Advanced Metal Sealing Solutions for Critical Valve Applications

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Sealing Solutions for Valve Applications

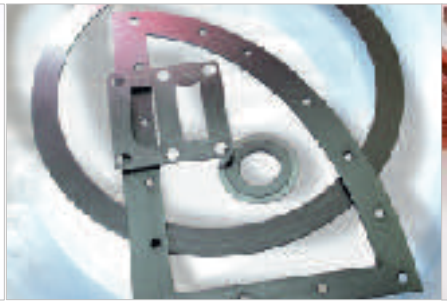
Metal Seals

Laminated Graphite Seals

Spiral Wound Gaskets

PEEK Components & Seals

Graphite Seals



Inflatable Seals

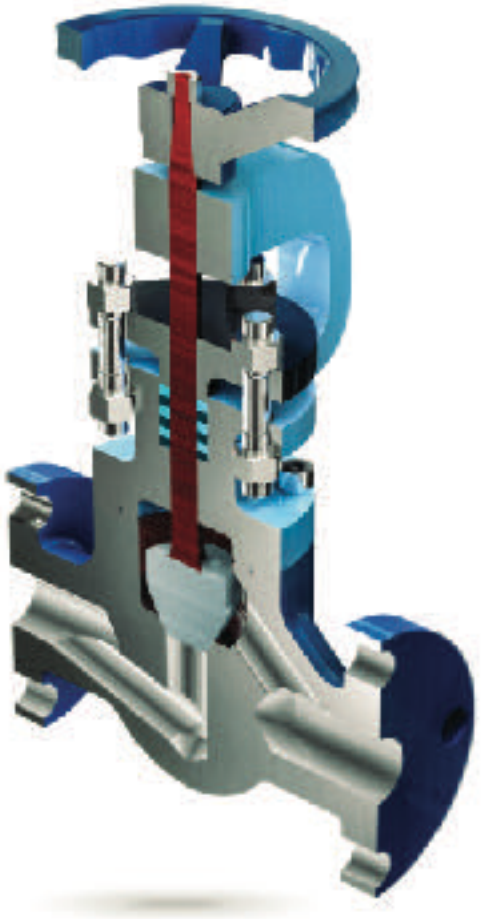
Edge-Welded Metal Bellows

The Valve Industry

- **Industry Evolution**
  - From conventional resources to very difficult recoverable fields
  - Higher temperature & pressure
  - Reliability & environmental concerns
- **Industry Requirements**
  - Extreme temperature and pressure
  - Corrosion resistance & extended seal life
  - Fluctuating pressure directions
  - Thermal & pressure cycles
  - Axial pressure / radial compression

Extreme Service Conditions for Metal Seals

- **High temperature / Cryogenic**
- **High pressure / Ultra high vacuum**
- **Cycling**
- **Chemical compatibility / Purity**
- **Radiation**
- **Longevity**
- **Ultra low leak rates / Fugitive emissions**
- **Low outgassing / Permeability**
- **Resiliency / Spring back**



Basics of Metal Seals

- **Fundamental design considerations**
- **Environmental conditions and variability over time**
- **Required leak rate and the media to be sealed**
- **Metal-to-metal contact; the sealing surface against the body material**
- **Surface finish - metal seals do not always require a very smooth surface finish and can even accommodate standard ANSI flange finishes**
- **Metal seal type, cross section, material & thickness**

Design Considerations for Metal Seals

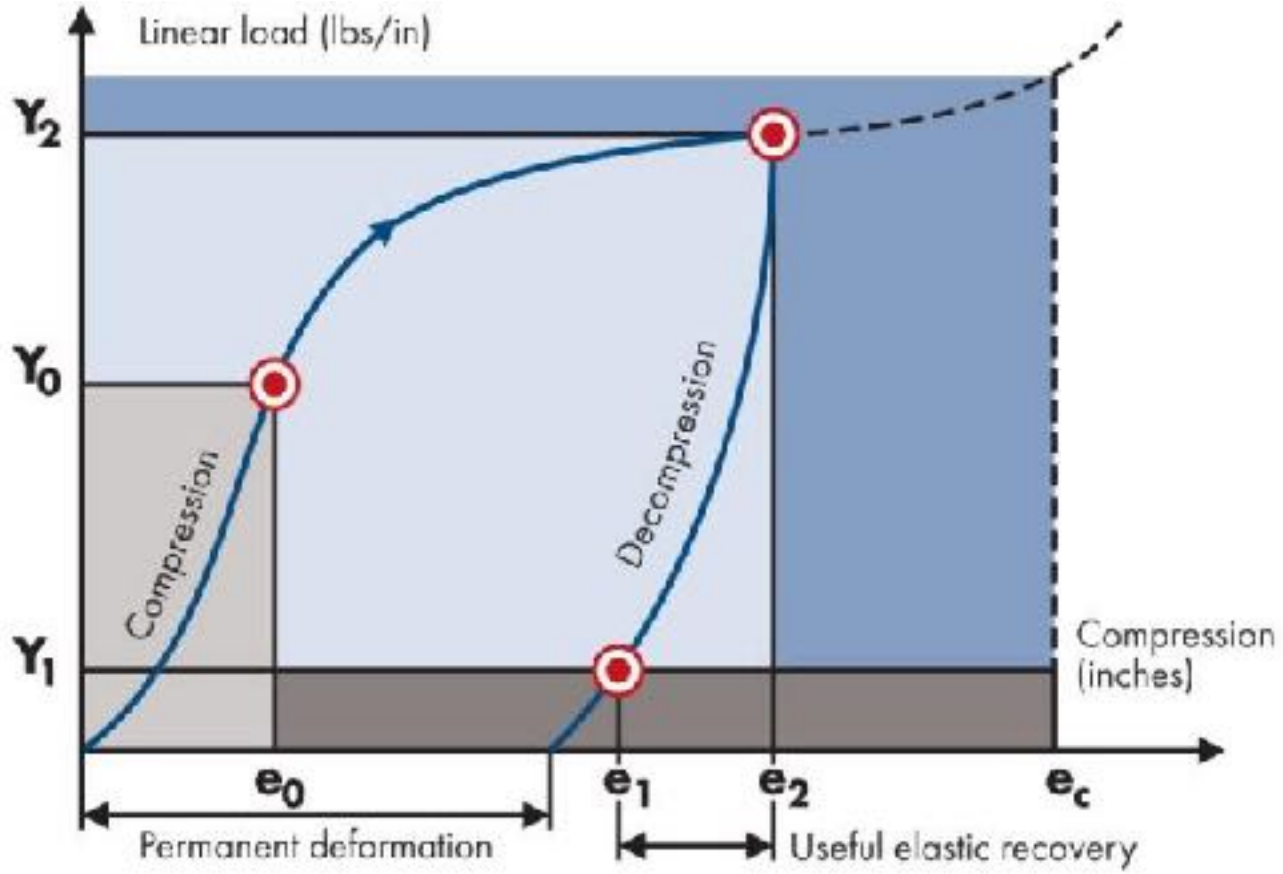
- **Leak Rate**
- **Temperature & Pressure**
- **Chemical Compatibility**
- **Loading / Fasteners**
- **Manufacturability**
- **Elasticity / Spring back**
- **Abrasion Resistance**
- **Joining / Weldability**
- **Movement / Fatigue**
- **Economical**

ZERO LEAKAGE DOES NOT EXIST

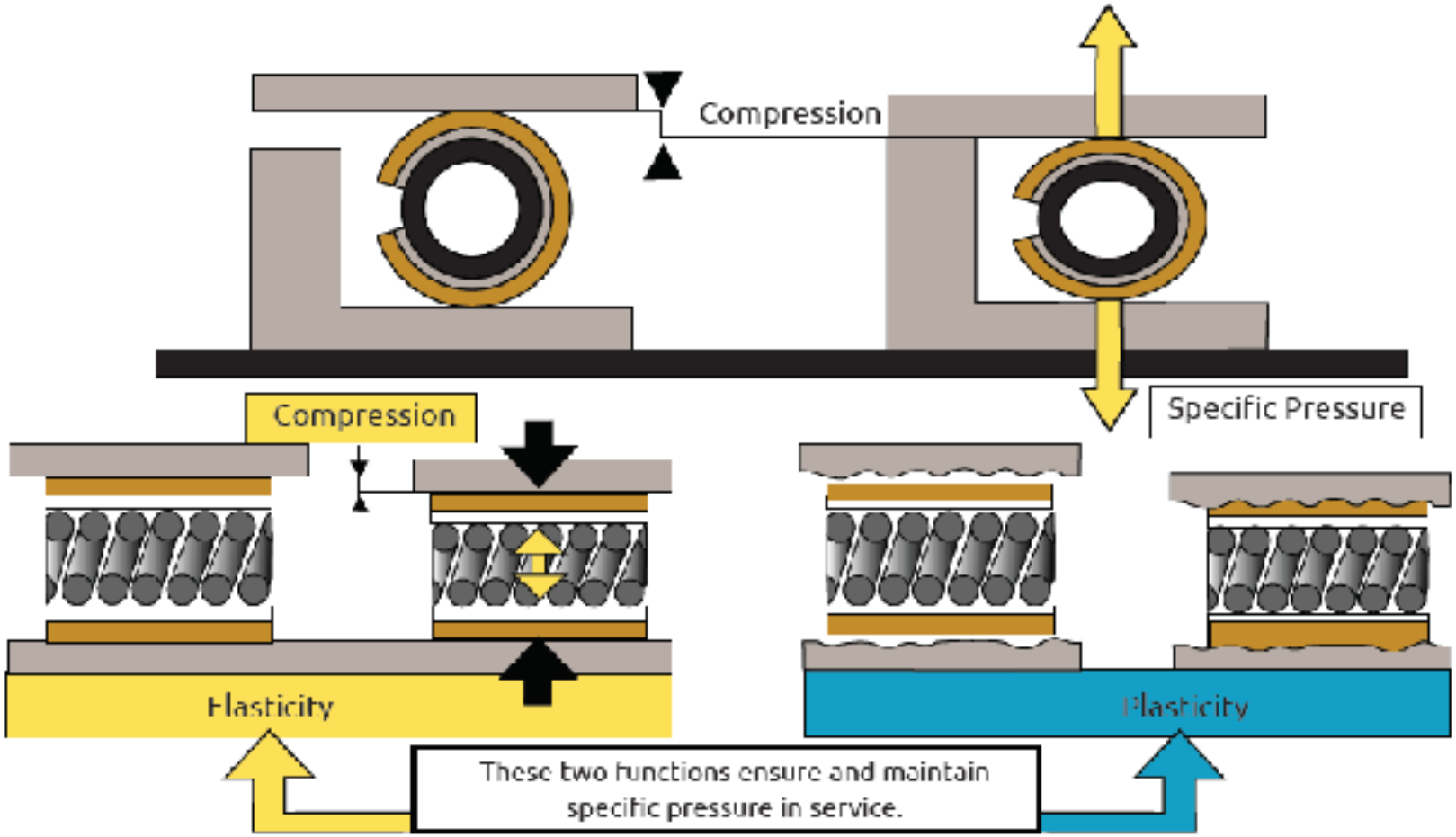
Gas Flow (Pa.m3/s) of He	Criteria	Illustration	Time	Volume
10^{-13}	Helium	Pinhead	2200 Years	0,1 cm^3
10^{-11}	Helium	Pinhead	20 Years	0,1 cm^3
10^{-9}	Helium	Thimble	5 Years	1,5 cm^3
10^{-7}	Helium	Thimble	2 Weeks	1,5 cm^3
10^{-5}	Bubble tight	Magnum of Champagne	6 Months	1,5 dm^3
10^{-3}	Bubble tight	Bucket	2 Weeks	15 dm^3
10^{-1}	Bubble tight	Tanker truck	20 Weeks	12 000 dm^3
10	Bubble tight	Tanker truck	1 Day	12 000 dm^3

Spring-Energized Metal Seals

Sealing Concept of Spring-Energized Metal Seals

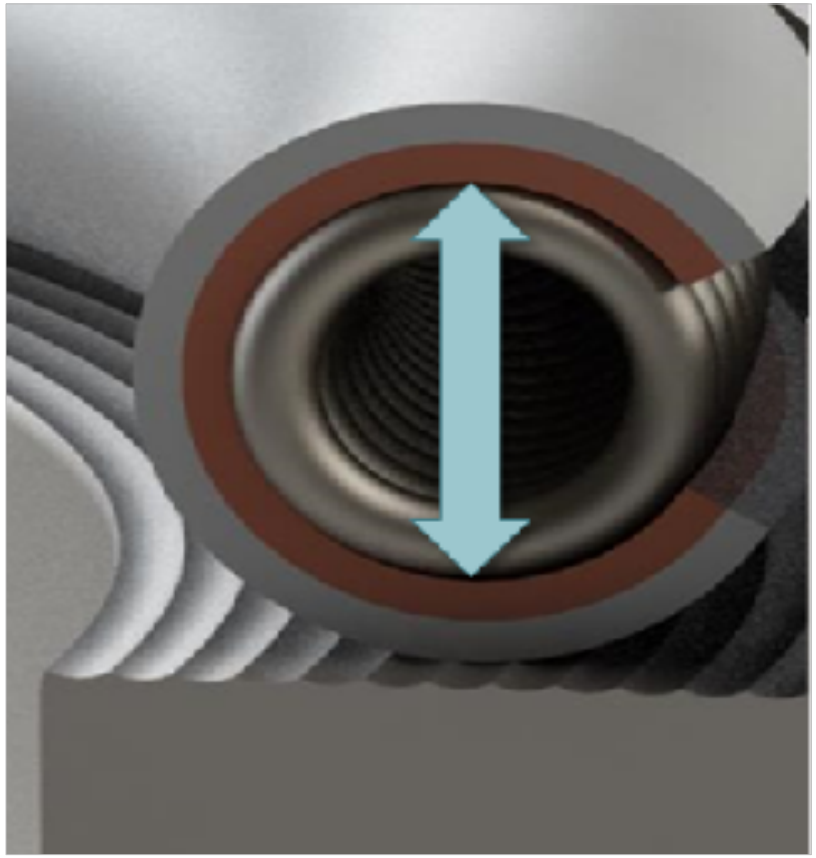


Elasticity –vs- Plasticity: Separate Performance



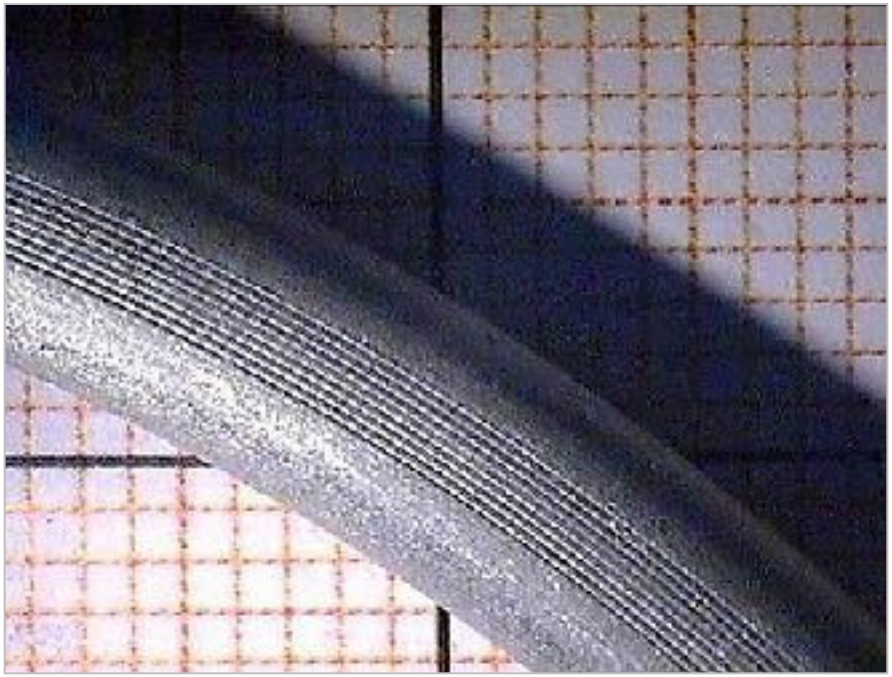
Deformations & Surface Finish

- **Elastic Deformation**
  - Spring Force & Spring Back from
  - Metal Substrate/Elastic Core: Spring/ Tubing/C-E-Profile)
  - Spring Rate varies based on Seal Type and Jacket/Plating
- **Plastic Deformation**
  - Jacket or Plating/Coating
- **Surface Finish**
  - Lathe Turned
  - Varies by Jacket/Plating



Plastic Deformation Examples

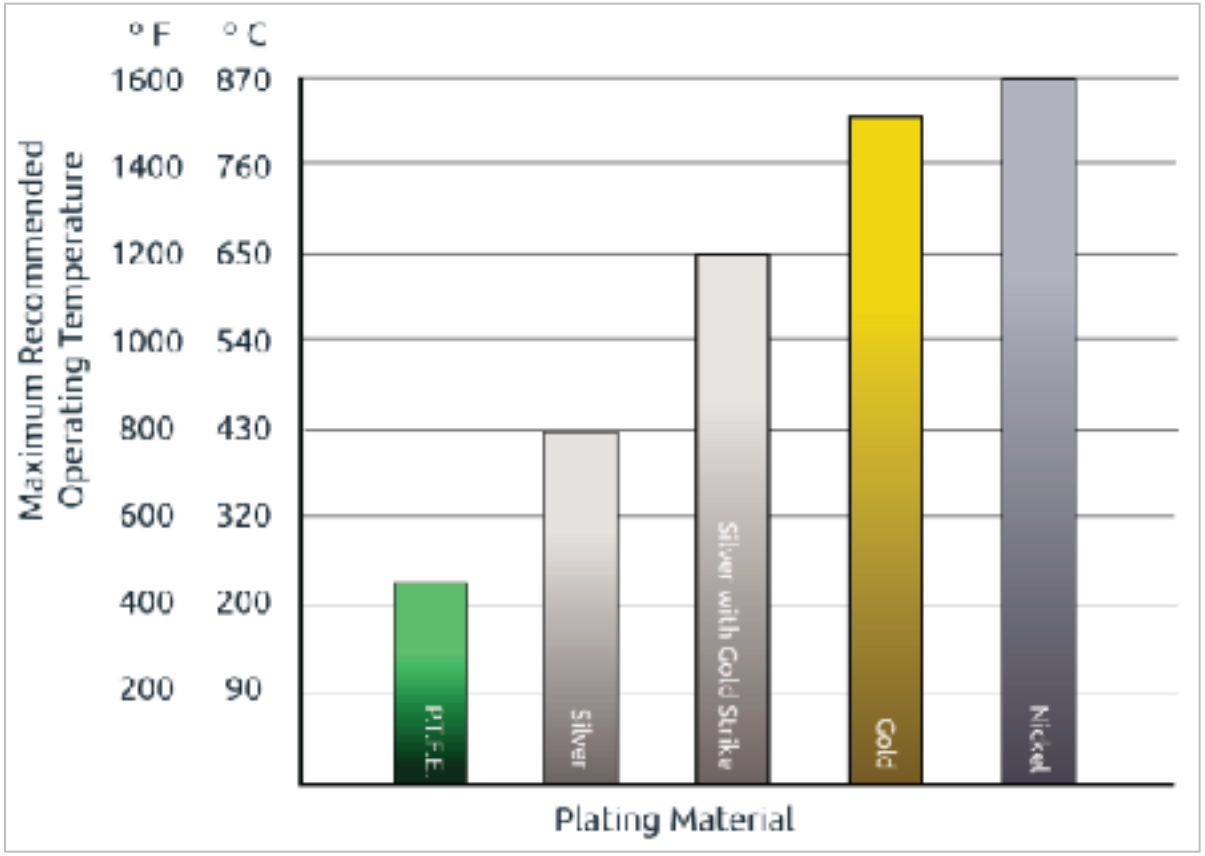
Silver Plating: O-Ring
Poor Flange Finish: Radial Marks

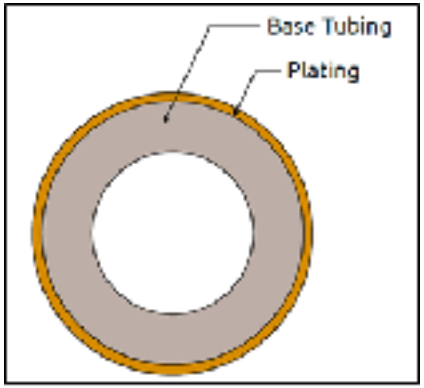


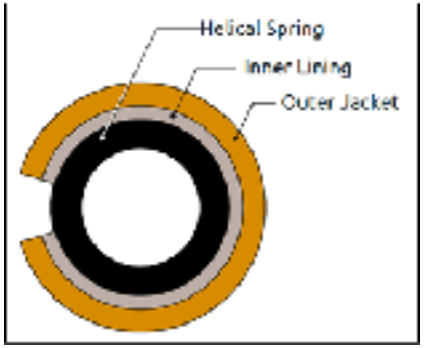
Silver Jacket: Spring-Energized
Good Flange Finish: Concentric Marks

Platings & Coatings

Maximum Recommended Operating Temperatures for Platings & Coatings

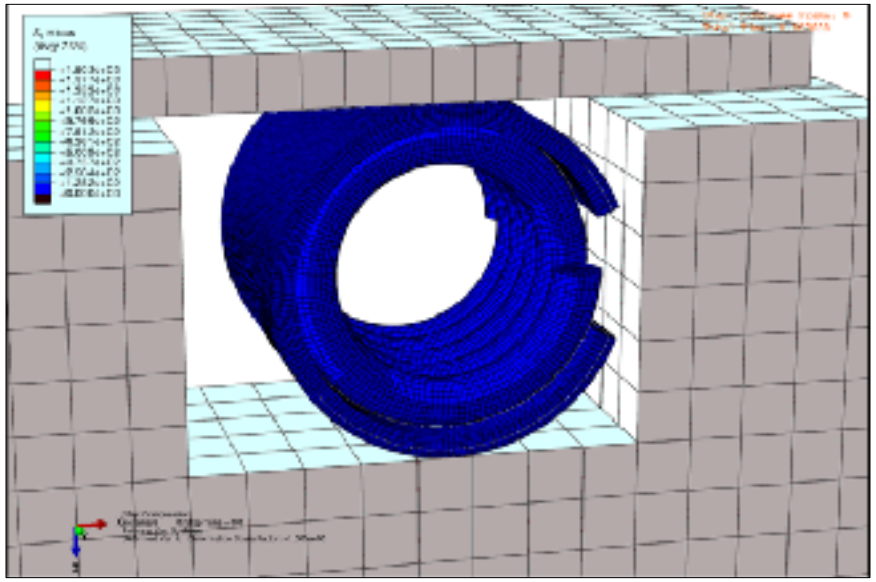


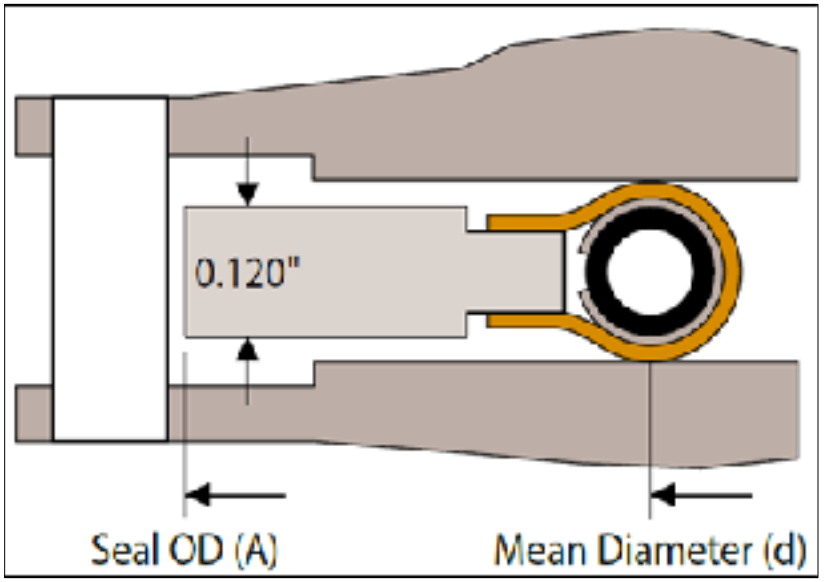




Metal to Metal Sealing Concept

- **Seal is protected**
- **Bolt preload increased**
- **Creep minimized**



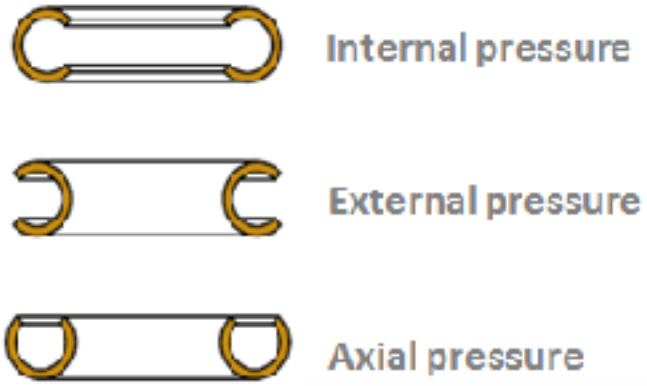


Wide Range of Metal Sealing Options

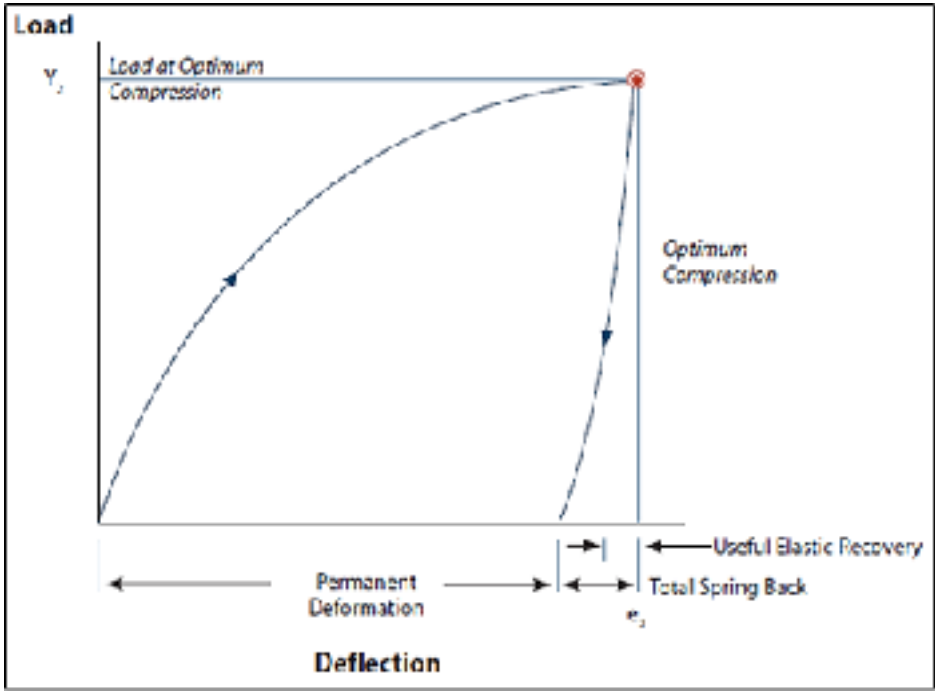
Pressure-energized seals include metal C-rings, O-rings, E-rings and Machined-rings




C-Ring Metal Seals

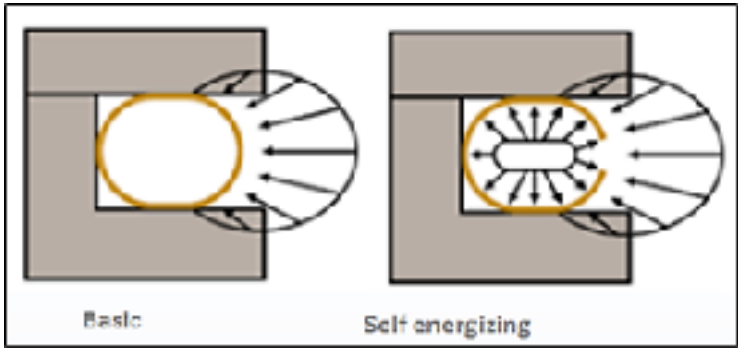


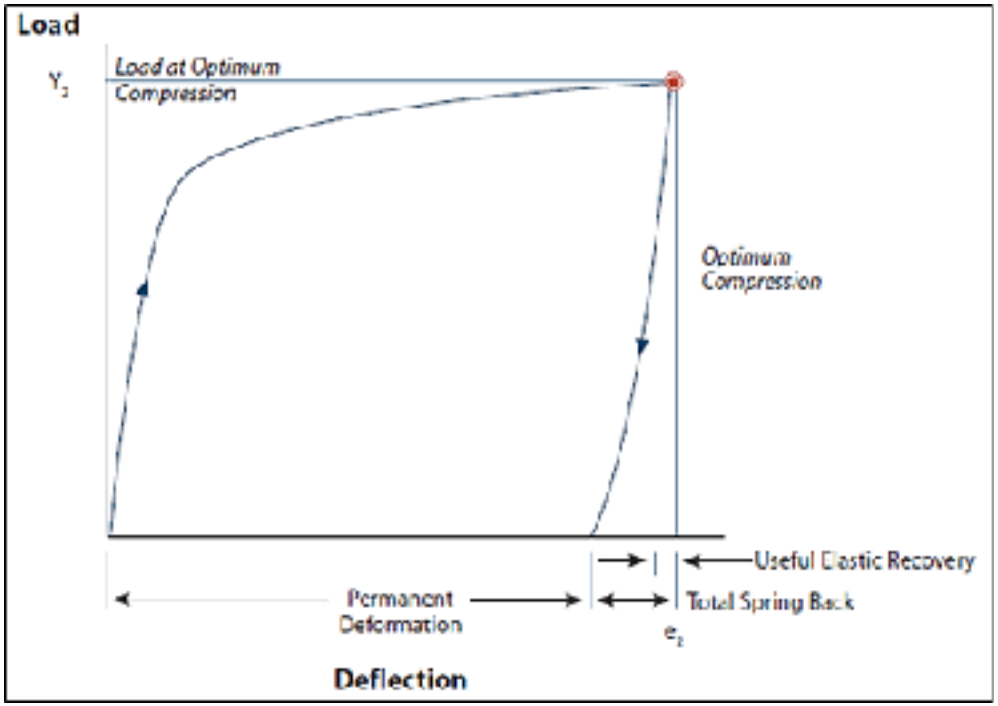
- **Elastic deformation of a metal “C” substrate**
- **Reduced load**
- **Moderate spring back**
- **Pressure-energized by the system**
- **Soft plating or coating to improve leak rate**



O-Ring Metal Seals

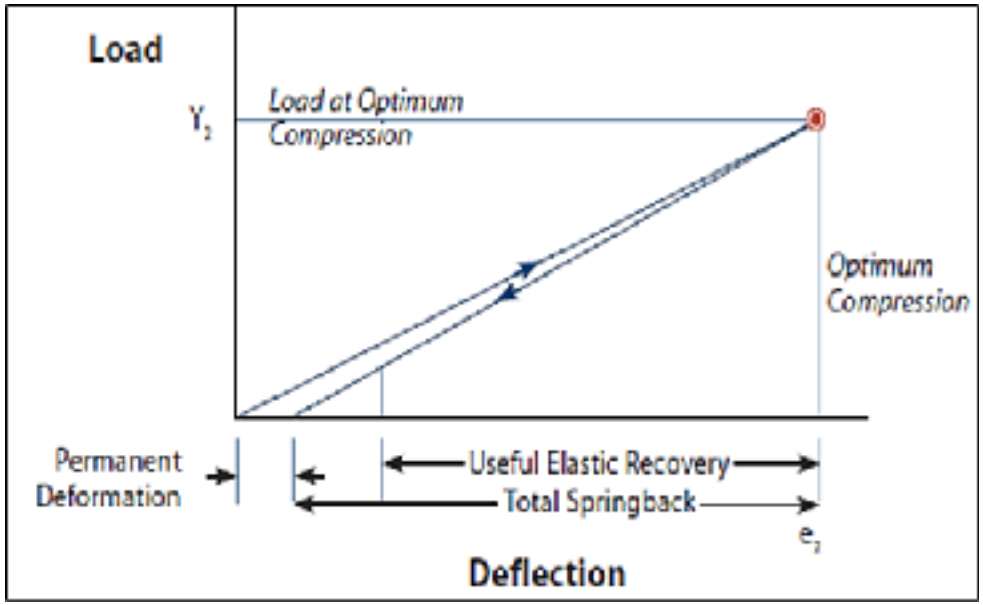
- **Elastic deformation of high strength metal tubing**
- **Moderate load & spring back**
- **Plating or Coating added to improve leak rate**





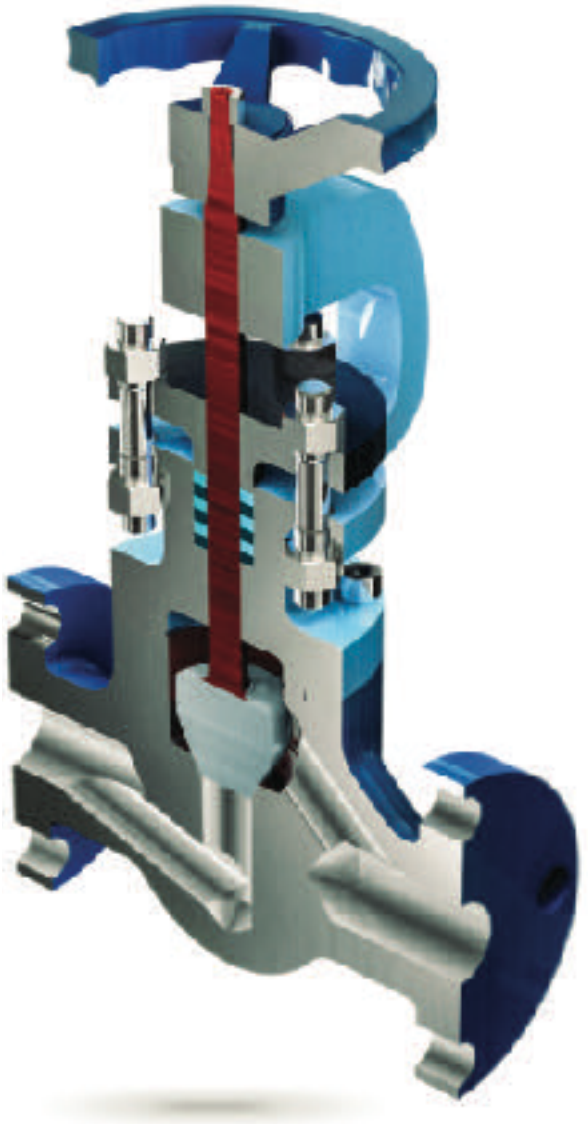
E-Ring Metal Seals

- **Elastic deformation of “bellows” like convolutions**
- **Low load**
- **High spring back: 90 to 100%**
- **Pressure-energized by the system**
- **No plastic deformation**
- **Wear coatings available**



Example Applications

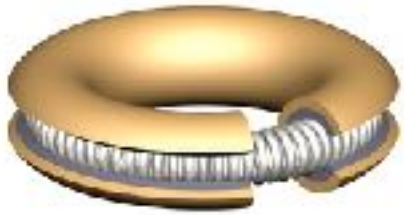
- **Body-Bonnet Connections**
  - Gate, Globe, Ball & Plug valve applications
  - Spring-energized metal seals, O-rings or C-rings are better solution when compared to traditional spiral wound gaskets, cut gaskets, and metal-graphite seals



Example Applications

- **Double & Quadruple Offset Butterfly Valves**
  - Consider needs for higher service temperatures, safety requirements, lifetime cycles, chemical resistance, and sealing performance
  - Spring-energized metal seals perform better than traditional softer materials
  - Jacket material typically Nickel or Inconel for high-temperature service; Copper for cryogenic service

Example Applications



- **Trunnion-Mounted Ball Valves**
  - Back-seat sealing a common industry problem
  - Typically serves a dual purpose, providing a seal between the body and seat and applying spring force against the seat and ball
  - Spring-energized metal seals, C-rings or E-rings can be used

Example Applications

- **Triple-Offset Butterfly Valves**
  - Up to 150 bar pressure
  - Seats often sealed with solid machined metal seals or laminated graphite seals
  - High precision and complex geometry
  - High leak tightness
  - High resistance over time

Conclusions

- **Metal sealing in the Valve Industry**
  - Resilient metal seal technologies improve leak rates, safety & reliability
  - Metal seals offer the widest range of design solutions
- **Large service conditions**
  - From cryogenic up to 800°C
  - From ultra high vacuum pressure up to 2500 bar
  - Controlled compression load
- **High resiliency**
- **Flexible design**
- **Helium leak rate**

Thank You for Your Time

Any Questions?

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