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Mechanical Seals

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Presenters:

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Senior Technical Trainer, Grundfos
Olathe, Kansas

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Senior Technical Trainer, Grundfos

Mechanical Seals in the Pump Industry

We will cover this subject in three webinars:

1. Introductory (today)
2. Advanced
3. Installation, service and failure analysis

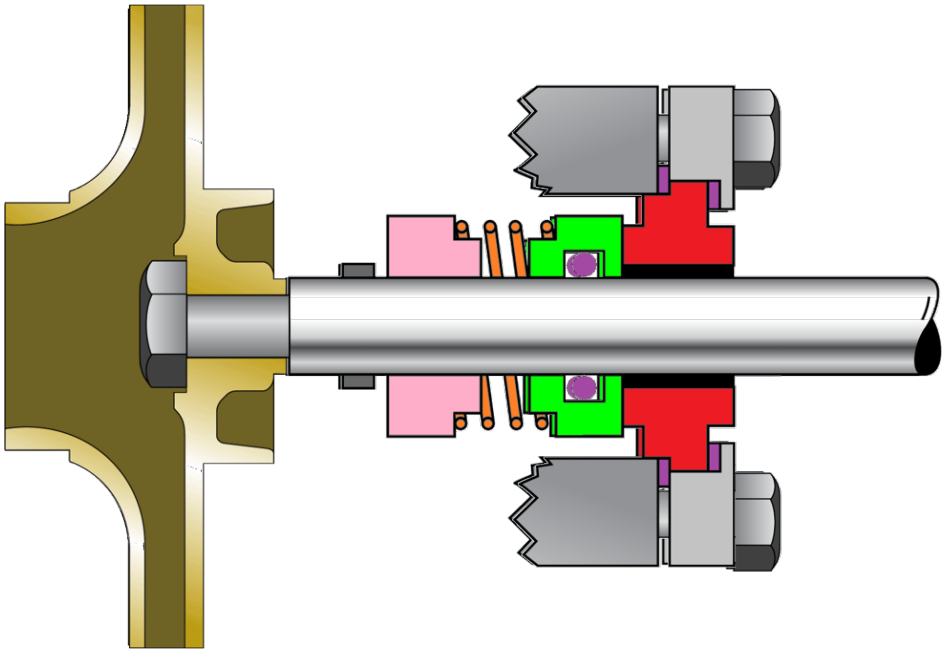
Course Learning Objectives

By the end of this course you will understand and can identify:

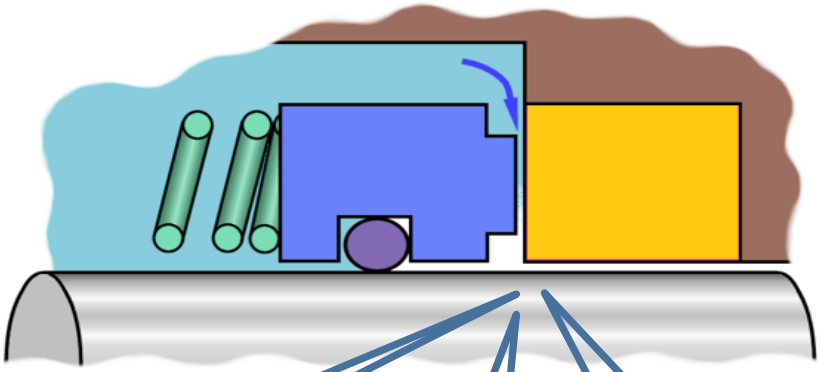
1. The purpose of the mechanical seal
2. The essential elements of a mechanical seal
3. The classification of mechanical seals
4. When to use different seal material types
5. Common seal flush plans

Shaft Seals

For most pumps a decisive element for the quality of the pump during its lifetime is a good and robust shaft seal.



Lubricating film

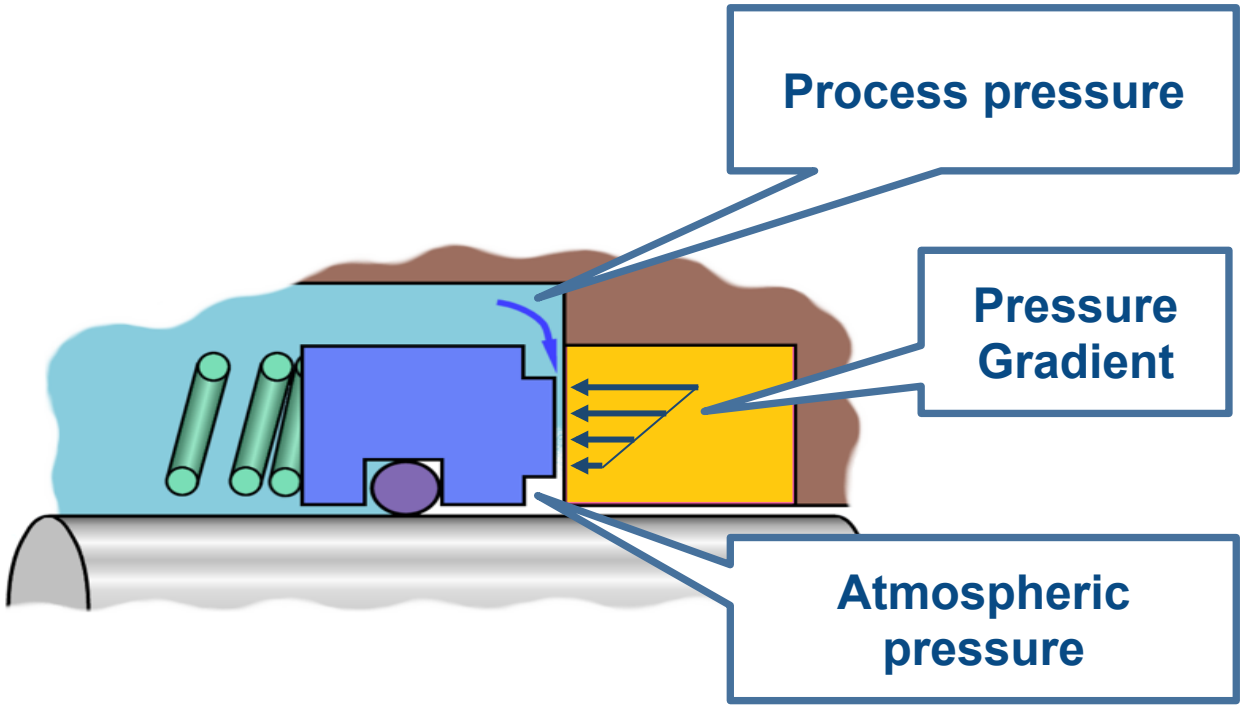


Lubricating film
(≈1µm)

Lubricating film
too thick

Lubricating film
too thin

Lubricating film

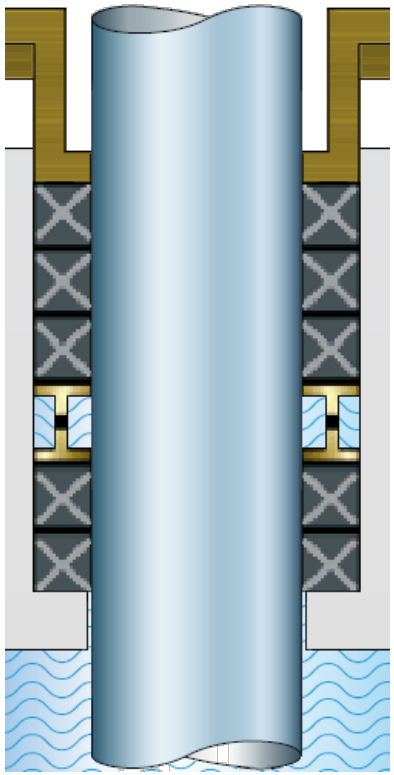


Lubricating film

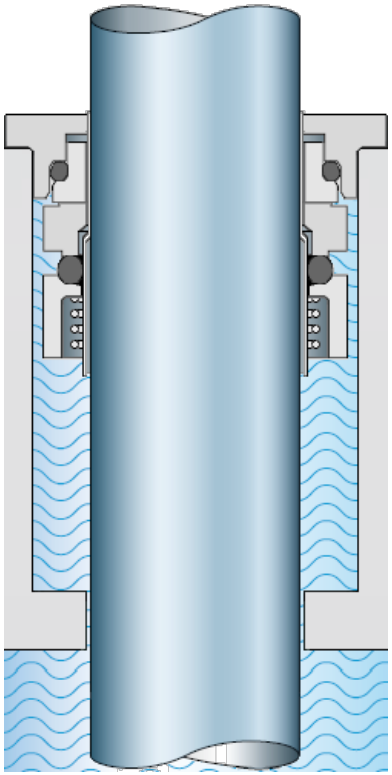
The six **“MUST”** of the lubricating film

- be always present
- be stable
- be clean, free of abrasives
- have reasonable viscosity
- have controlled temperature
- have acceptable pressure

Shaft Seal Types



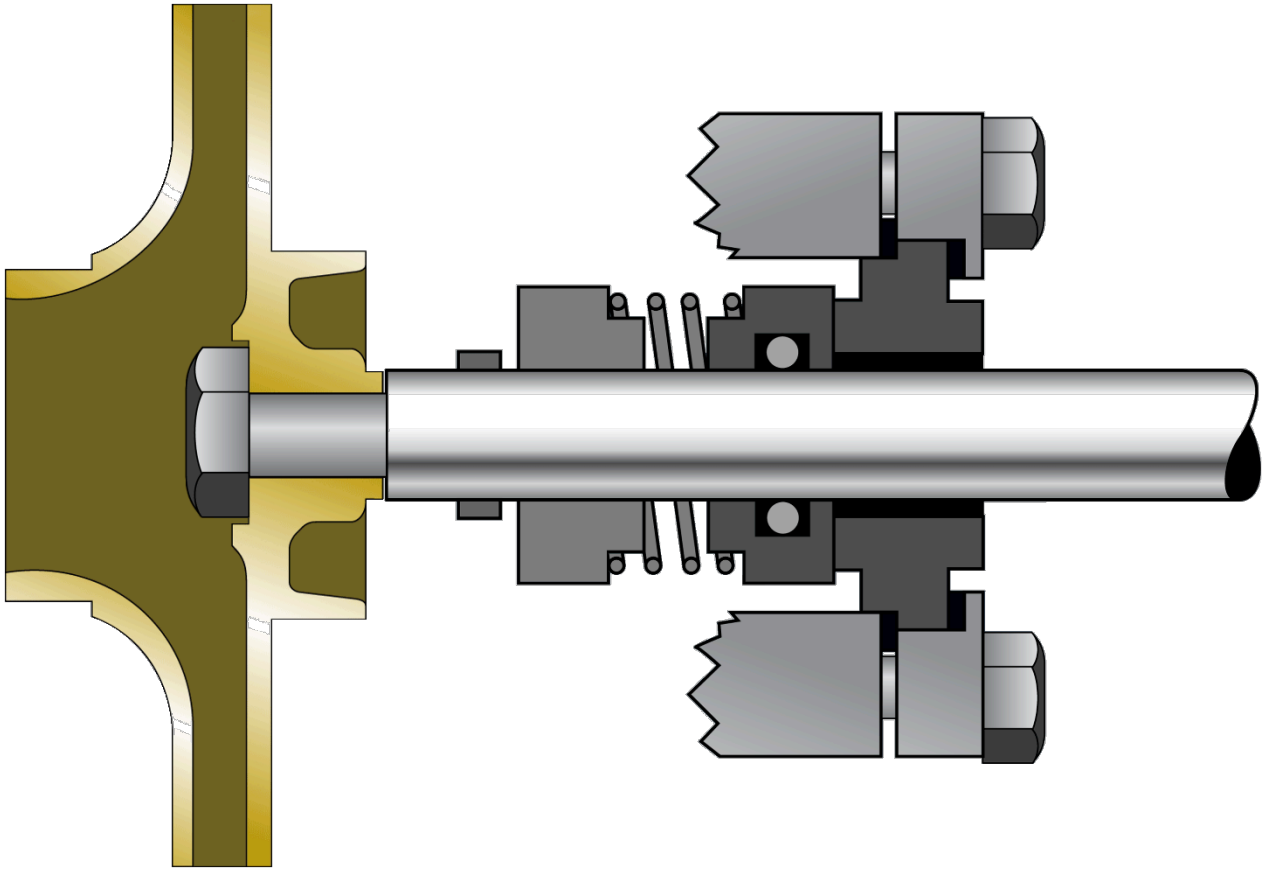
Stuffing Box



Mechanical Seal

Purpose of a Mechanical Seal

The purpose of the mechanical seal is to control leakage from the stuffing box or seal chamber and prevent air from leaking back into the pump.



Packing vs Mechanical Seals

Packing

- Seals with visible leak
- Constant monitoring for adjustments
- Shaft wear or use sleeve
- Special handling not required
- Low initial cost

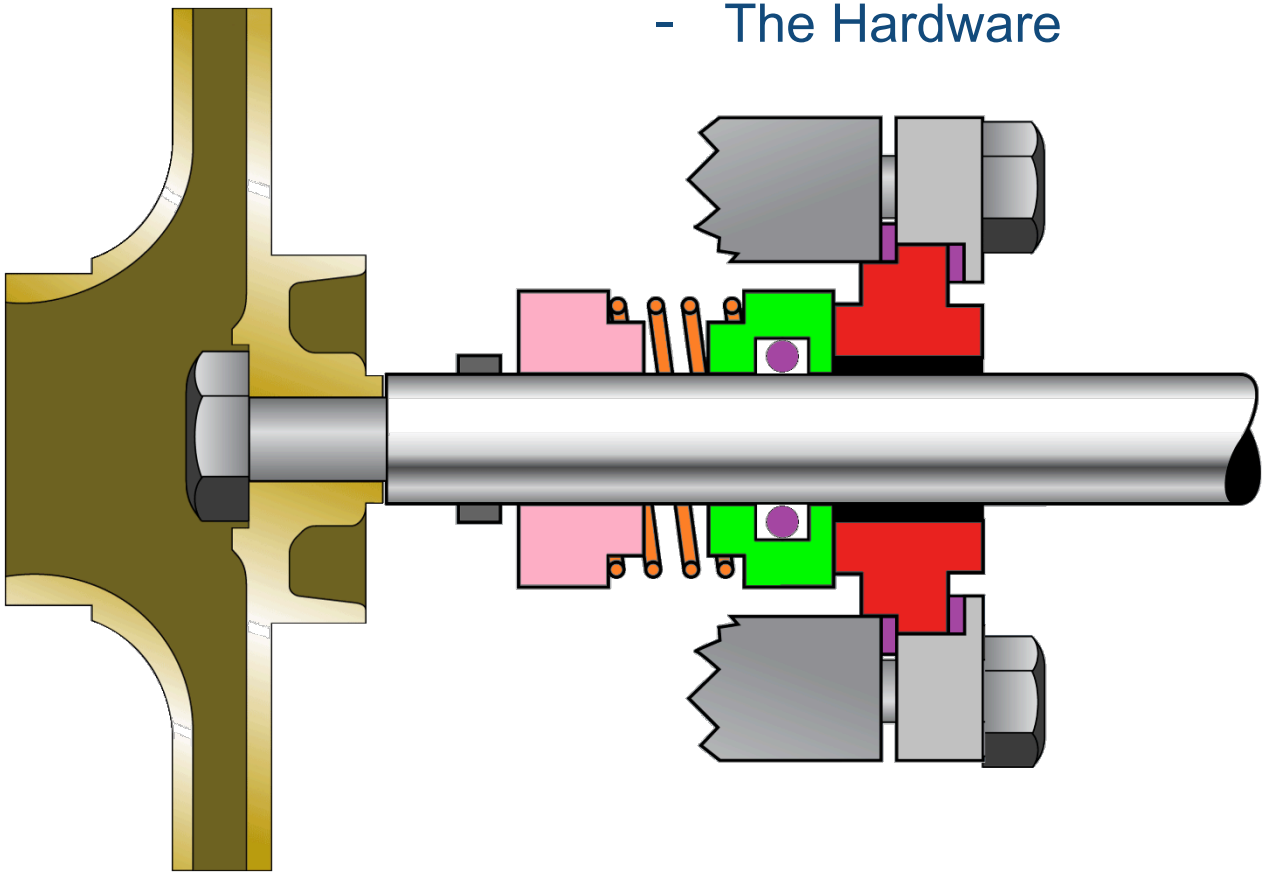
Mechanical Seals

- Seals with invisible leak
- Minimal monitoring and no maintenance
- Virtually no shaft drag
- Handle with care
- High initial cost

Mechanical seal Anatomy

The essential elements of a mechanical seal:

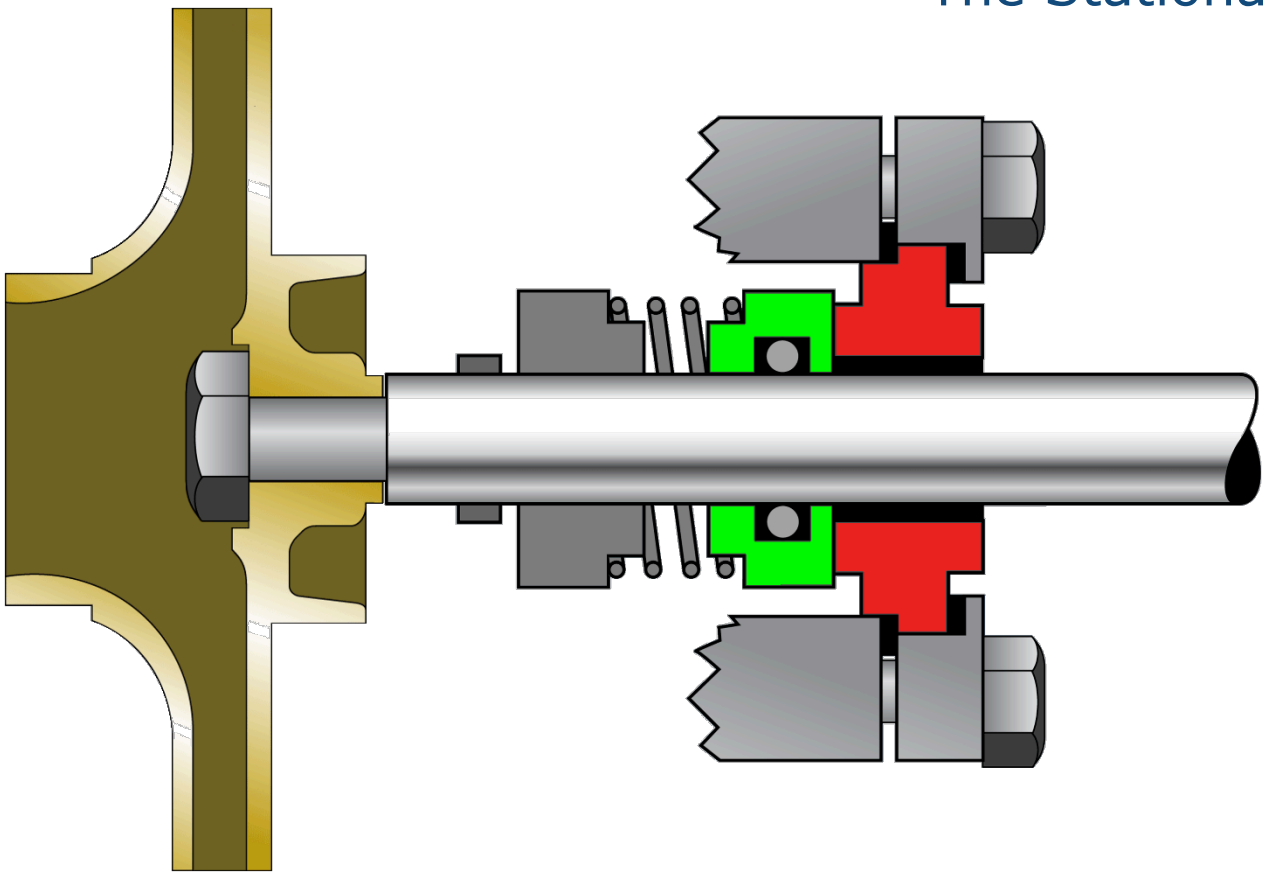
- The Primary Sealing Element
- The Secondary Sealing Elements
- The Hardware



Primary Sealing Element

The Primary Sealing Elements

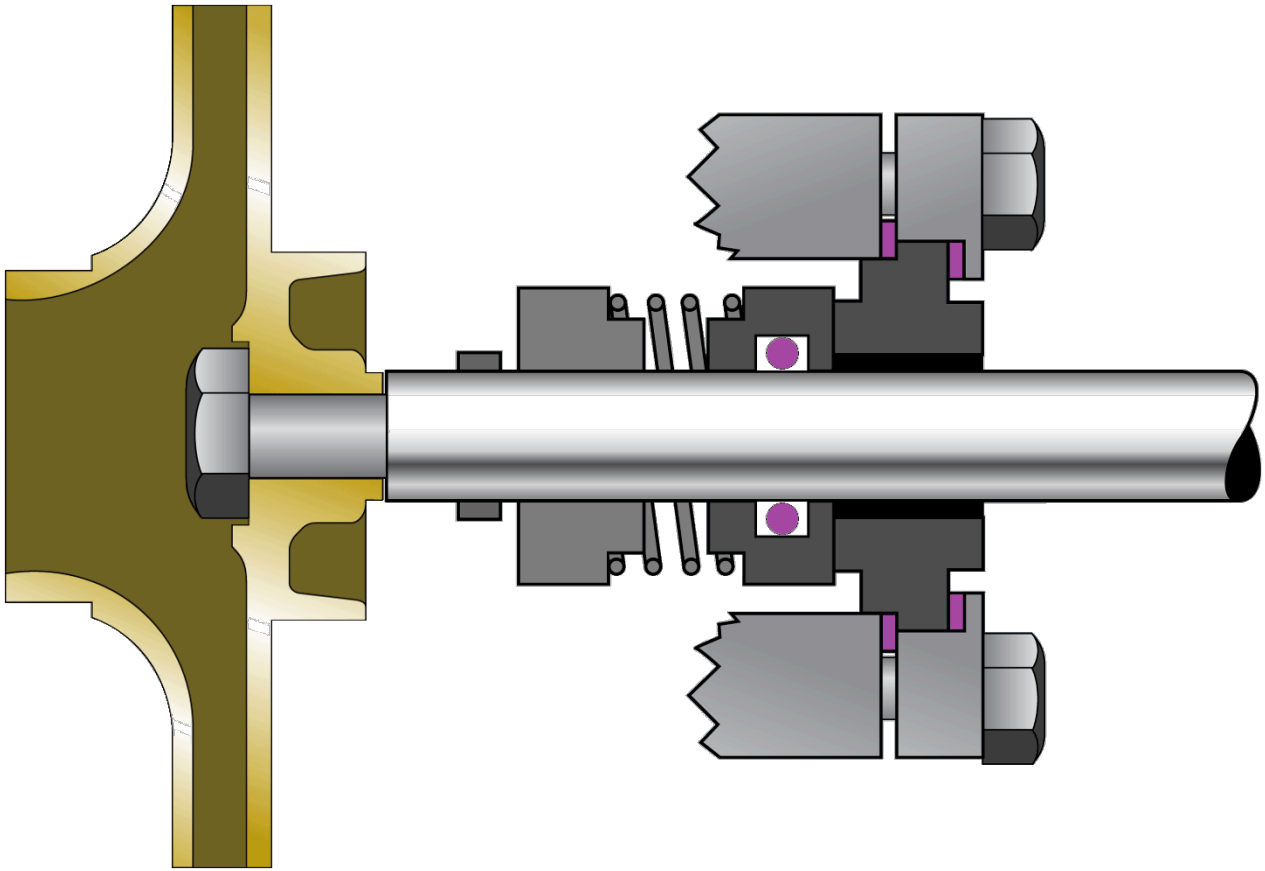
- The Rotating Ring
- The Stationary Ring



Secondary Sealing Elements

The Secondary Sealing Elements

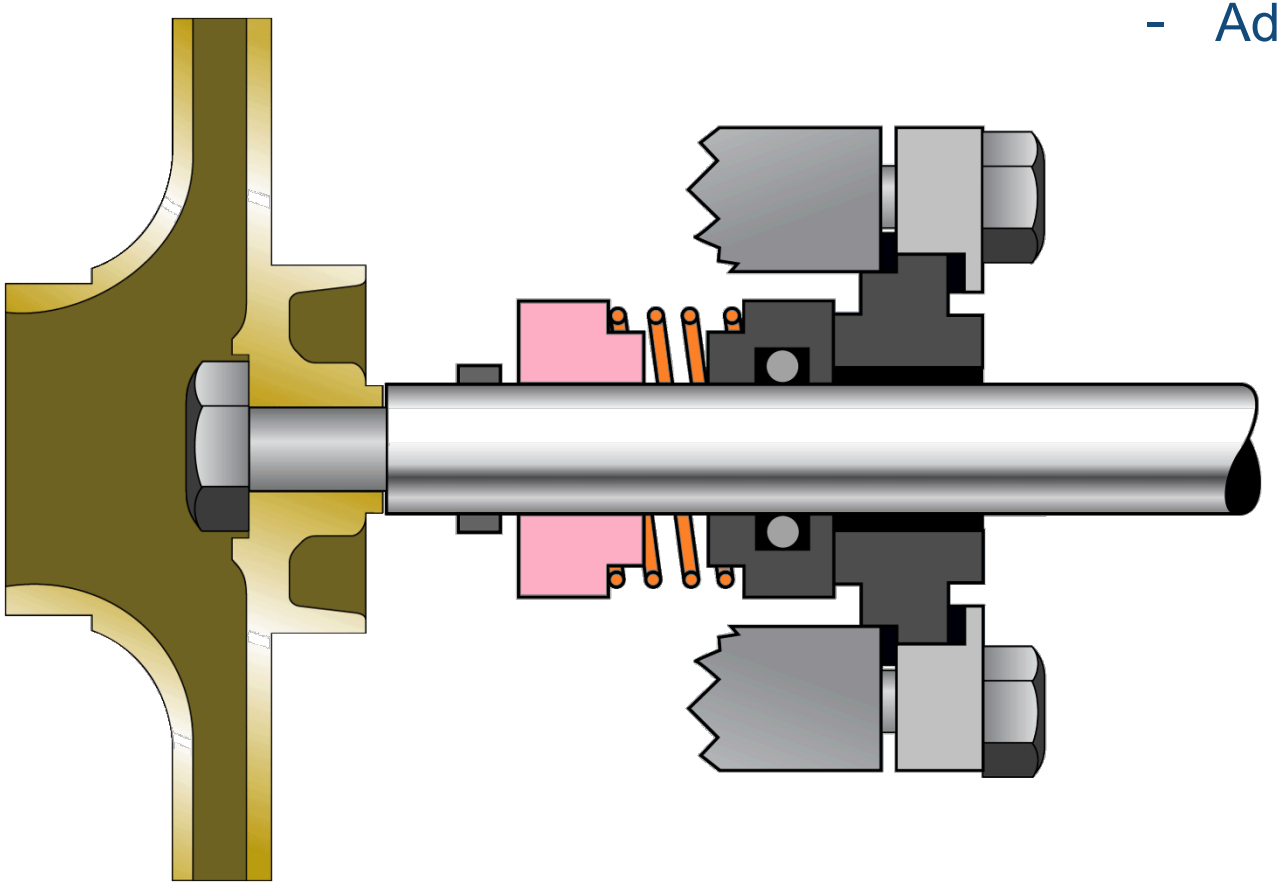
- Dynamic Seal
- Static Seal



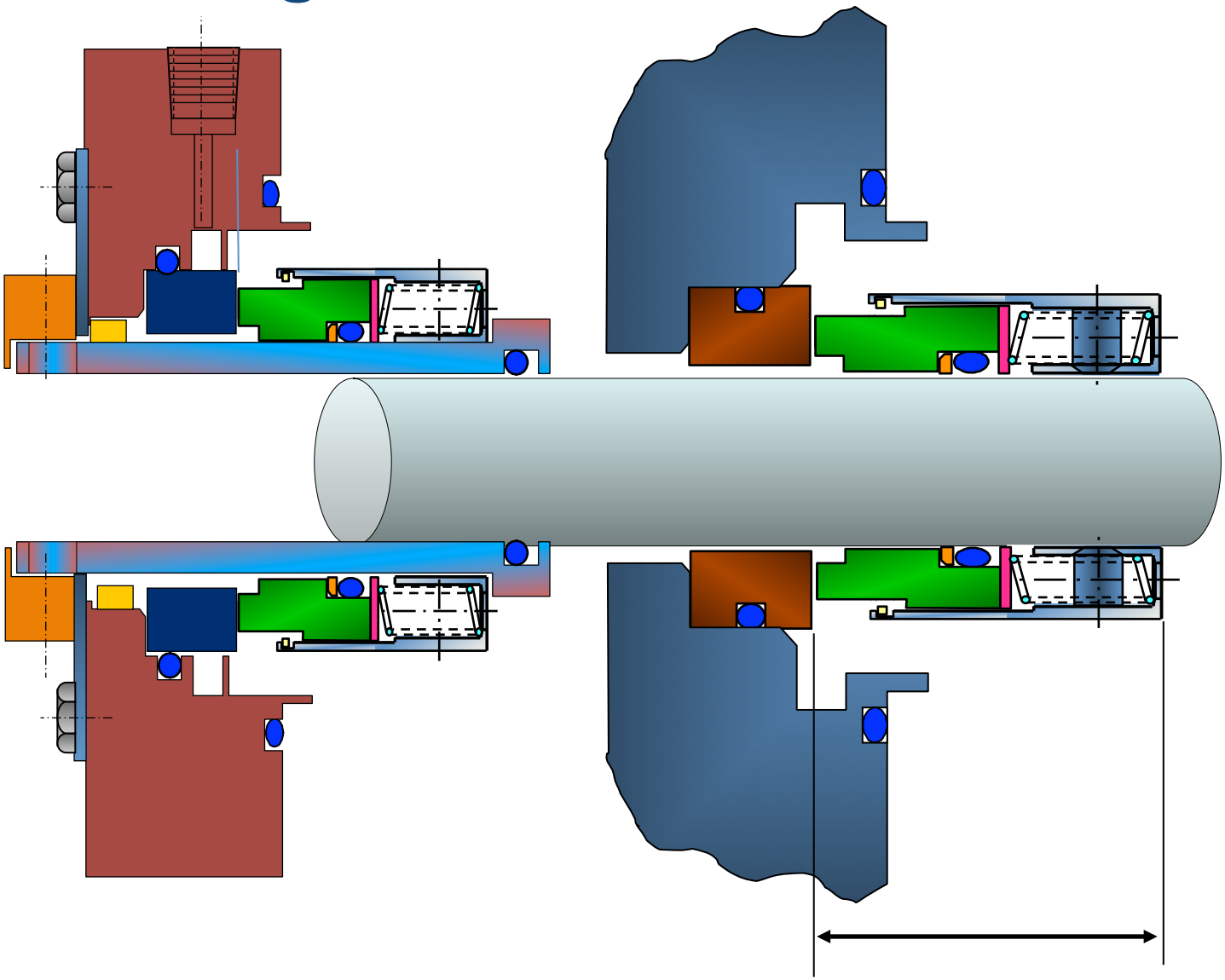
Hardware

The Hardware

- Drive Elements
- Load Element
- Adaptive Elements



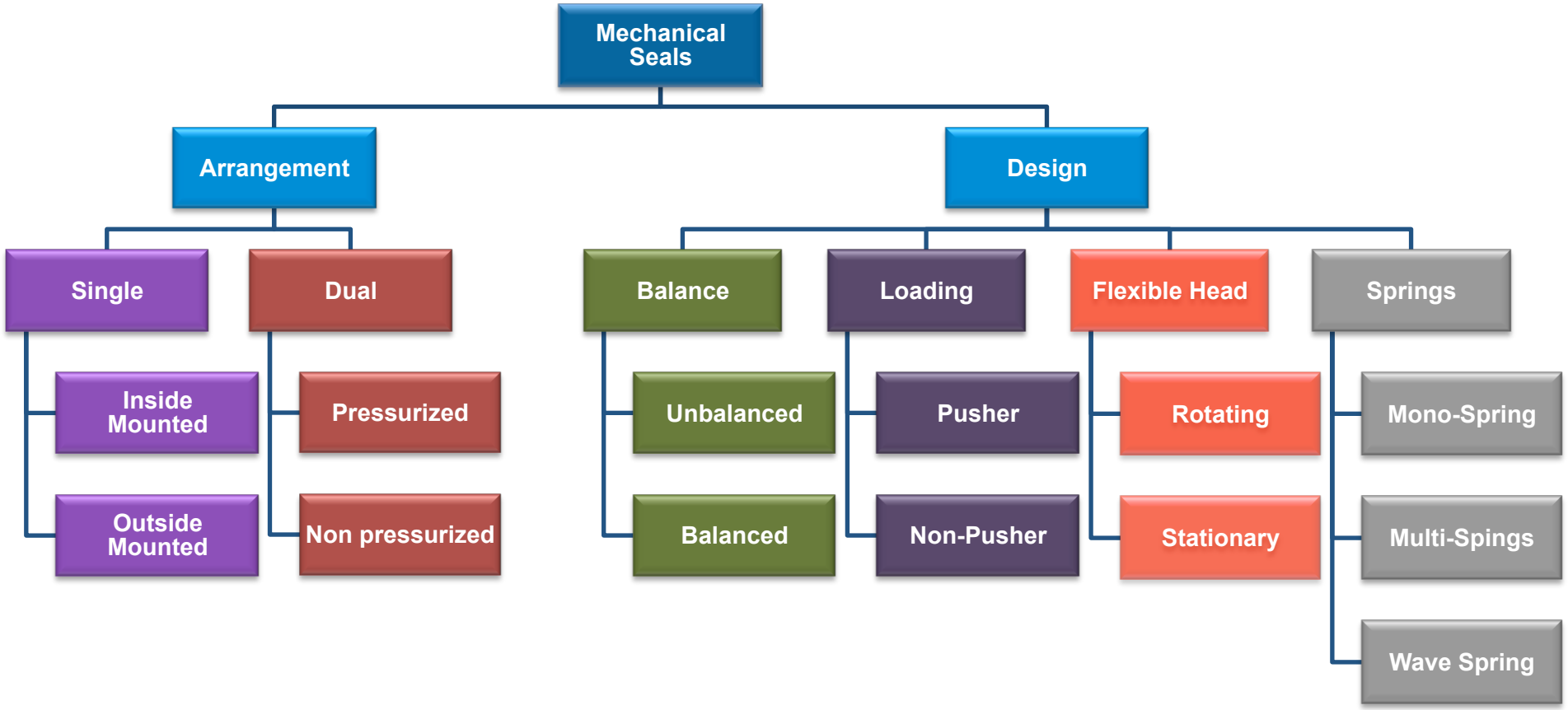
Cartridge Seal



- Shaft
- Seal Housing
- Drive Collar
- Rotating Ring
- O-Rings
- Mating Ring
- Seal Gland
- Seal Sleeve

Mechanical Seal Classification

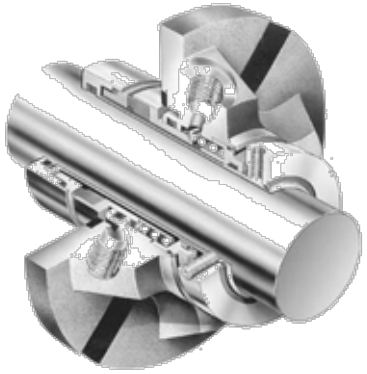
Mechanical seals are typically divided into two categories: by Arrangement and by Design.



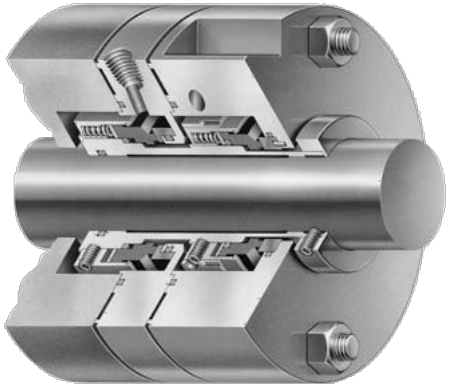
Arrangement Classification

Single Inside Mounted

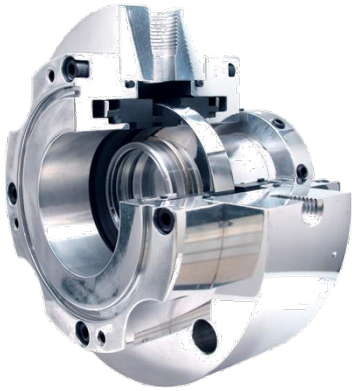
Single Outside Mounted



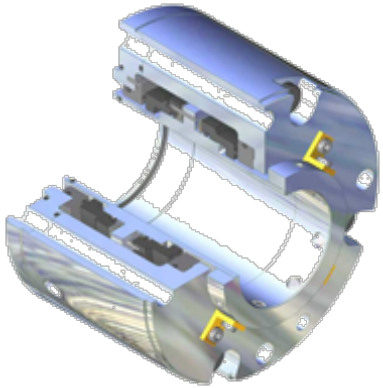
Cartridge Seal



Dual Tandem

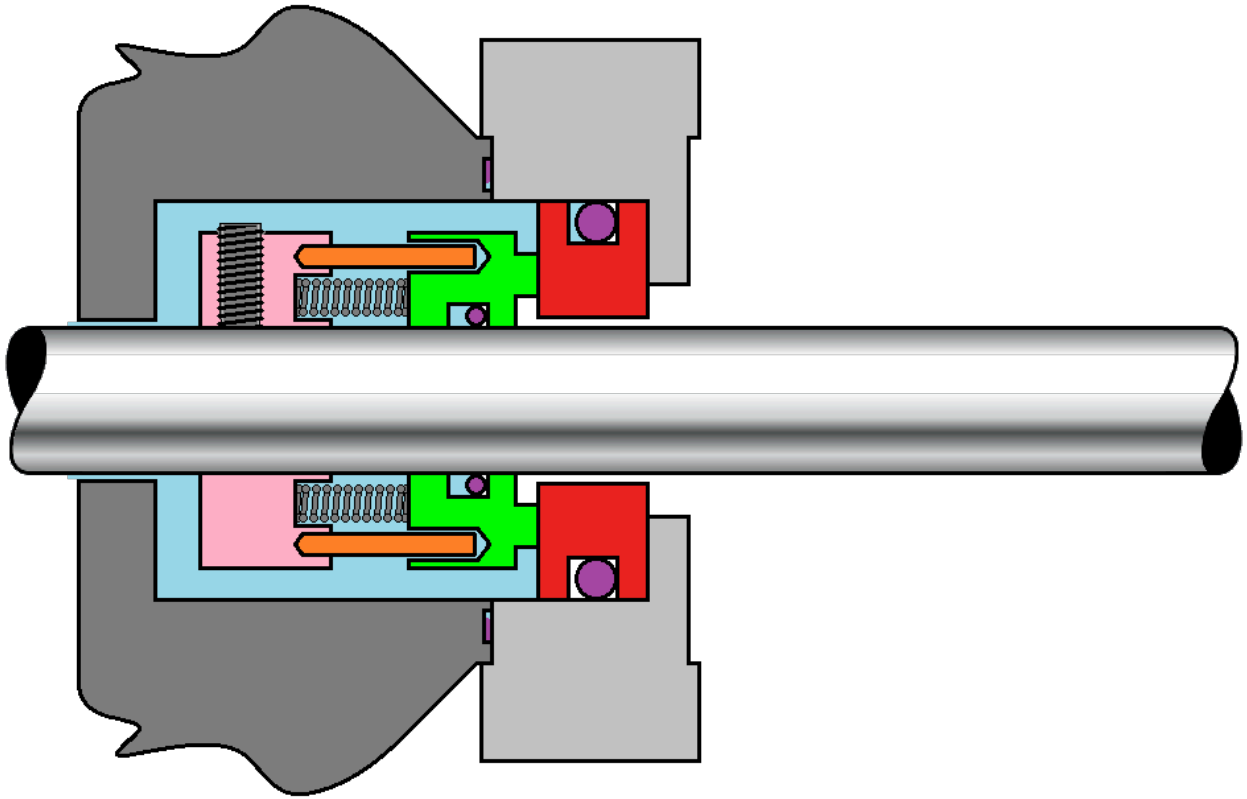


Dual Face-to-Face



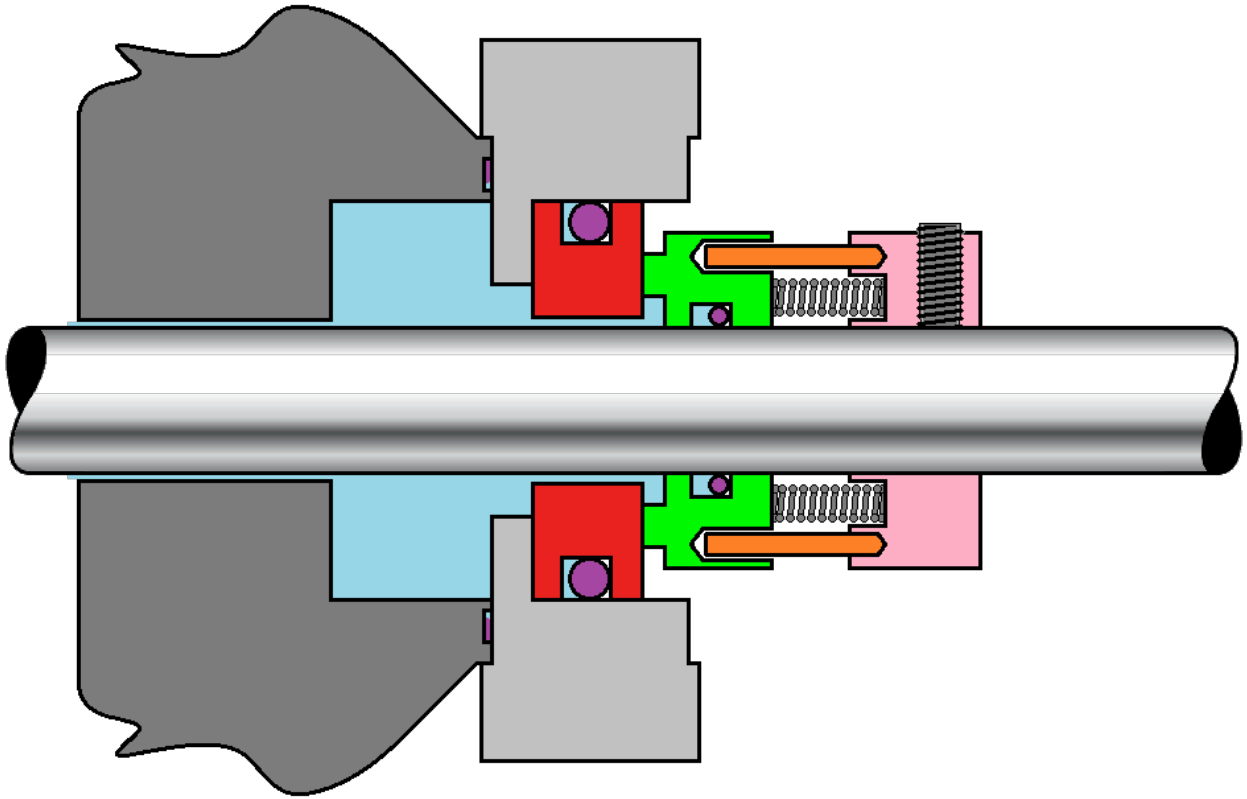
Dual Back-to-Back

Single – Inside Mounted



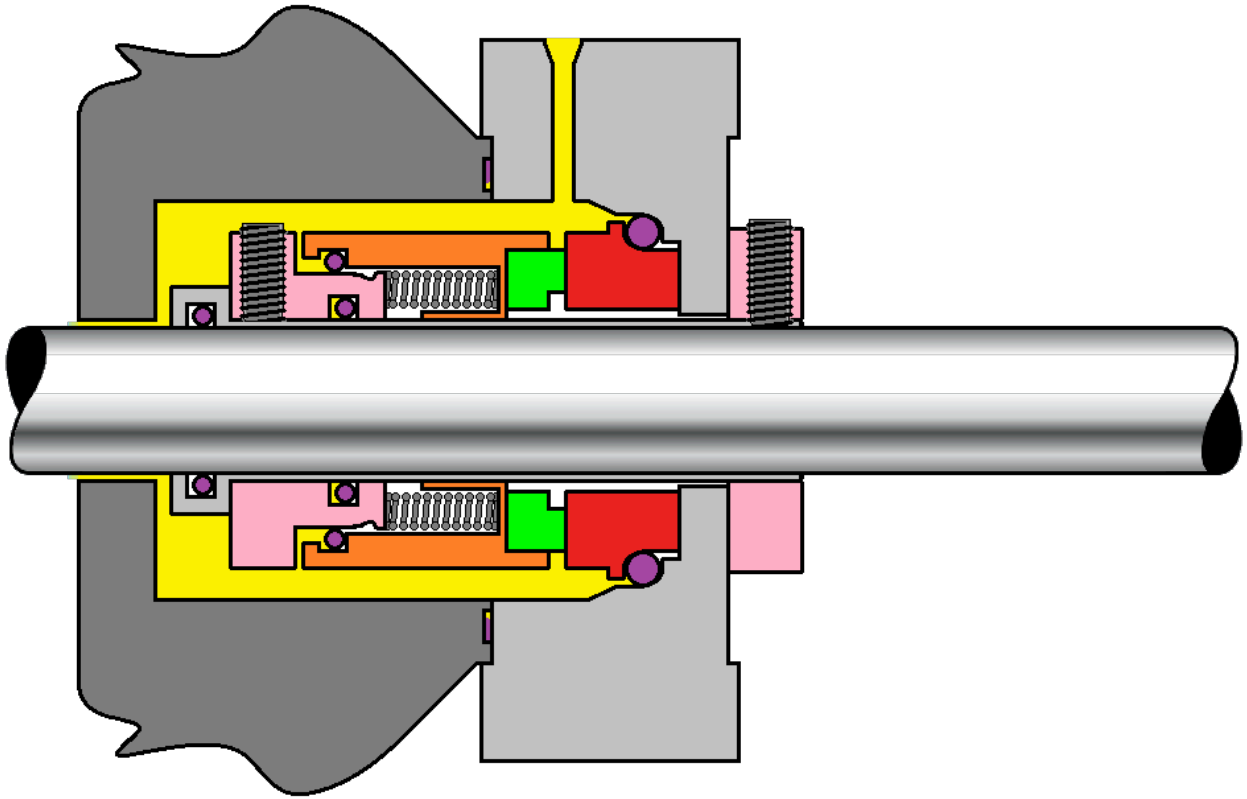
- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Drive Pin
- Multi-Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket
- Seal Gland

Single – Outside Mounted



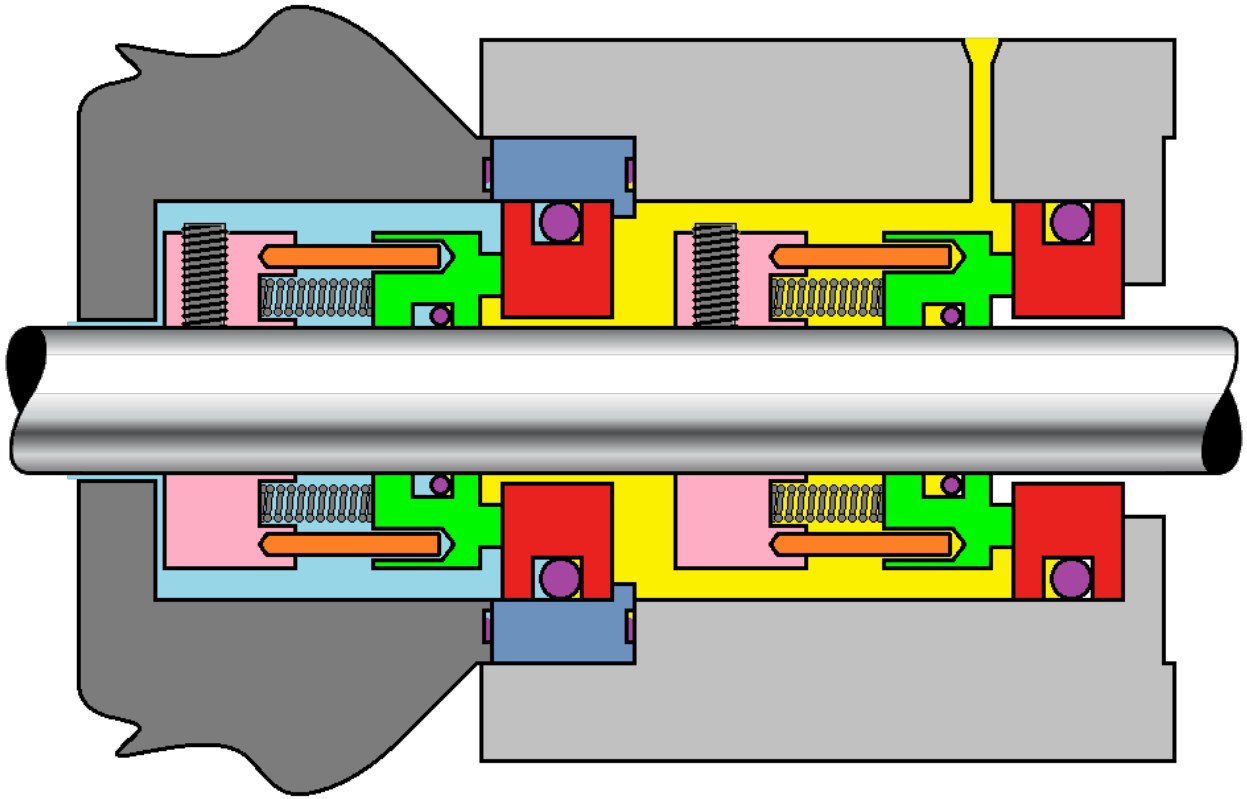
- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Drive Pin
- Multi-Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket
- Seal Gland

Cartridge – Cartridge Seal



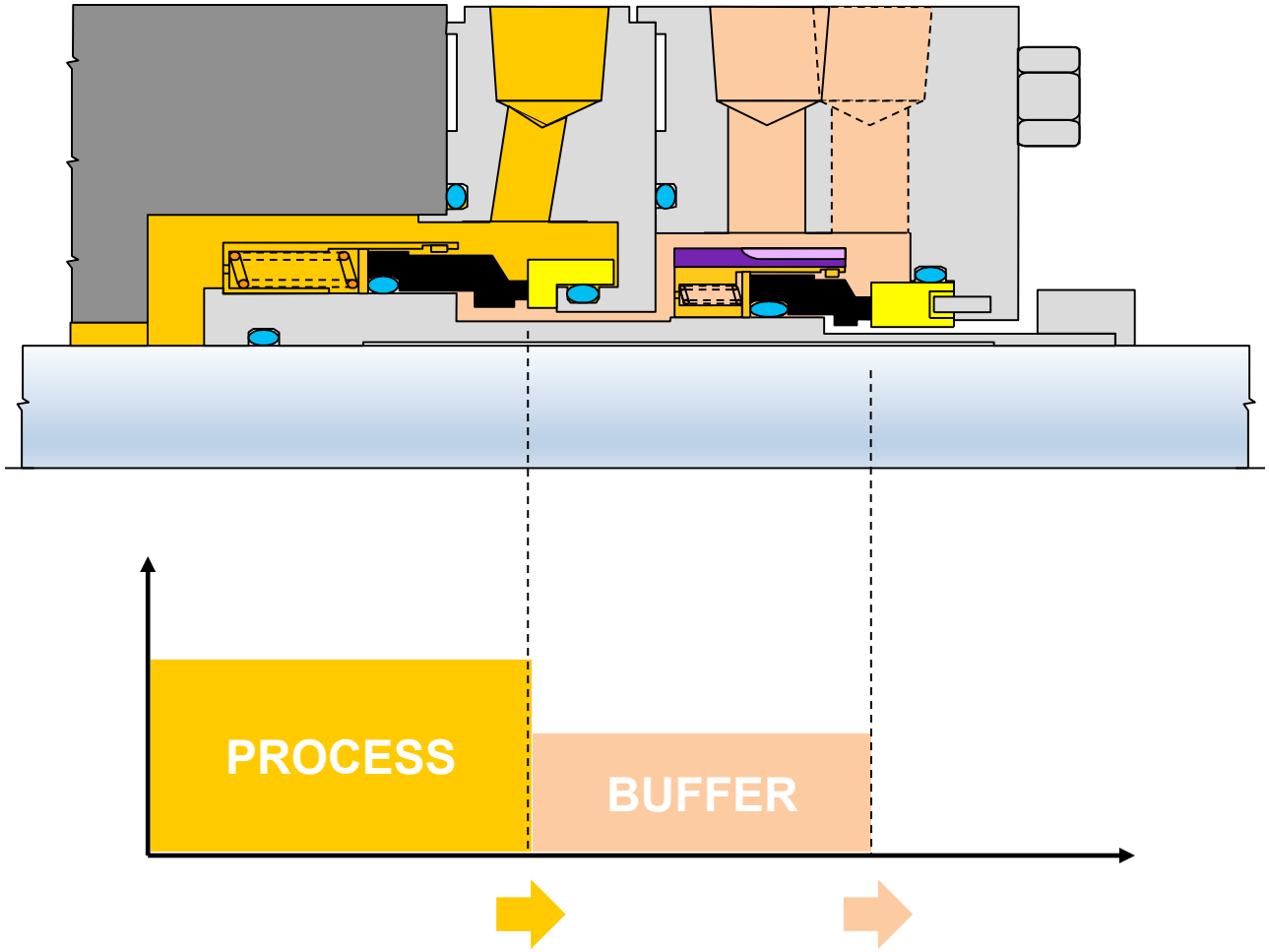
- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Drive Pin
- Multi-Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket
- Seal Gland
- Barrier Fluid
- Seal Sleeve

Dual Unpressurized Seals (former Tandem seals)

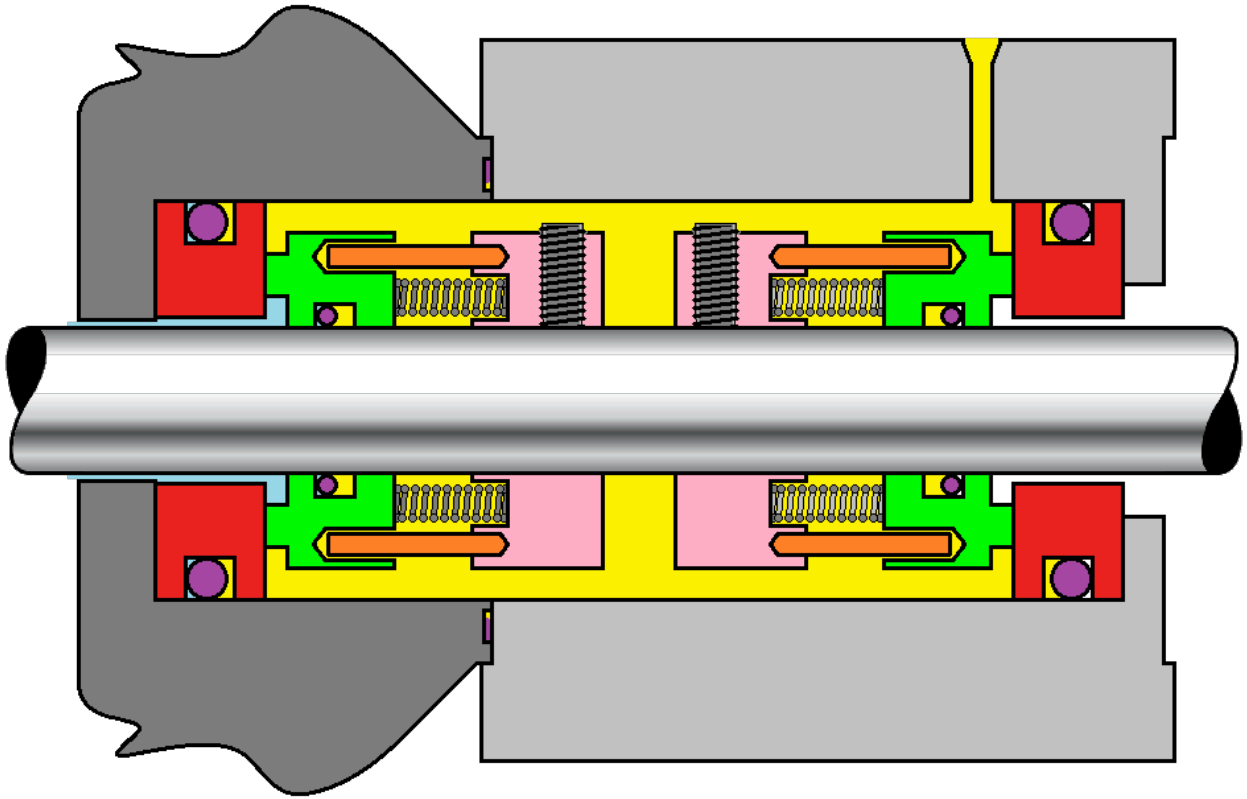


- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Drive Pin
- Multi-Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket
- Seal Gland
- Buffer Fluid
- Adaptive Ring

Dual Unpressurized seals

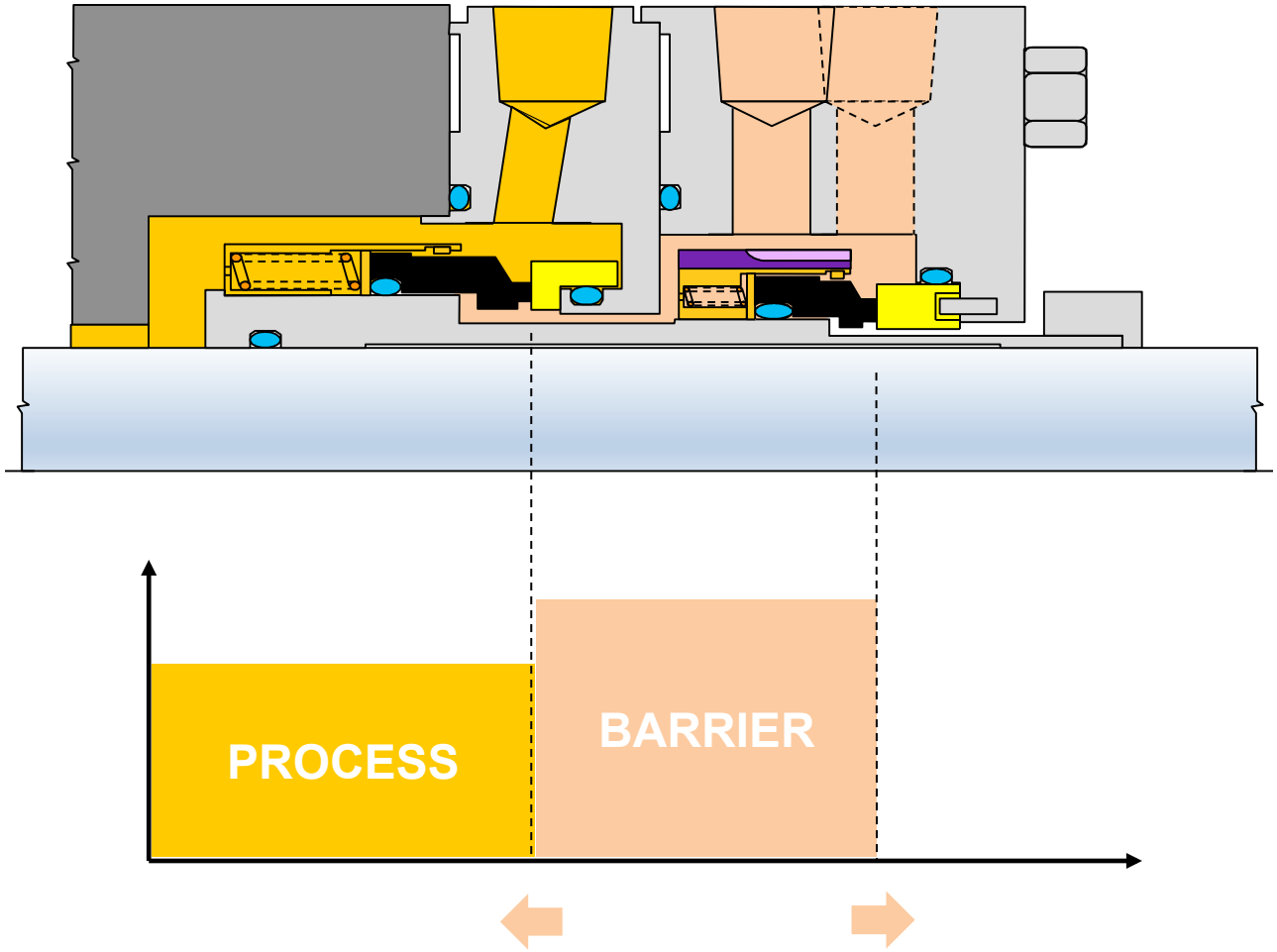


Dual Pressurized Seals (former Double seals)



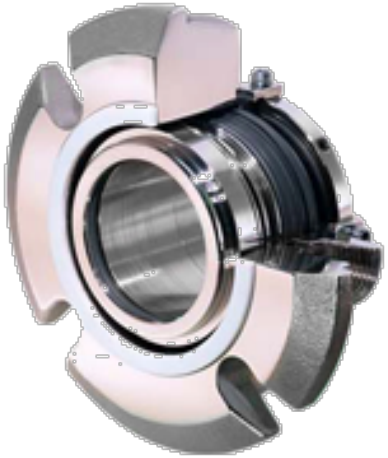
- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Drive Pin
- Multi-Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket
- Seal Gland
- Barrier Fluid

Dual Pressurized Seals



Design Classification

Unbalanced Pusher

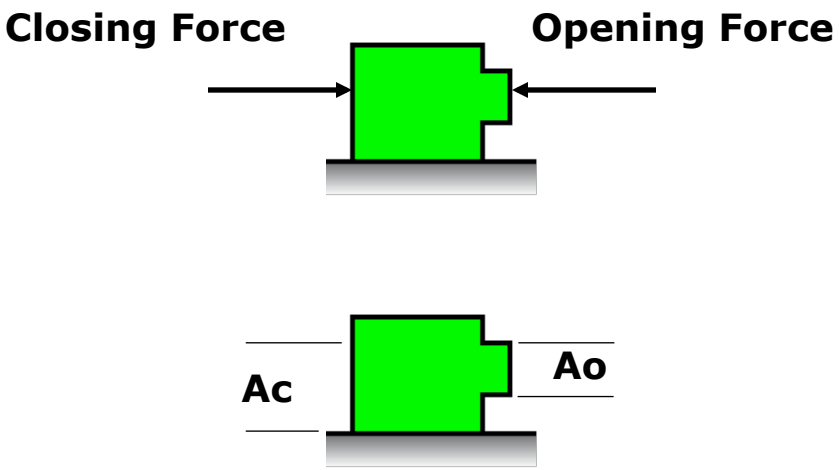


Pusher Cartridge Seal

Non-Pusher (Metal Bellows)

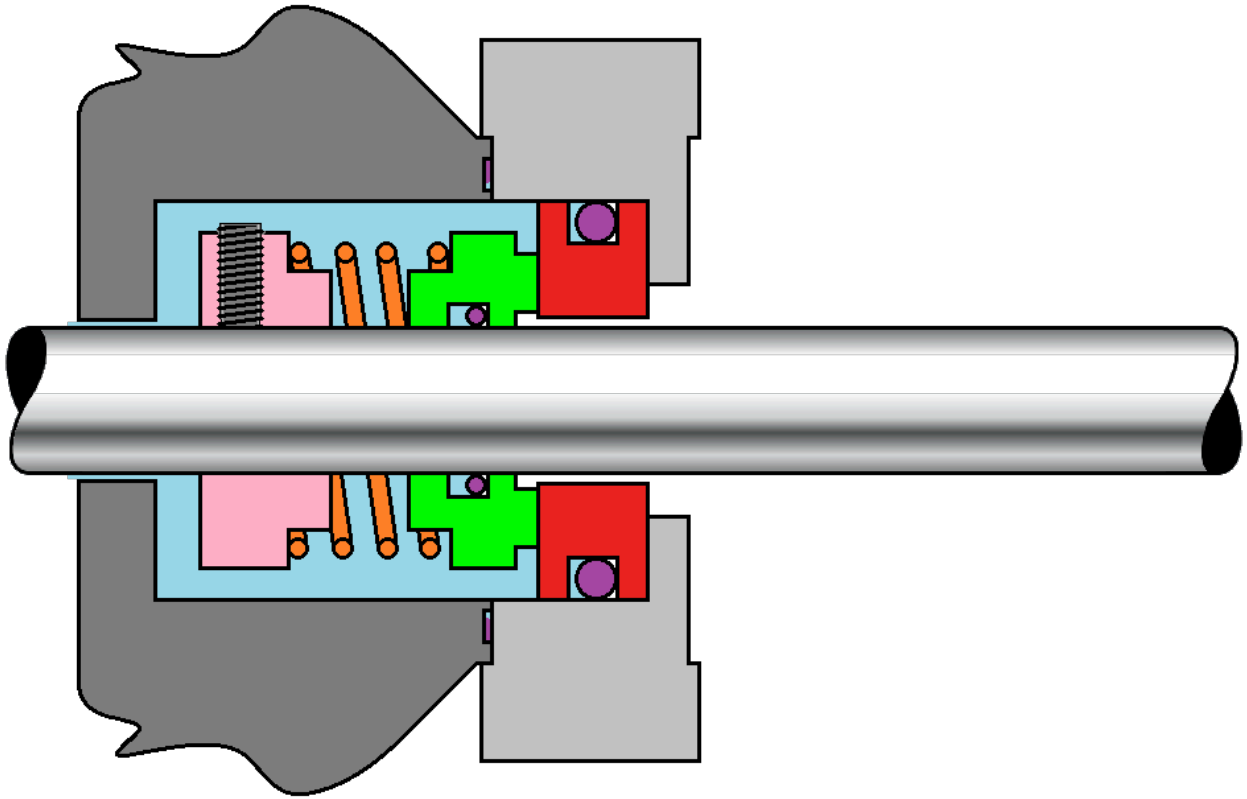
Balanced Pusher

Design – Balance



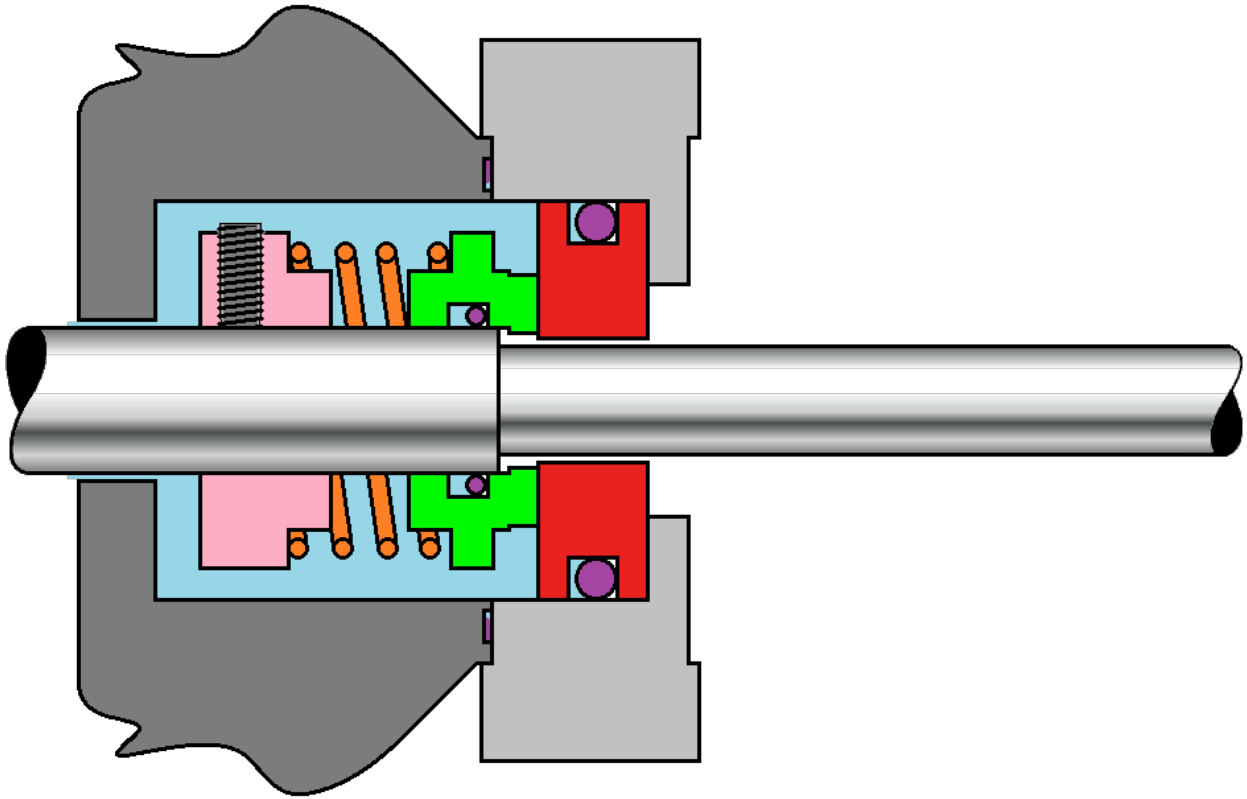
$$Balance\ Ratio = Closing\ Area\ (Ac) / Opening\ Area\ (Ao)$$

Balance – Unbalanced Seals



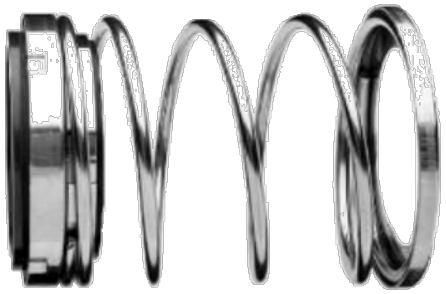
- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Seal Gland
- Single Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket

Balance – Balanced Seals

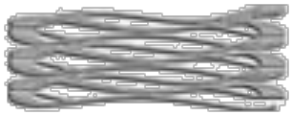


- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Seal Gland
- Single Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket

Design – Loading

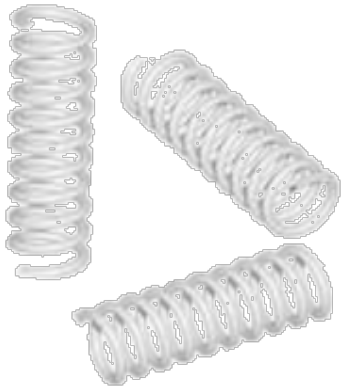


Single Spring



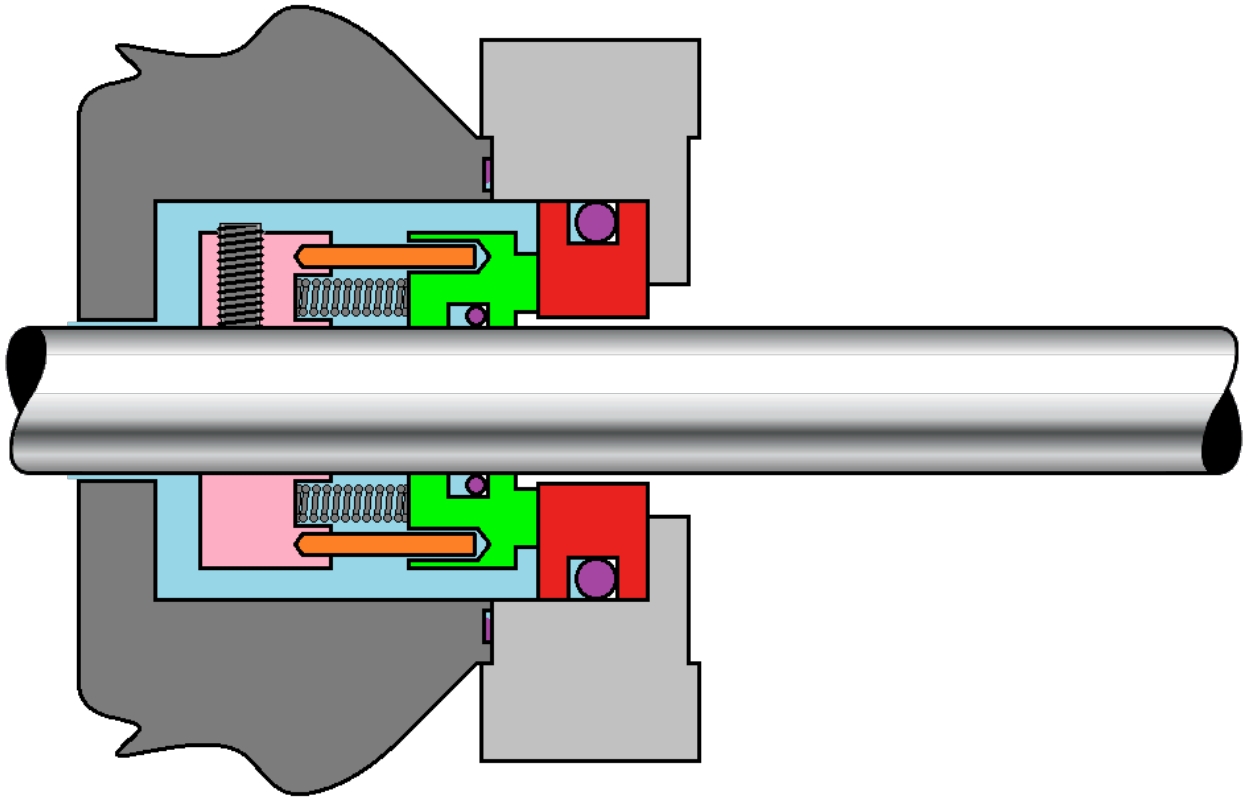
Wave Springs

Metal Bellows



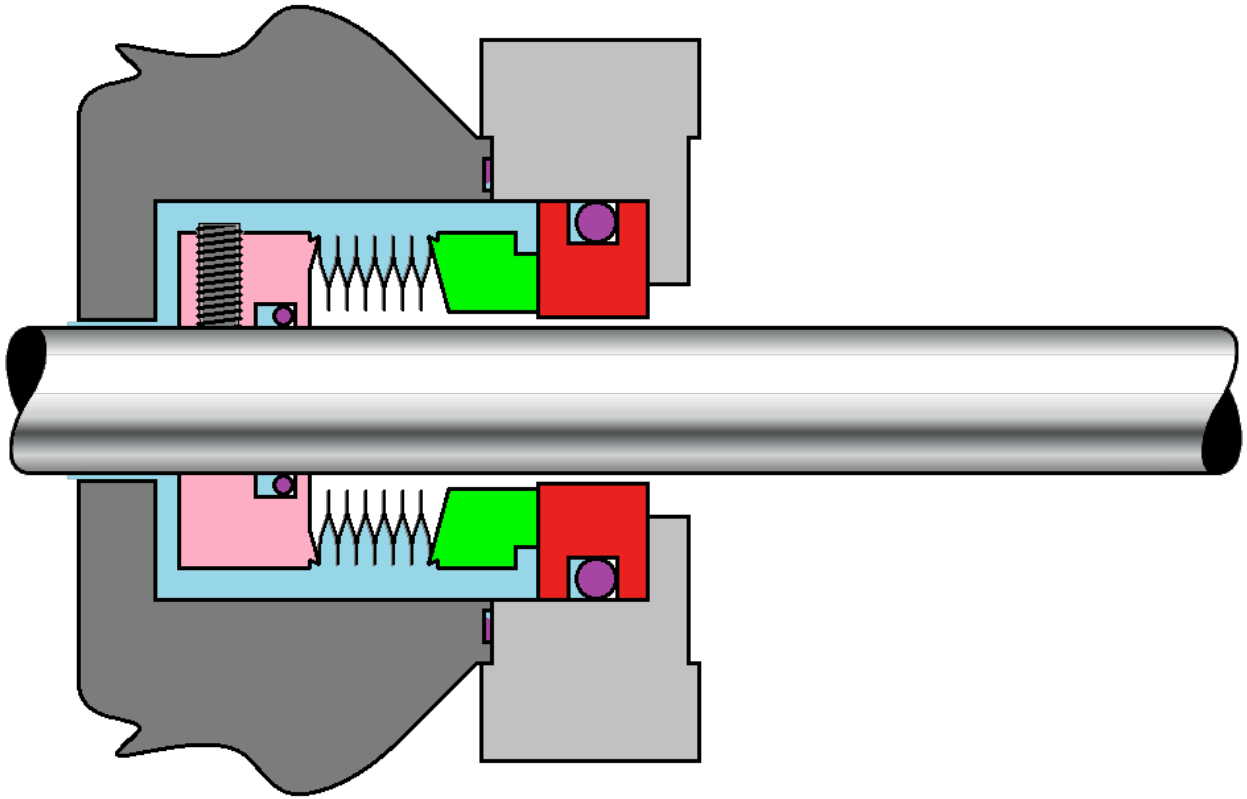
Multi-Springs

Loading – Pusher Seals



- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Drive Pin
- Multi-Spring
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket
- Seal Gland

Loading – Non-Pusher Seals



- Shaft
- Seal Housing
- Process Fluid
- Drive Collar
- Set-Screw
- Seal Gland
- Metal Bellows
- Rotating Ring
- O-Rings
- Stationary Ring
- Static Gasket

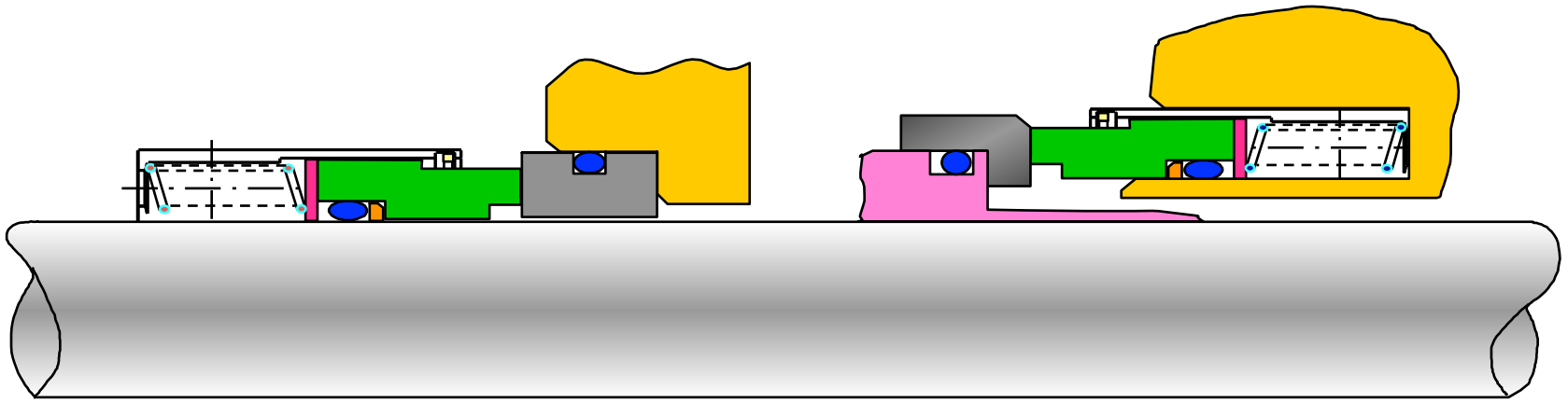
Rotating Vs. Stationary Head

Rotating head:

- Springs or bellows rotates with the shaft.
- Peripheral velocity up to 75 feet/sec
- Perpendicularity required
- Self cleaning
- Sensitive to shaft deflection

Stationary head:

- Springs or bellows do not rotate
- Peripheral velocity above 75 feet/sec.
- Ancillary plan should clean the head
- Allows some degree of perpendicularity error



Material Selection

What you need to know about the liquid:

- Corrosiveness
- Temperature
- Specific Gravity
- Vapor Pressure and boiling point
- Viscosity
- Abrasiveness

Primary Seal Materials

Common Primary Seal Faces:
- Tungsten carbide / tungsten carbide
- Silicon carbide / silicon carbide
- Carbon / tungsten carbide or carbon / silicon carbide
- Carbon / ceramic (aluminum oxide)
- Various

Secondary Seal Materials

Common Secondary Seal Materials:
- NBR
- EPDM
- FKM (Viton)
- FXM (Flouraz)
- FFKM (Kalrez)

Hardware Materials

Common Hardware Materials:

- 316SS
- Hastelloy "C“
- Duplex SS
- Carpenter 42 or Invar 36 (for Bellows)

Ancillary plans

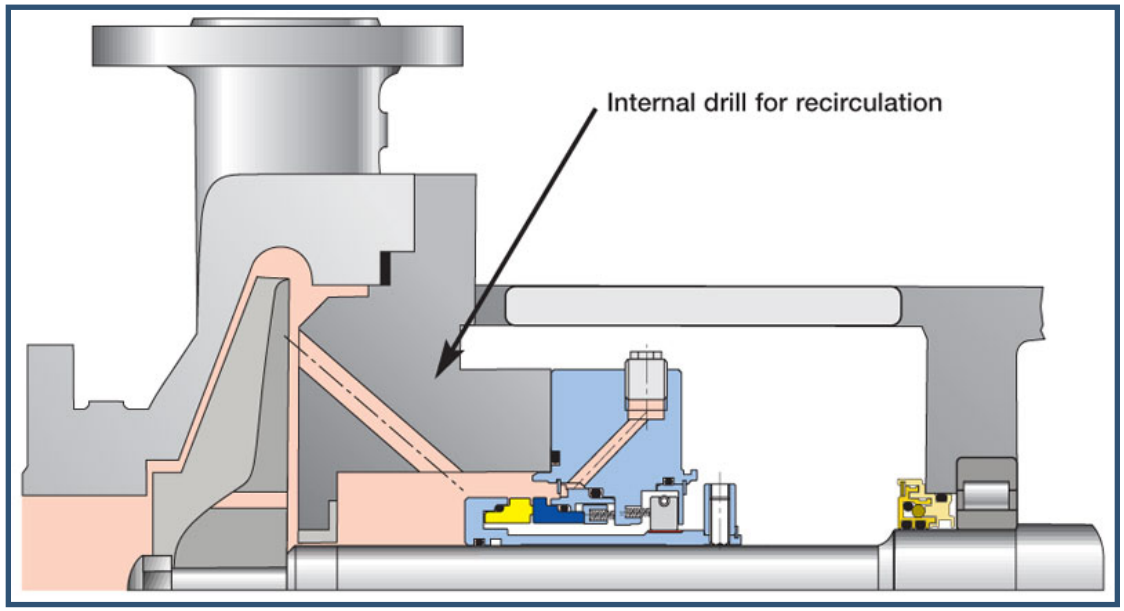
The main functions of ancillary plans are:

- Circulation
- Heat exchange
- Solids management
- Risk management
- Emission management
- Gas barrier management

CIRCULATION

Plan 01:

Internal recirculation from pump discharge area to seal chamber.

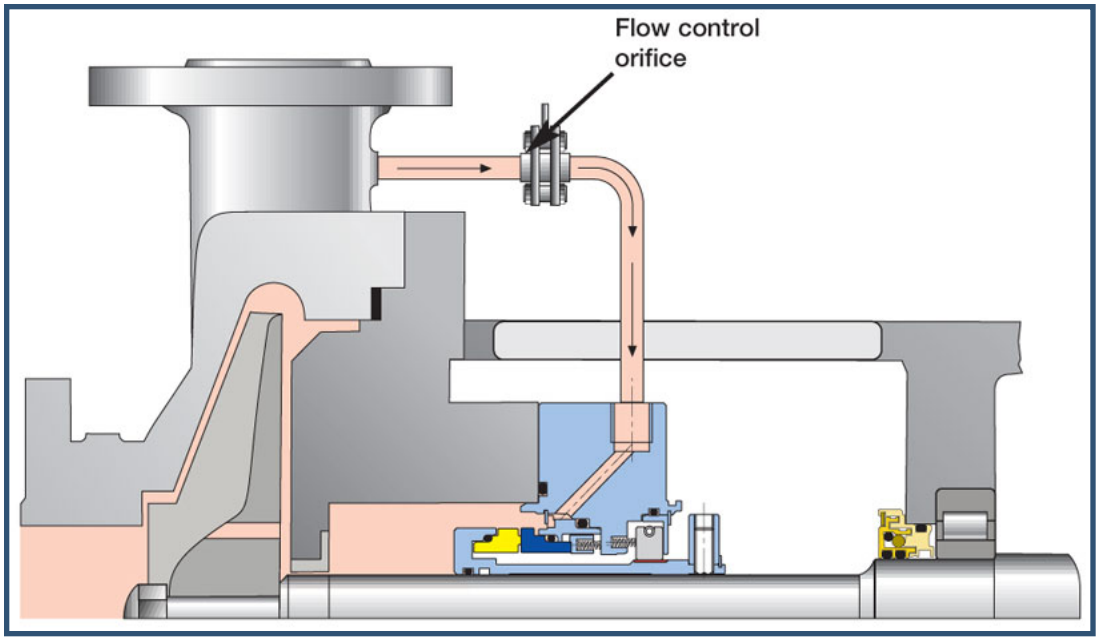


- **Cooling the seal.**
- **Venting the seal box.**
- **Fixed flow.**
- **Could cause erosion if there are solids.**

CIRCULATION

Plan 11:

External recirculation from pump discharge area to seal chamber through an orifice

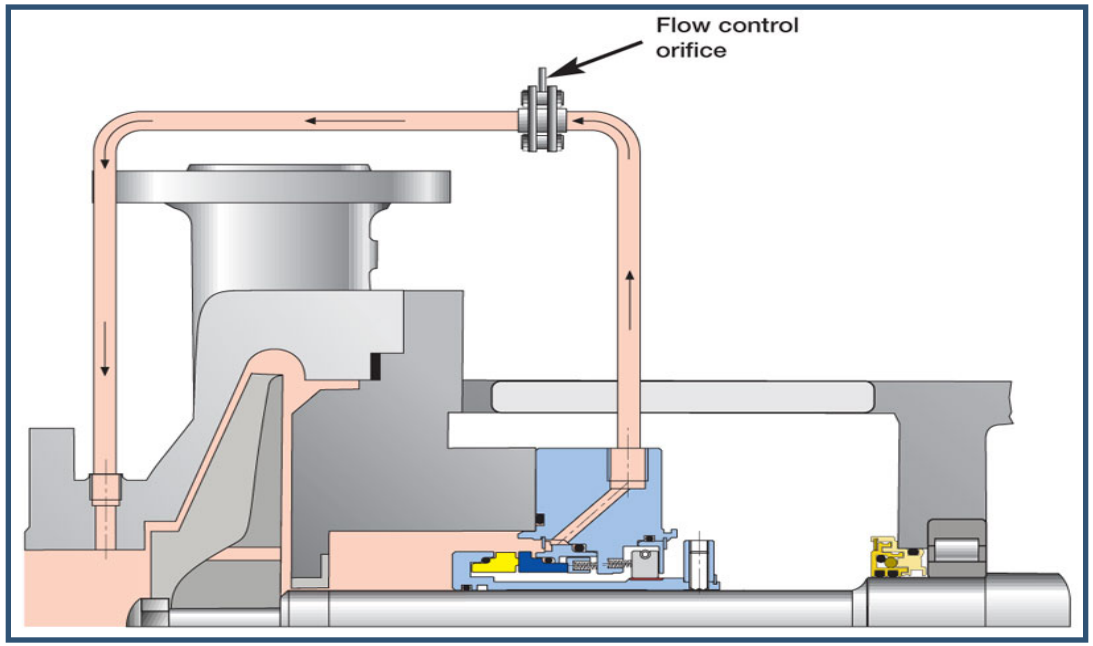


- Cooling the seal.
- Venting the seal box.
- Adjustable flow changing the control orifice.
- Could cause erosion if there are solids.

CIRCULATION

Plan 13:

External recirculation from pump suction area to seal chamber through an orifice

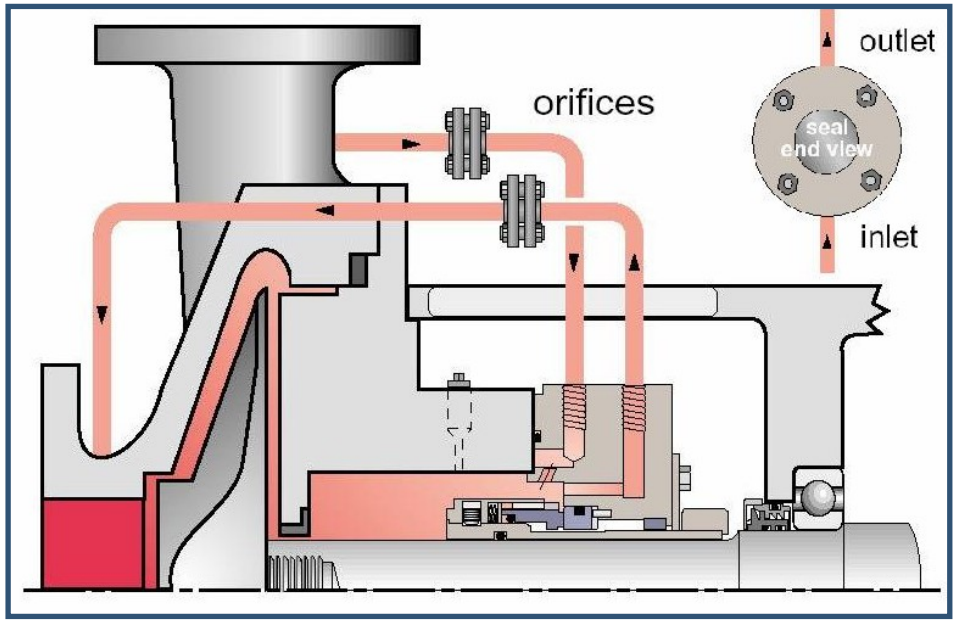


- **Cooling the seal.**
- **Venting the seal box.**
- **Lower the seal box pressure.**
- **Cleaning the seal chamber.**

CIRCULATION

Plan 14:

External recirculation from pump discharge area to seal chamber through an orifice, then back to the suction area.

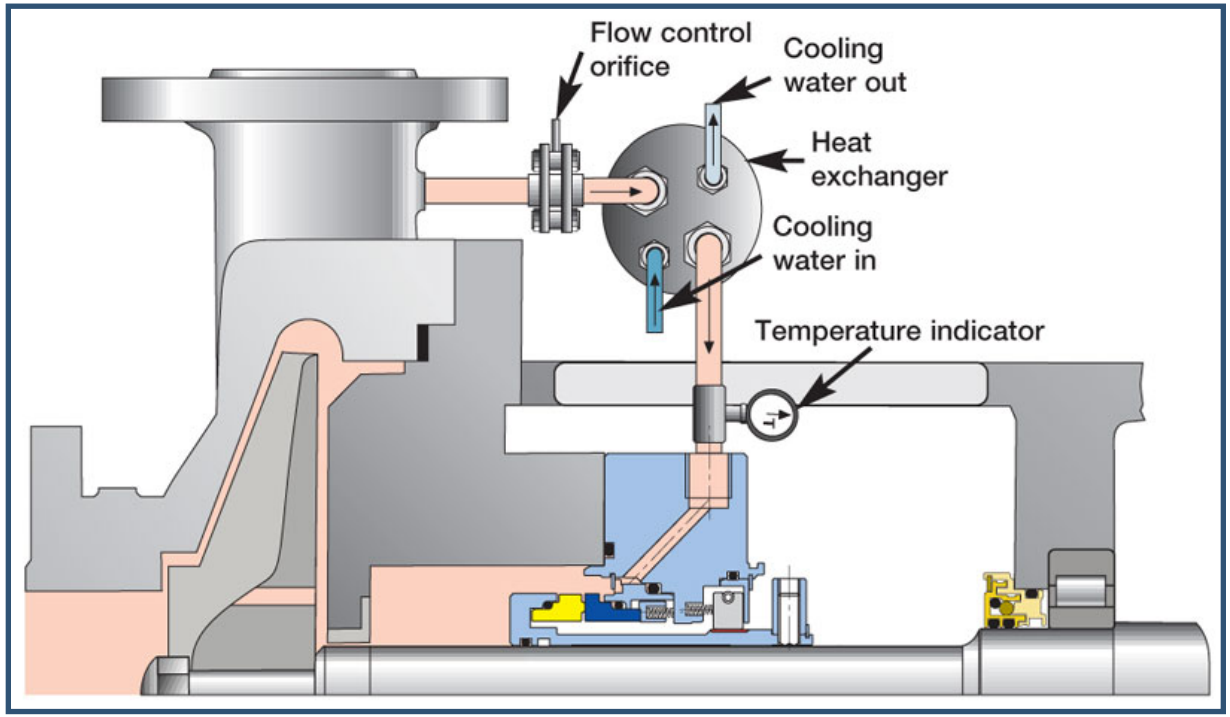


- **Plan 11 + Plan 13 = Plan 14**
- **Cooling the seal.**
- **Venting the seal box.**
- **Adjustable flow changing the control orifices.**
- **Used in pumps with no impeller balance holes**

COOLING

Plan 21:

Circulation from discharge though a heat exchanger, then to the seal box

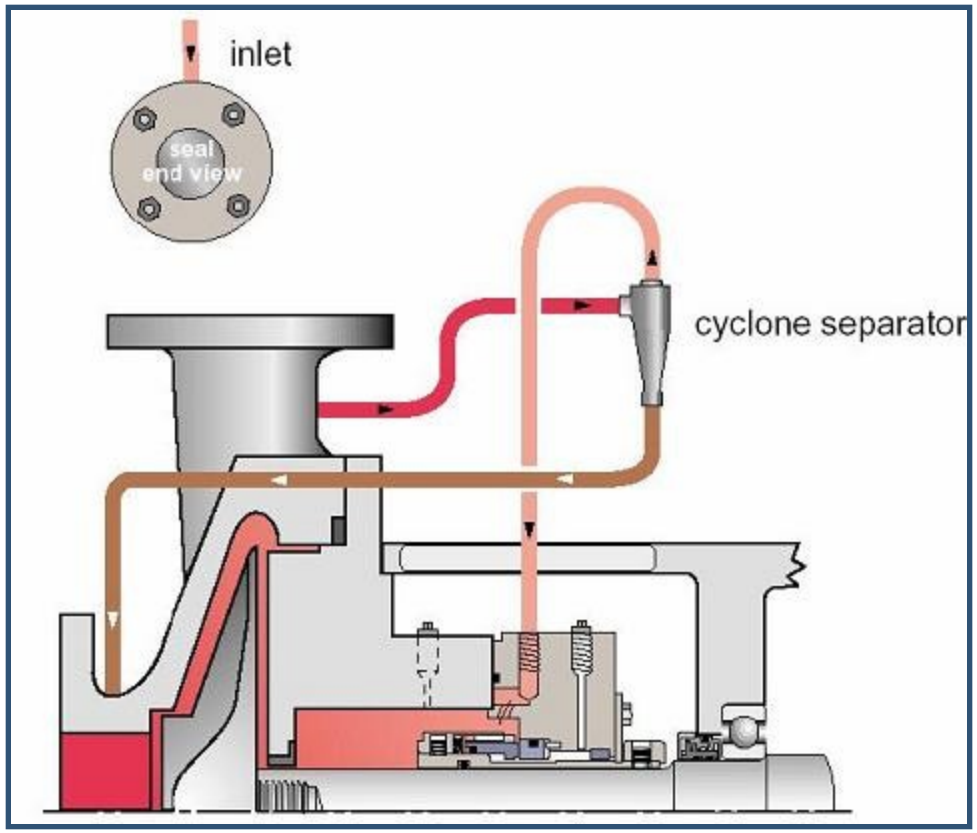


- **Plan 11 + Heat Exchanger**
- **Effective, but not so efficient.**

CLEANING

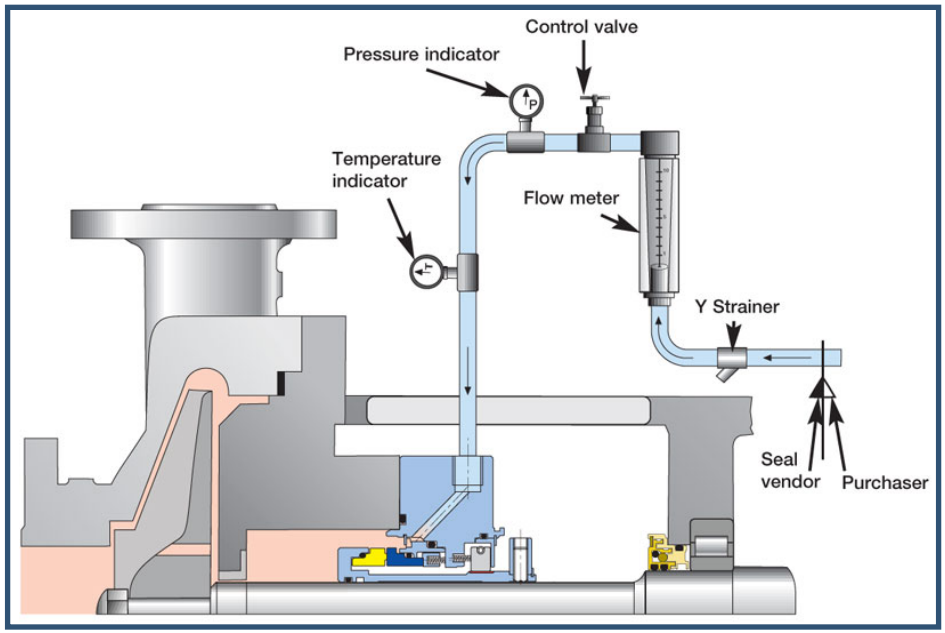
Plan 31:

Circulation from pump discharge passing through a solids separator, then to the seal box. The line with higher solids concentration goes to the pump suction.



CLEANING

Plan 32:
External fluid injection in the seal box.



- **The seal works with a mixture of process fluid and injection fluid**

- **The injected fluid must be compatible with process fluid**

- **The injection fluid cost is an issue to consider**

Course Learning Summary

In this course we learned today:

1. The purpose of the mechanical seal
2. The essential elements of a mechanical seal
3. The classification of mechanical seals
4. When to use different seal material types
5. Common seal flush plans

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Thank you for completing this course!

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