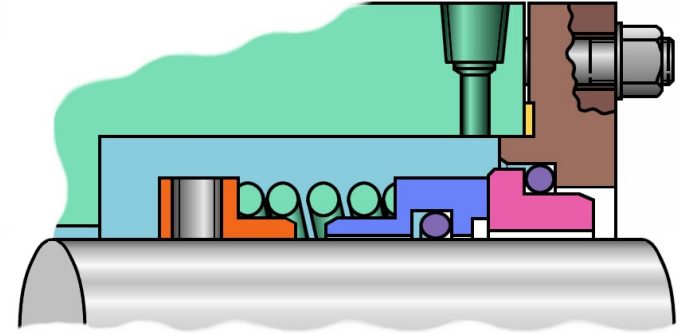
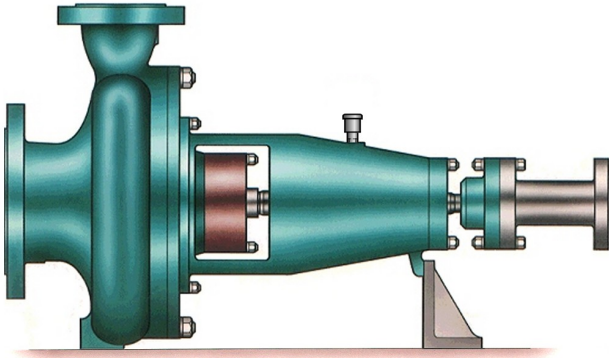
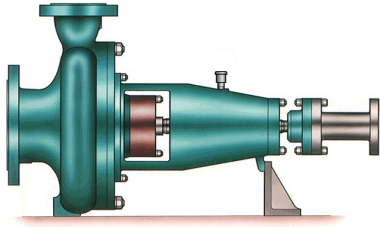


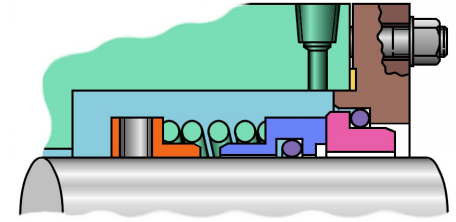


PUMP & MECHANICAL SEALS

By : Lalit Chhajer

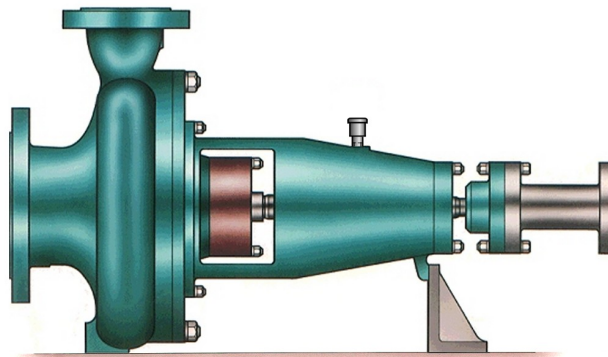


Content

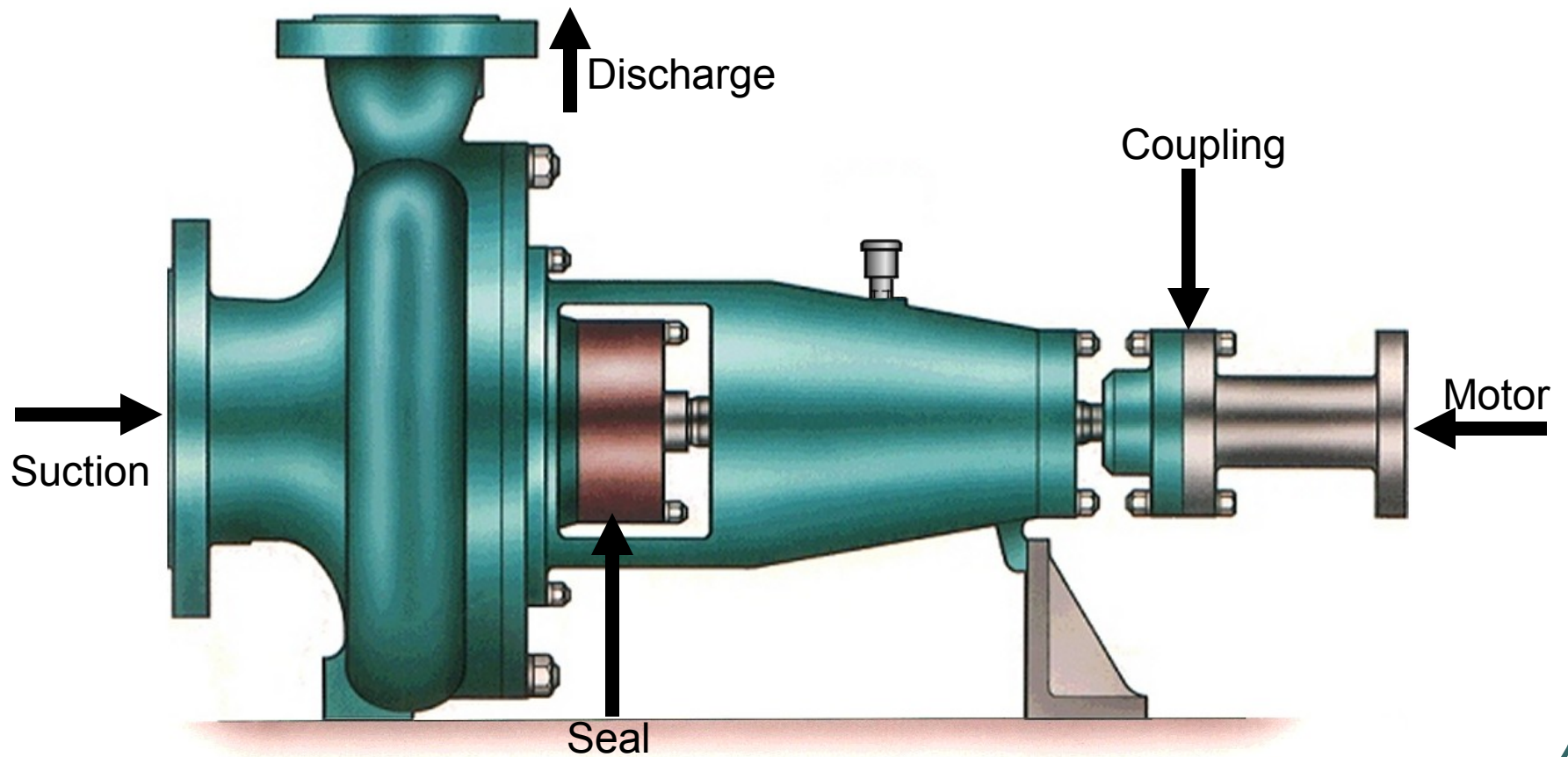


- General Components of Pump
- Mechanical Seal

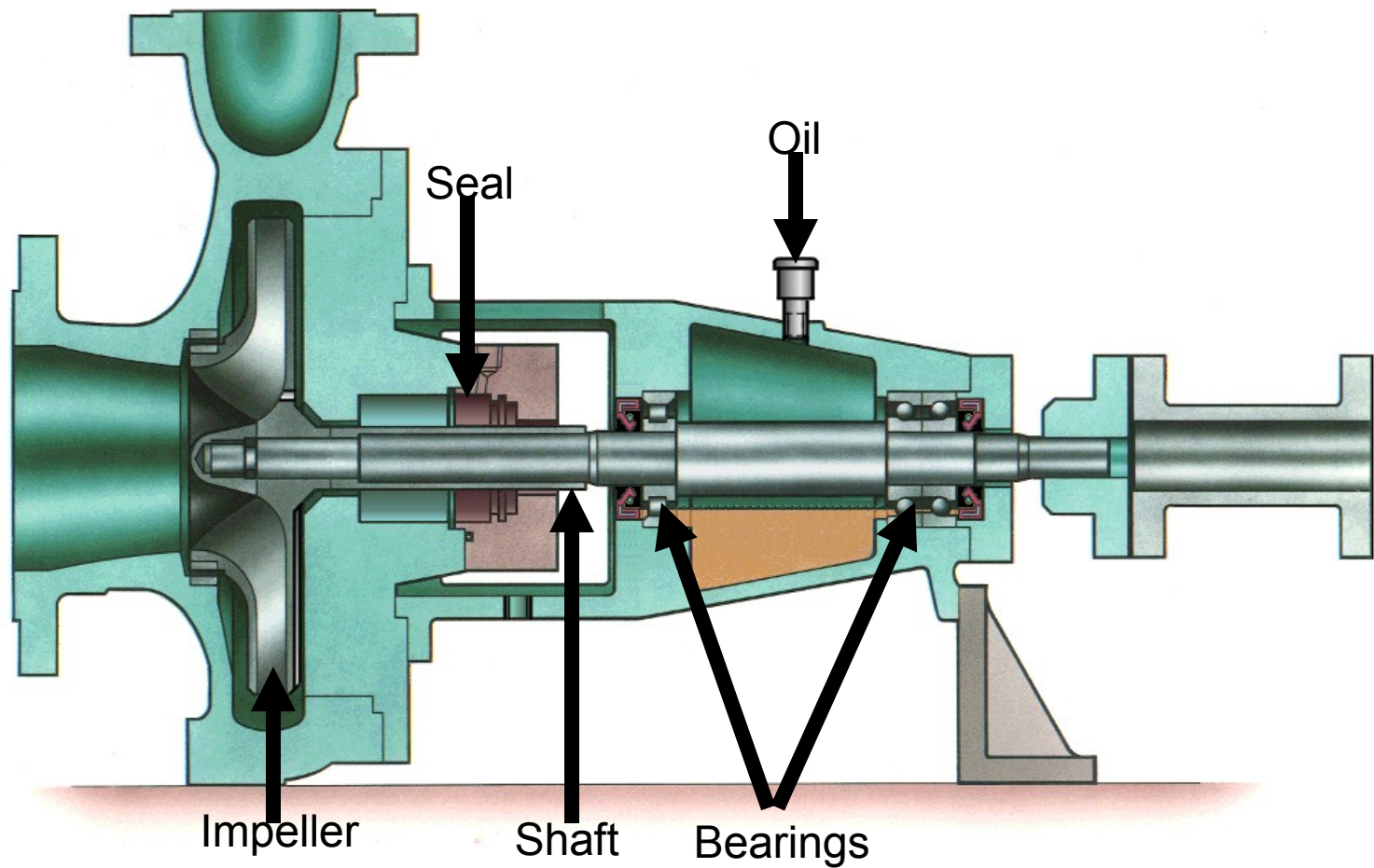
PUMP



Pump - Typical

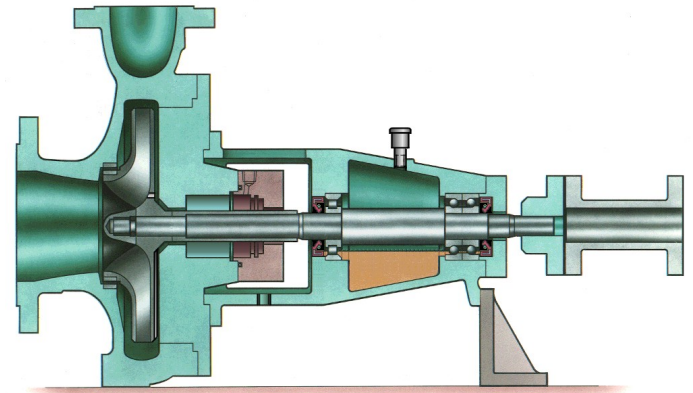


Pump - Sectioned

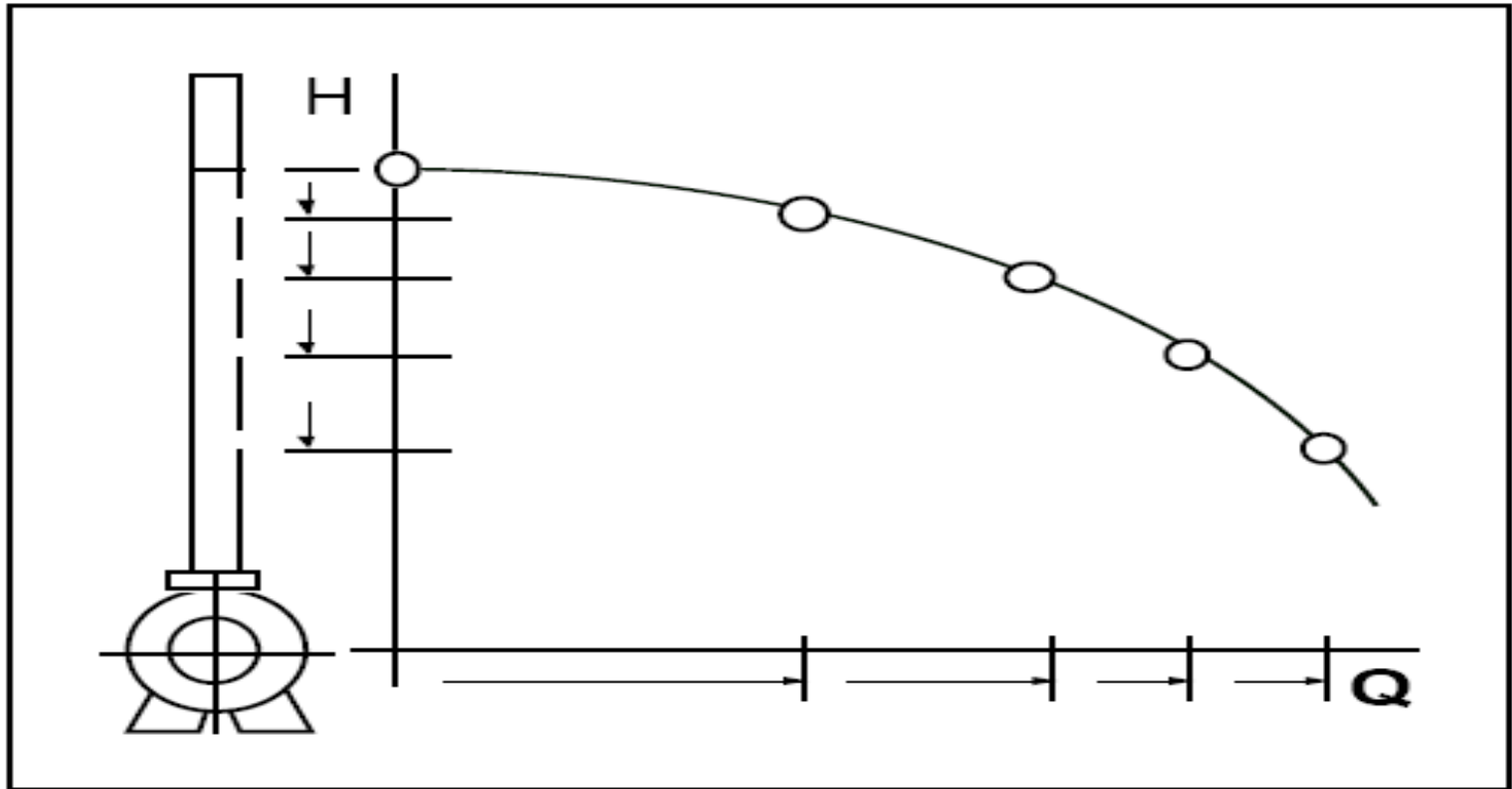


Components of Pump

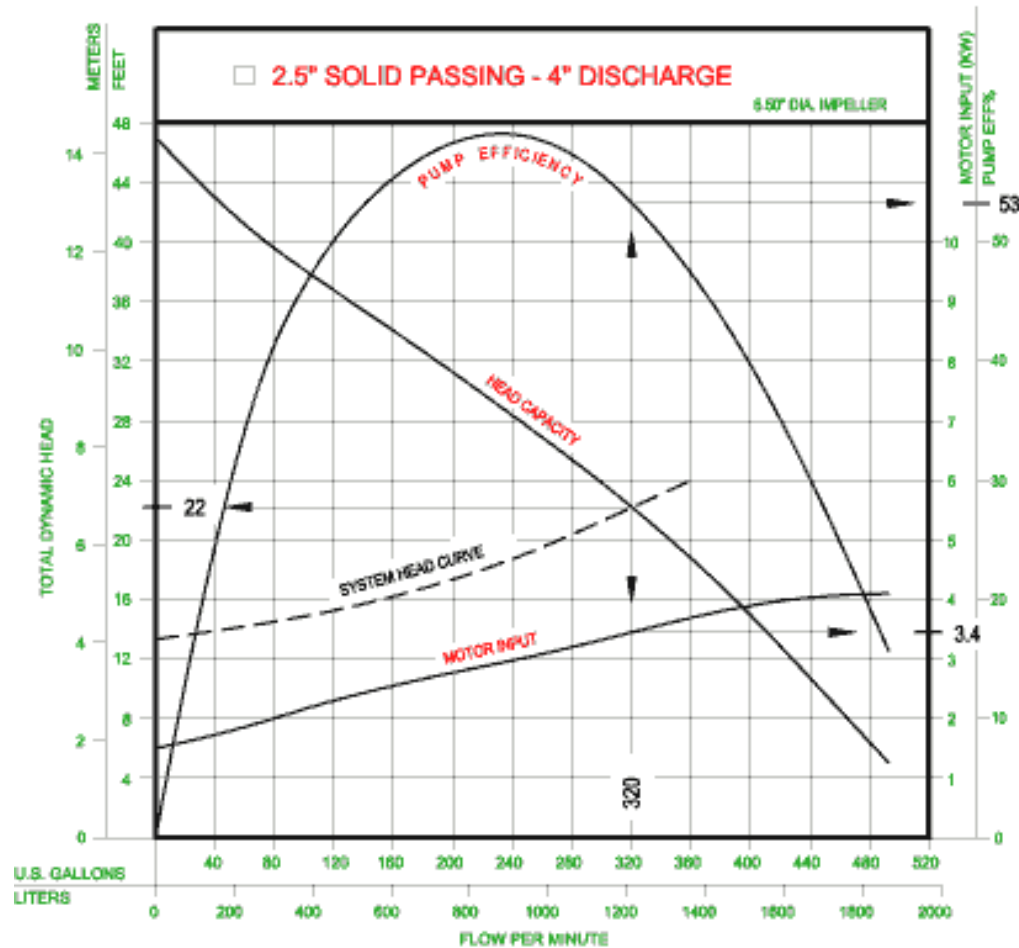
- **Pump Casing** - To keep the fluid in the pump.
- **Impeller** - The component that drives the fluid to a higher pressure
- **Shaft** - The rod that connects the motor to the impeller
- **Motor** - The part that powers the pump
- **Packing Seal , Mechanical Seal** - To keep the fluid from leaking out to the atmosphere. There are some magnetically driven centrifugal pumps that do not need such seals or packing.
- **Bearing** - To keep the shaft rotating freely in place.
- **Outboard bearing** - Bearing at motor end of shaft
- **Inboard bearing** - Bearing at impeller side of pump. Need 2 bearing to hold shaft in place
- **Oiler** - To provide oil to lubricate the bearing so it will not jam.



PUMP PERFORMANCE CURVE



PUMP PERFORMANCE CURVE



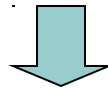
BASIC REQUIREMENT – Smooth Operation

- No Cavitation
- Minimum Flow
- No Leakage / Emission

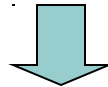
CAVITATION

- It can be referred to as **HEART ATTACK** to a pump. The steps in Cavitation are

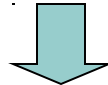
Formation of Bubbles inside the liquid



Growth of Bubbles



Collapse of Bubbles



CAVITATION

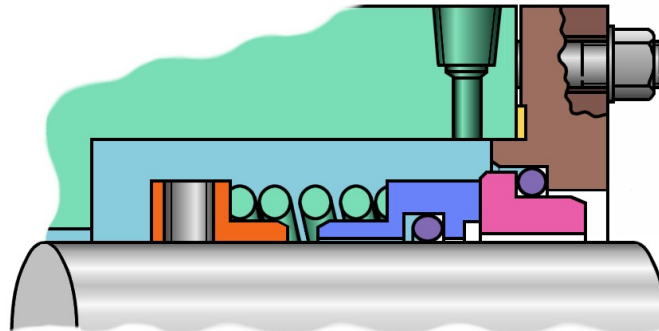
MINIMUM CIRCULATION

- Continuous operation of a pump at low flow or reduced capacities leads to a number of unfavorable conditions
 - Reduced Motor Efficiency
 - Excessive Radial Thrust
 - Excessive temperature rise in pumping liquid
 - Internal Re-circulation

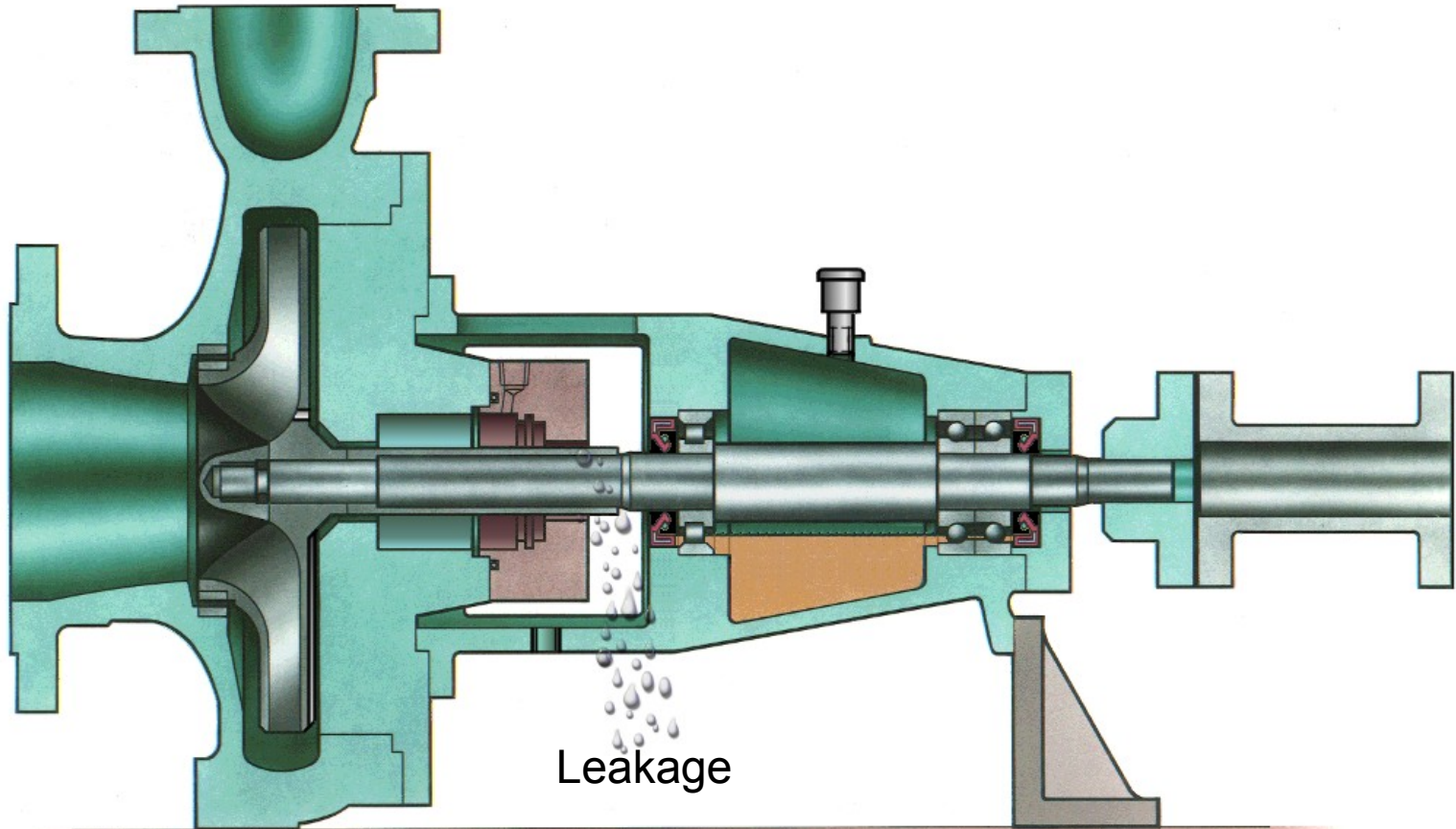
NO LEAKAGE / EMISSION

- Bad Seal is a major contributor for Leakage or Emission
- If the product is toxic, pyrophoric, then leakage in a pump result in serious Health hazard.
- If the product is costly then, it can result in significant loss.

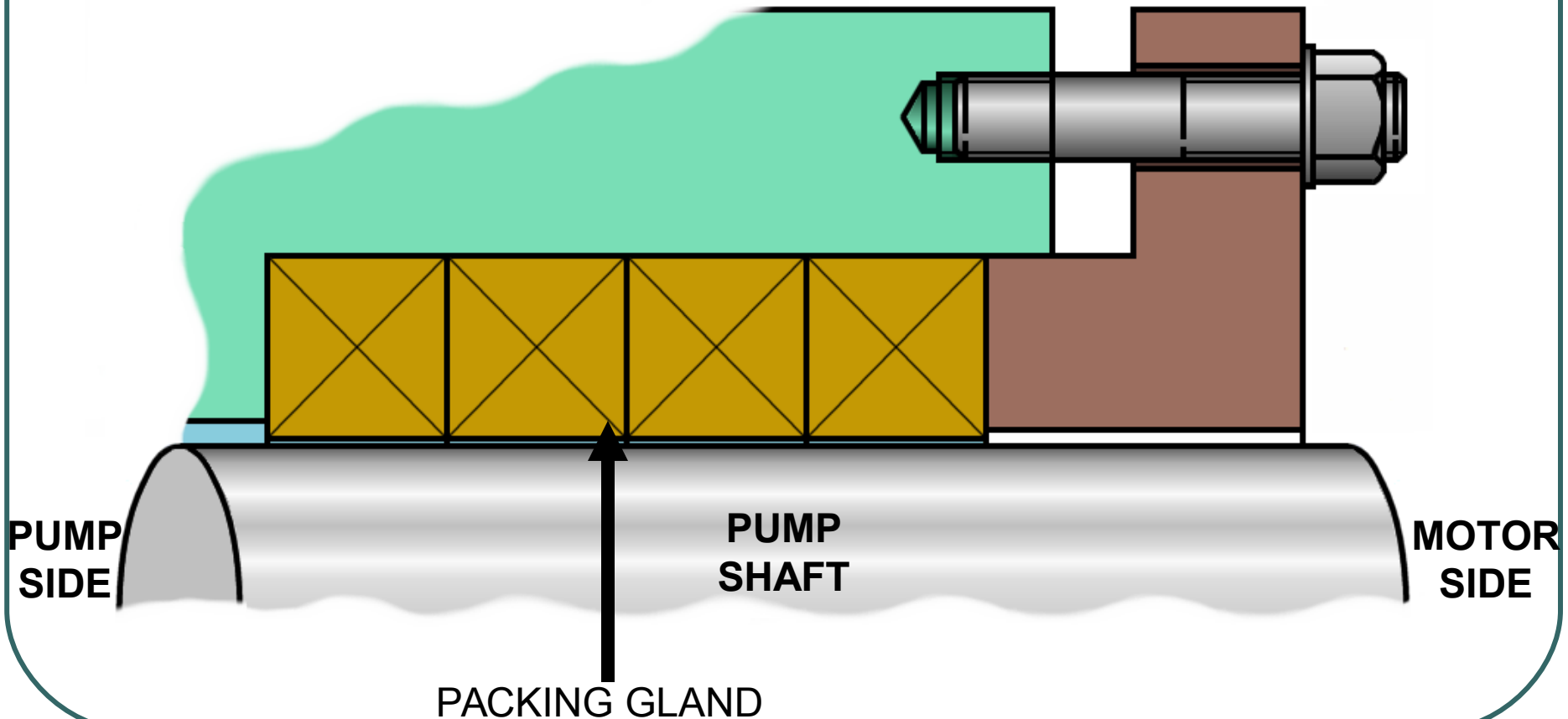
MECHANICAL SEAL



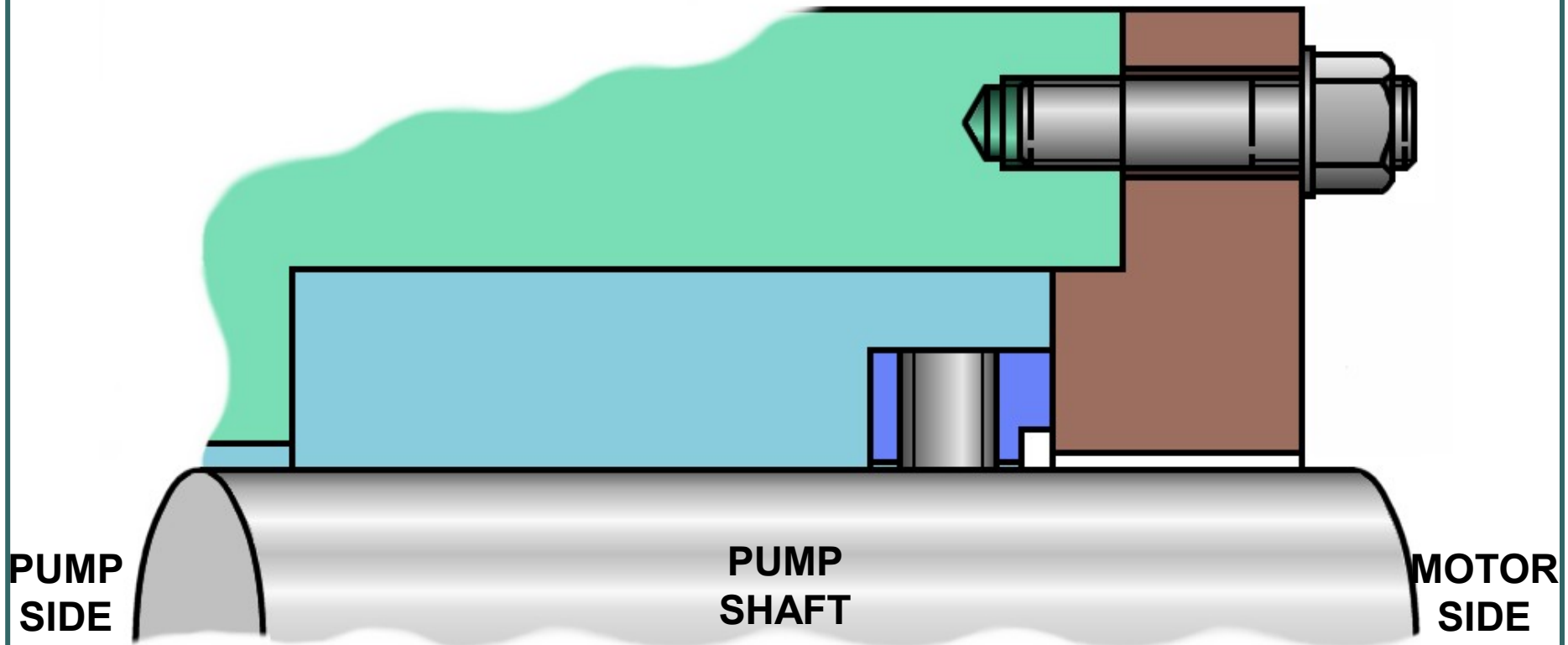
LEAKAGE FROM PUMP



Gland Packing – An older Version to seal



MECHANICAL SEAL – Basic Version



What is Mechanical Seal ?

- A **mechanical seal** is a type of seal utilized in rotating equipment, such as pumps and compressors.
- When a pump operates, the liquid could leak out of the pump between the rotating shaft and the stationary pump casing. Since the shaft rotates, preventing this leakage can be difficult.
- Earlier pump models used mechanical packing to seal the shaft. Since WWII, mechanical seals have replaced packing in almost all applications.

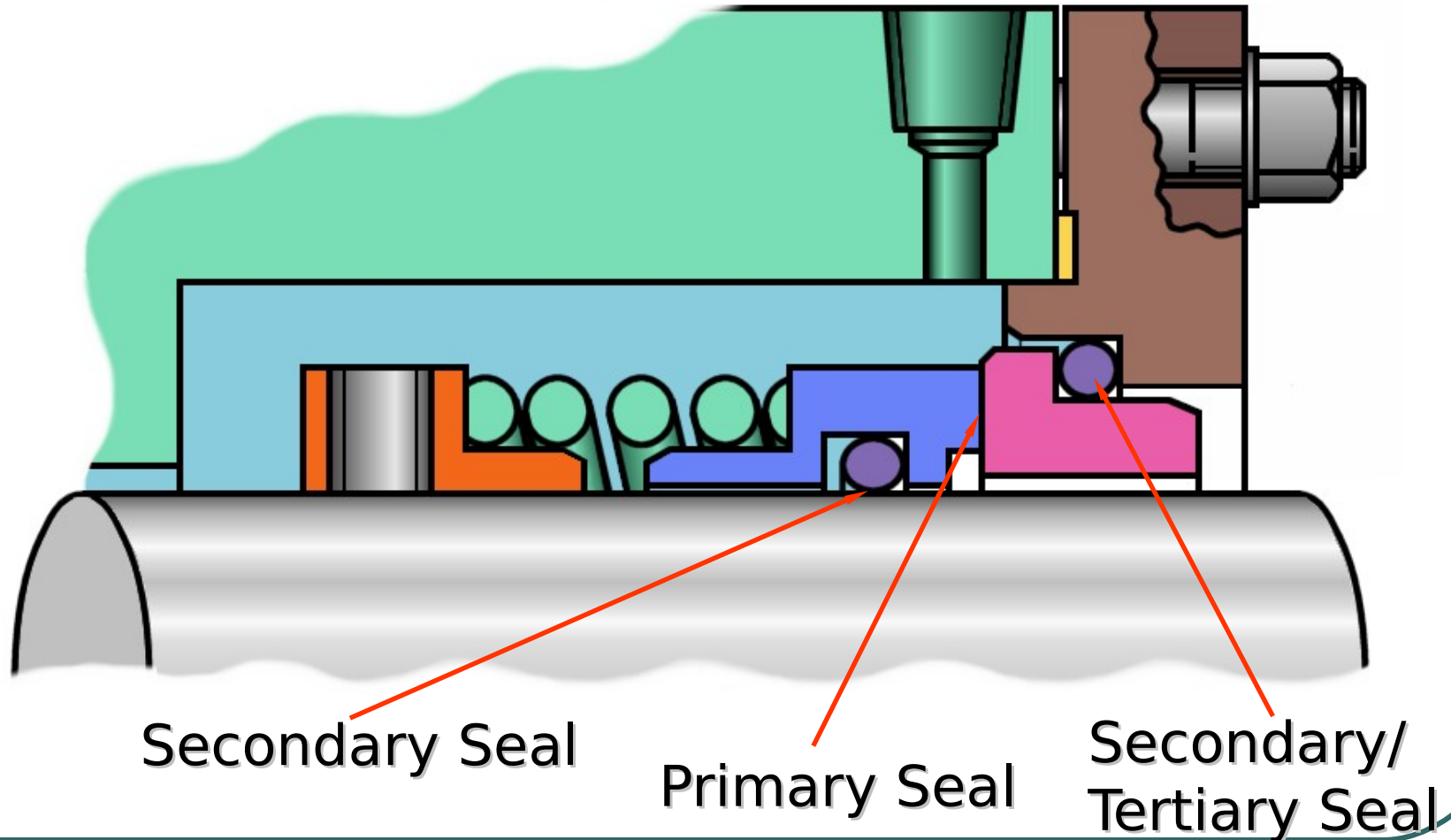
Mechanical Seal Fundamentals

A mechanical seal must contain four functional components:

- 1) Primary sealing surfaces,
- 2) Secondary sealing surfaces,
- 3) a means of actuation and
- 4) a means of drive.

- 1) The primary sealing surfaces are the heart of the device. A common combination consists of a hard material, such as silicon carbide embedded in the pump casing and a softer material, such as carbon in the rotating seal assembly. Many other materials can be used depending on the liquid's chemical properties, pressure, and temperature. These two rings are in intimate contact, one ring rotates with the shaft, the other ring is stationary. These two rings are machined using a machining process called lapping in order to obtain the necessary degree of flatness.
- 2) The secondary sealing surfaces (there may be a number of them) are those other points in the seal that require a fluid barrier but are not rotating relative to one another.
- 3) In order to keep the two primary sealing surfaces in intimate contact, a means of actuation must be provided. This is commonly provided by a spring. In conjunction with the spring, it may also be provided by the pressure of the sealed fluid.
- 4) The primary sealing surfaces must be the only parts of the seal that are permitted to rotate relative to one another, they must not rotate relative to the parts of the seal that hold them in place. To maintain this non-rotation a method of drive must be provided.

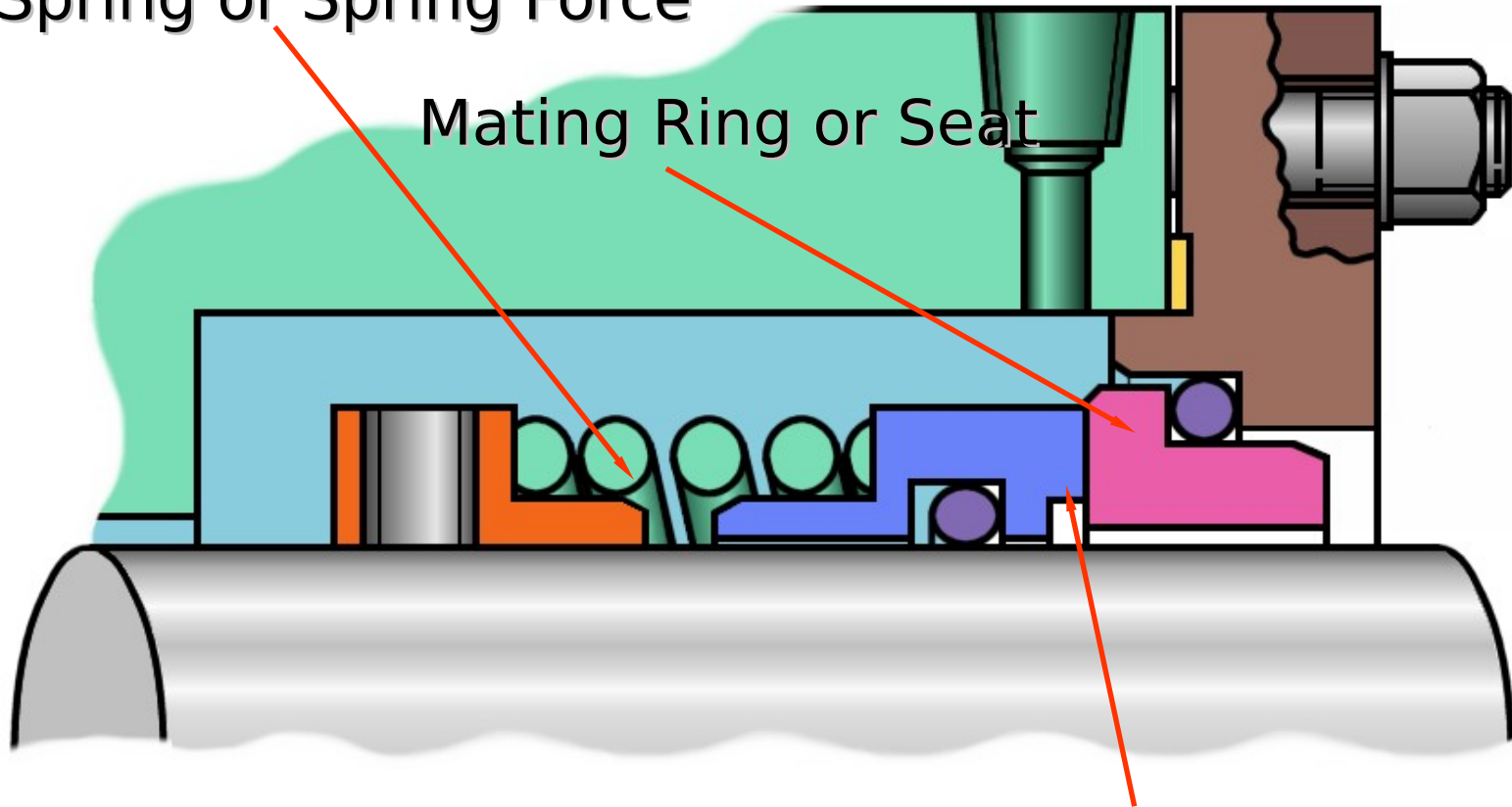
MECHANICAL SEAL – Fundamentals



MECHANICAL SEAL – Fundamentals

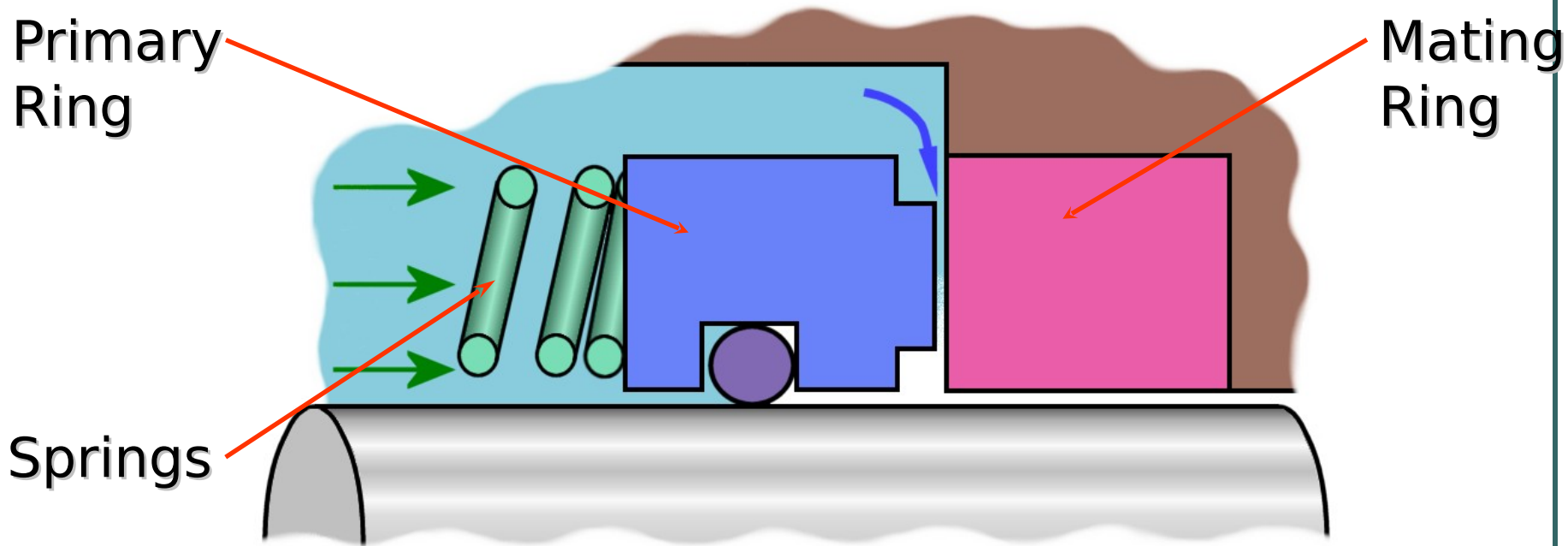
Spring or Spring Force

Mating Ring or Seat



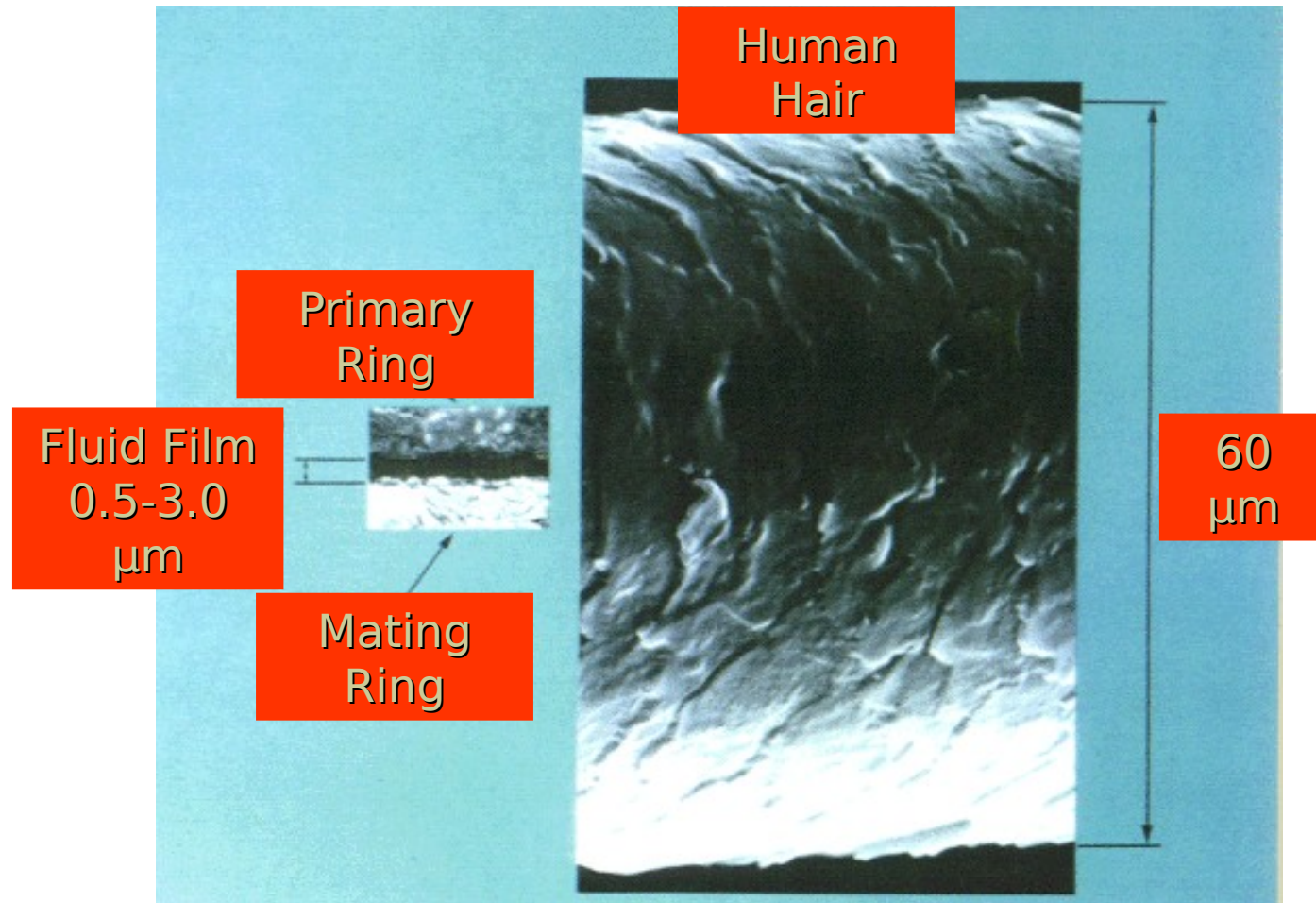
Primary Ring or Face

PRIMARY SEAL



Fluid is forced between faces to lubricate
Springs keep faces closed when no pressure

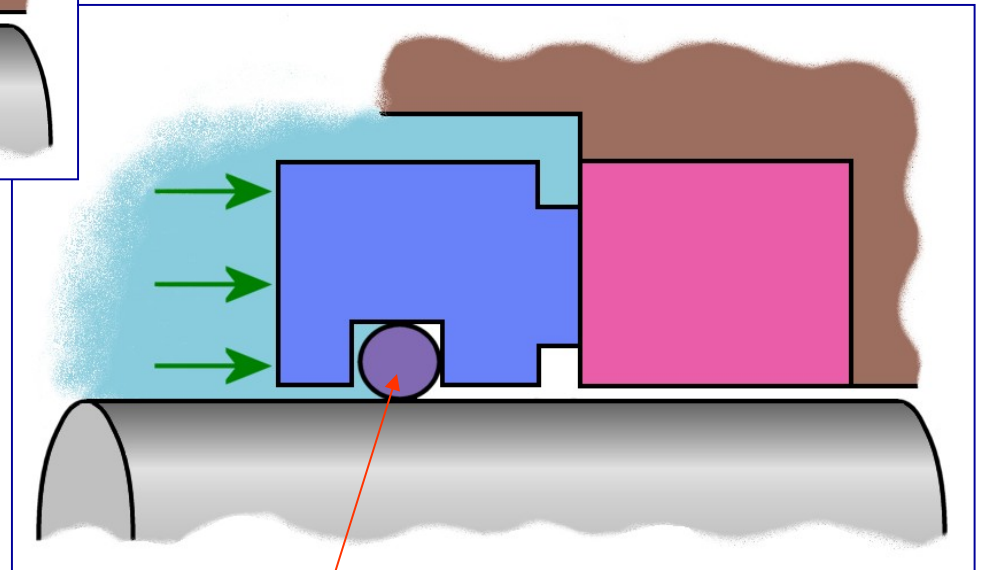
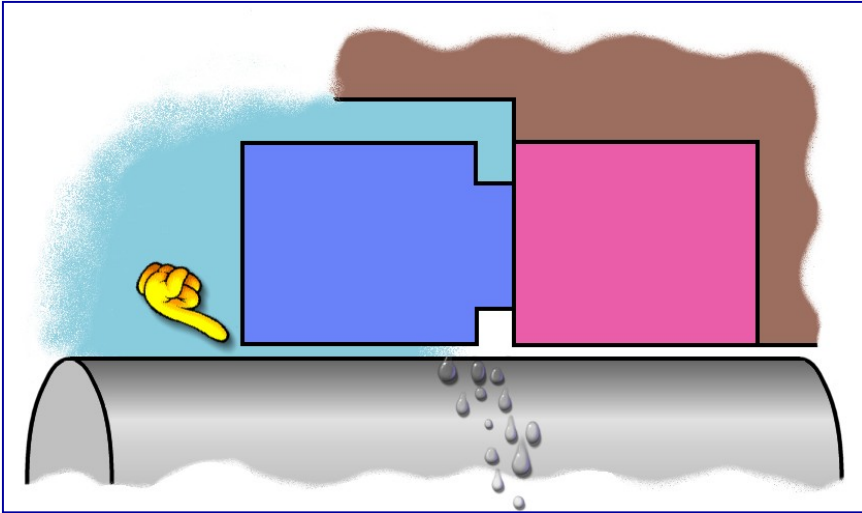
PRIMARY SEAL



Faces lapped flat to within 1 - 3 light bands

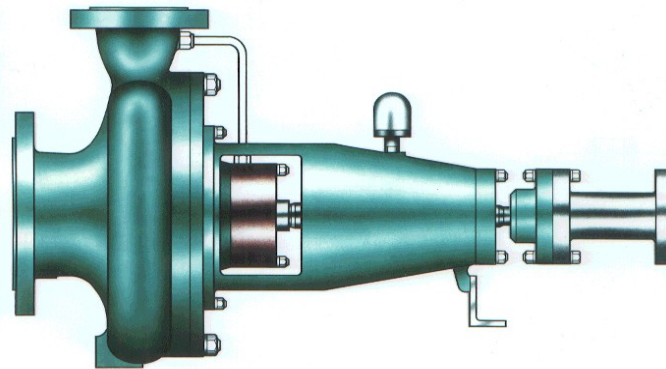
1 light band = 0.00001181 inch or 0.0003 mm

SECONDARY SEAL



O-Ring

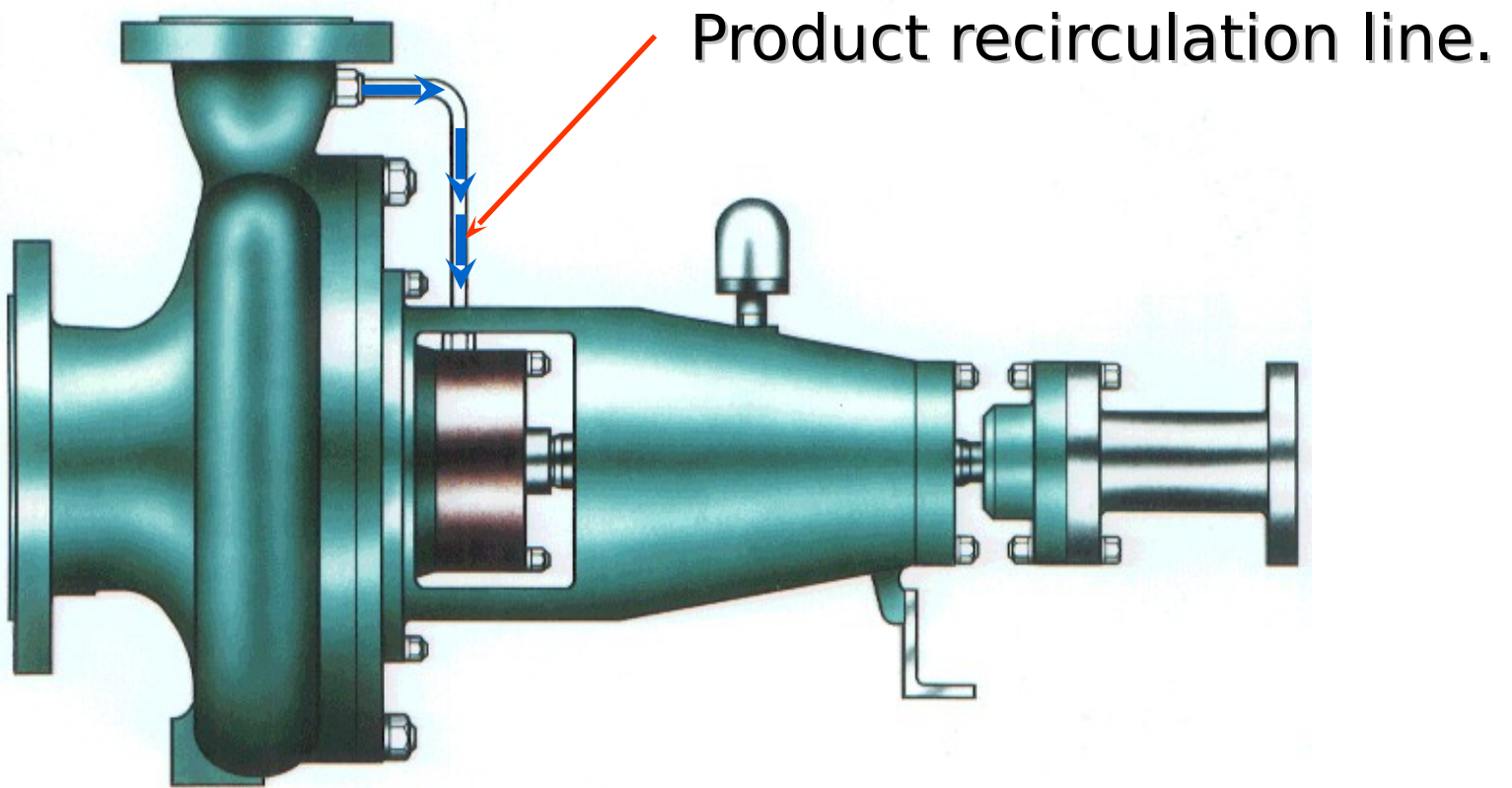
API PLANS FLUSHING & COOLING



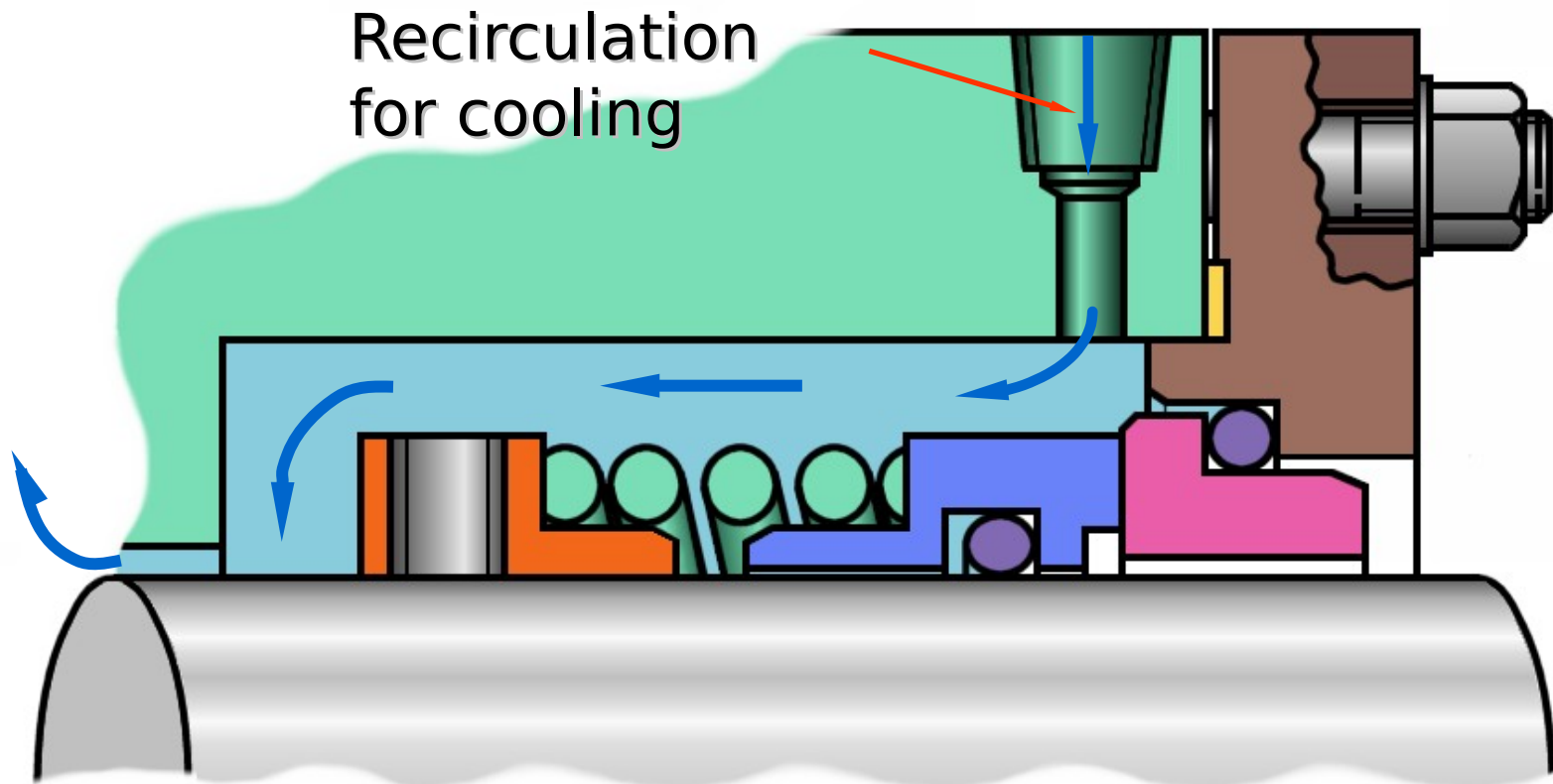
API PLANS

- Since the rotating seal will create heat, this heat will need to be carried away from the seal chamber or else the seal will overheat and fail. Typically, a small tube connected to either the suction or the discharge will help circulate the liquid. Other features such as filters or coolers will be added to this tubing arrangement depending on the properties of the fluid, and its pressure and temperature. Each arrangement has a number associated with it, as defined by API. API Plans are there to
 - Keep the Seal faces clean of any dirt
 - Keep the Seal cool
 - Lubricate the Seal Faces
- There are 17 API plans available for Mechanical Seal applications.

Example – API Plan 11 (SEAL COOLING)



Example – API Plan 11 (SEAL COOLING)



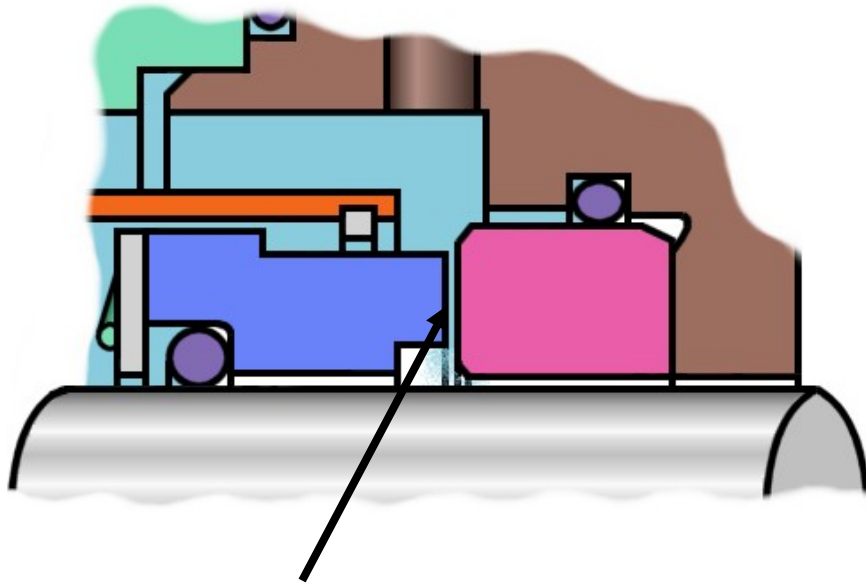
Multiple Seals

Tandem
Unpressurised

Multiple Seals

- Since almost all seals are designed to leak slightly, dangerous chemicals or flammable petroleum must not be allowed to leak into the atmosphere or onto the ground. In these applications a second seal is placed after the primary seal along the pump shaft. The space in between these two seals is filled with a neutral liquid or gas.

Single seal is not enough

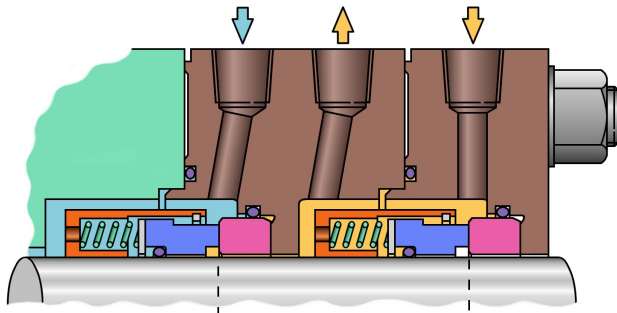


Single seals utilise process gas or fluid to provide the lubricating interface film

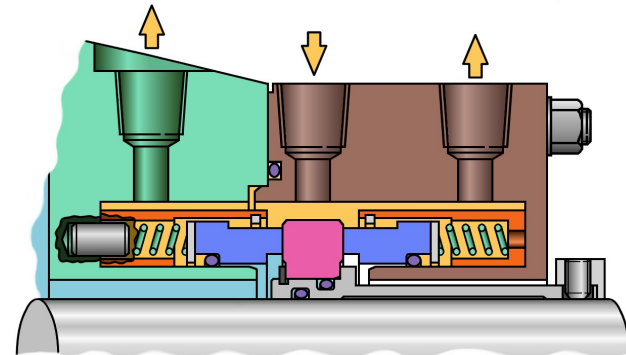
• Use multiple seals if:

- product is toxic
- product is flammable
- environmental
- isolation required
- product changes state
- product is not a good lubricant or is abrasive
- suction pressure is low
- expensive product
- critical machine

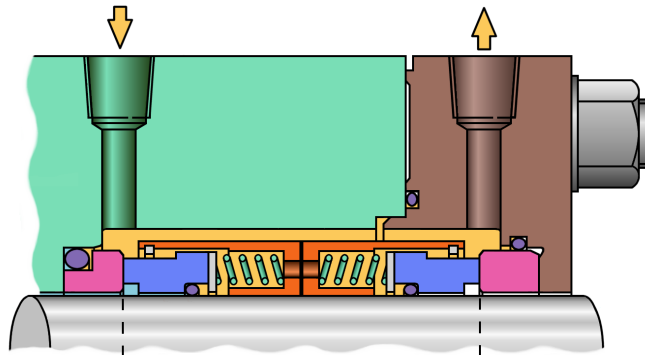
MULTIPLE SEALS



Tandem Seal



Double Seal – Face To Face

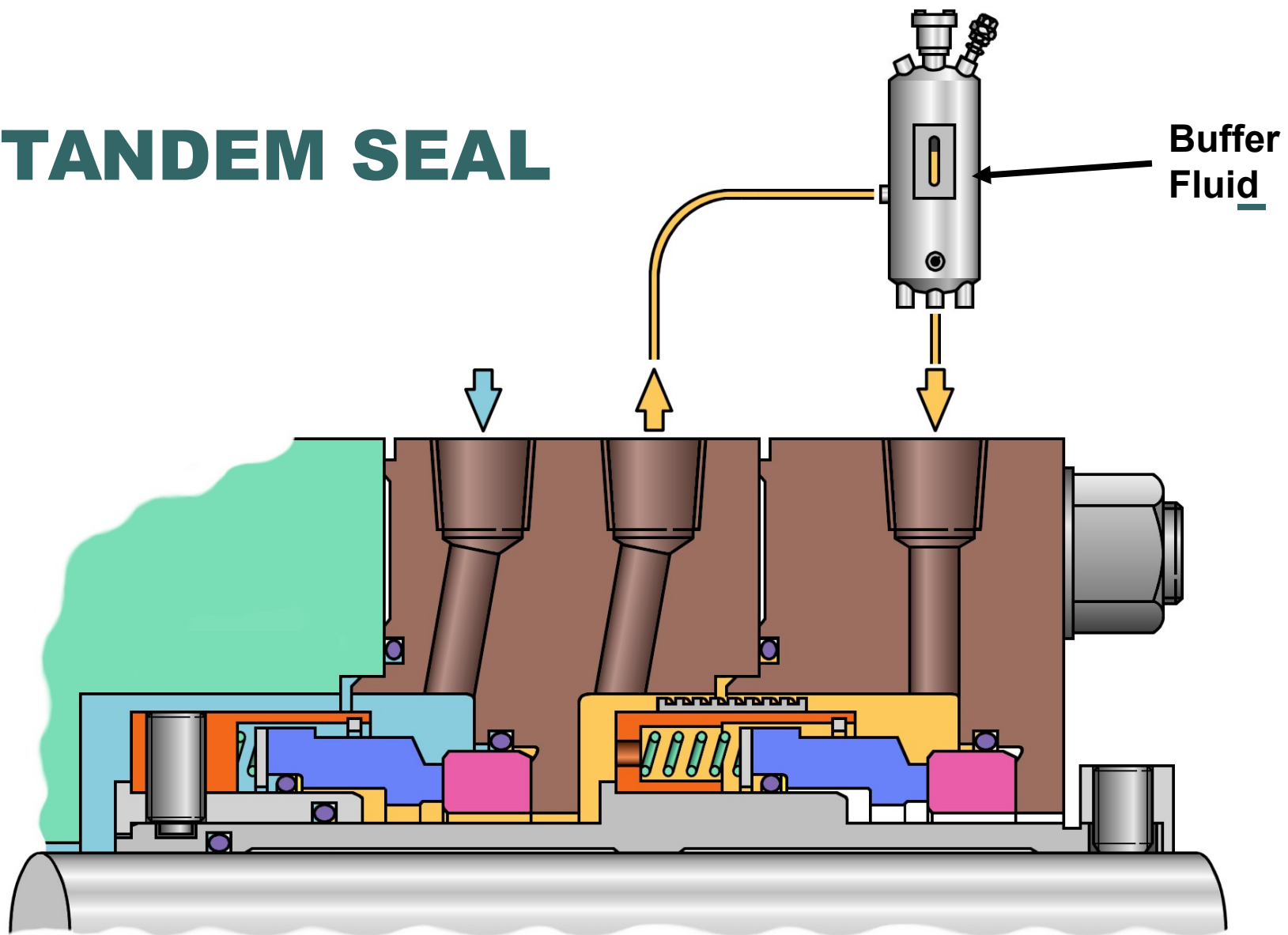


Double Seal – Back To Back

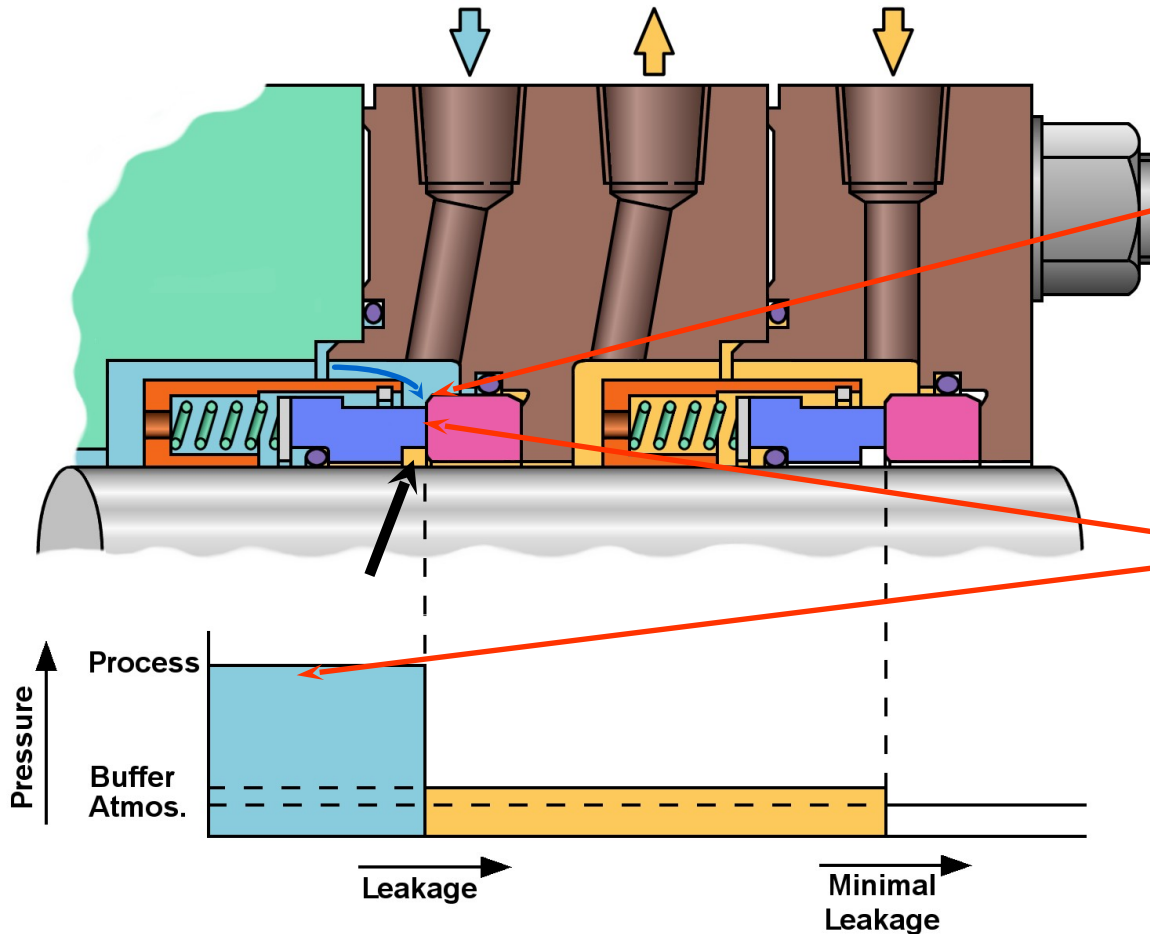
MULTIPLE SEALS

- Two common arrangements
 - **Tandem**
 - low pressure buffer fluid
 - high integrity secondary containment
 - inboard seal lubricated by product
 - **Pressurised Double (e.g., Back-to-Back)**
 - pressurised barrier fluid
 - inboard seal lubricated by barrier fluid
- There are many other arrangements
 - **Face-to-Face; Dual; Concentric; etc.**

TANDEM SEAL



TANDEM - INBOARD SEAL



Inboard Seal

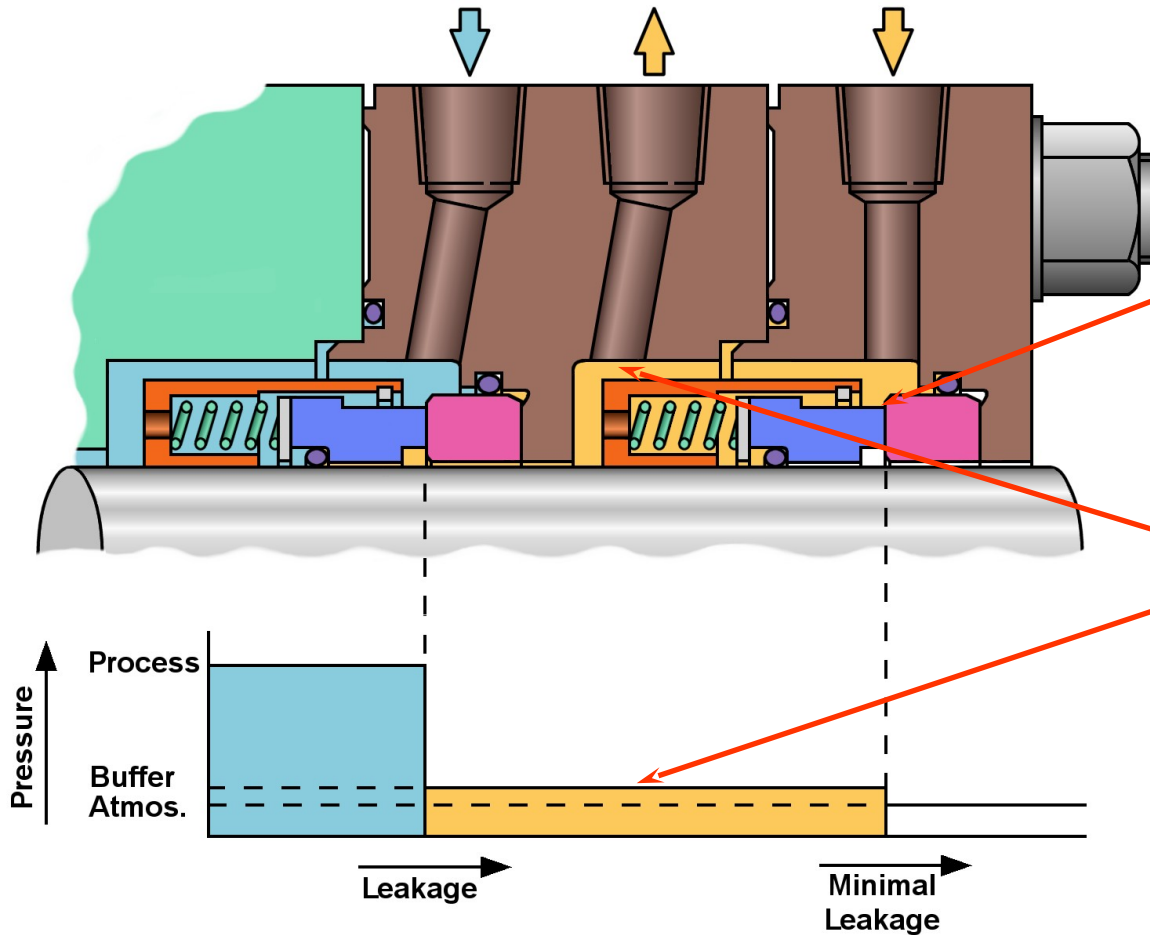
Product lubricates this seal

This seal is under full product pressure

Note possible contamination of buffer fluid

TANDEM - OUTBOARD SEAL

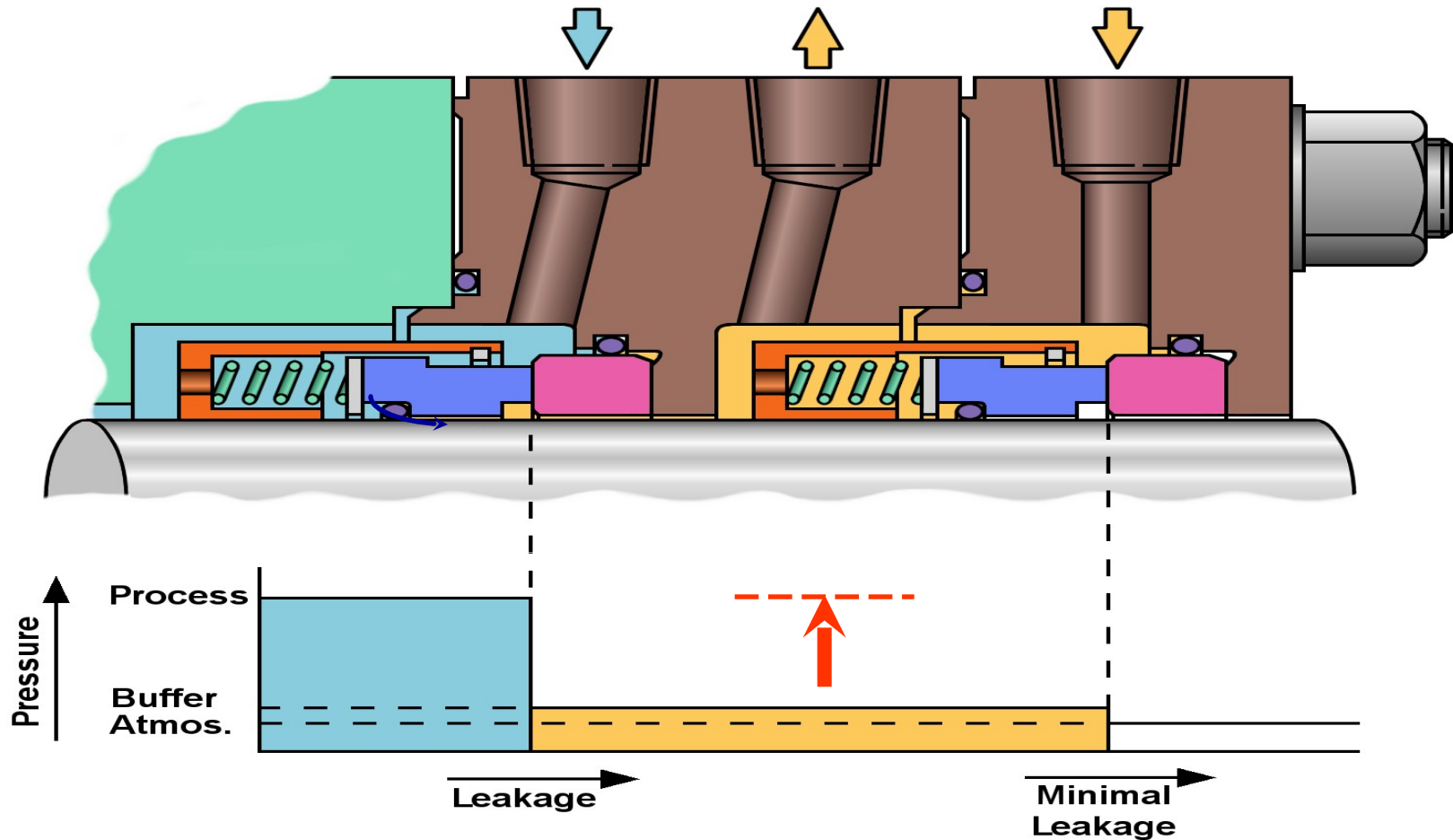
Outboard Seal



Clean buffer fluid lubricates this seal

Buffer fluid is at low (atmospheric) pressure

TANDEM SEAL



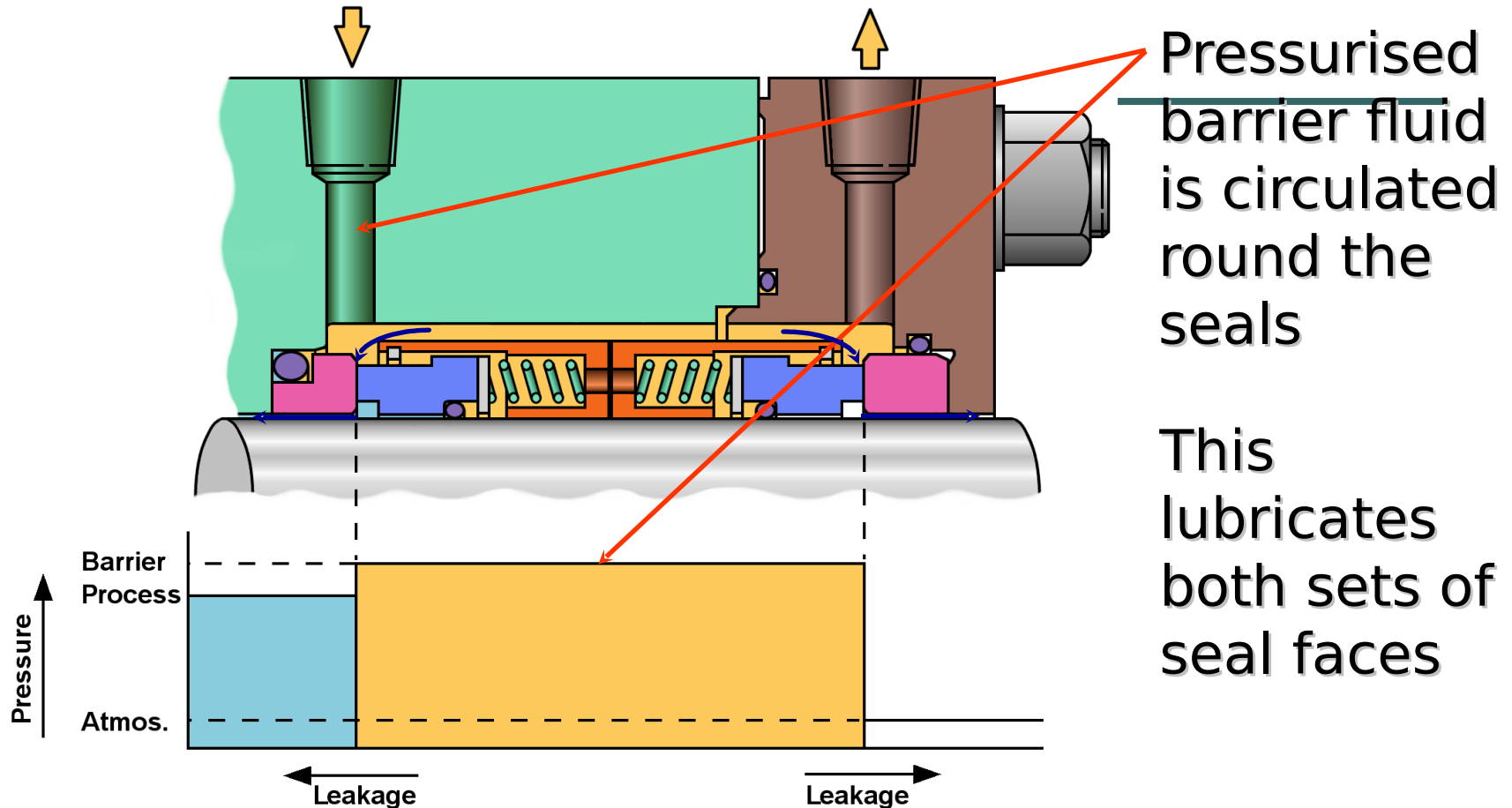
- Inboard seal most likely to fail first

- Process can continue until completed

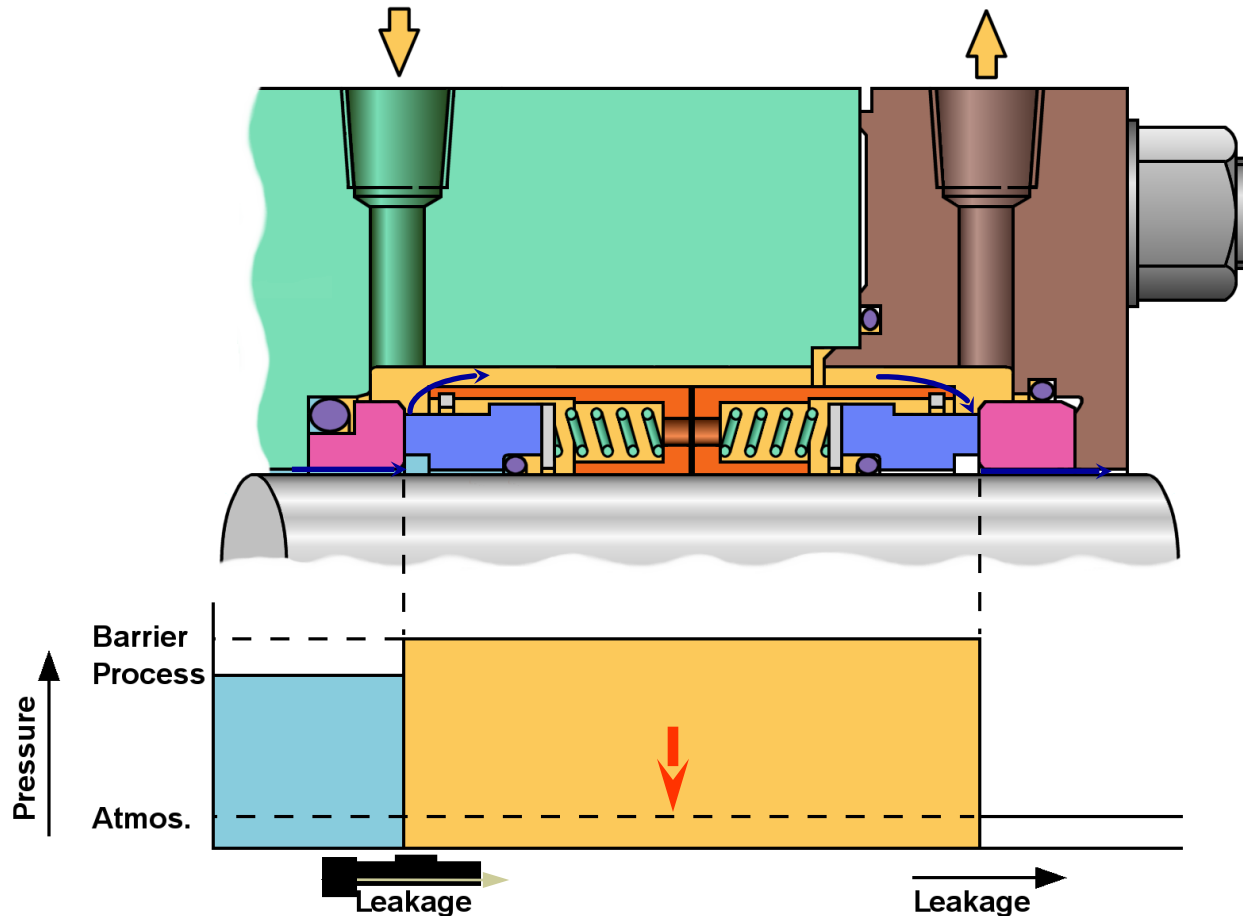
- Buffer fluid level/pressure will rise

- Outboard seal acts as secondary containment

Double Seals: Back-to-Back

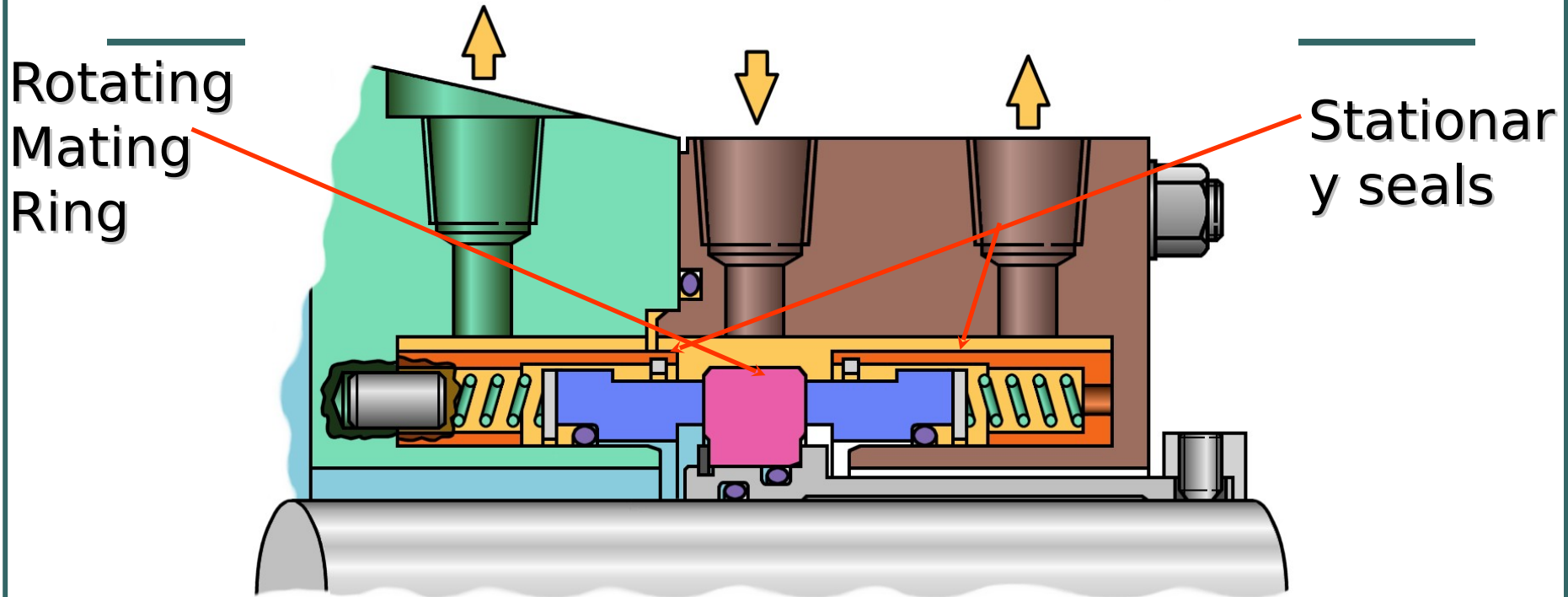


Double Seals: Back-to-Back



If outboard seal fails, barrier pressure will fail and pump must be switched off as product will leak out

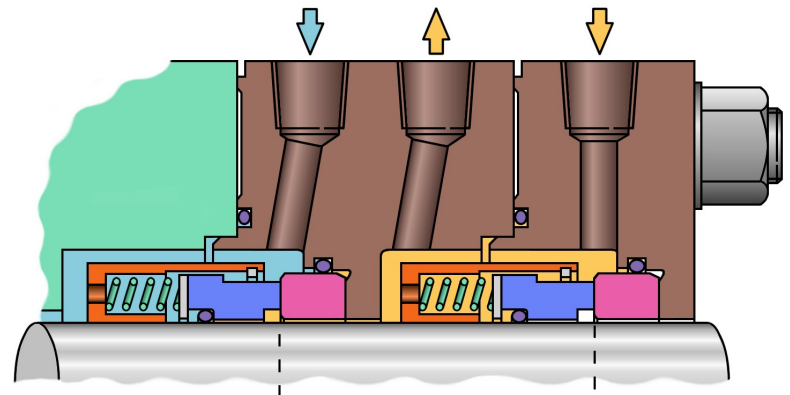
Double Seals: Face-to-Face



Similar in operation to back-to-back double seal
Much shorter - only one mating ring
Simple rotating components

Multiple Seals

- In a tandem seal, the seal will leak to the unpressurized cavity. If the cavity registers a dramatic increase in pressure, operator will know that the primary seal has failed. If the cavity is drained of liquid, then the secondary seal failed. In both instances, maintenance will need to be performed. This arrangement is commonly used when sealing fluids that would create a hazard or change state when contacting open air.



Multiple Seals

- In a double seal, the liquid in the cavity between the two seals is pressurized. Thus if the primary seal fails, the neutral liquid will leak into the pump stream instead of the dangerous pumped fluid escaping into the atmosphere. This application is usually used in gas, unstable, highly toxic, abrasive, corrosive, and viscous fluids.

