FUNDAMENTALS OF MECHANICAL SEAL

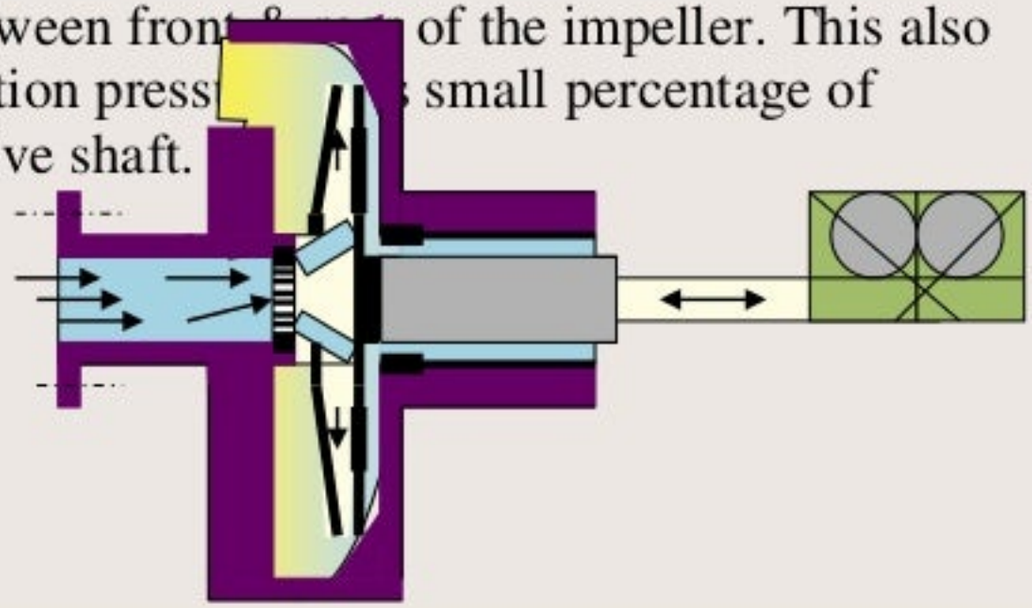
Author

Prem Baboo
Sr. manager(Prod)
National Fertilizers Ltd,India
F.I.E. Institution of Engineers India,
Technical Advisor & an Expert for
www.ureaknowhow.com

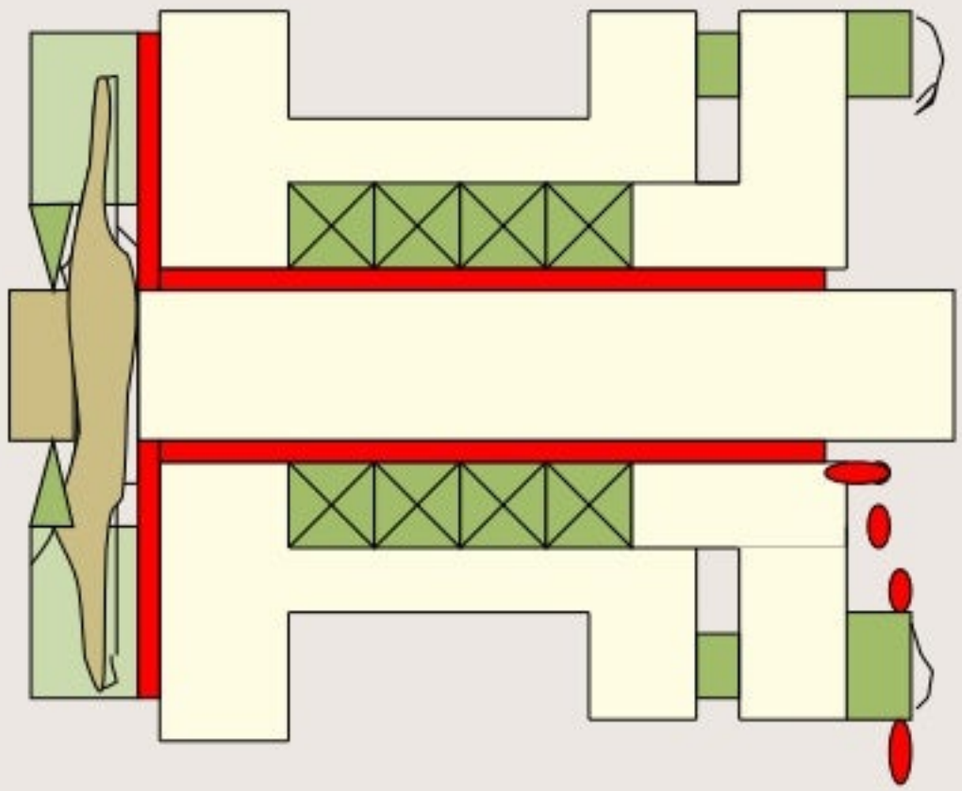
FUNDAMENTALS OF MECHANICAL SEAL OPRATION

- The liquid to be pumped enters the suction inlet at the eye of the impeller.As the impeller rotates at relatively high speed .The liquid centrifugally forced to the out side diameter of the impeller where it flows out through the discharge nozzle. This same discharge pressure, however, flow down behind the impeller to the drive shaft which is connected to a driver out side the pump. This is the shaft that must be efficiently sealed if the pump is to be of any practical use.
- Relieving the high pressure behind the impeller to the low pressure suction eye of the impeller. The clearance between the back of the impeller and the pump back head actually much closer. Small pumping vanes are often placed on the back side of the impeller. Balance hole can also be drilled through the suction eye.

By decreasing the pressure differential between fron[illegible] of the impeller. This also reduce axial thrust on the shaft. So the suction press[illegible] small percentage of discharge pressure always surround the drive shaft.



Stuffing box with compression pkg.



- If this pkg. Were to rub against the shaft,without lubrication present to prevent a build-up of frictional heat,it would soon destroy it self. So liquid must be allowed to flow between the pkg.and shaft , because of surface irregularities of pkg. , eccentricity between the stuffing box bore and the shaft,as well as shaft run out a significant amount of pkg. Must be used to compensate for these irregularities. It is this generous amount of pkg. that requires a proportionately generous amount of lubrication. When this flow of lubrication exit from the pkg.it becomes identified as leakage.

Mechanical seal

Introduction-.

In modern process / chemical industries where highly corrosive and expensive fluid are handled. Leaks are not tolerated. Since soft packing works on the principle of controlled leakage. The system is not accepted, hence mechanical seal preferred as they tend to seal with no visible leak.

.

Function of mechanical seal

– The function of every mechanical seal is to prevent.The escape of a fluid.The clearance between rotating shaft and the passage way through the wall of a housing /casing or pressure vessel.

Three primary sealing points

- 1) Between stationary element and casing
- 2) Between rotating element and shaft
- 3)Between mating surfaces of the rotating and seal elements

Three basic components

- A set of primary sealing element
- A set of secondary sealing element
- Hardware for attaching,positioning and maintaining face to face contact

Primary sealing element

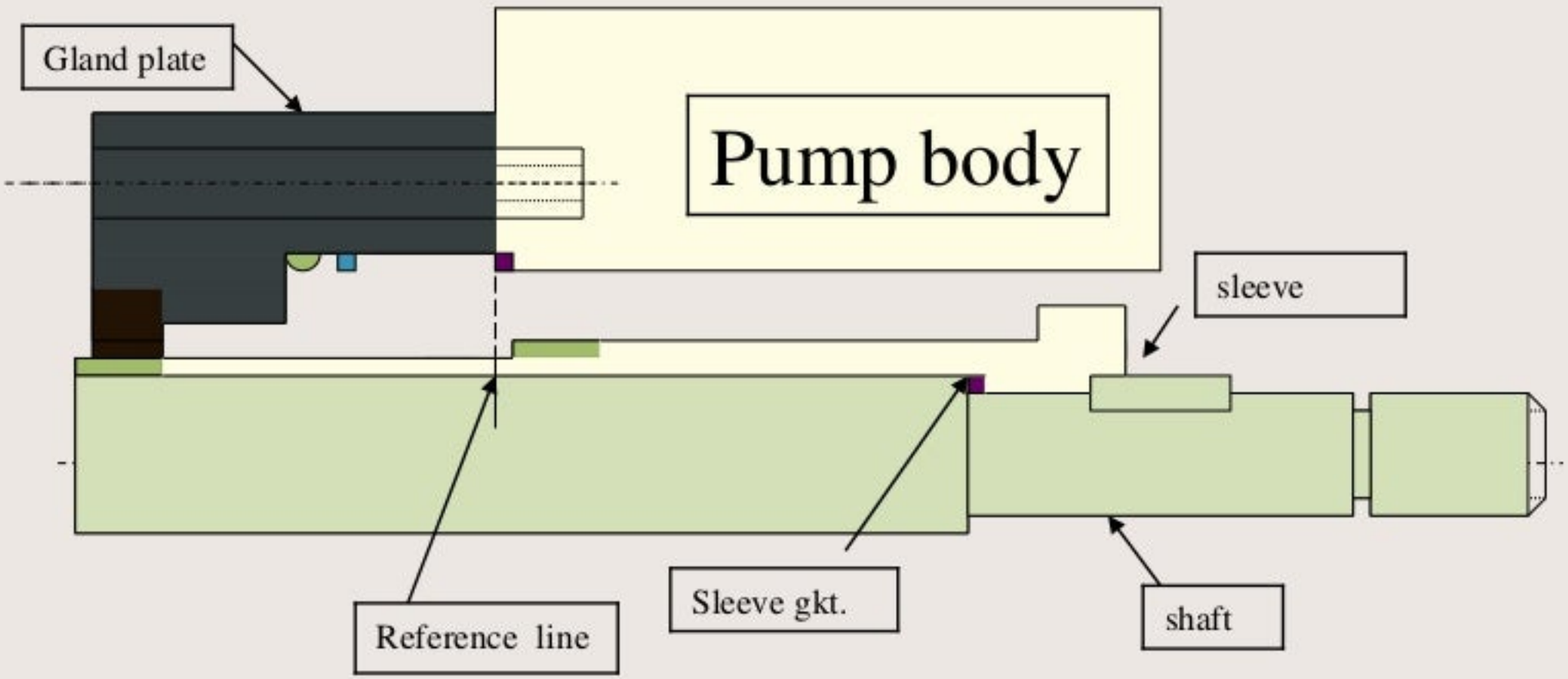
- It is formed by two highly polished /lapped faces.
- One face is kept stationary and other face is fixed to a rotating shaft.
- (That create very difficult leakage due to rubbing contact between them.all seals leak but leakage is not visible.the leakage is very small and non hazardous).

Secondary sealing element

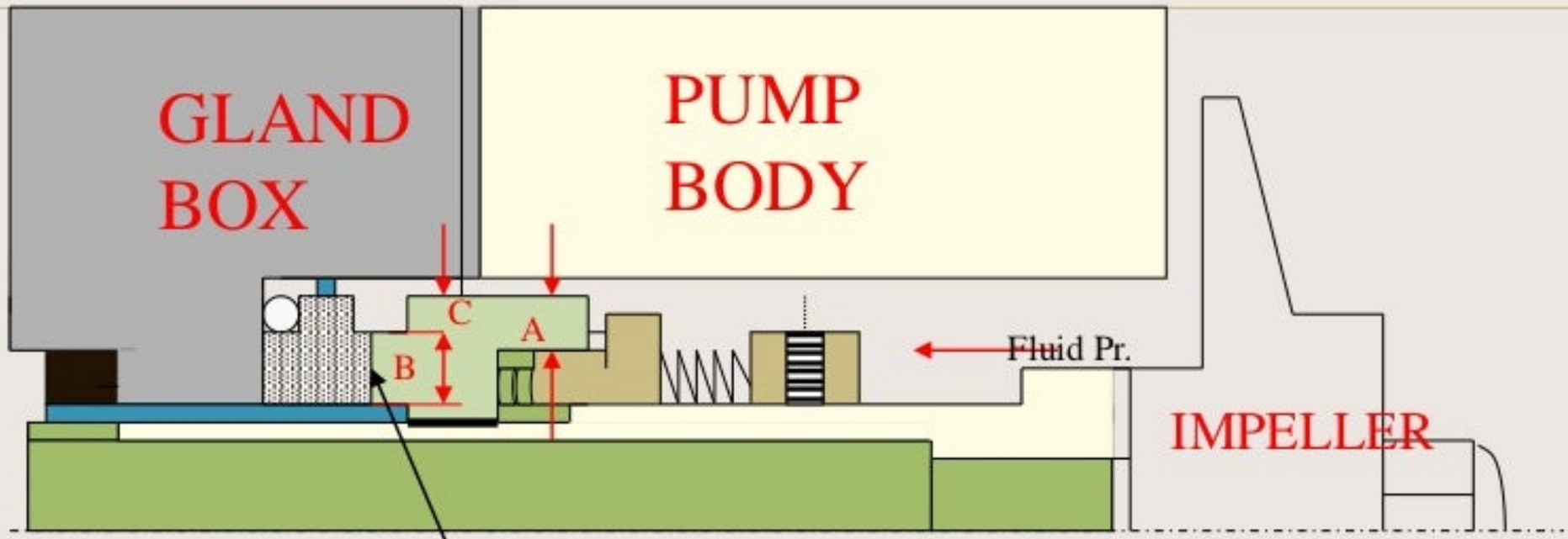
- Leakage path around stationary and rotating face are closed by secondary seals.
- The secondary seals are made up of various fluro-castomers.
- For pusher type of seals must move forward along the shaft to compensate for wear and vibrations at the seal faces.
- For non pusher type seals such as T metal bellows,wear are taken internally and secondary seals are truly static.

Hardware

- Adapt seal to various pieces of equipment. This hardware consist of a sleeve or housing to make for an easier more precise seal setting.
- Provides mechanical pre-loads to seal faces until hydraulic pressure can take over. This is largely accomplished by a large single coil spring or by a set of small coil spring.
- Transmit torque to both stationary and seal faces. Drive pins,dents, notches or screws incorporated into the seal design.


Gland plate
Pump body
sleeve
Reference line
Sleeve gkt.
shaft

MECH. SEAL

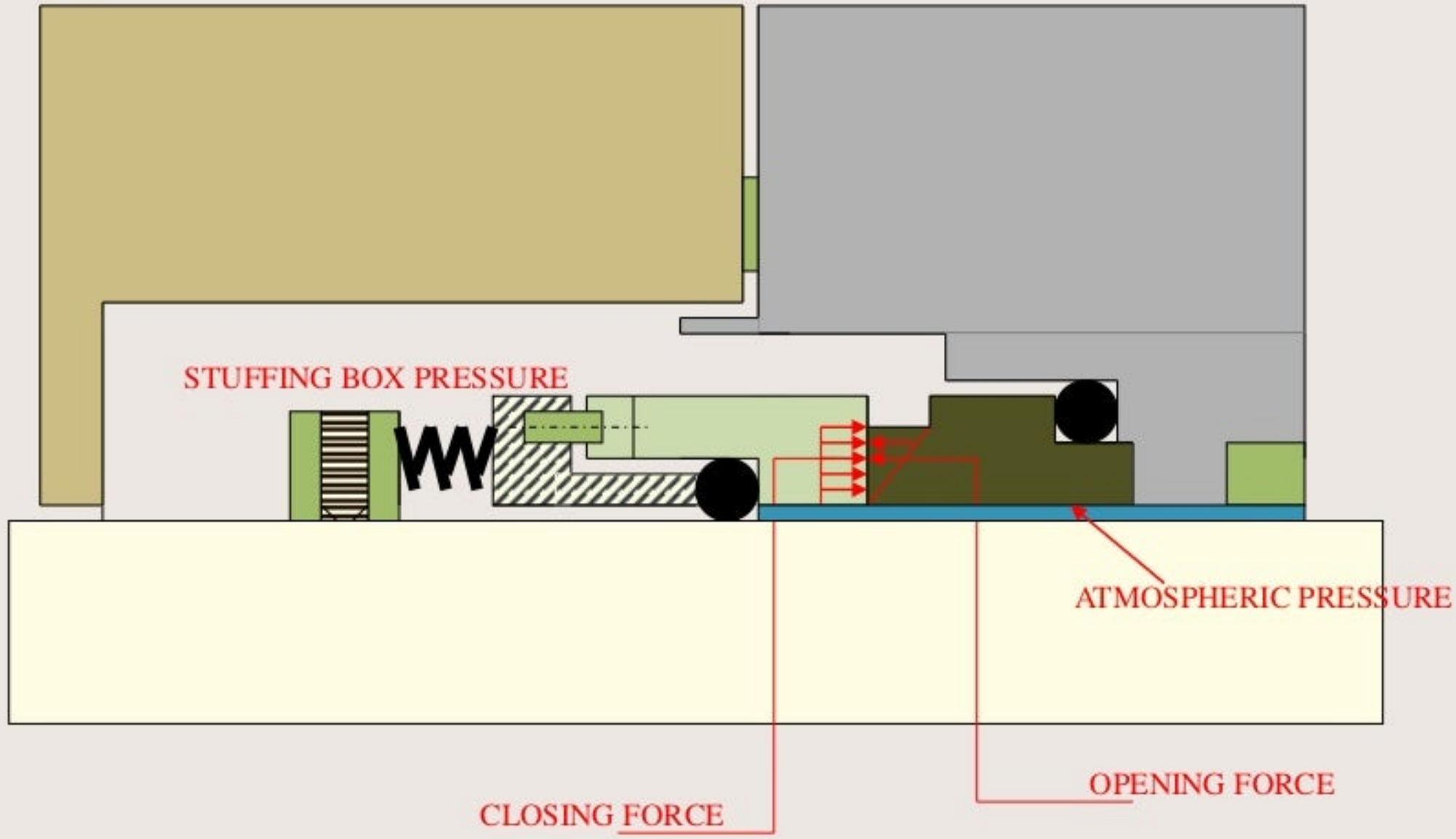


(Hydrostatic Pr.+Hydrodynamic Pr.) P`

CLOSING FORCE=P*AREA(A-C)+SPRING FORCE

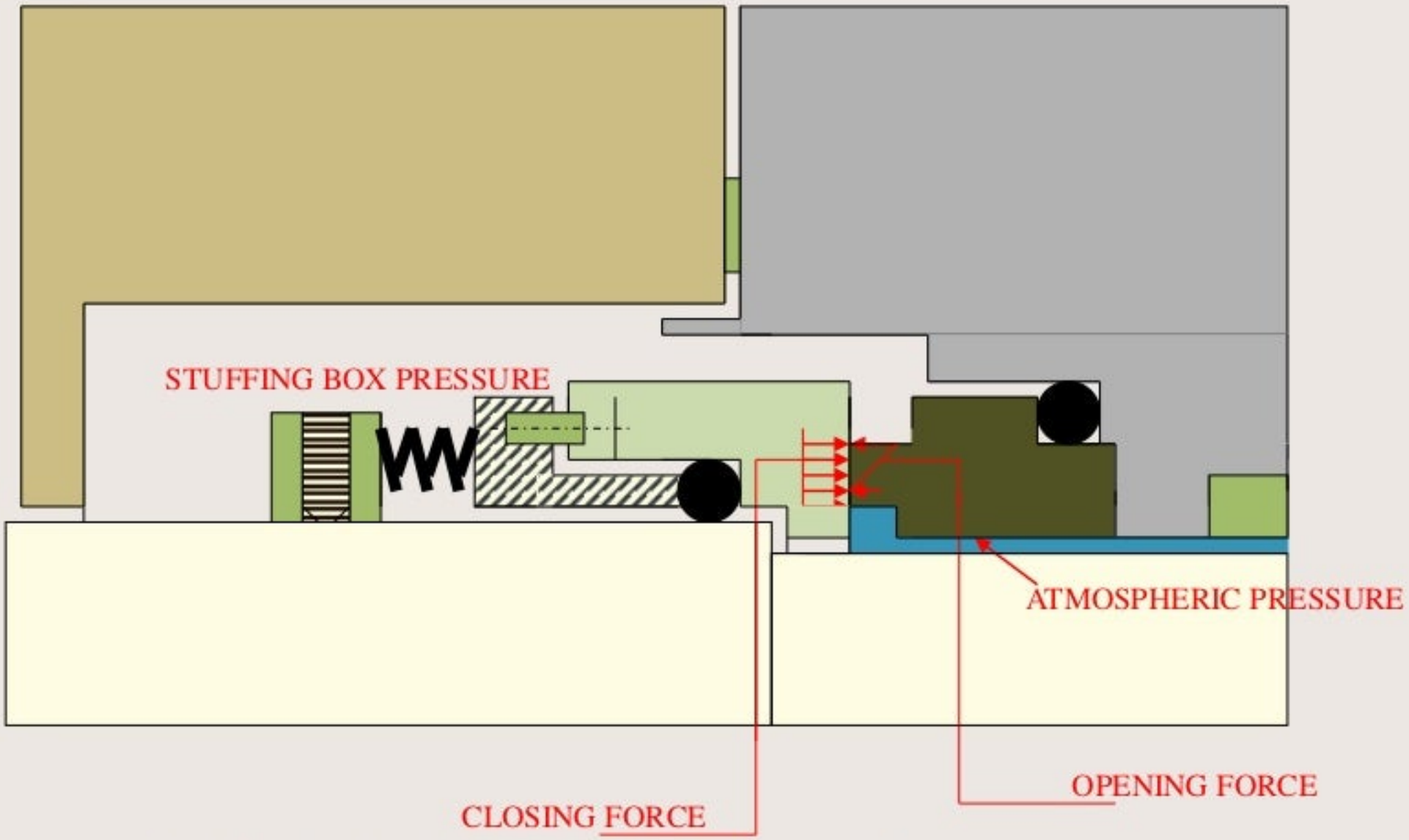
OPENING FORCE=P`*AREA B

INSIDE UNBALANCED SEAL



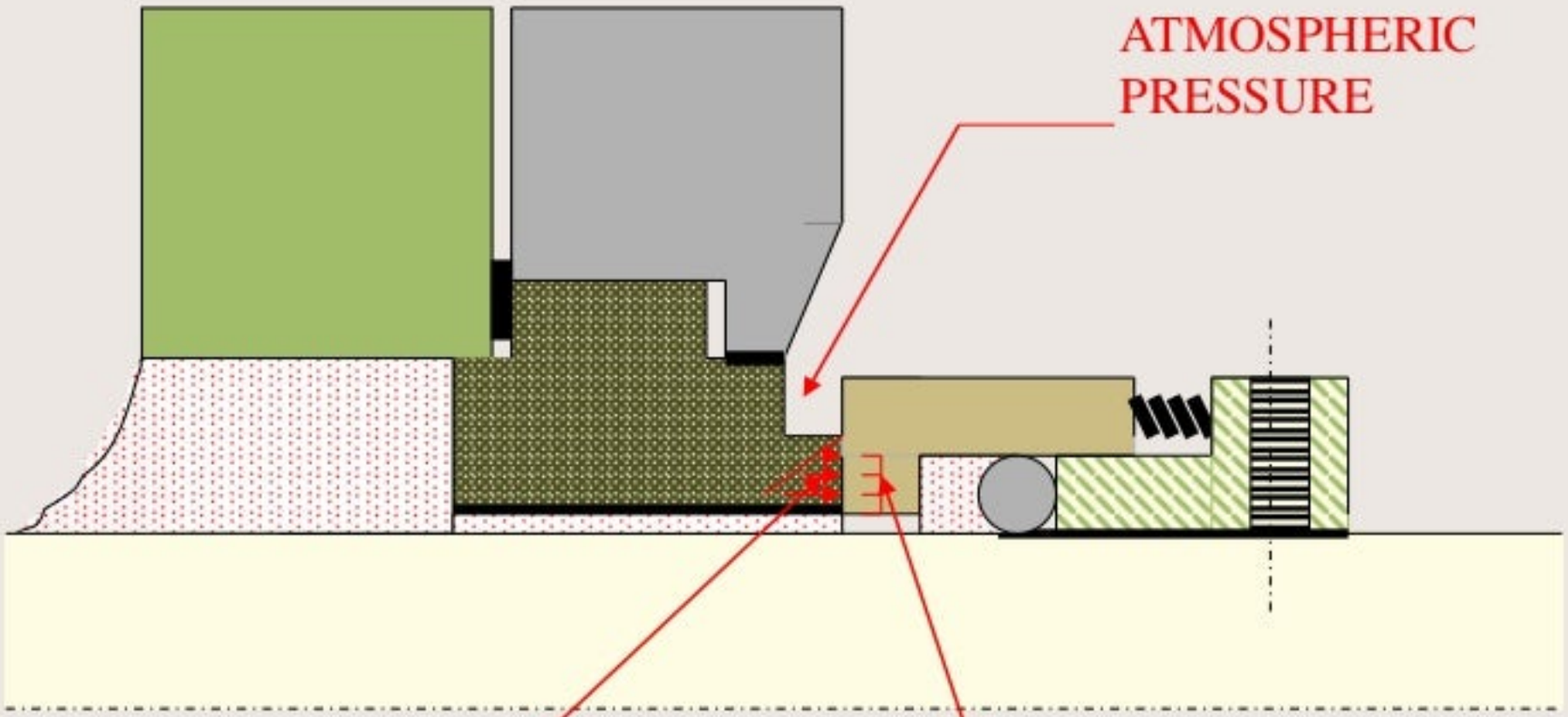
FOR PR. UP TO 20 Kg/Cm2

INSIDE BALANCED SEAL



FOR PR. UP TO 40 Kg/Cm2

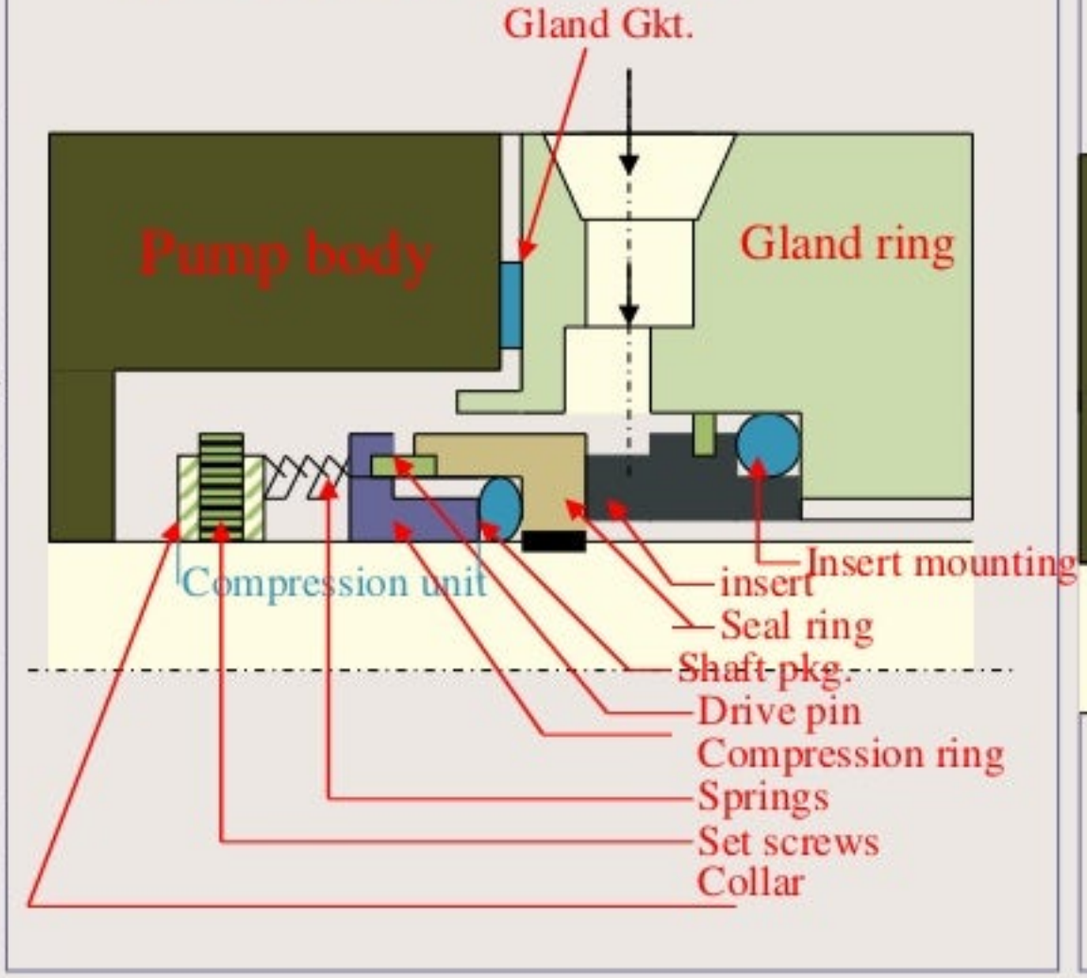
OUTSIDE BALANCED SEAL



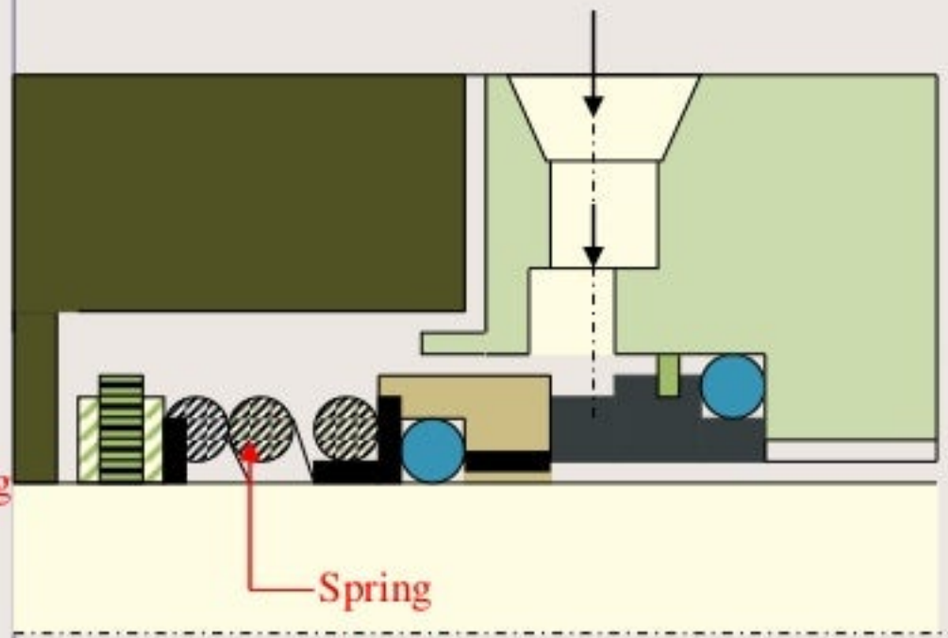
FOR PR. UPTO 27 Kg/Cm2

FUNDAMENTAL SEAL DESIGNS

- MECHANICAL SEAL WITH MULTIPLE SPRINGS

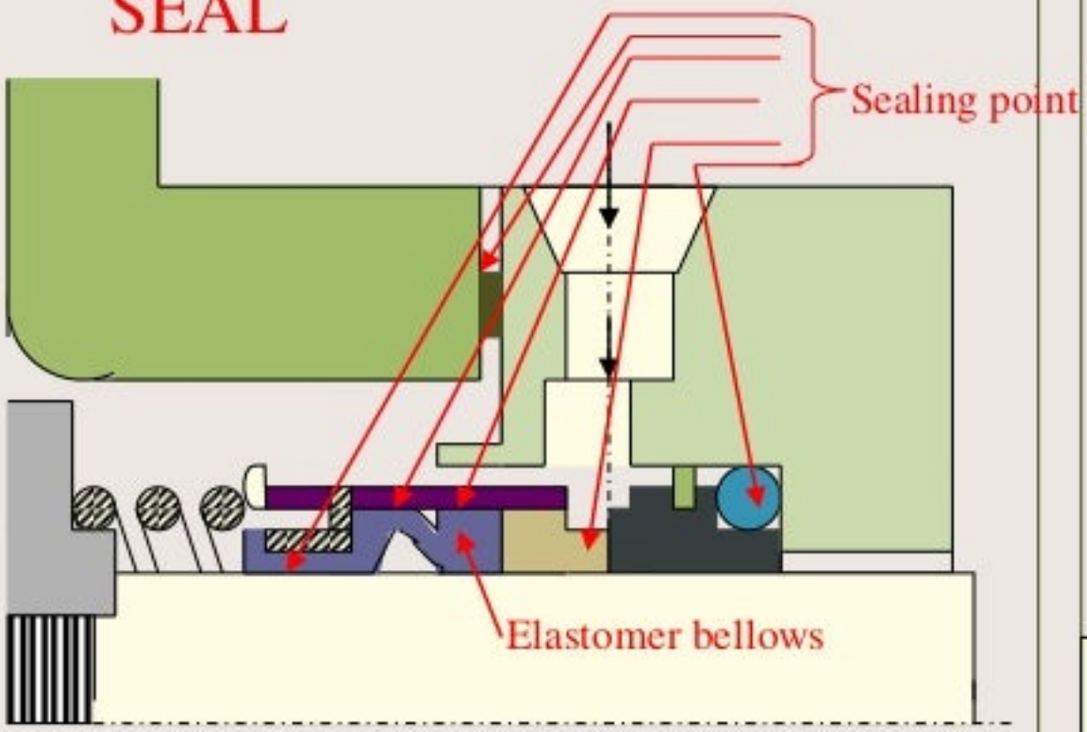


- SINGLE COIL SPRING SEAL

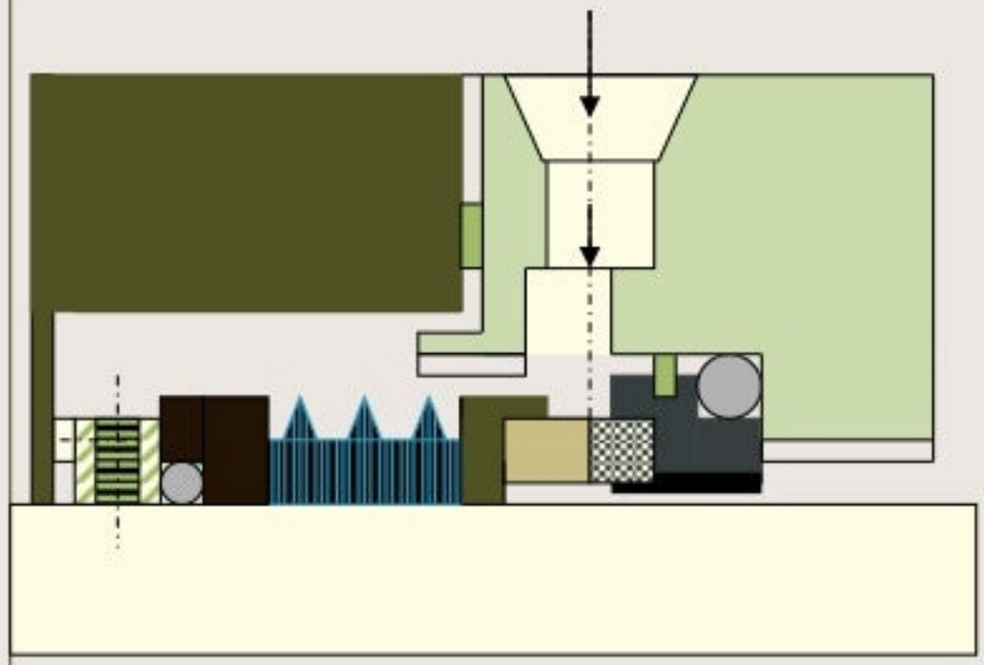


FUNDAMENTAL SEAL DESIGNS

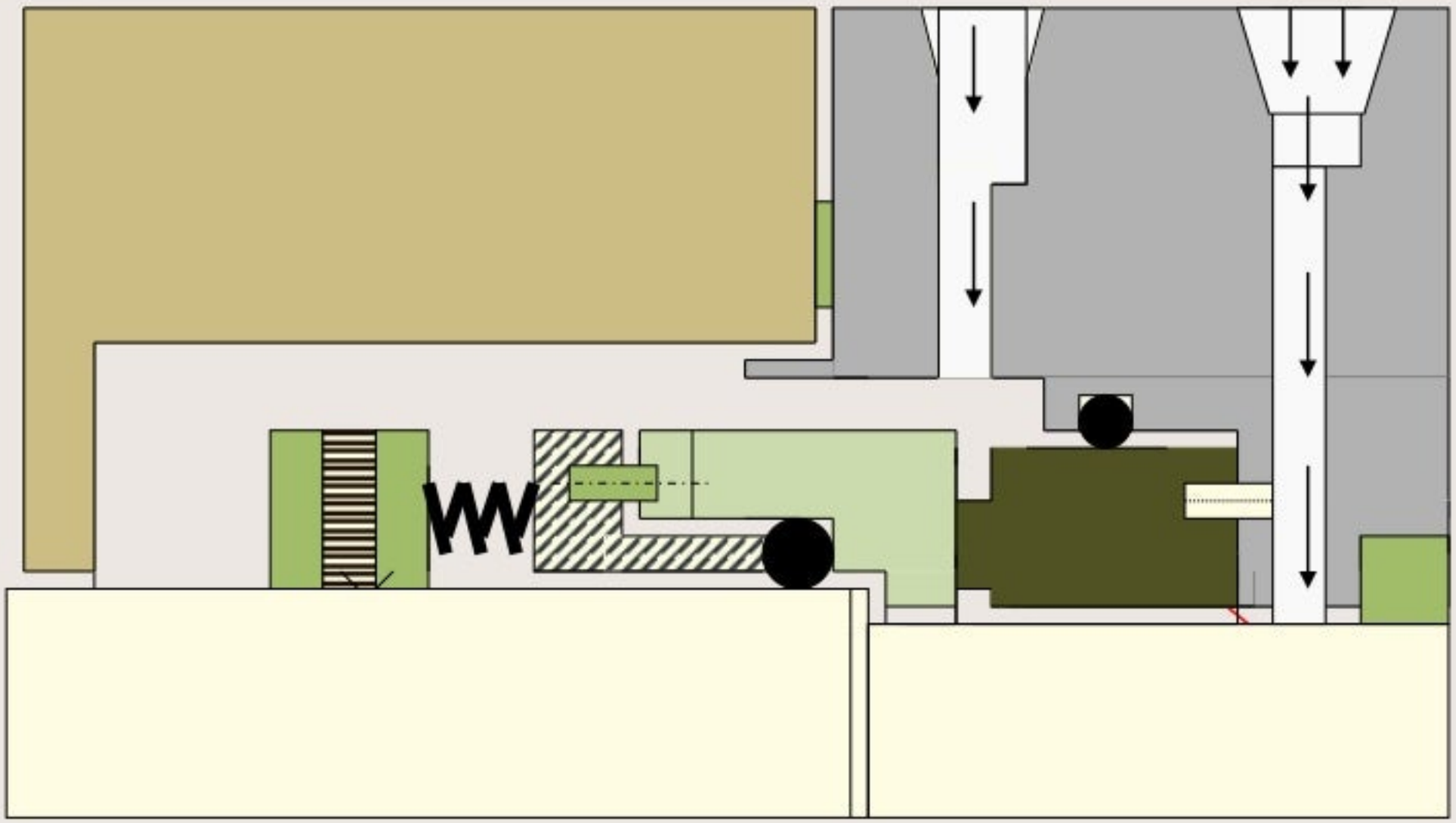
- ELASTOMER BELLOWS SEAL



- METAL BELLOWS SEAL

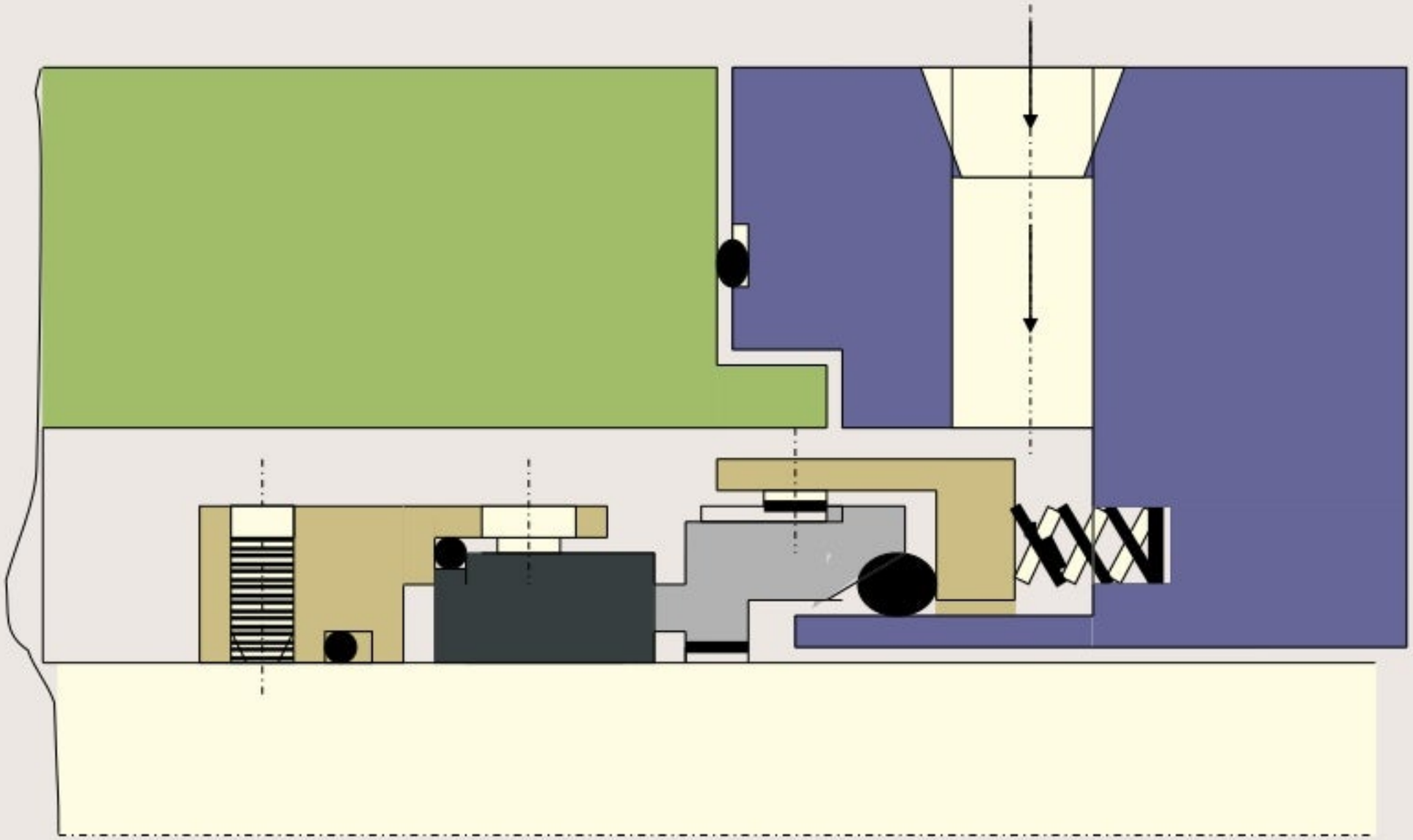


HIGH PRESSURE SEAL



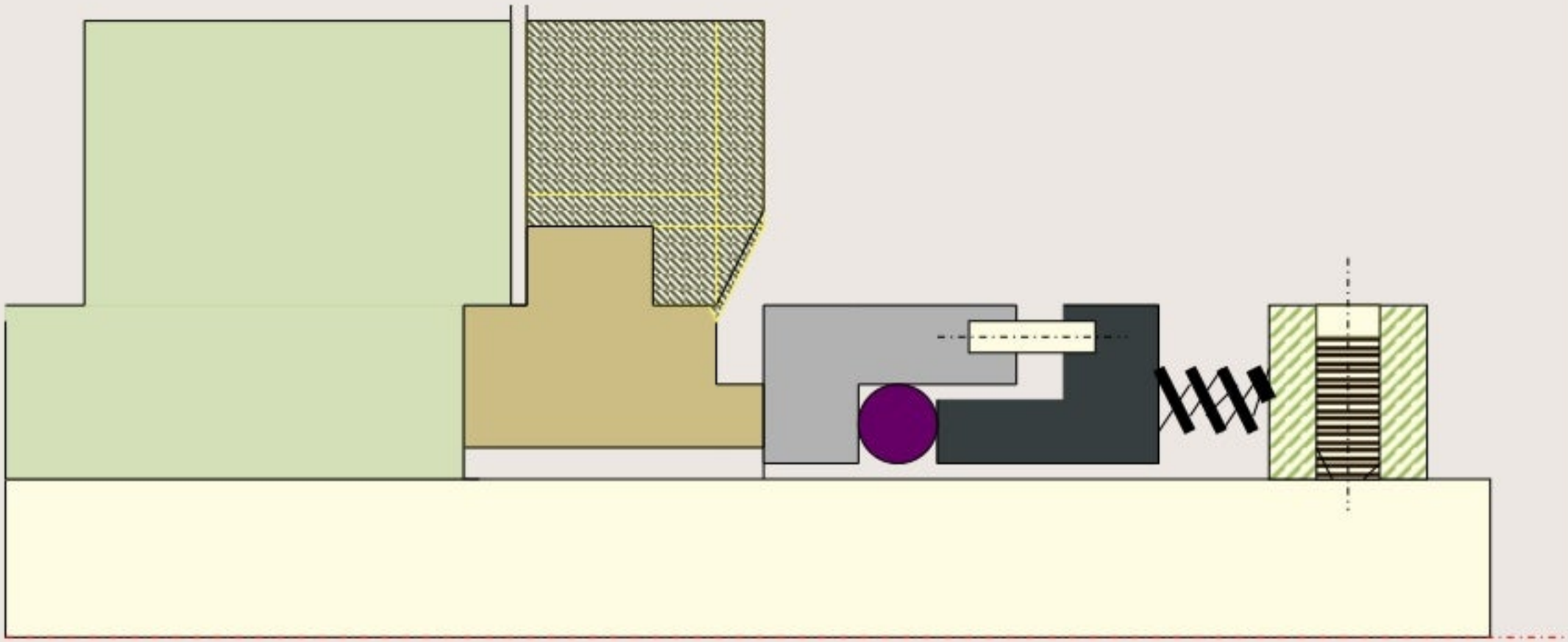
FOR PR. UPTO 170 Kg/Cm2

HIGH SPEED SEAL



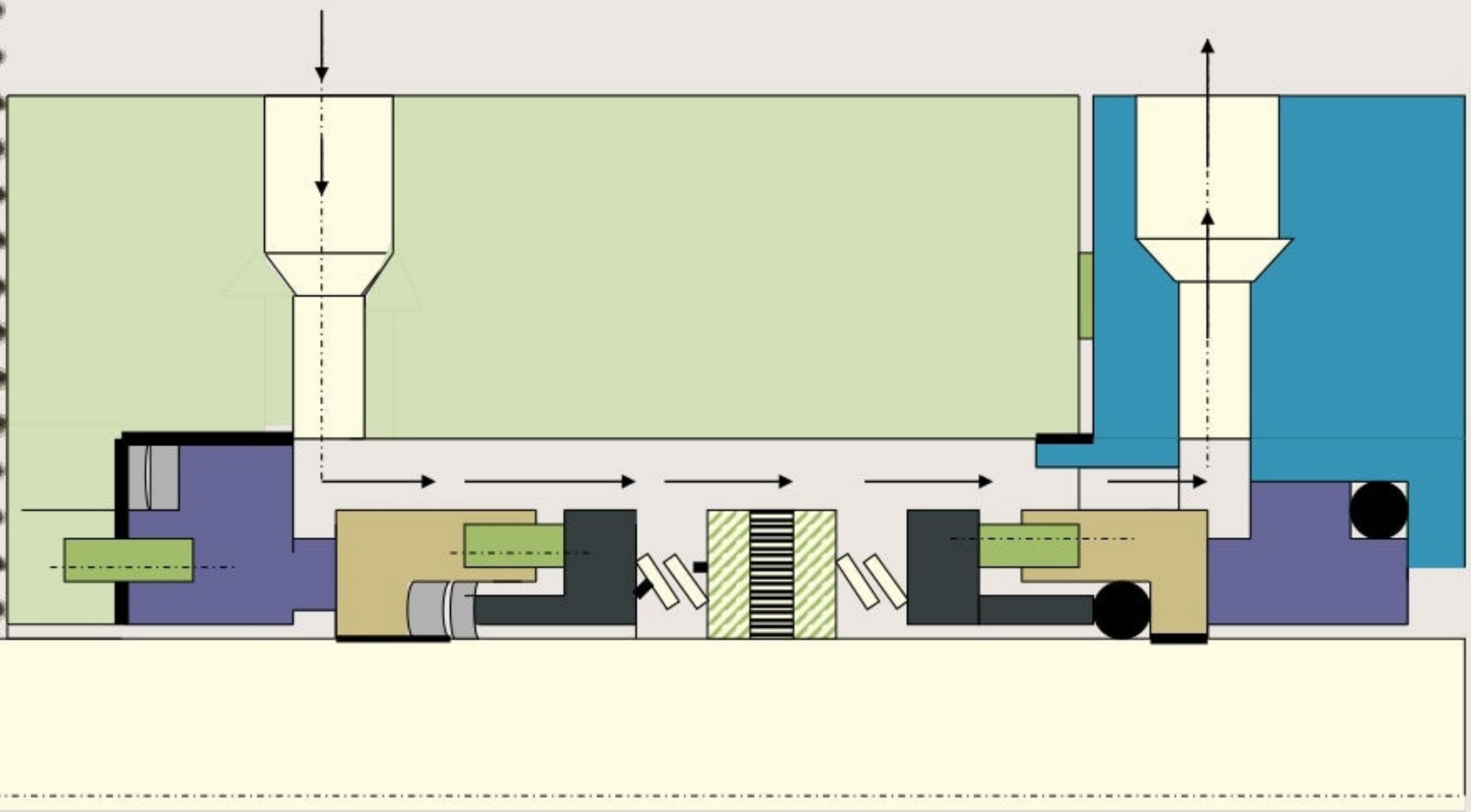
FOR PR. UPTO 80 Kg/Cm2

MECHANICAL SEAL ARRANGEMENTS

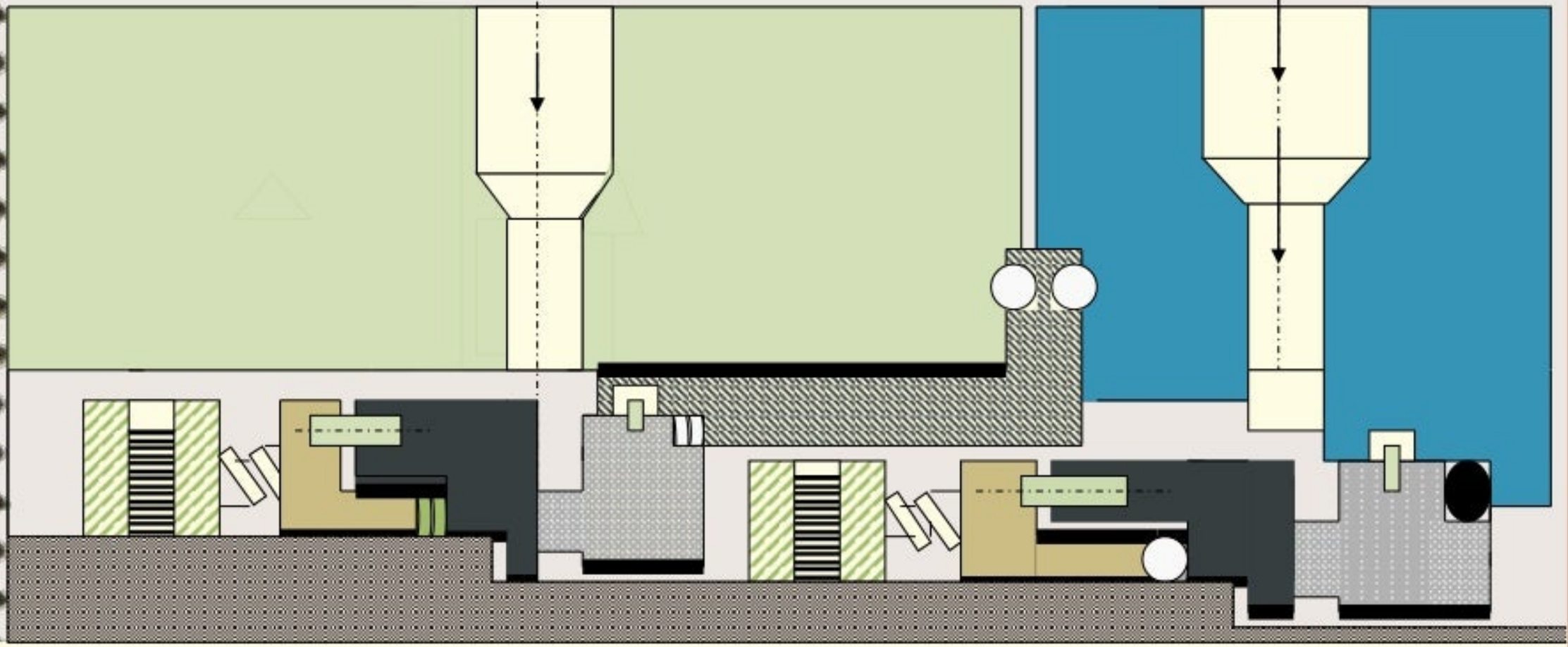


SINGLE OUT SIDE SEAL

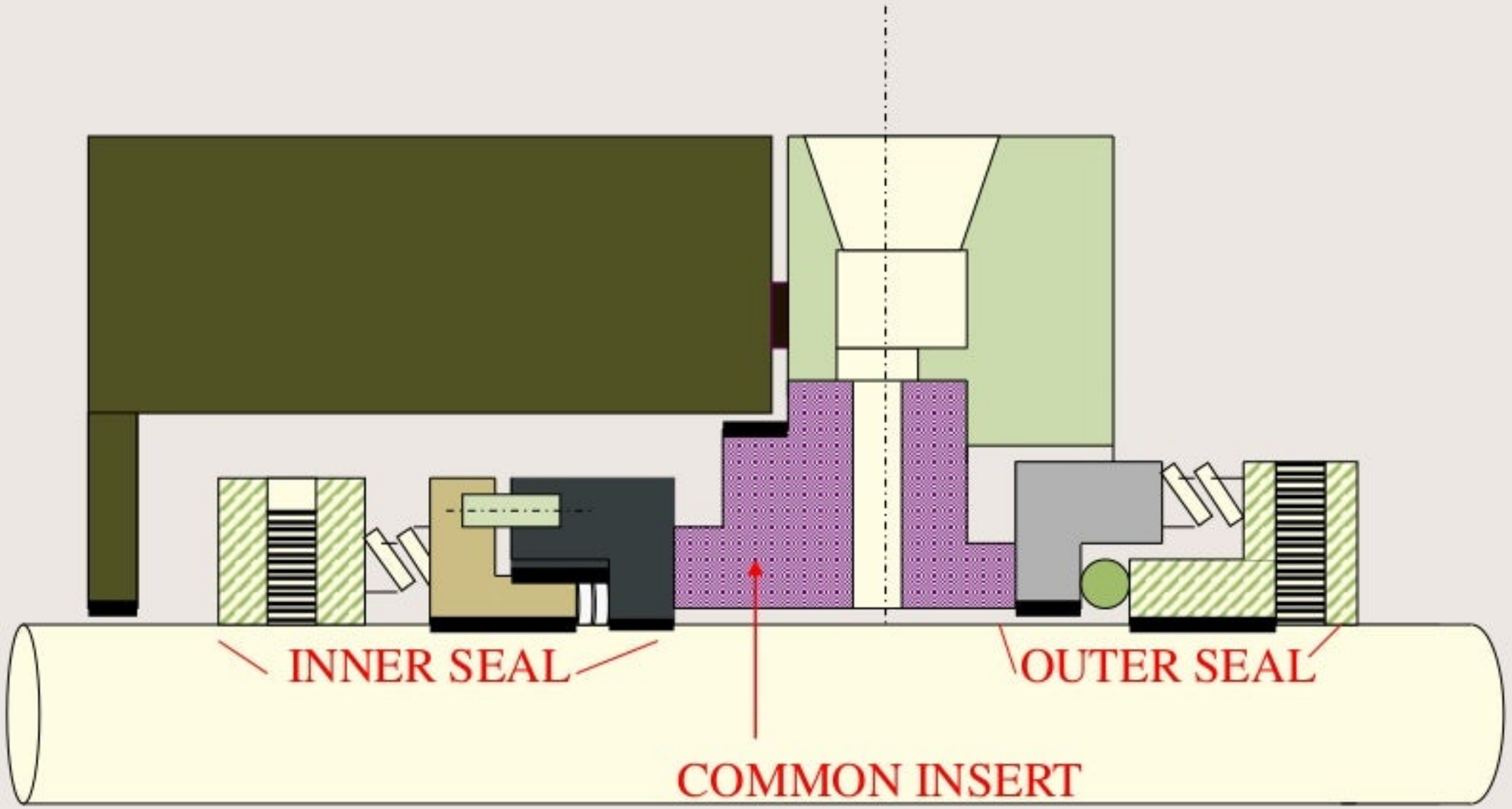
DOUBLE INSIDE SEAL



DOUBLE TANDEM SEAL



DOUBLE INSIDE - OUTSIDE SEAL



INSTALATION OF SEAL

- The following important point should be observed and strictly followed during seal installation.
- Checked up- stuffing box face, axial movement of shaft,radial movement of shaft, shaft run out , stuffing box square ness, concentric of stuffing box bore and alignment and pipe strain .
- Removed all burrs and sharp edges from the shaft or shaft sleeve.
- Check the stuffing box bore and stuffing box face to insure they are clean and free from burrs.
- All the seal assembly drawing gives the seal setting dimensions from the face of the stuffing box to the back of the rotary assembly.
- Shaft or sleeve should be oiled lightly prior to seal assembly to allow the move freely over it.
- Wipe seal faces clean and apply a clean oil film prior to complete the equipment assembly.
- Complete the equipment assembly taking care when compressing the seal in to the stuffing box.
-

SEAL FACE MATERIAL COMBINATION

- WATER
  - CARBON-GRAPHITE
    - Bronze
    - Ni-Resist
    - Ceramic
    - Tungsten Carbide
  - TUNGSTEN CARBIDE
    - Bronze
    - Tungsten Carbide
- CAUSTICS
  - CARBON-GRAPHITE
    - Filled TFE Resins
    - Stellite
    - Ceramic (pure AL2 O3)
  - TUNGSTEN CARBIDE
    - Tungsten Carbide

SEAL FACE MATERIAL COMBINATION

- ACIDS
- CARBON-GRAPHITE
  - Duramate
  - Stellite
  - Ceramic
  - Hestelloy
  - Filled TFE Resins
  - Tungsten Carbide
- CERAMIC
  - Filled TFE Resins
- TUNGSTEN CARBIDE
  - Tungsten Carbide

SEAL FACE MATERIAL COMBINATION

- OILS
- CARBON-GRAPHITE
  - Cast Iron
  - Ni-Resist
  - Ceramic
  - Stellite
  - Duramate
  - Tungsten Carbide
- BRONZE
  - Cast Iron
  - Ni-Resist
  - Stellite
  - Tungsten Carbide
- OXIDIZING FLUIDS
- SILICON CARBIDE
  - Ceramic
  - Tungsten Carbide
  - Silicon Carbide

MECHANICAL SEALS MATERIALS

Mechanical properties

High modulus of elasticity
High tensile strength
Low coefficient of friction
Excellent wear characteristics and hardness
Self lubricating

Thermal properties

Low coefficient of expansion
High thermal conductivity
Resistant to thermal shock
Thermal stability

Chemical properties

Corrosion resistant
Good wetability and adhesive characteristics

ADDITIONAL

- Dimensional stability
- Good machinability & ease of manufacture
- Economical and readily available

	Composition (% of each element)													
Material	Cr	Ni	C	Fe	Si	Mn	S	P	Mo	CU	Co	Cb	Ti	N0H
304SS	18-20	8-12	.08	64-70	1	2	.03	.045						
316SS	16-18	10-14	.08	62-71	1	2	.03	.045	2-3					
20SS	20	29	.07	44.18	1	.75	-	-	2	3				
MONEL	-	63-70	.3	2.50	.5	2	.024	-	-	24-31	R			
Hastelloy B	1	64	.12	5	.70	.80			28	-	-	2.50		
Hastelloy C	16.50	53	.15	5	.70	.8	W 4				2.5			
Titanium	-	-	.10	.40	-	-	-	-	-	-	-	-	99.03	.5,.4,.15
NICKEL	-	99	-	.15	.05	-	-	-	-	.10	.05	-	-	-
Tantalum	Tant 99.81	.013	.027	.015	..20		W.01					.044	.012	.014,.027,.007

SECONDARY SEAL MATERIALS

- ELASTOMERS "O"RINGS
- **Buna N-** Excellent resistance to petroleum,temp.rang –40 oc to +107oc, not passes good resistance to ozone sunlight or weather.
- **Neoprene-** Chloroprene rubber or synthetic rubbers, It continues used for refrigerant such as Freon & Ammonia, like Buna-n temperature rang –40 oC to +107oC
- **Butyl-** Butyl rubber will resist the deteriorating effects many mild liquid , acetone but should not be used in petroleum. Temperature rang –40 oCto +107 oC
- **Silicone Rubber-** Silicone elastomers are made from silicone, oxygen,hydrogen and carbon. Poor tensile strength tear and abrasion resistance. Temperature rang –62oCto +204oC
- **Viton-** Fluorocarbon rubber , temp. ranging from –18oC to +204oC , it is applicable to petroleum oils diester base lubricants, silicon fluid, halogenated hydrocarbon water low temperature steam ,acids and many other fluids.

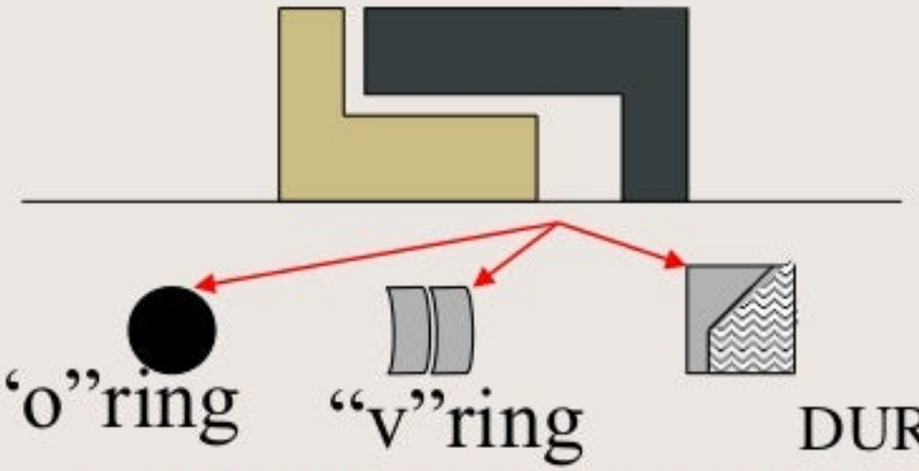
SECONDARY SEAL MATERIALS

- "V" RINGS
- Applied as a shaft pkg.The lips of two ring energized by the nose of compression ring then by forcing them into intimate contact with the O D of shaft and the shaft pkg.bore of the seal ring.
- 'V'Ring applied as insert mounting. A spreader ring is used to press the lips of the 'v' ring against the O D of the insert and the gland ring bore.
- Material TFE resin the trade name of teflon(duraflone) can be used in temperature –73 oC to +177 oC . In higher temperatures used glass filled

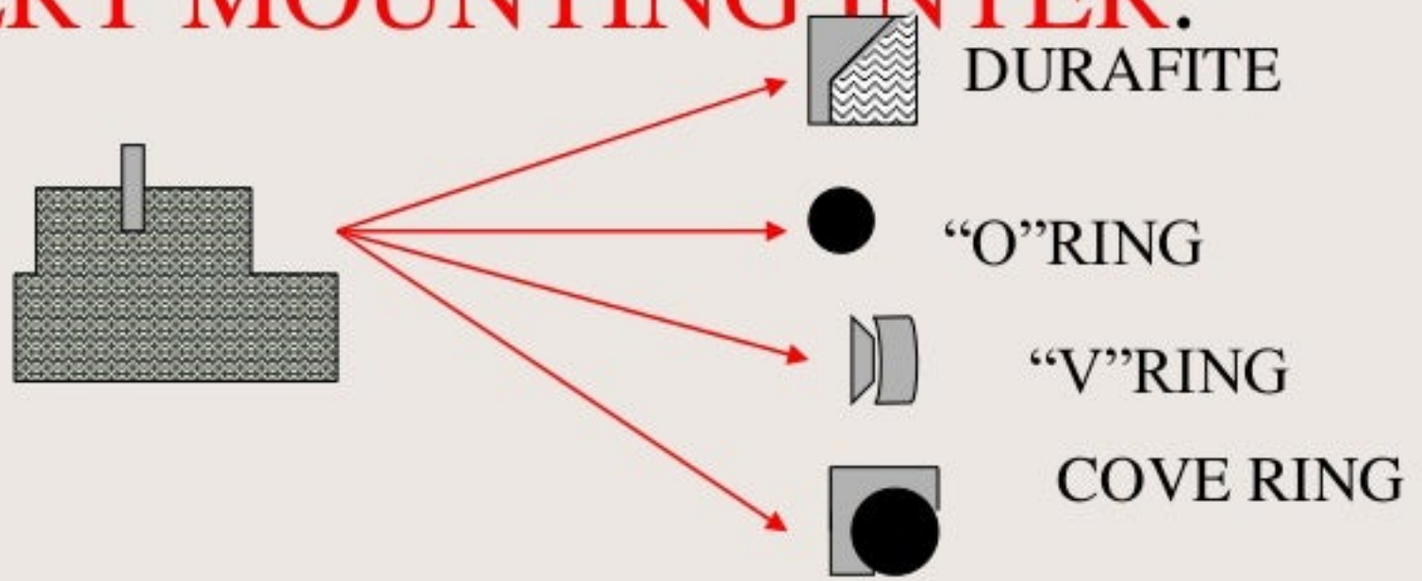
  Duraflon rang –115 oC to +232 oC

INTERCHANGEABILITY OF SECONDRY SEALS

- SHAFT PKG. INTERCHANGEABILITY



- INSERT MOUNTING INTER.



Mechanical seal start-up & operation

- To make sure that seal faces are immersed in liquid.
- All cooling lines heating lines should be operating and remain so far at least a short period after equipment is shut down.
- Not to run the equipment dry while checking motor rotation.
- The stuffing box should always be vented prior to start-up. Air may be entrapped in the top portion of stuffing box.
-

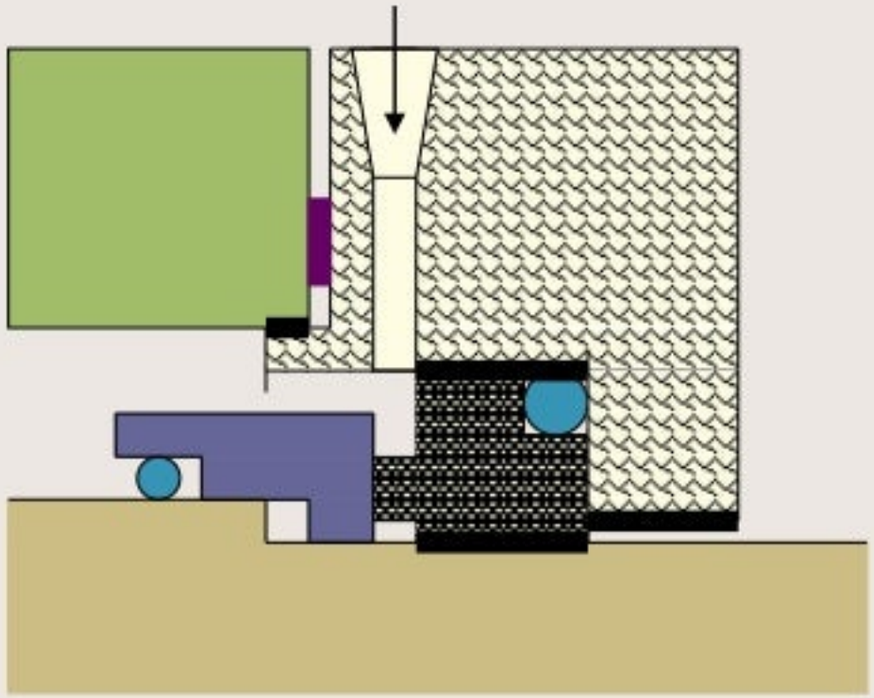
ENVIRONMENTAL CONTROLS

- TEMPERATURE CONTROL
- The temperature surrounded the seal in a stuffing box is an extremely important consideration certain part of seal ,such as secondary pkg. & carbon may deteriorate under exposure to extremely high temp. viton below (204 0c) carbon break down above 260
- These material must also be able to resist chemical attack by the liquid surrounding them. If often become necessary to protect same of materials by cooling the seal area.

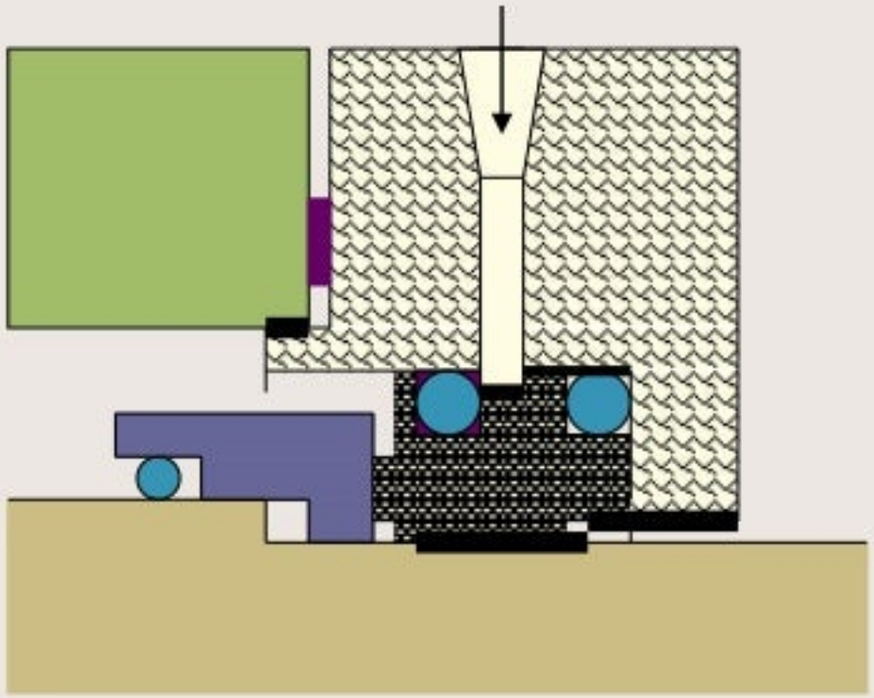
- FLUSHING-BYPASS
- COOLING OR HEATING
- QUENCHING OUTSIDE &INSIDE SEAL

ENVIRONMENTAL CONTROLS

- FLUSHING



- COOLING



ENVIRONMENTAL CONTROLS

- The material being pumped solidifies at ambient temperature.(liquidity by heating)
- Boiling point of the liquid in the stuffing box. The product must remain below its boiling point if it is to be pumped stuffing box can be heat traps.
- Vaporization may also cause precipitation of salts minerals or other abrasive impurities.

FLUSHING- BY PASS

- Introduction of a liquid in to a stuffing box at a higher pressure then stuffing box pressure.
- When it is desired to use by pass flushing for cooling, inside & out side seal, a recirculation line is run from the discharge nozzle through a heat exchanger or with out heat exchanger, to a connection in the gland ring located over the seal faces.
- Assuming that the product is dirty, a by pass flushing arrangement can be called upon to flood the stuffing box with clean liquid.

****