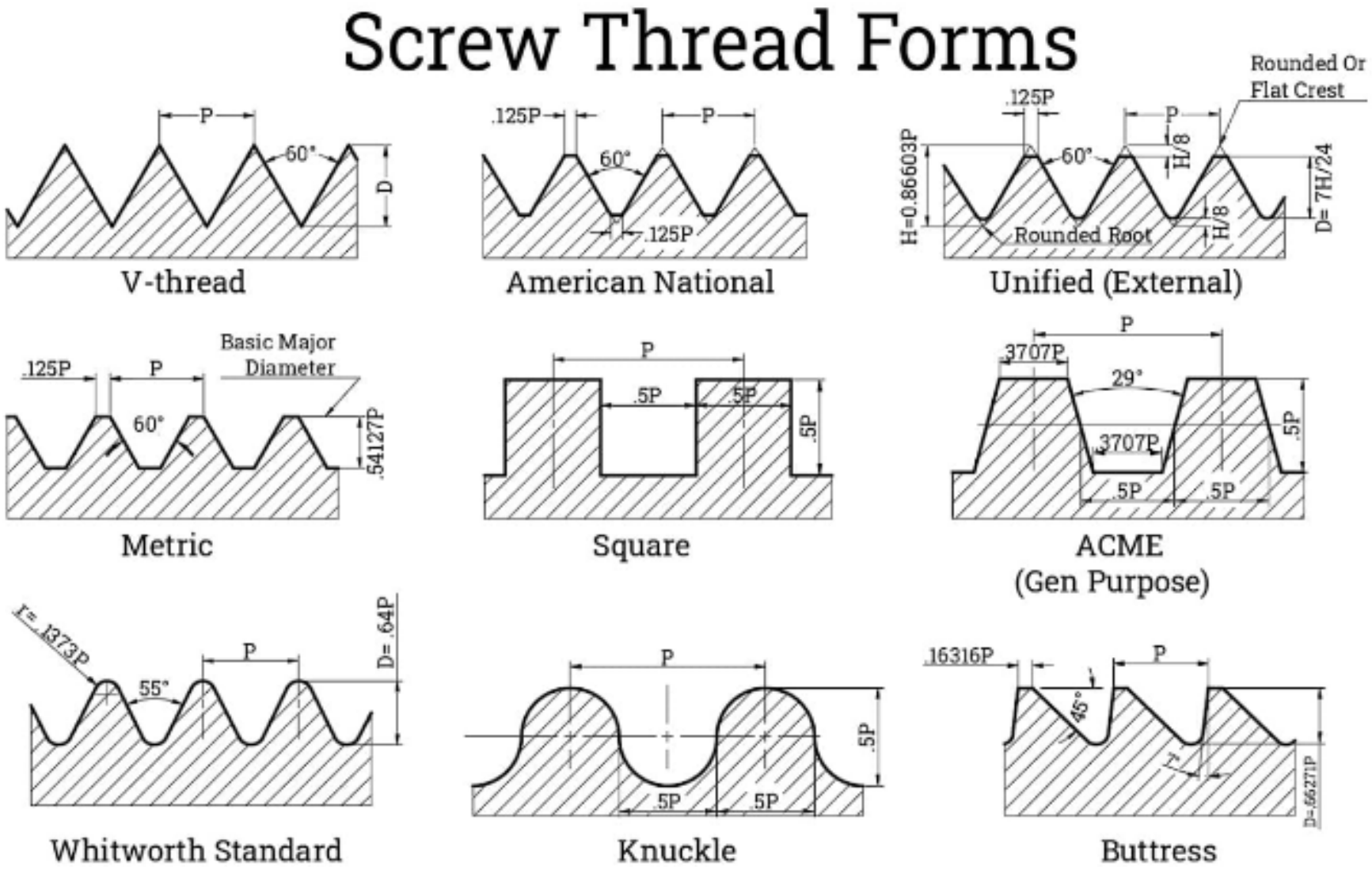
Agenda

- Introduction
- Part 1: Different threads
- Part 2: Understanding a good seal
- Part 3: Different kind of seals
- Summary

Part 1: Different threads

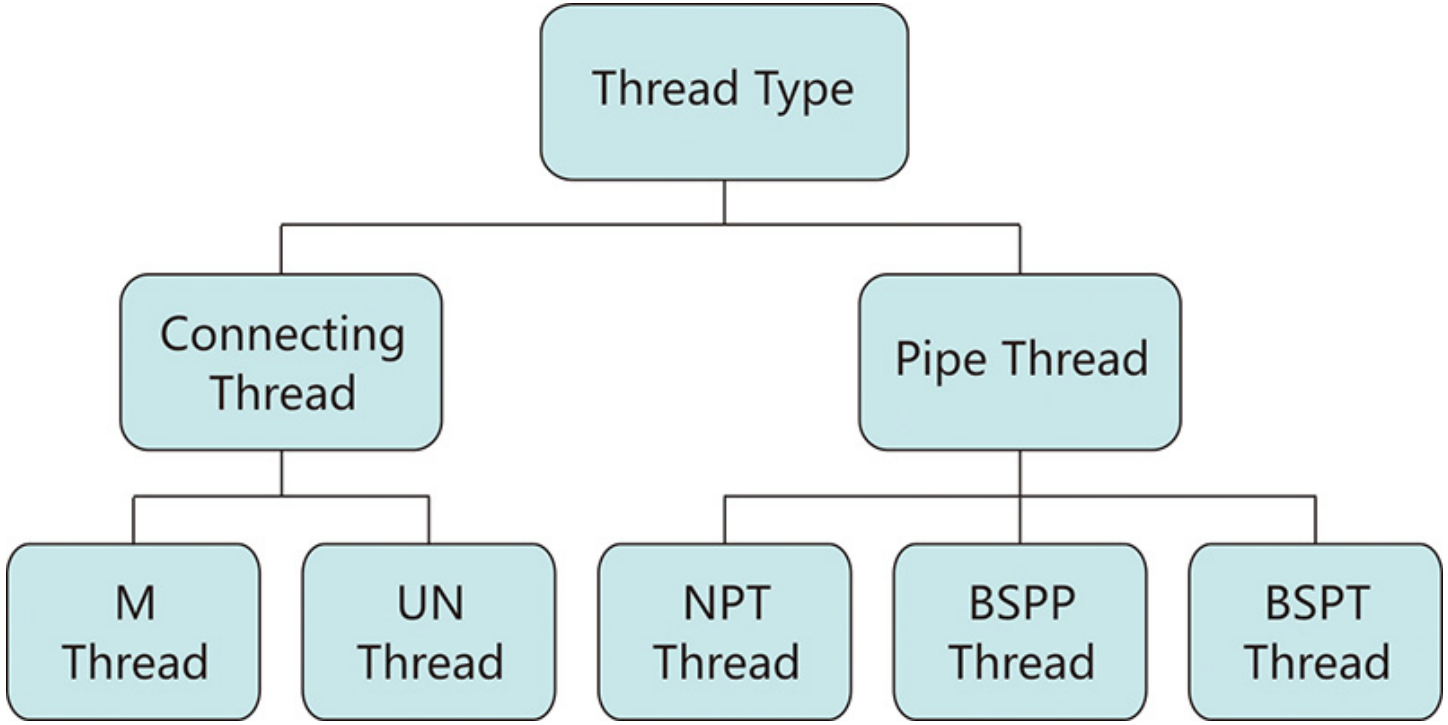
Part 1: Different threads



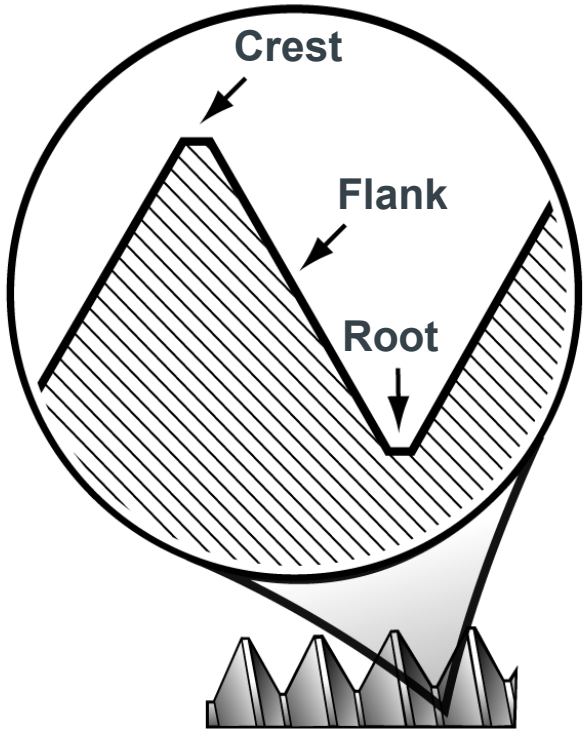
Part 1: Connection versus Pipe Thread

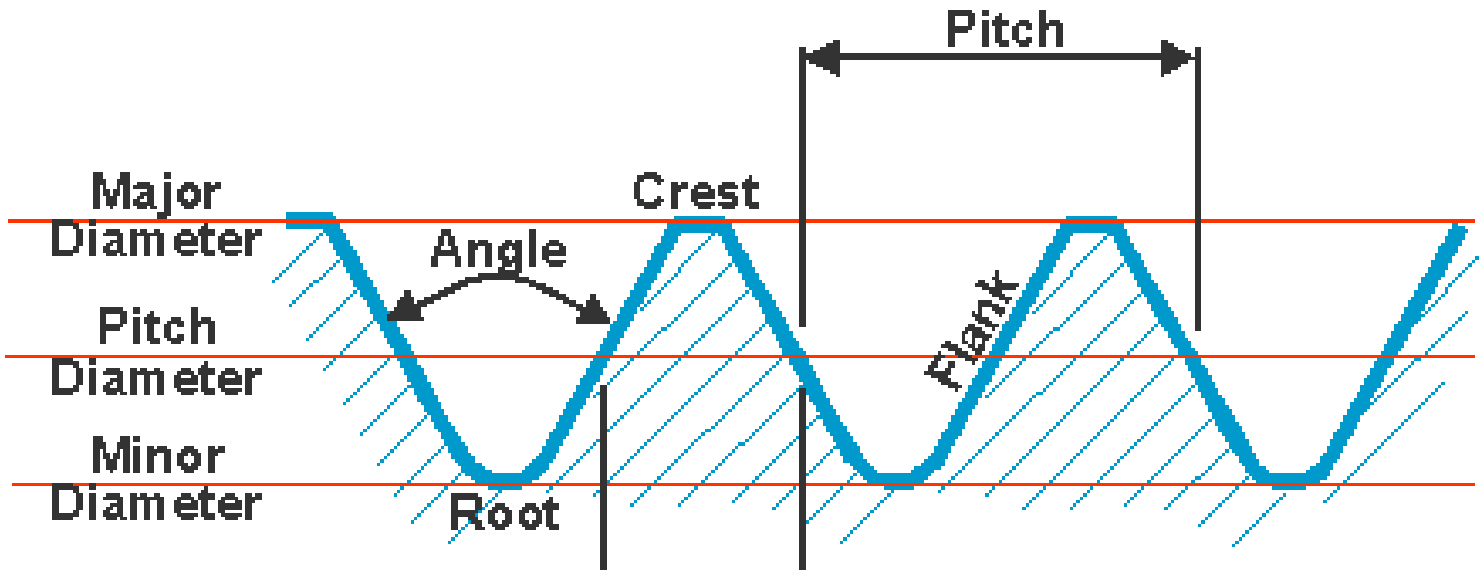
Types:

- Connection thread
  - UNC / UNF / UNEF
  - Metric
- Pipe threads
  - Tapered (NPT, BSPT, ISO 7/1, JIS)
  - Parallel (NPS, BSPP, Unified, ISO 228/1, ISO 261)



Part 1: Screw Thread Terminology

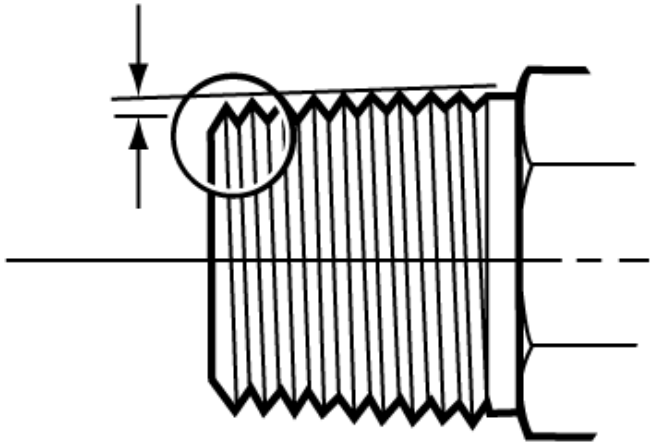




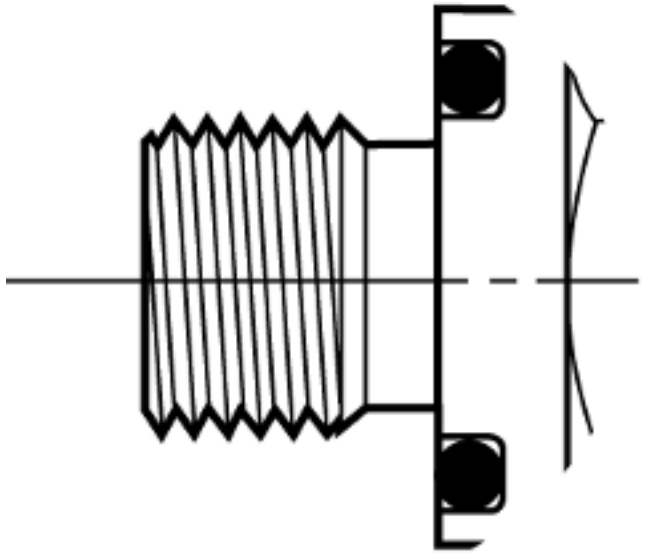
Part 1: Screw Thread Terminology

1:16 Taper Ratio

1º47’ Angle



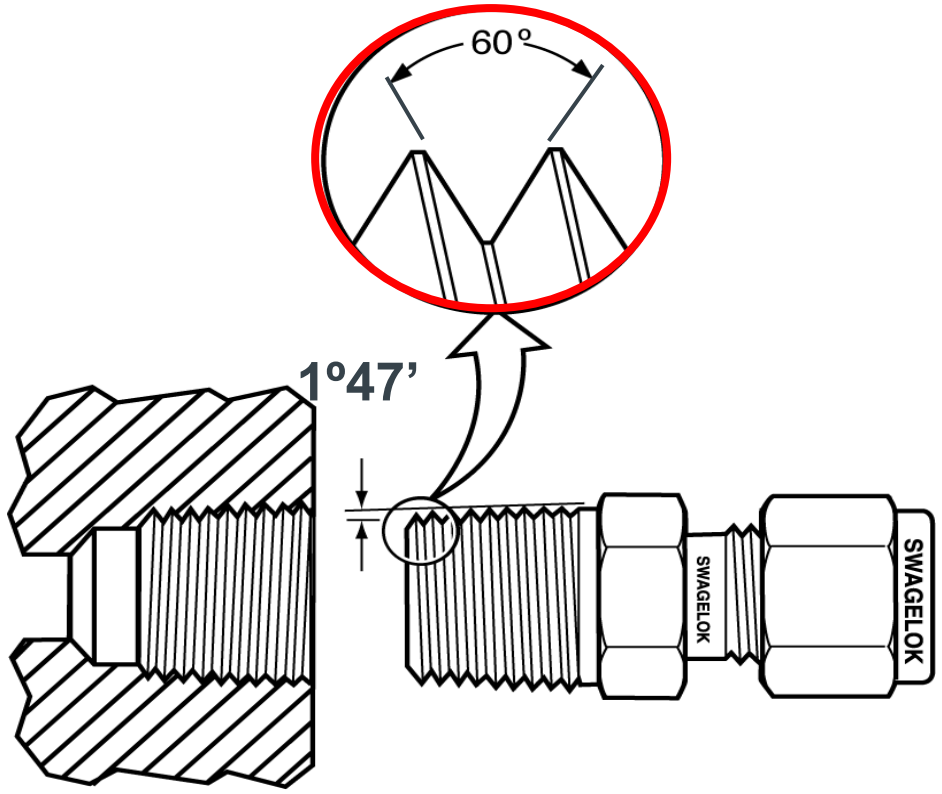
Tapered Thread (Dynamic)



Parallel Thread (Mechanical)

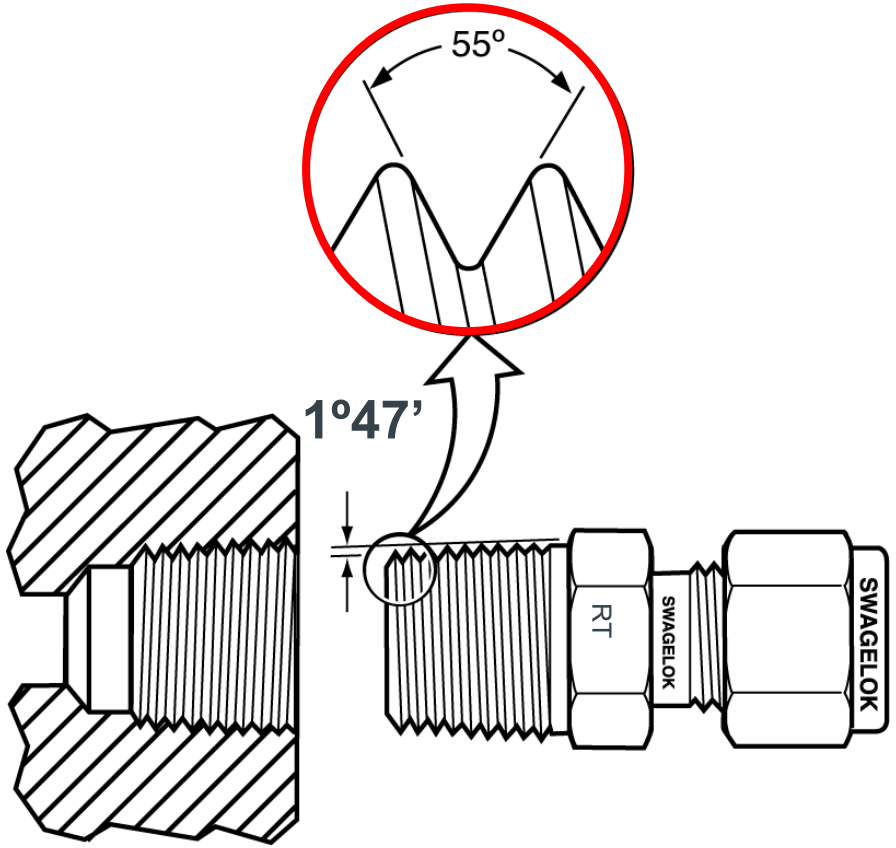
Part 1: Tapered Threads

- ***NPT (National Pipe Tapered)***
  - ***Threads typically feel sharp to the touch***



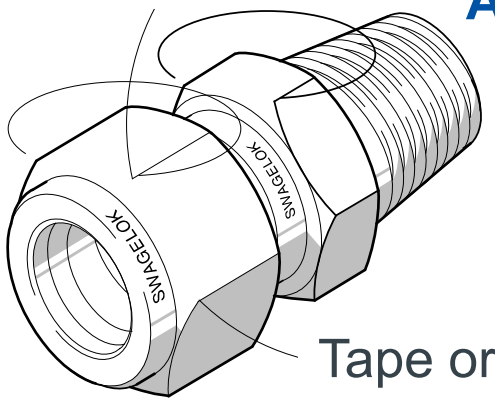
Part 1: Tapered Threads

- *ISO 7/1, JIS, BSPT*
  - *Threads typically feel smooth to the touch*

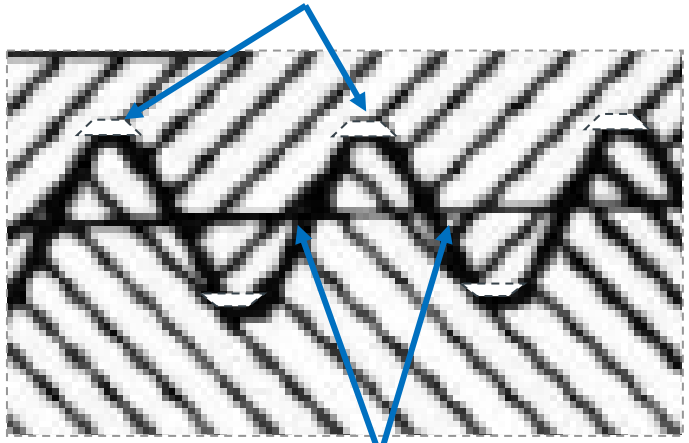


Part 1: Threaded Fitting Installation

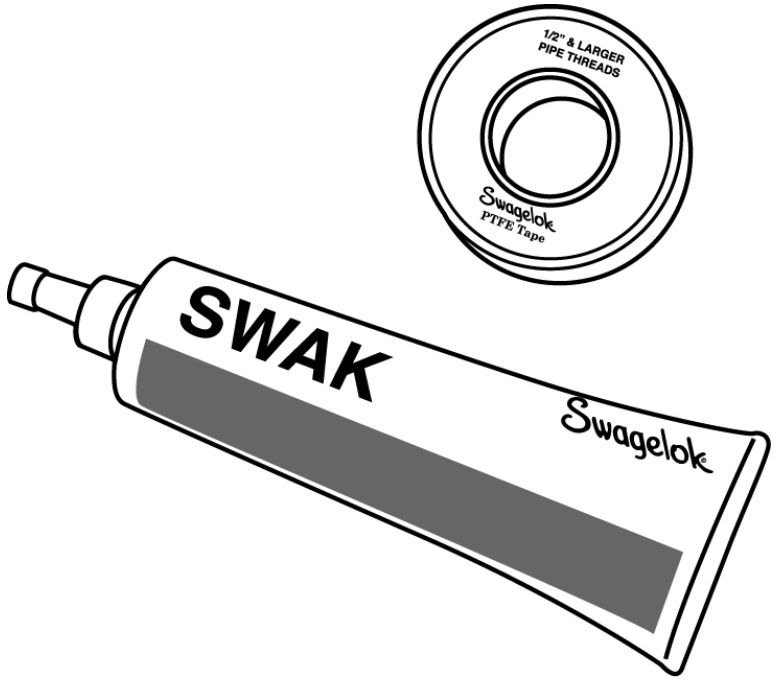
Always install the threaded connection end first



Tape or SWAK seal

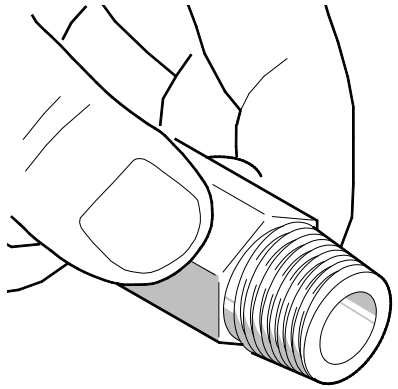


Flank (Metal) seal



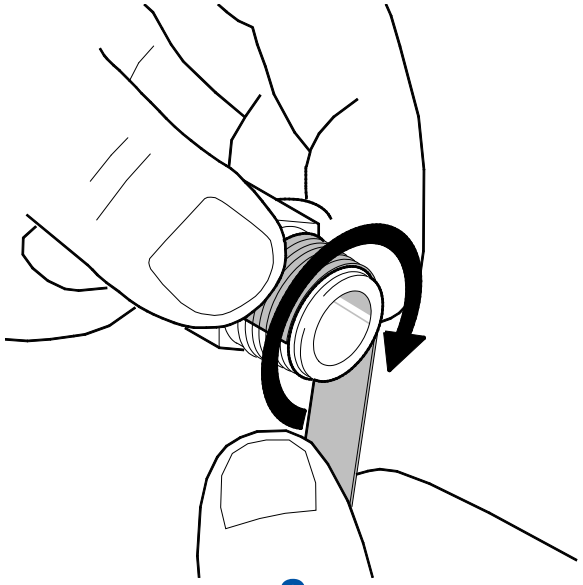
Tapered threads always need a sealant for assembly

Part 1: Tapered Thread Installation Using PTFE Tape



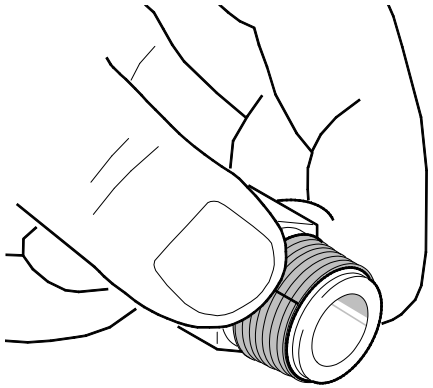
1

Clean both male and female threaded ends



2

Wrap tape 2 to 2 1/2 wraps

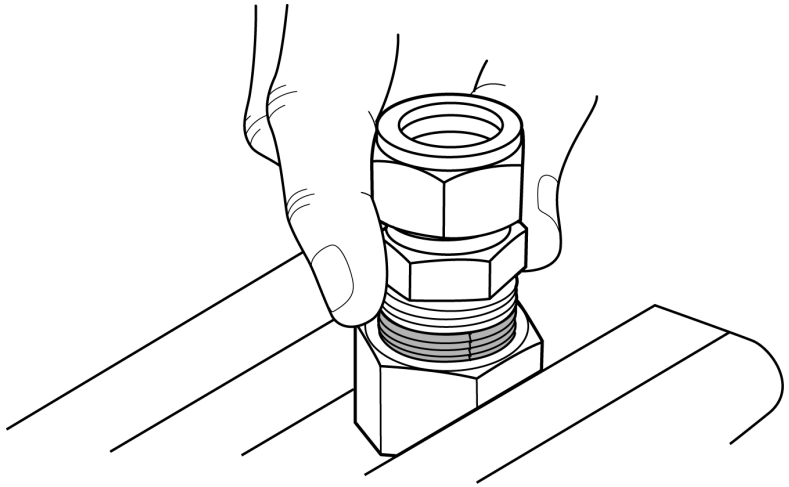


3

Cut off excess tape*

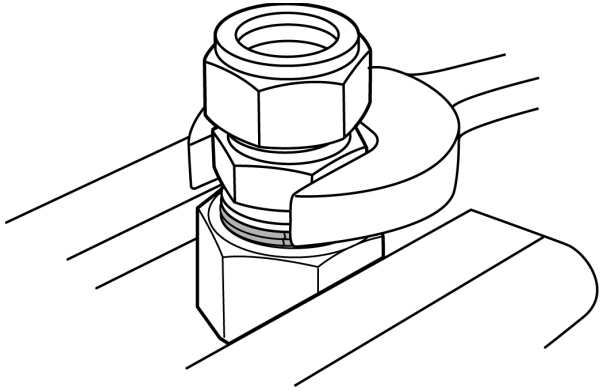
***Tape should not overhang the first thread as it could shred and get into the system. Begin taping at the first full thread. Always use good quality tape.**

Part 1: Tapered Thread Installation Using PTFE Tape



4

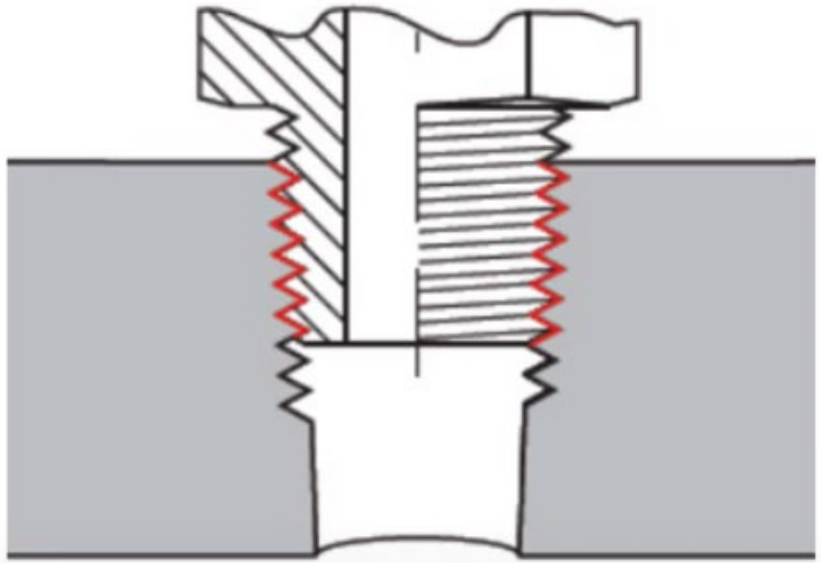
Tighten until finger-tight



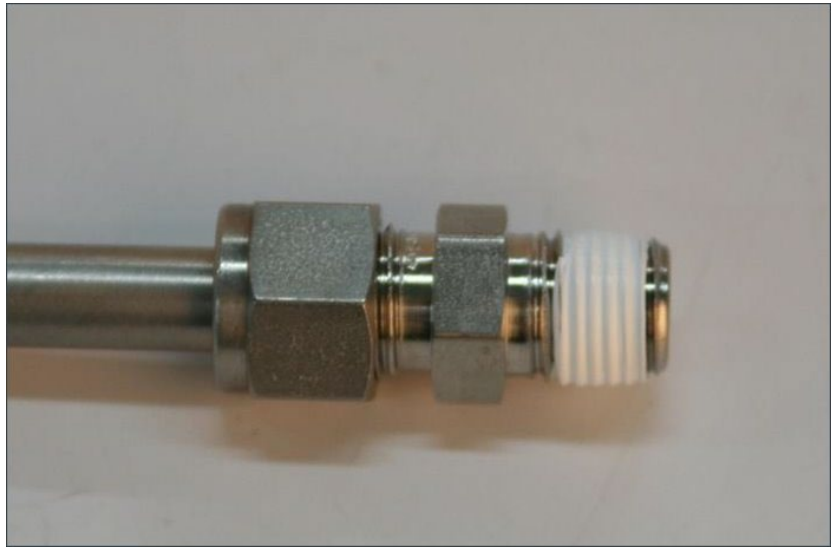
5

Tighten until wrench-tight

Part 1: Tapered Thread Installation Using PTFE Tape

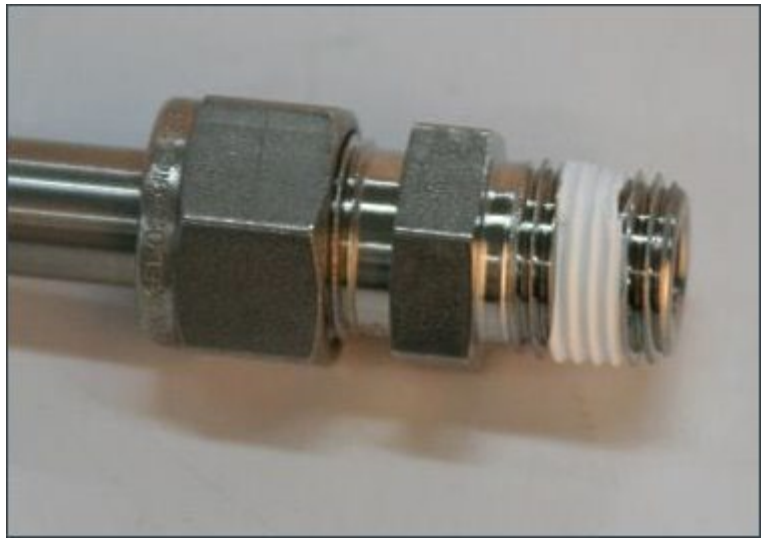


Seal is accomplished via metal-to-metal wedging



Part 1: Tapered Thread Installation Using PTFE Tape

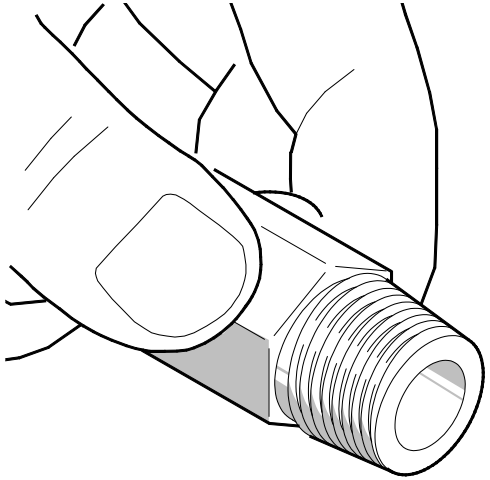
Too much



Too little

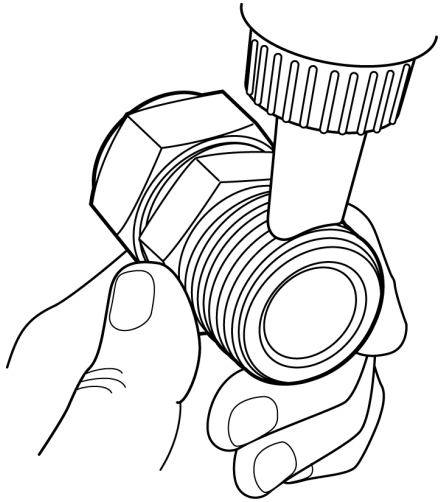
Over the first threads

Part 1: Tapered Thread Installation Using Liquid Thread Sealants



1

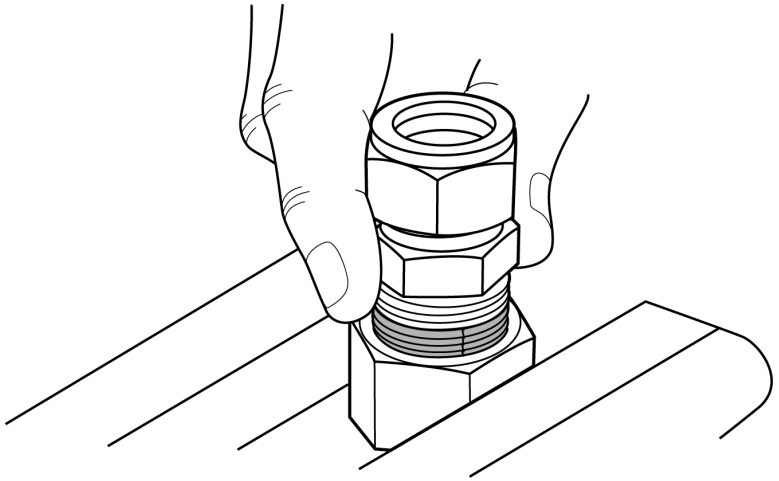
Clean both male and female threaded ends



2

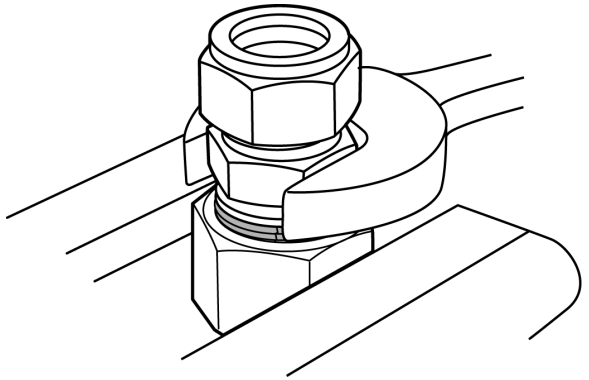
Apply sealant to second and third threads

Part 1: Tapered Thread Installation Using Liquid Thread Sealants



3

Tighten until finger-tight



4

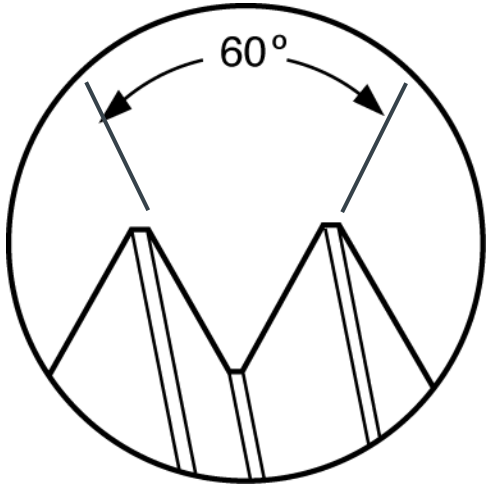
Tighten until wrench-tight

Part 1: Using Thread Sealants

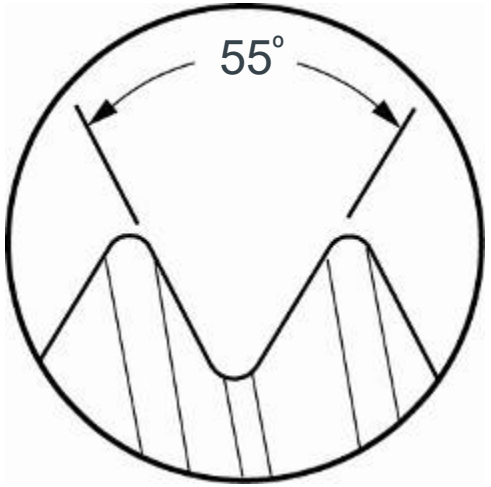
- PTFE tape:

- Sealants:

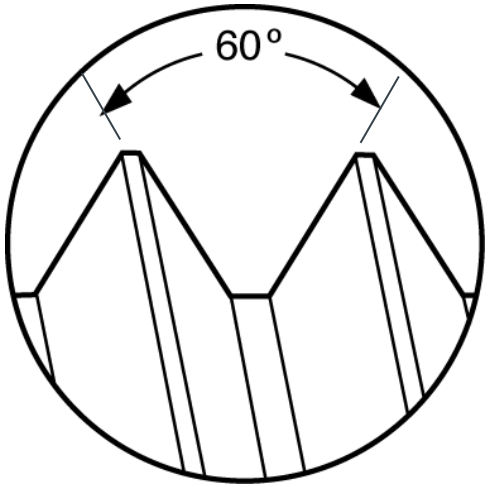
Part 1: Parallel Threads



Unified



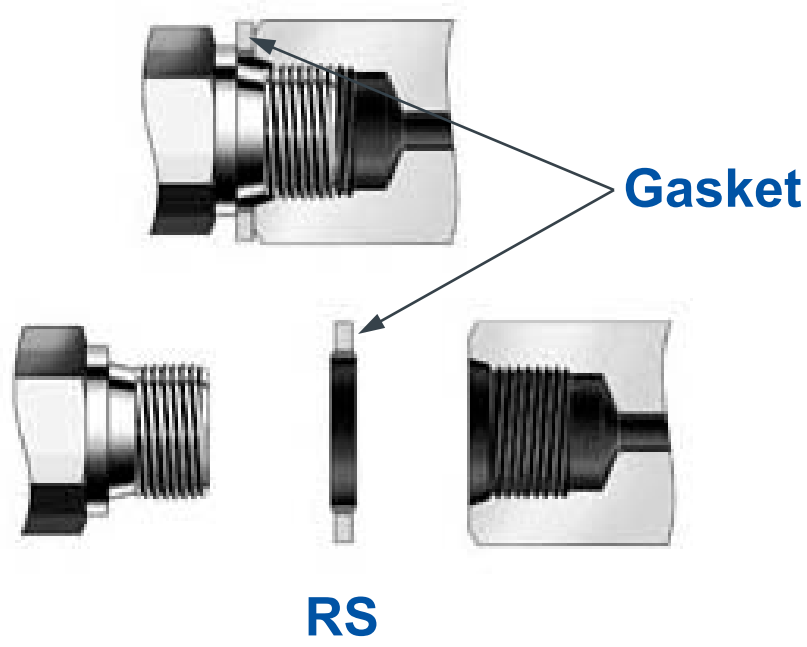
ISO 228/1 (BSPP)

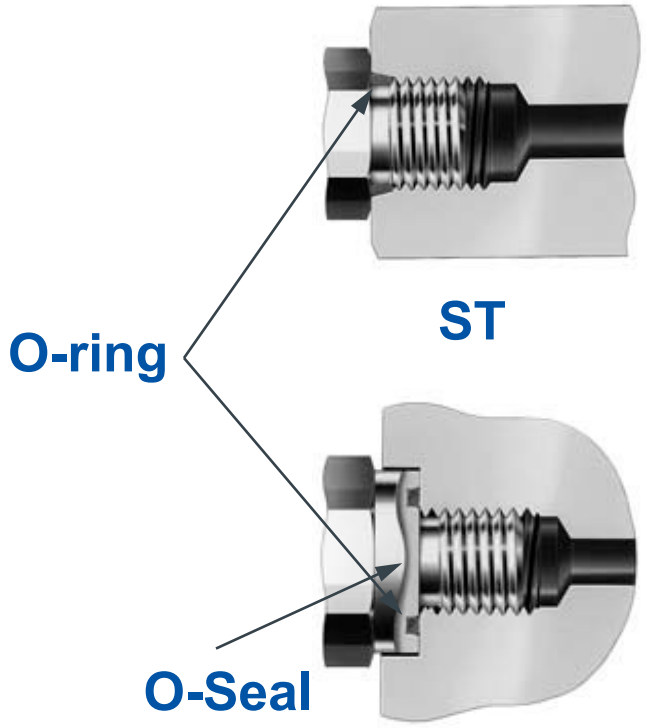


ISO 261 (Metric)

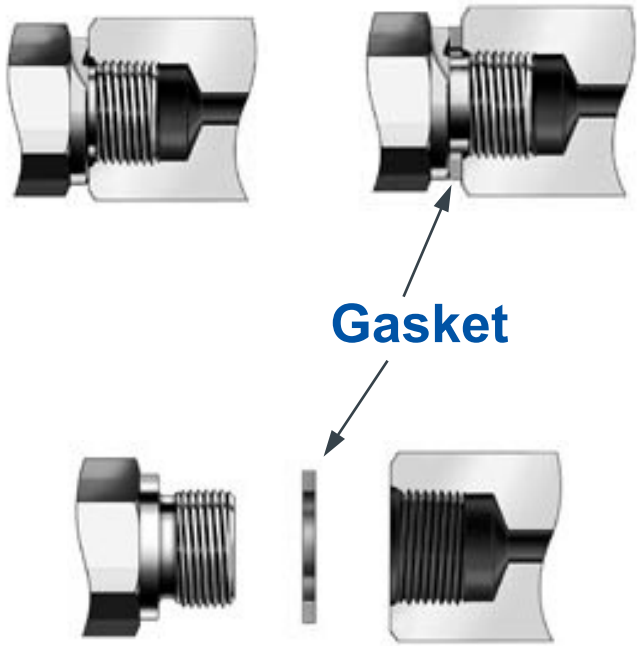
Part 1: Parallel Threads

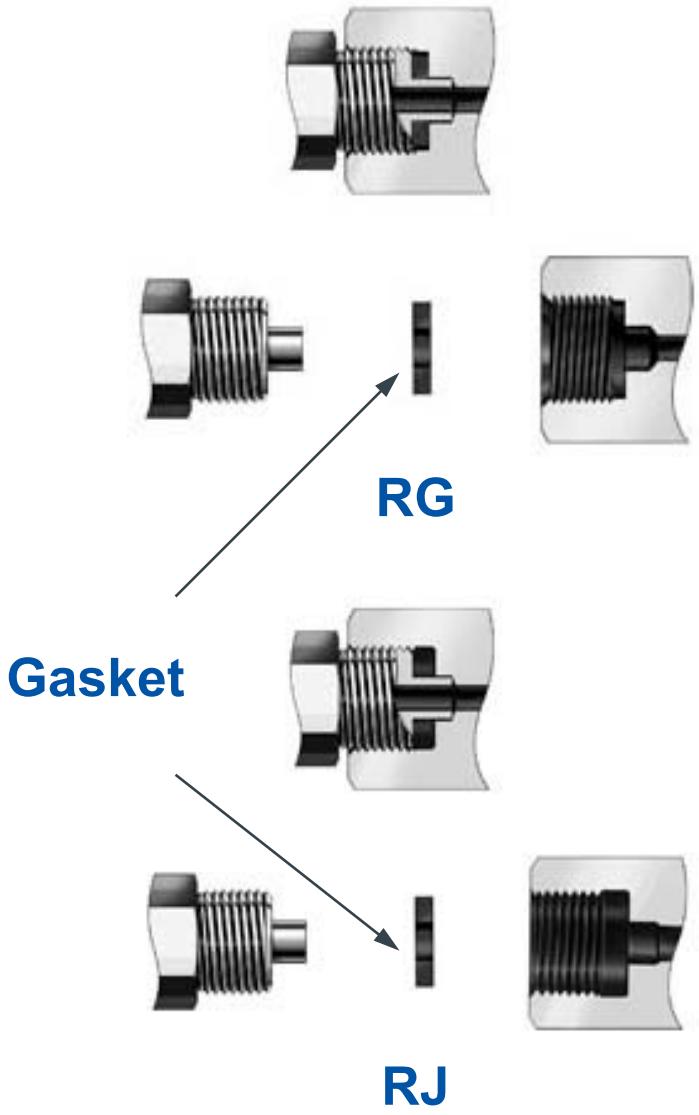
- Parallel threads do not create a seal. The seal must be made with a gasket, O-ring, or metal-to-metal contact.
- Use of a thread lubricant may be desired to resist galling during assembly.





Part 1: Parallel Threads





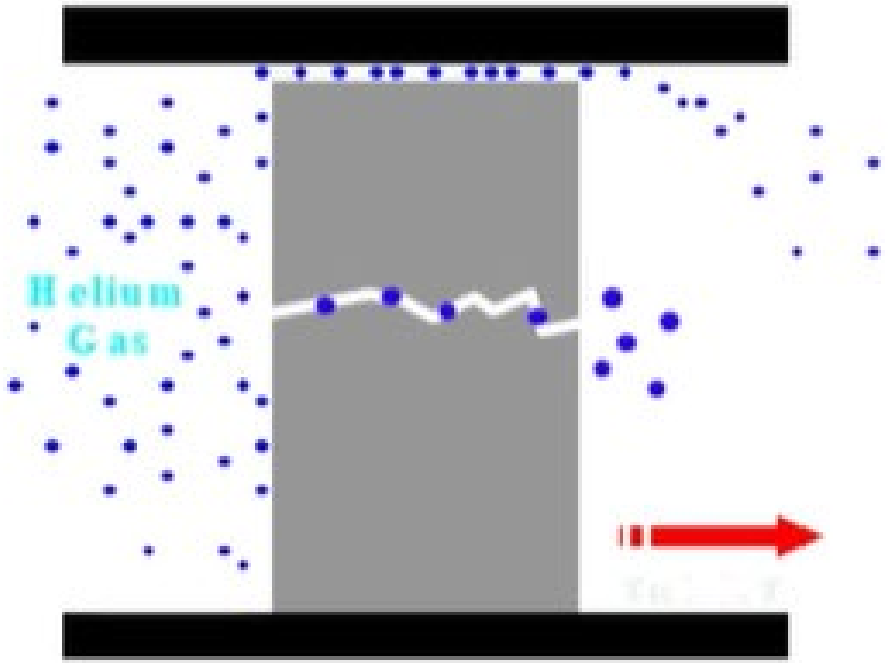
Part 1: Terminology of threads

How to identify the different thread

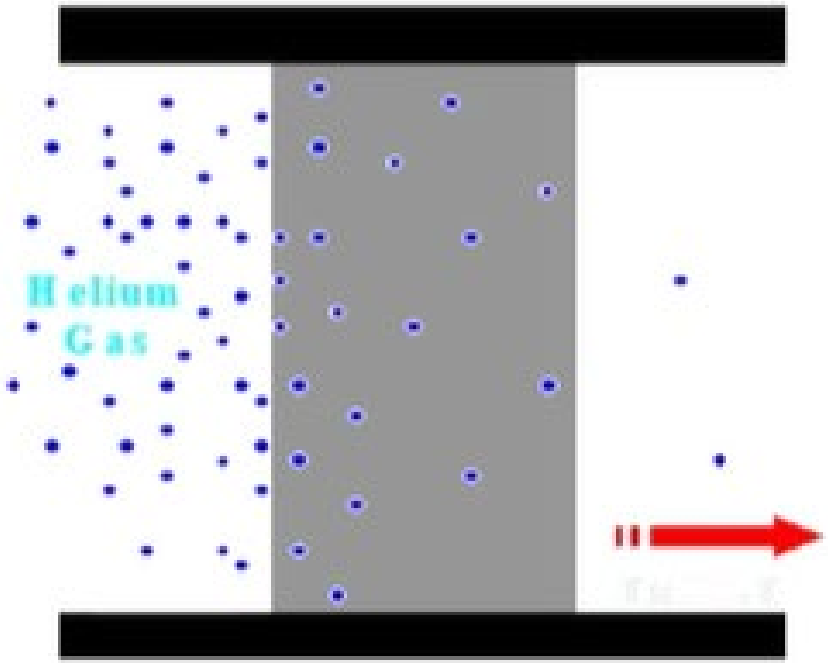
- Caliper
- Pitch gauge
- Thread identification guide

Part 2: Understanding a good seal

Understanding a “leak” vs “permeation”

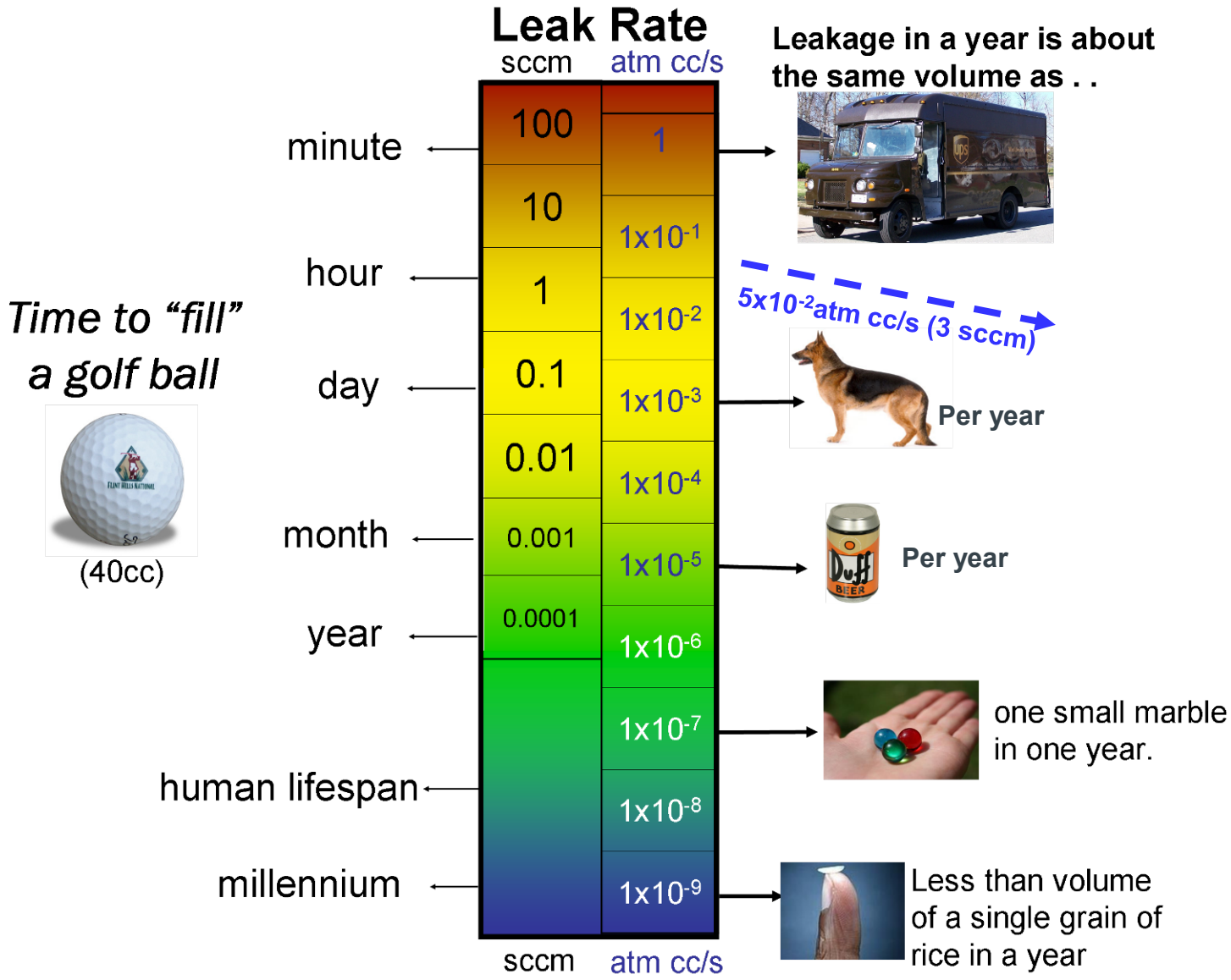


“Path” leak



Permeation

Perspective on Leak Rates



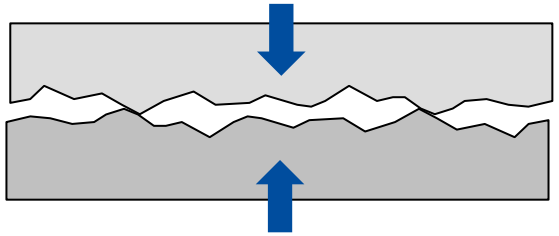
Part 2: Factors that drive leak rates

Factor	Description
Pressure	Increased pressure will speed up the leak rate
Temperature	Increased temperature speeds up molecules and will have impact on leak rate
Seal Length	Longer permeation paths (seal thickness) will decrease the flow of gas through the material
Seal Material	These two factors are the two most impactful variables and the two hardest to quantify
Gas/Fluid	

Objective: Eliminate **continuous pore structure** between mating surfaces

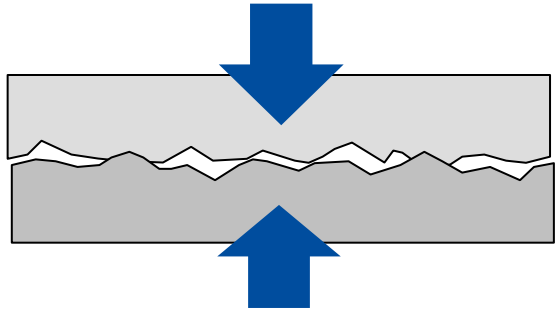
- All machined surfaces have a degree of roughness
- Peaks and valleys can link to make leak paths between mating components

Two-dimensional representation of rough surfaces coming together to form a seal.



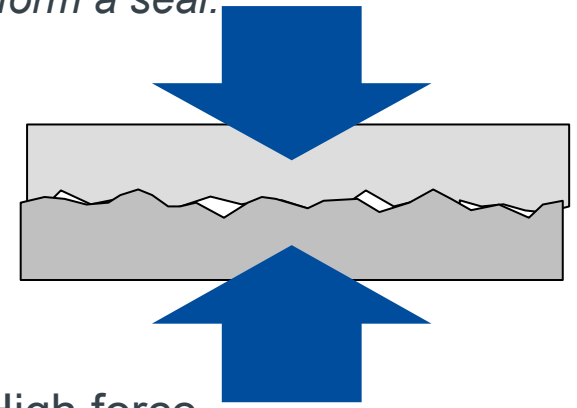
Low force

- Little-to-no deformation provides long life
- Poor seal-ability
- May require lube to create seal, which washes away creating leaks



Medium force

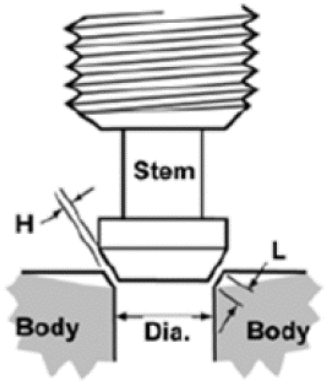
- Deformation can remain elastic, minimizing damage
- Ideal for valves that see high cycles
- Typical seal range for softer materials

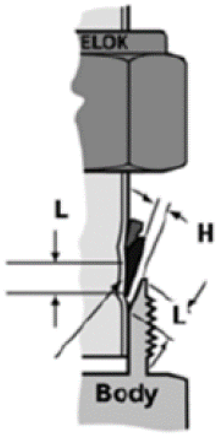


High force

- Deformation becomes plastic
- Often burnishes the pieces, making gas seals more reliable
- Lower remakes due to permanent deformation

Part 2: Leak Paths

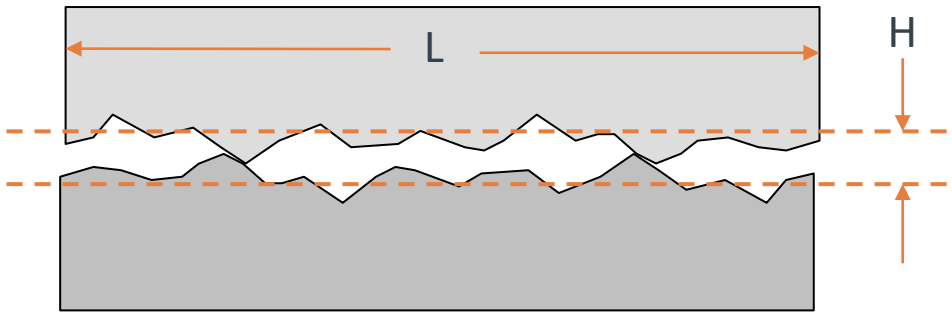




$$Q = \frac{\Delta P \times H^3 \times W}{\mu \times L}$$

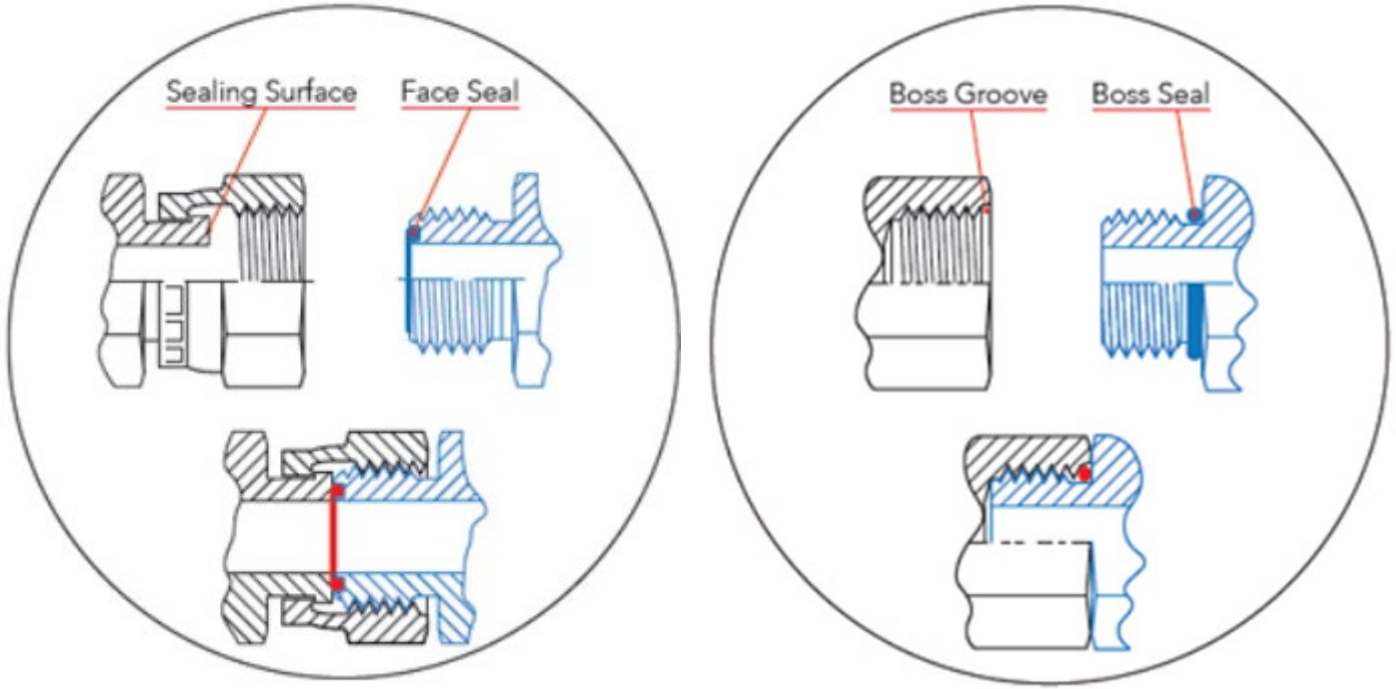
How much force is the fitting putting into the seal area (minimize H)?

How long is the sealing area (maximize L)?



Part 3: Different kind of seals

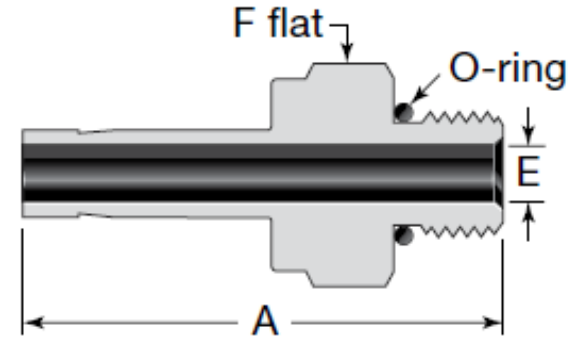
Part 3: O-ring Sealing Fittings

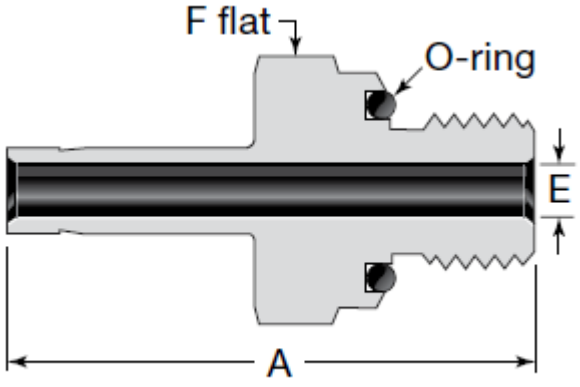


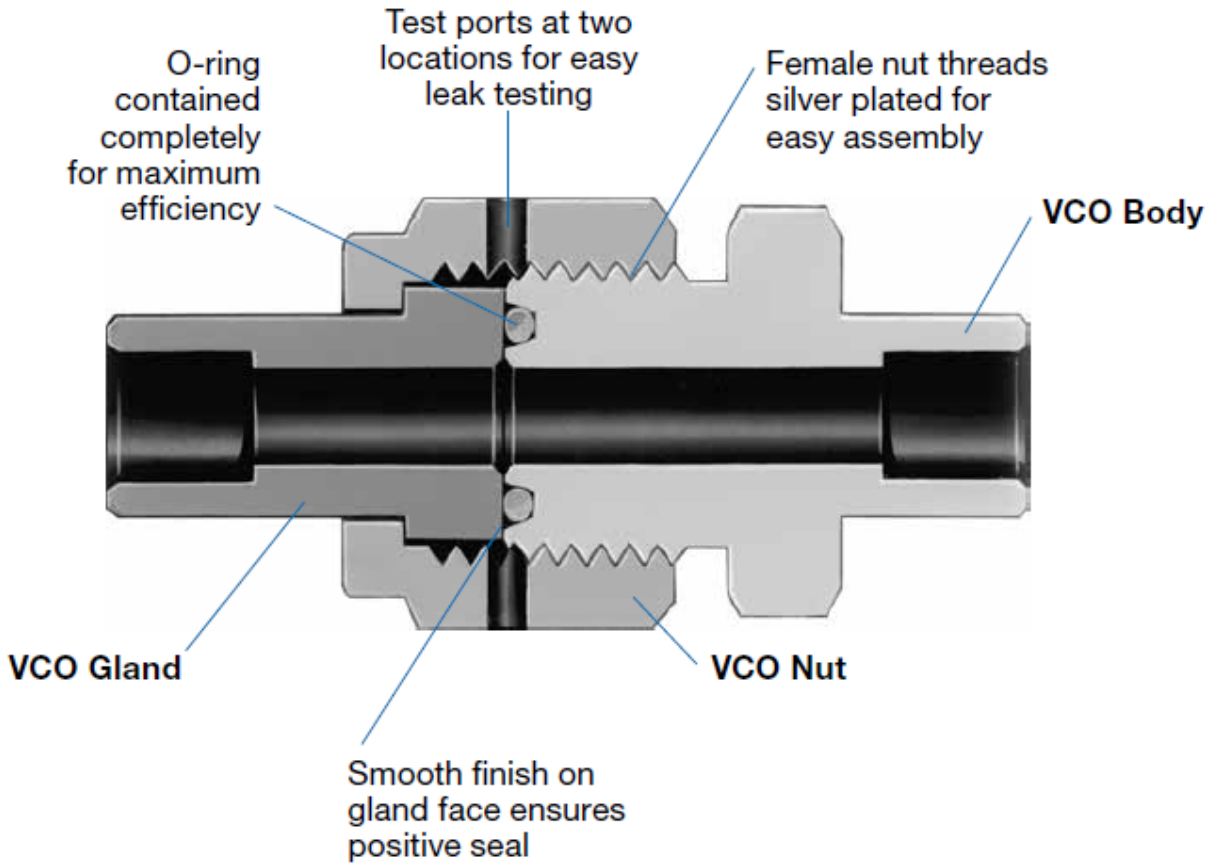
- O-rings will rapidly permeate, especially at high pressures
- Internal O-rings are in direct contact with system media
- O-rings can only provide minimal seal force
- Lack of compatibility with media can cause premature O-ring failure

https://www.adaptall.com/info-tutorials/sealing-methods.php

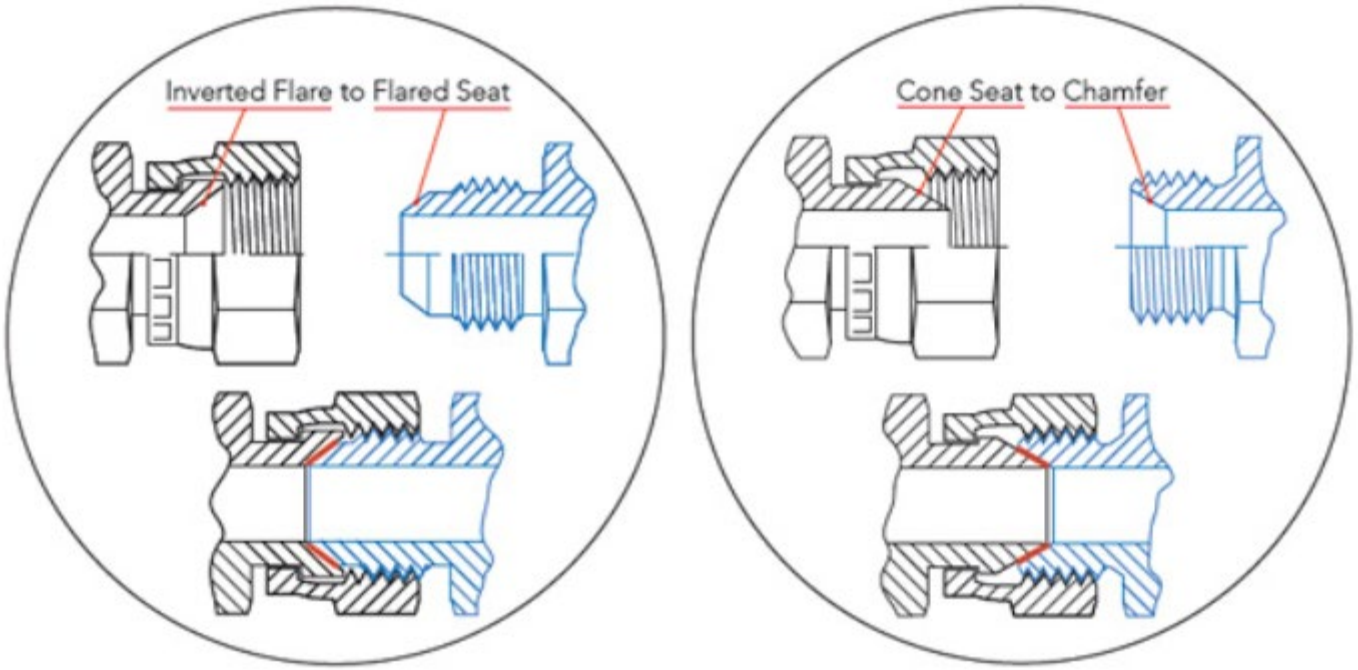
Part 3: O-ring Sealing fittings







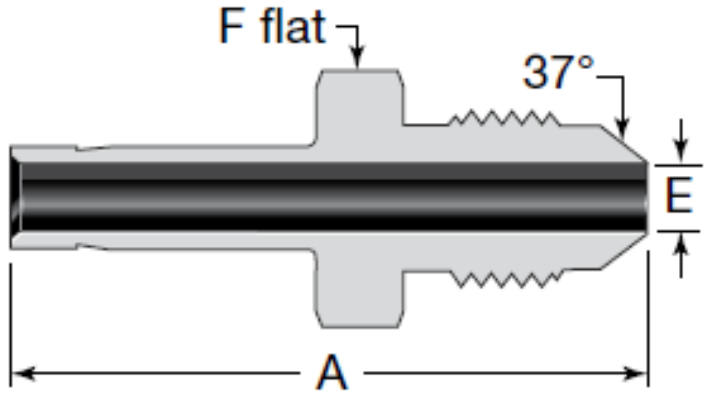
Part 3: Flare-Style Fittings



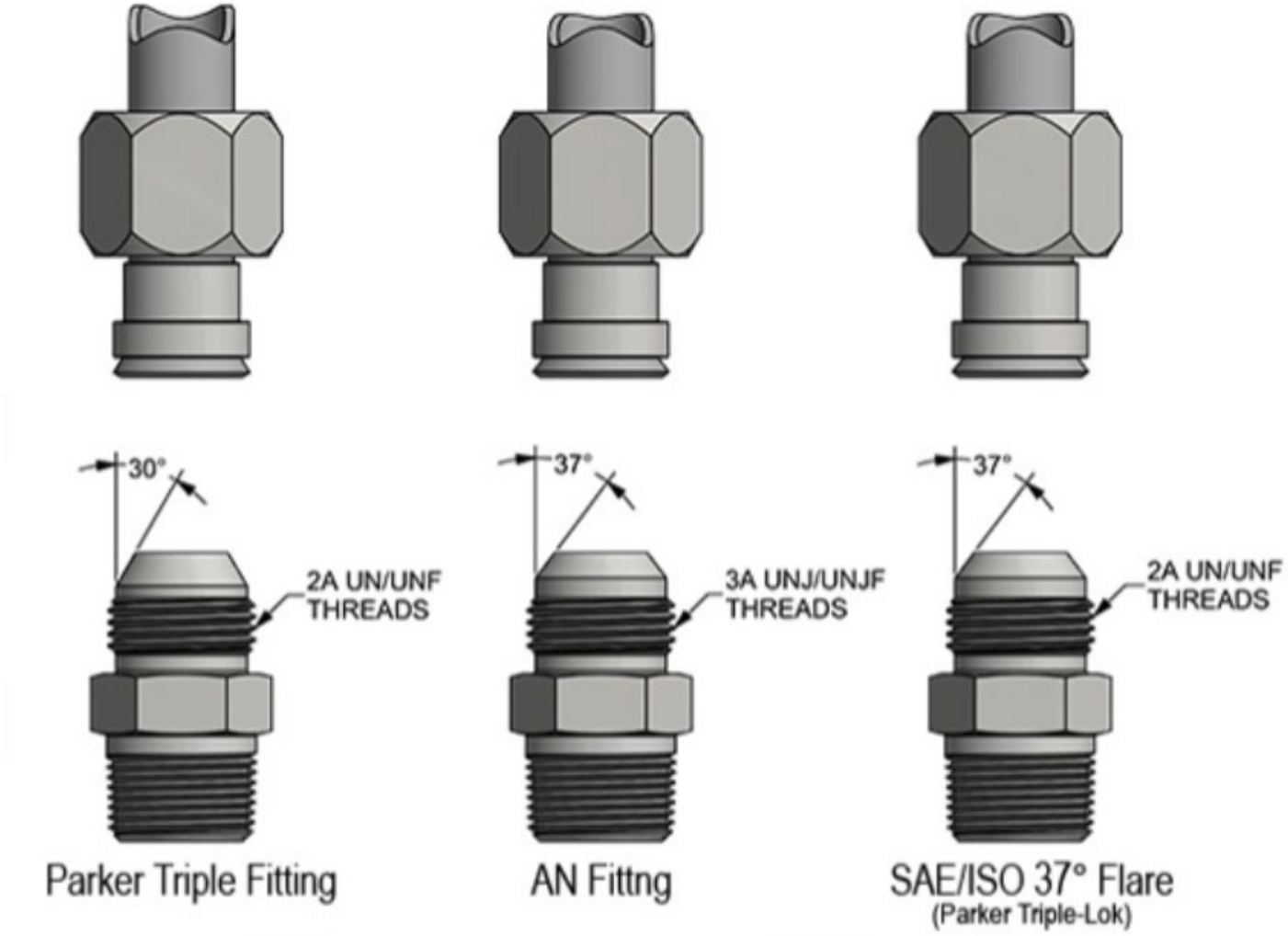
https://www.adaptall.com/info-tutorials/sealing-methods.php

- Cone can be on the female or male end
- Short seal length with difficulty creating a “burnish”
- Little flex support with the cone area taking full force
- Some nuts have “weep” holes for leak detection which provides corrosion sites

Part 3: Flare-Style fittings



AN Thread

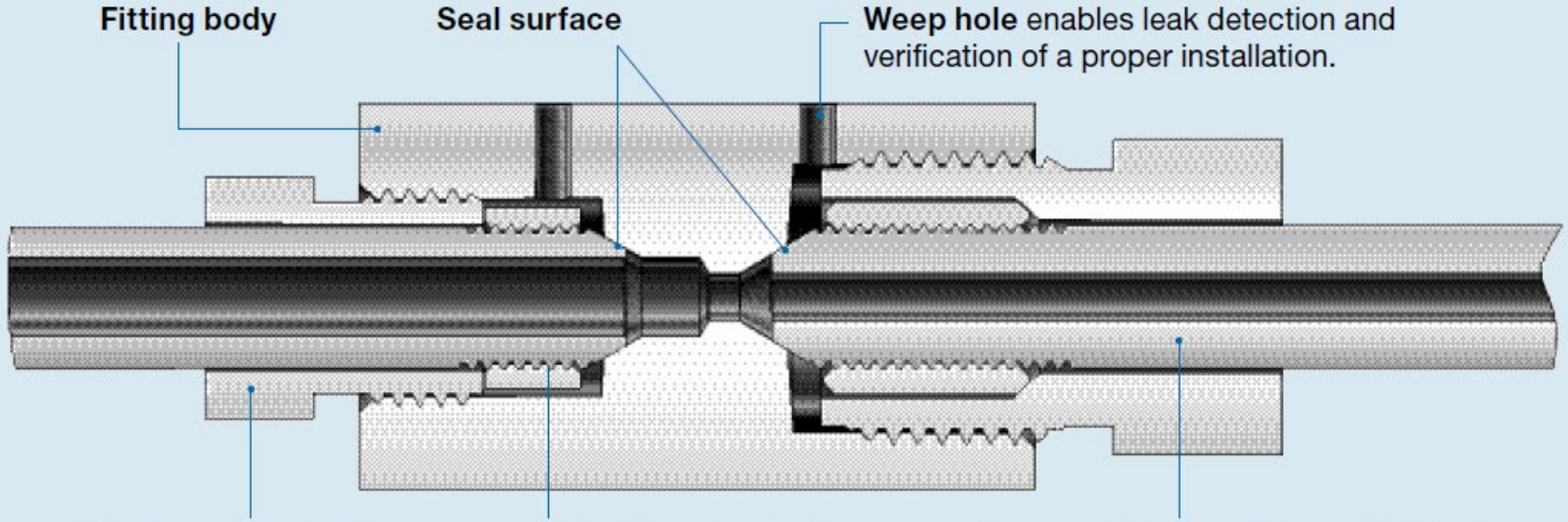


Part 3: Cone and Thread

Cone and Thread Fitting—IPT Series

Medium-pressure cone and thread end connection shown on left side of fitting

High-pressure cone and thread end connection shown on right side of fitting



Part 3: Cone and Thread

- Thread and cone are machined into the tubing
- Considered blowout-proof due to the collar assembly. However, thread shear does occur if not properly formed
- Low sealing area (similar to flare-style design)
- High sealing force from larger thread mechanical advantage
- Very susceptible to vibration failure
- Require grease to create reliable seal

Part 3: Cone and Thread

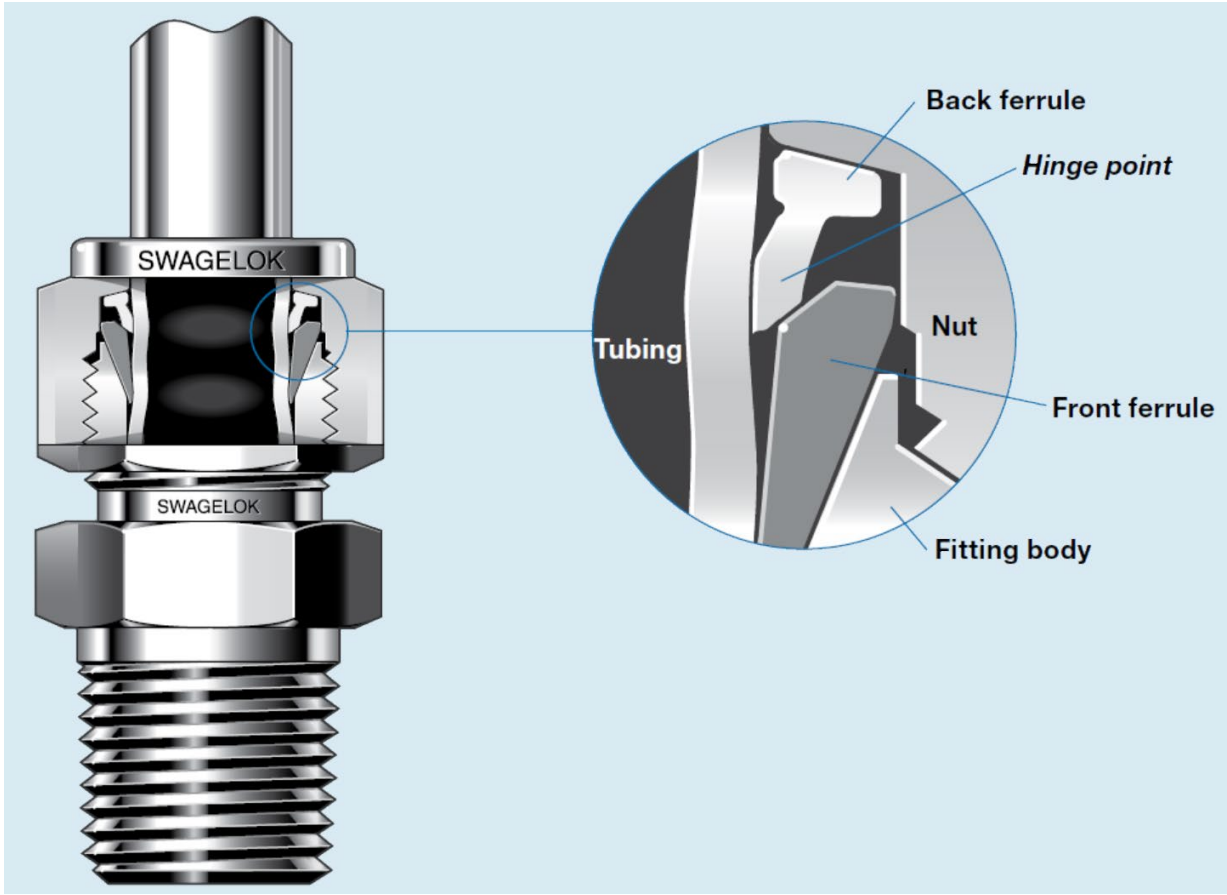
Part 3: Swagelok Tube Fitting Technology

Swagelok's two-ferrule fitting provides robust product performance

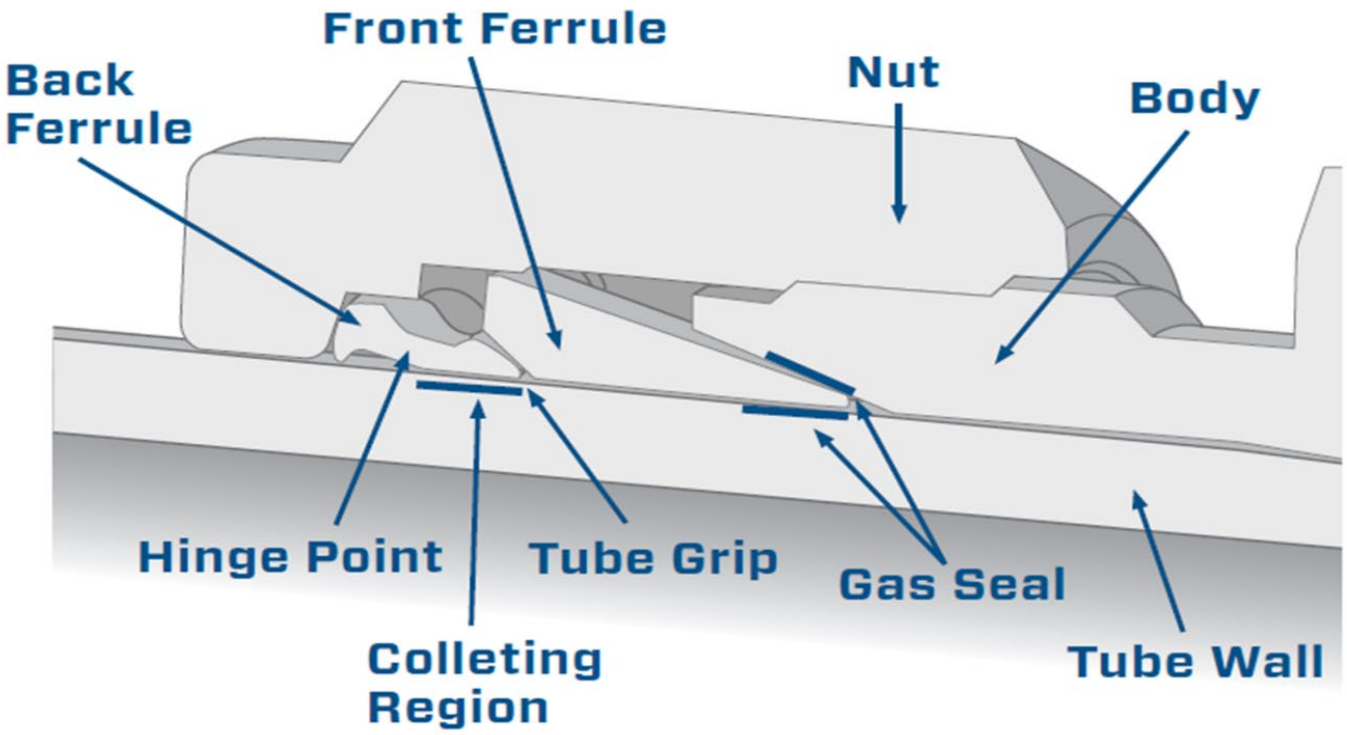
- Gas seal in small molecule applications
- Vibration resistance from high tube grip

Quick and easy installation

- Assembly by 1-1/4 turn
- Gaugeable
- Pre-swage and other tools

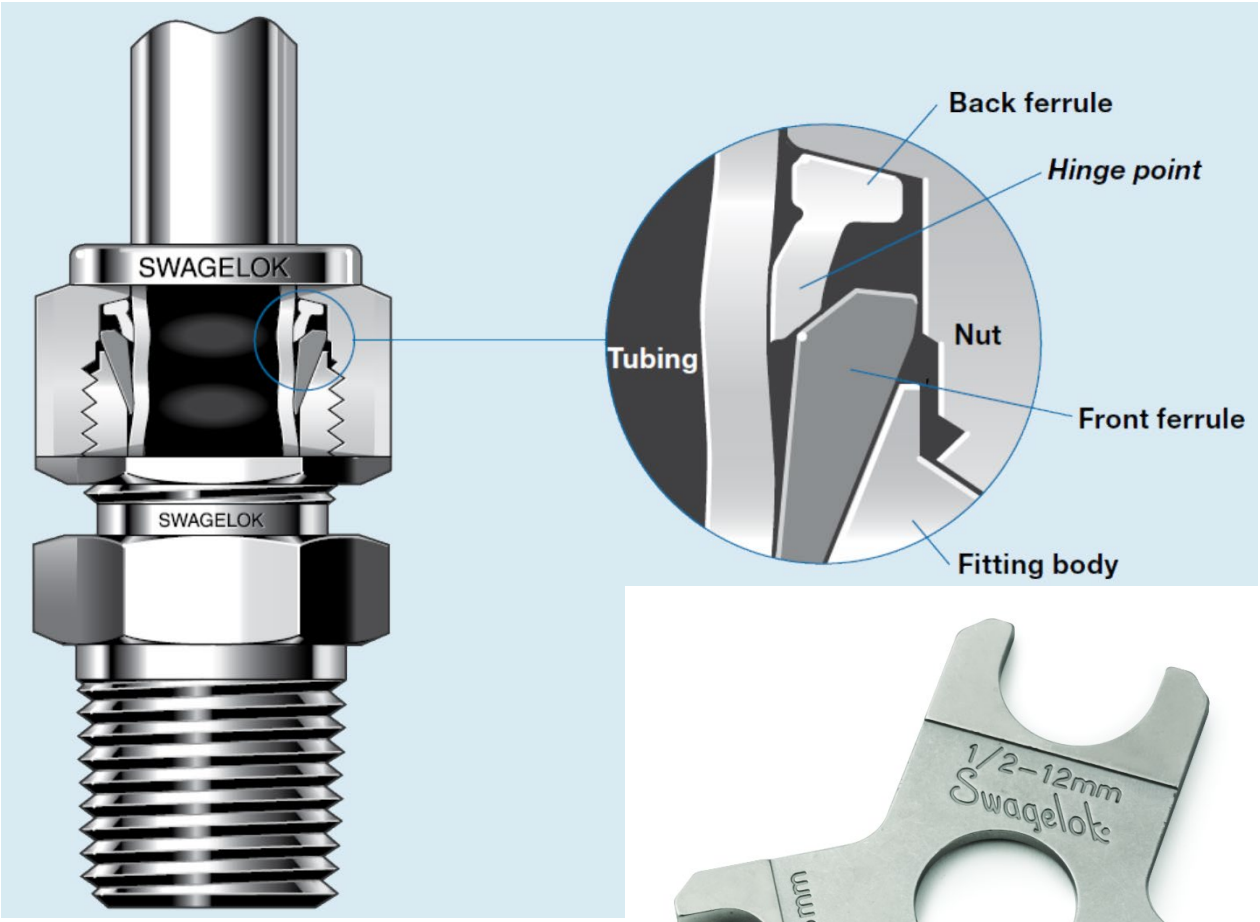


Part 3: Two-Ferrule Style



- An additional ferrule “collets” to the tube, significantly improving support
- Front ferrule burnishes to the tube and body to create high seal force
- Easily gaugeable using the tolerance between nut and body
- Second longest seal length (tapered thread) given multiple seal points

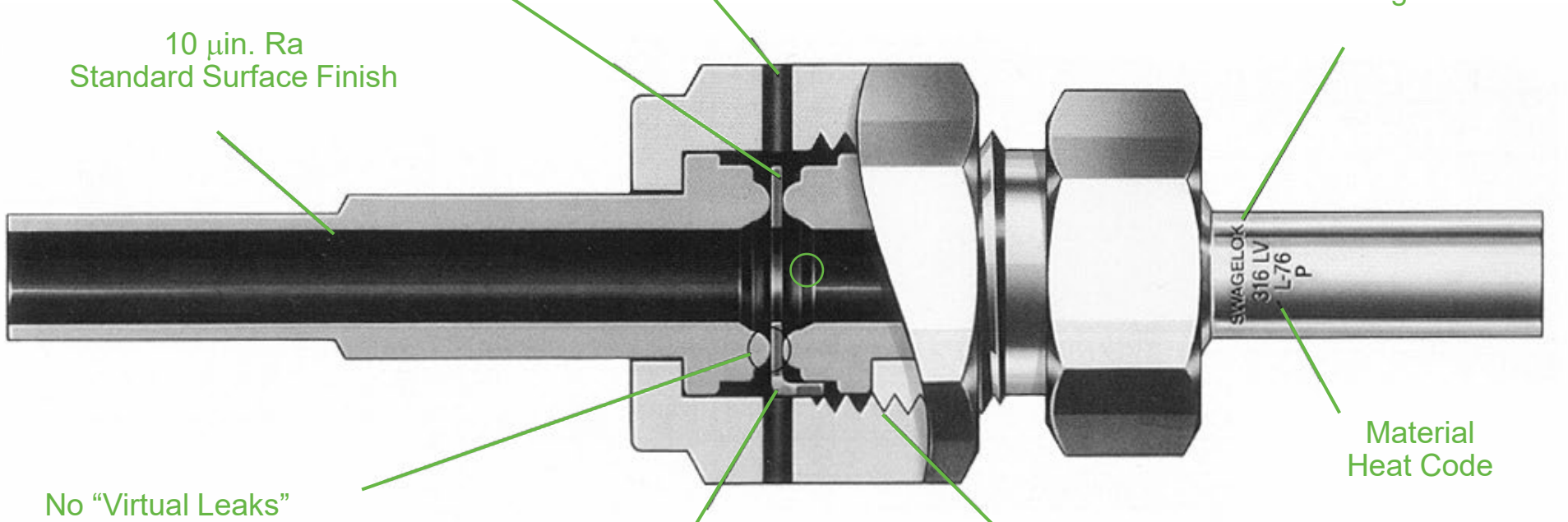
Part 3: Fittings: Swagelok Tube Fitting Technology



- Advanced-geometry, Hinging-Colleting Back Ferrule design
  - Excellent gas-tight sealing and tube-gripping action
  - Easily achieved proper installation
  - Consistent remakes
  - Excellent vibration and tube support

Gaugeable between nut and body

Part 3: VCR Face Seal Fitting



Side-load
Retainer Gasket

Test Port

Product Identification
Markings

10 µin. Ra
Standard Surface Finish

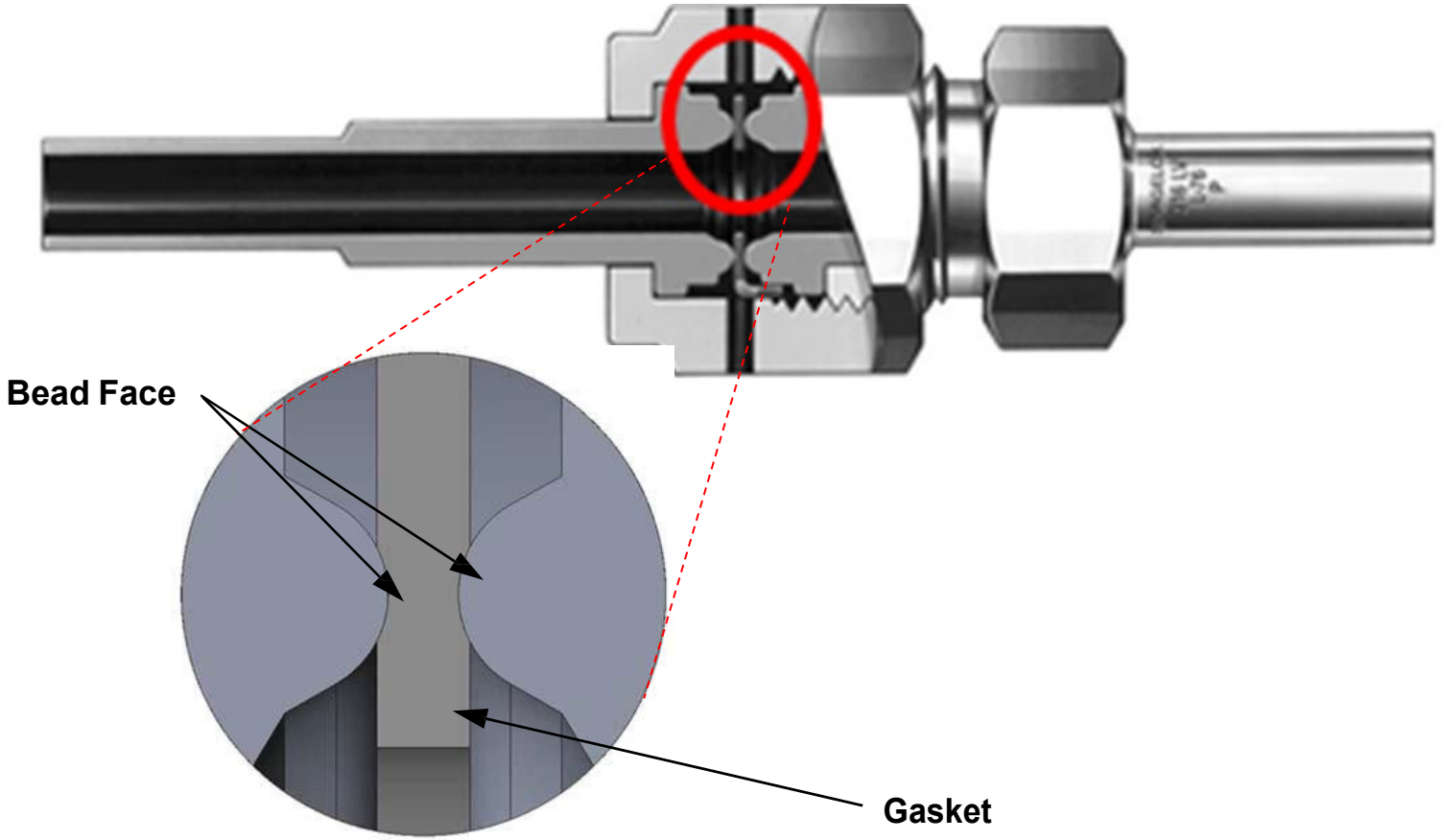
Material
Heat Code

No “Virtual Leaks”

Precision
Manufactured Gasket

Silver Plated
Female Threads

Part 3: The VCR Seal

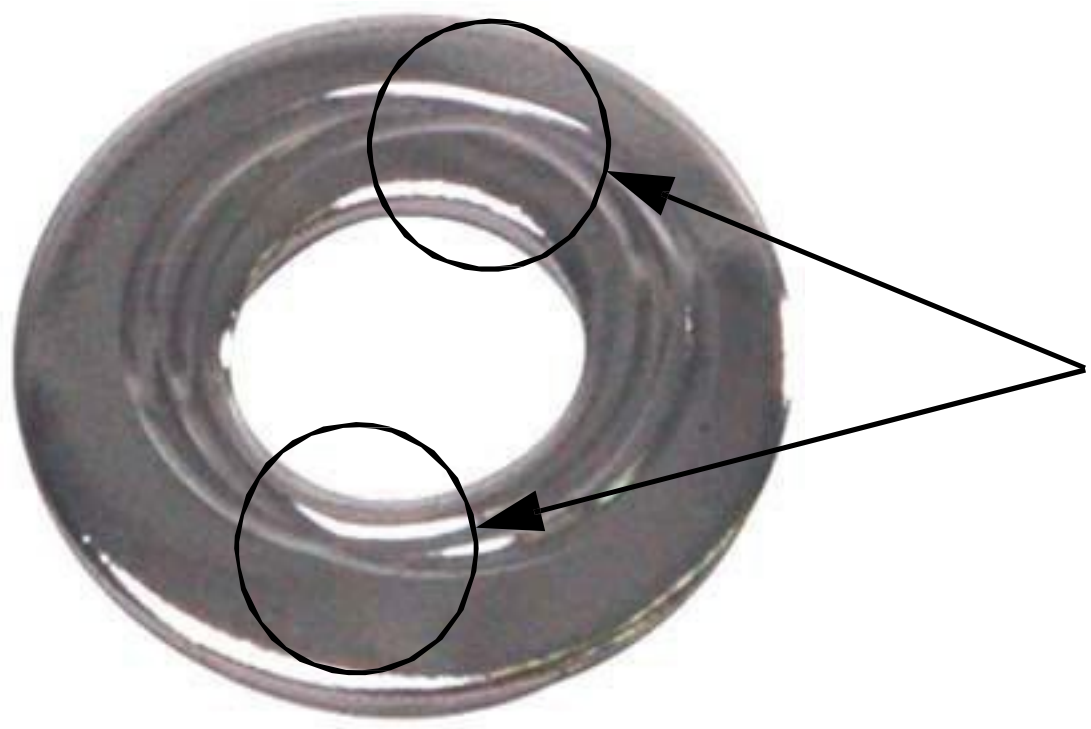


Typical bead impression found on a standard gasket, post-installation

A seal is formed when the beads are compressed into the gasket

Never re-use the VCR Gasket

- The existing bead impression may not align with the seal bead and a leak will occur at the intersection of the two impressions



Part 3: VCR Installation and Trouble Shooting

Impression on a standard gasket after proper tightening at 1/8 or 1/4 turn past finger-tight.

Over-tightened impression on a standard gasket after 1/2 turn. Note the distortion.

Summary

- Which thread will you use for your system?
- Which sealing method fits your process?

Contact

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