# Sealmatic Mechanical Seals

## Power Plant Operation + Pumps








# Contents

- Definition
- General
- Seal cooling
- Seal selection for hot water
- Pumps and their seals in power plants








# Application Fields

- Nuclear power stations
- Conventional power stations coal or oil fired
- Combined cycles
- Water power stations

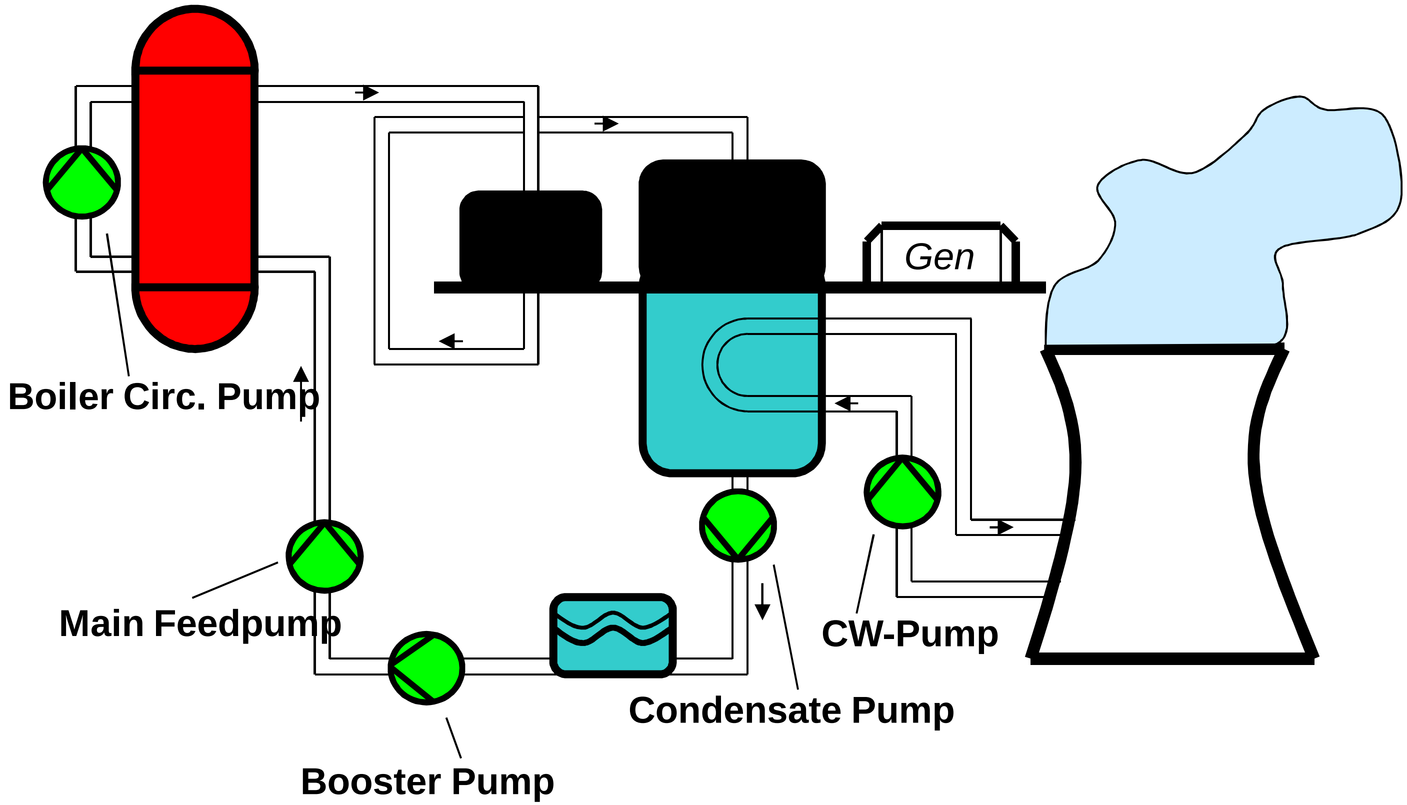









# General View of a Power Plant





# GENERAL

The medium in pumps in a power plant is nearly always water. The water quality is important for the seal selection.

Pressure/speed/temperature are decisive for the necessary cooling Measures. The cooling measures have to ensure, that evaporation between the seal faces (dry-running) never happens. Otherwise a short seal life can be expected

| | | |
|---|---|---|
| The vapour pressure of water : | At 140 $^{o}$C | 3.61 bar |
| | At 225 $^{o}$C | 25.5 bar |

Water can transport twice the heat quantity as compared to thermal oils with the same volume, due to its very high specific thermal capacity.

The viscosity decreases with increase of temperature.
Therefore the lubricating properties of water decreases with increase in temperature.

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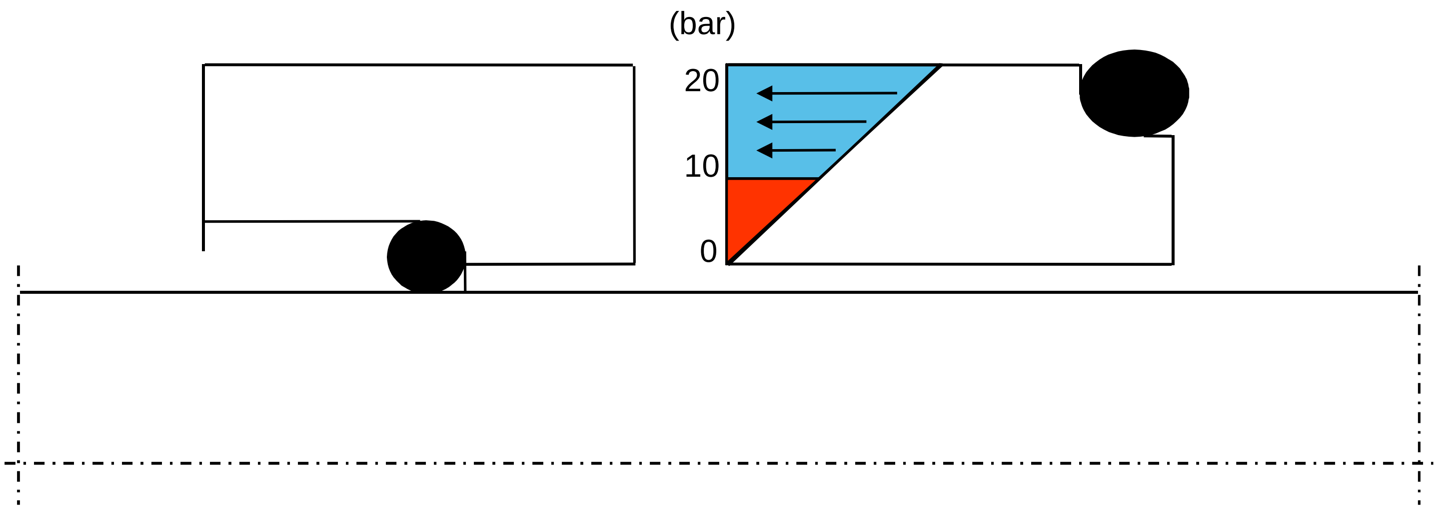
# General

<u>Pressure Drop in the Sealing Gap</u>

Example:
180°C, 20 bar (356°F, 290 psi)
Vaporization starts at 9,2 bar (134 psi)



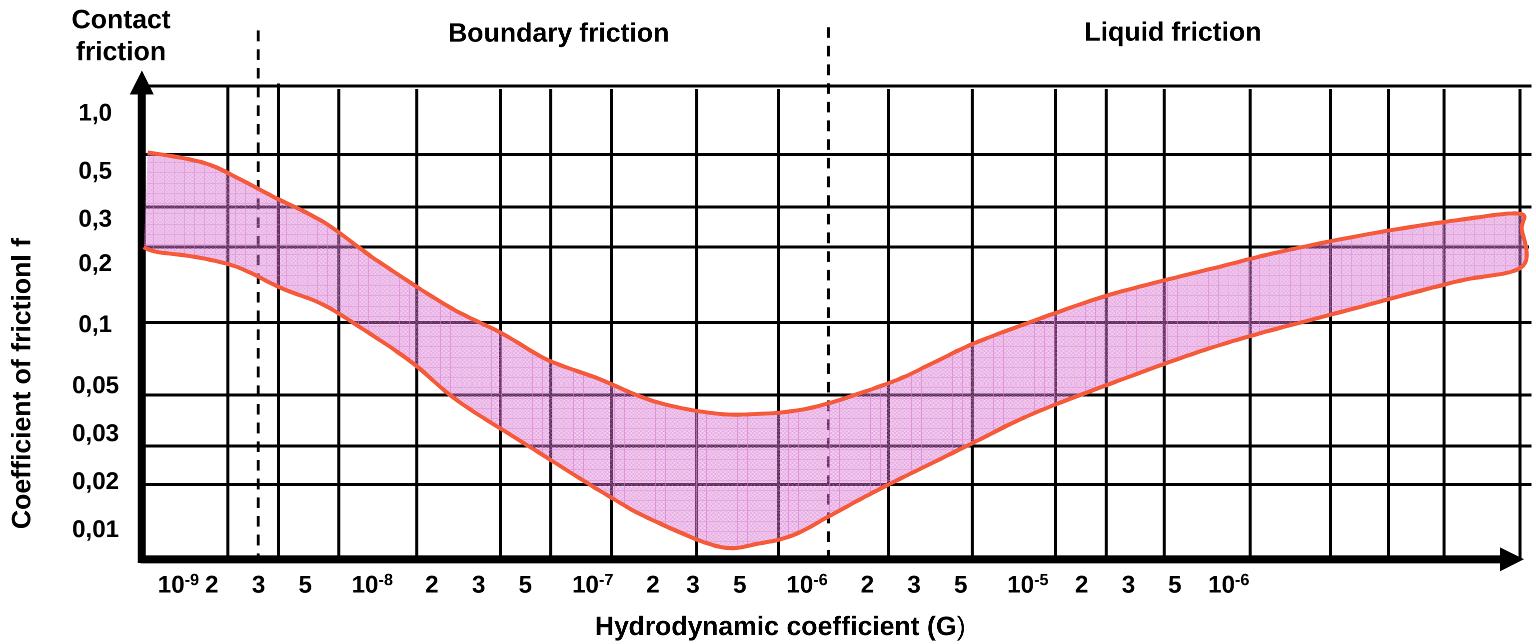

VAPORIZATION → Dry running

→ Precipitation of additives



# General

## Hydrodynamic Coefficient (Gümbel-number)




$$\text{G-number} = \frac{\text{gap viscosity x sliding velocity}}{\text{balance ratio x pressure differential}}$$








# Hot Water in Power Plants

- In thermal power engineering

→ as feed water

- As heat transfer medium

→ in district heating networks

→ in heating systems

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# HOT WATER

## DEFINITION

Hot water is the term used to describe the state of water when it has risen above 100 $^{o}$C but has still not passed into vapour state due to the prevailing conditions of pressure.

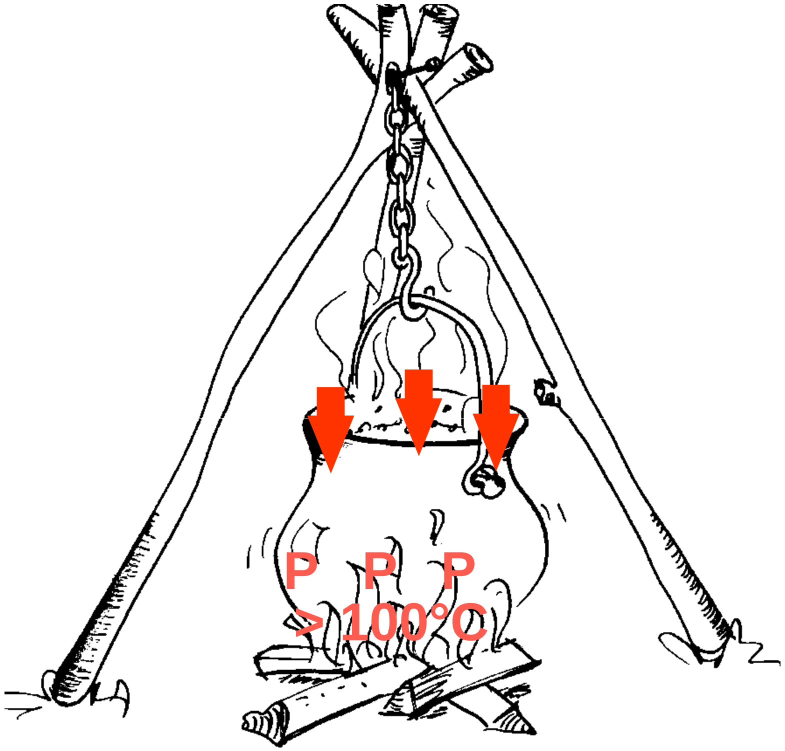
Hot water for use in power plants is usually fully or partially demineralised or softened, and often it is additionally inoculated. On the one hand, these measures are taken to prevent the deposition of salts and on the other hand to provide protection against corrosion.








# HOT WATER




Hot water =
water > 100 °C,
due to pressure ratio
not yet vaporized

Extreme increase of vapour pressure:

| | |
|---|---|
| 140°C | 3,61 bar |
| **225°C** | **25,50 bar** |

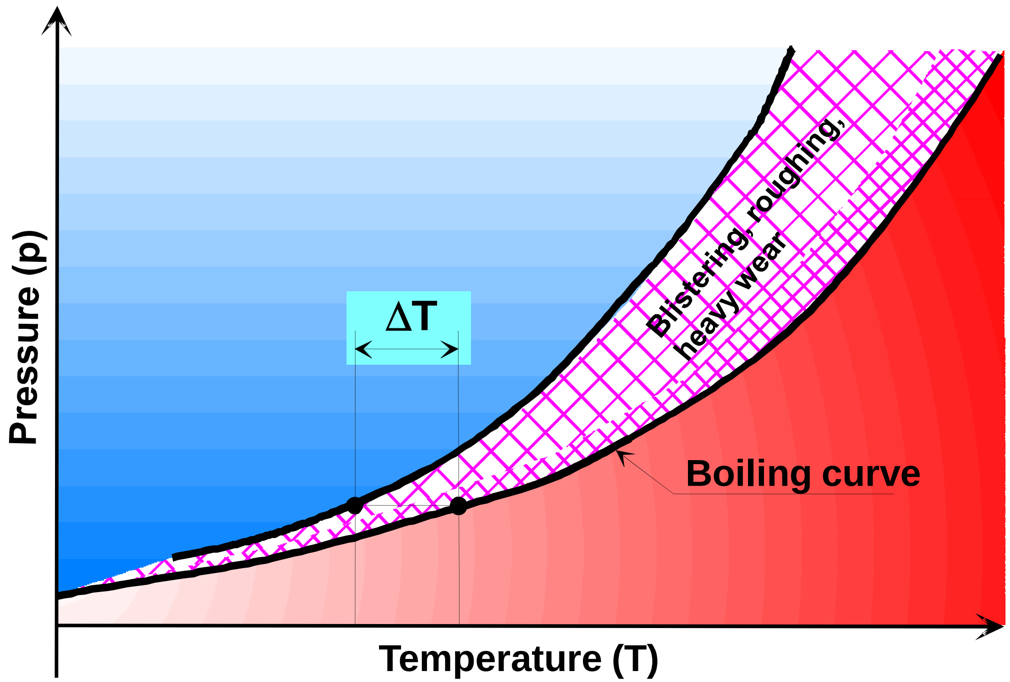








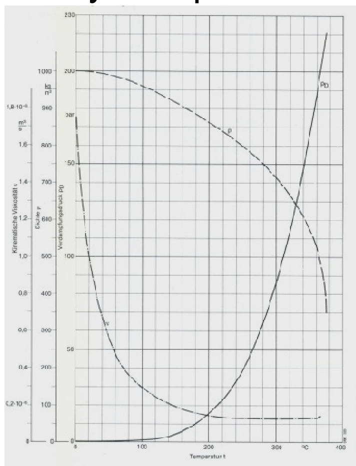

# Operating range for Hot Water Seals




Neccessary distance ΔT to the boiling point

# Hot water

Hot water =
water > 100 °C,
due to pressure ratio
not yet vaporized



Extreme increase of
vapour pressure:

140°C ➔ 3,61 bar
**225°C ➔ 25,50 bar**

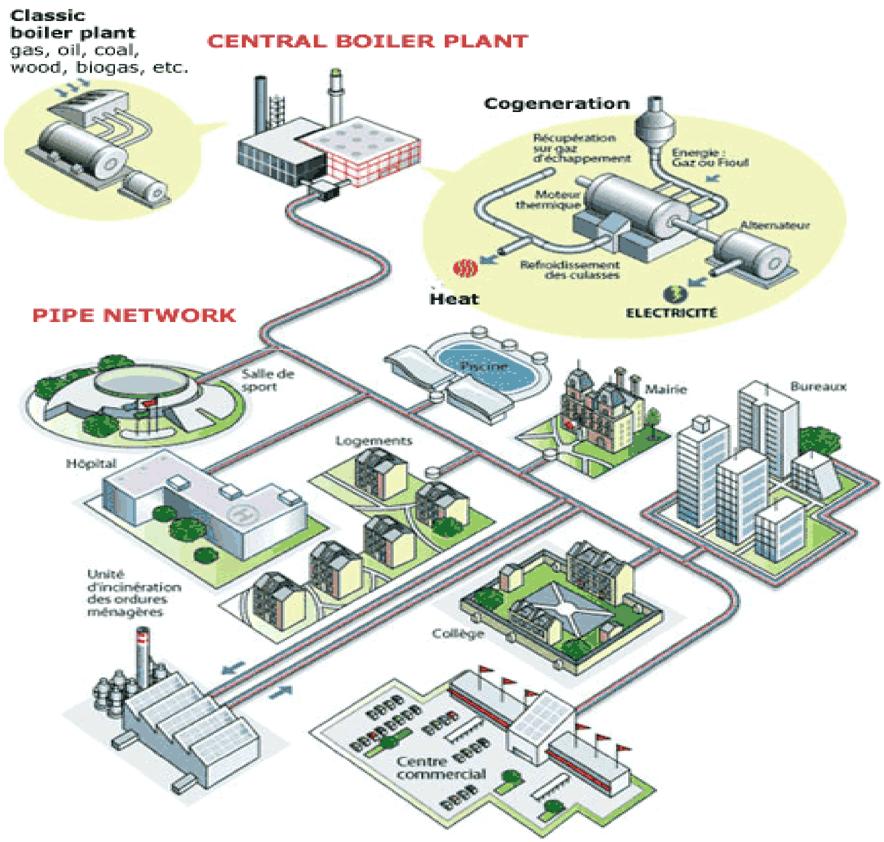









# Hot Water in Power Plants




<u>Hot Water in Power Plants</u>

- In thermal power engineering
  → *as feed water*

- *As heat transfer medium*
  → *in district heating networks*
  → *in heating systems*








# HEAT DISSIPATION

*Heat is produced by*

- *Friction between the sliding faces*
- *Turbulences in the seal chamber*
- *Heat soak from the pump*

*This heat is transmitted to the medium surrounding the seal and has to be dissipated effectively*










# POSSIBILITIES TO DISSIPATE HEAT

*Recirculation of the medium from pump to seal. ( API Plan 11/13)*

*Additional cooling measures,*

*Injection to seal chamber with clean fluid  via a heat exchanger. (API Plan 32)*

*Recirculation  to the seal chamber via heat exchanger.  (API Plan 23 )*

*Seat and /or jacket cooling. (API Plan 02 )*

<u>*In both cases a constant lubricant film in the sealing gap can to be ensured.*</u>










# PRESSURE / TEMPERATURE RATIO

*Care should be taken to keep the temperature at the sliding faces as low as possible.*

*At low temperatures the release of gas is low which helps to prevent the detrimental formation of a gas ring at the sealing gap.*

*A release of gas takes place at the smallest rotating diameter where the highest temperature is produced.*

*The temperature of the product in the area of the mechanical seal must be at least 30 degC lower than the boiling point to ensure lubrication between the faces and prevent vaporization due to friction.*








# WATER TREATMENT & EFFECTS ON THE SEAL

*1. Water chemistry*

*Treated water reacts no longer like pure water due to the added agents.*

*The seal has to be able to handle the following phenomena:*

- *elements which boil faster than water, e.g. ammonia, etc.*
- *Crystallizing additives, e.g. sulphate, phosphate,*
- *Solids such as magnetic, hematite, silicates, etc*

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# WATER TREATMENT & EFFECTS ON THE SEAL

*2. Dry run*

*At temperatures exceeding $80^{o}$C a 2-phase flow is produced in the sealing gap,*

*<u>The seal has an area where it runs dry</u>*

*In this area there is an increased temperature development.*

*In addition undissolved (e.g. magnetite) or dissolved components (e.g. sulphate) may precipitate.*



# WATER TREATMENT & EFFECTS ON THE SEAL

*3. Deposits.*

*There are two forms of deposits which have a particularly negative effect on the mechanical seal.*

*Deposits on the I.D. of the seal and or the shaft sleeve.*

*-- They prevent the axial movement of the seal face.*

*-- The seal will open or may have hang up.*

*Precipitations of additives (sulphates, phosphates, etc.) in the sealing gap.*

*-- The crystallizing particles will embed in the carbon and enter into the seat material (mostly silicon carbide).*










# WATER TREATMENT & EFFECTS ON THE SEAL

*4. Formation of gas ring on O.D.*

*Easily boiling elements in the water such as air, ammonia, etc. tend to deposit on the smallest rotating diameter.*

*This effect will be increased by the fact that the highest temperature is in the area of the seal face.*

*A gas ring at the sliding face will be formed resulting in dry-run.*

→ *An efficient degassing of the seal chamber is of vital importance.*

# WATER TREATMENT & EFFECTS ON THE SEAL

*5. Cooling water (seat cooling)*

*Water quality*

*If treated water or condensate is not available,*
*the water quality should fulfill the following minimum requirements:*

→ *Clear, colorless, free of solids*

→ *pH-value of $\leq 7$*

*Temperature,* *$30^{o}C$ to $40^{o}C$.*








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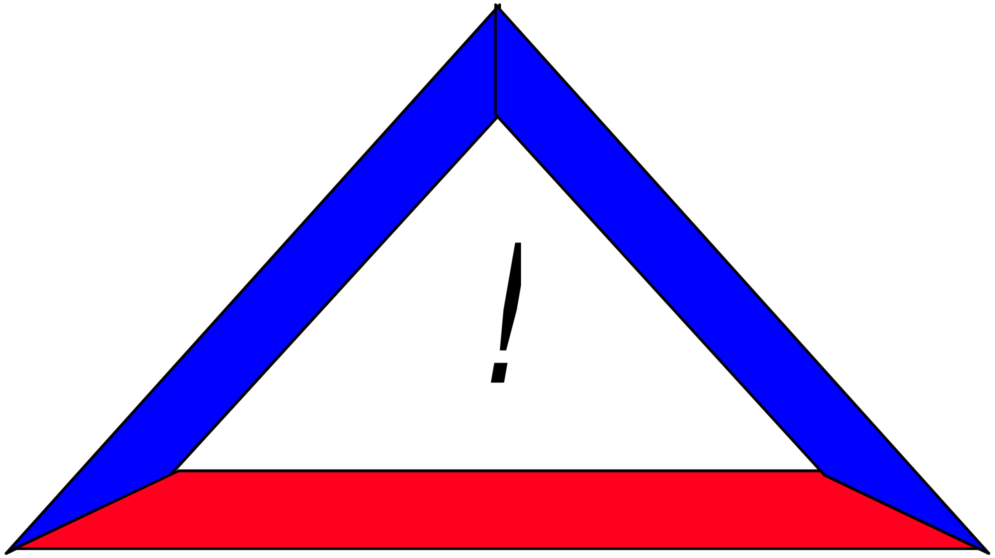
# Feed Water Quality

*Disregard of the quality*
*can result in unsatisfactory seal life*




*Heavy duty seals have to be designed*
*especially for the feed water they are used*










# Examples Of Damages In Hot Water Seals

✳ *Due to crystallizing of salts*

- *Abrasion on sliding materials, in particular on SiC-face*
- *Prevention of axial movability of dynamic o-rings*

✳ *Vaporization of the product in the sealing gap*

- *Insufficient lubrication ⇒ dry-run*

✳ *Due to influence of greases and oils containing Mineral oils*

- *EPDM-o-rings will swell*

*⇒ Problems with axial movability*










# Examples Of Damages In Hot Water Seals

✳ *Mechanical deformation of the carbon seat due to rusting of the seal housing. (grey-cast iron)*
*= Distortion of the sliding faces.*
*⇒ Increasing leakage.*

✳ *Shut-down of the jacket cooling at standstill e.g. with feed pump seals.*
*= Overheating, distortion of the sliding faces.*
*⇒ Increasing leakage at standstill.*
*⇒ High leakage at start up.*

✳ *Deformation of pump housing parts e.g. due to Internal stresses in the pipes. Stresses at the housing cover due to fastening with two bolts only.*

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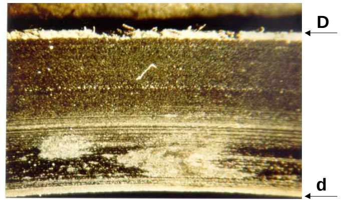
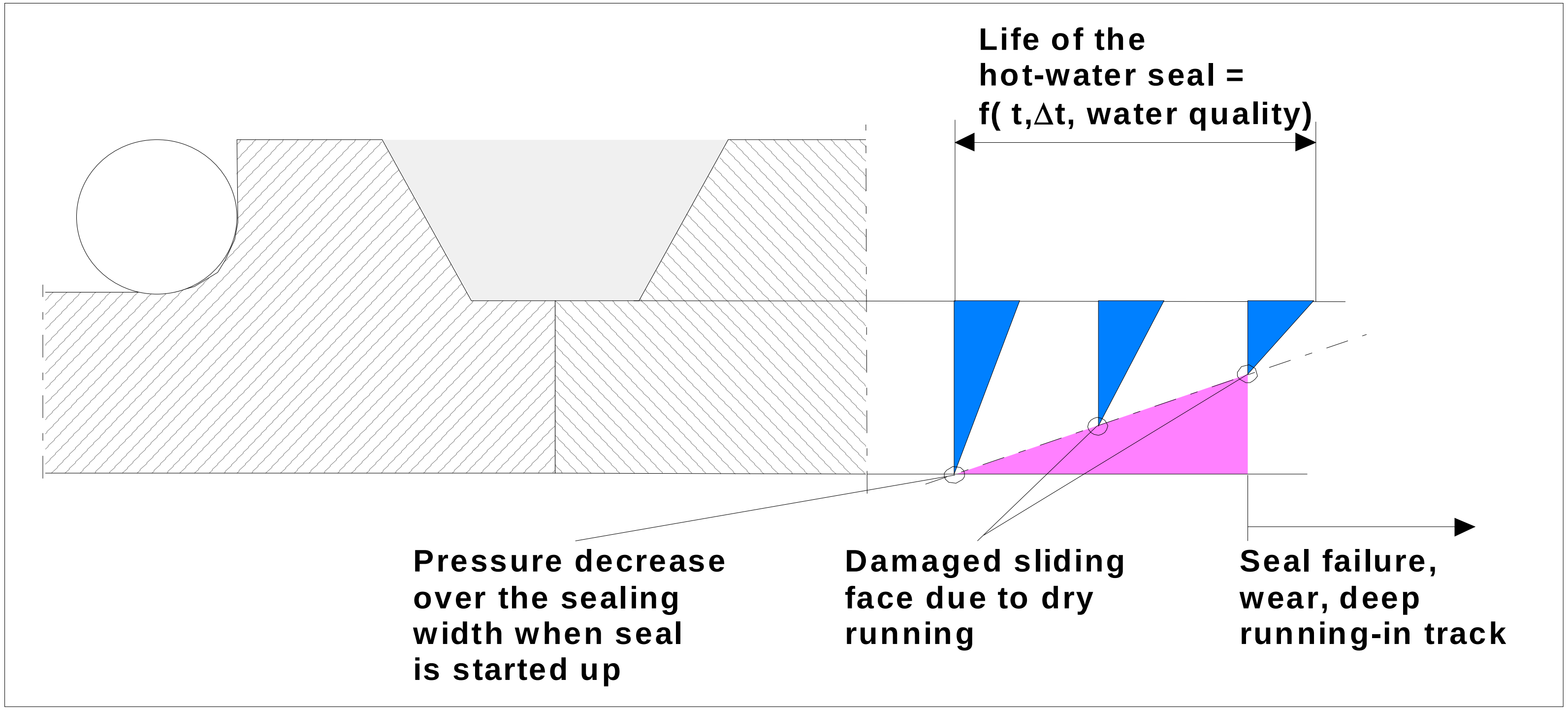
# Pressure decrease over the sealing width & the resulting appearance of the sliding face




Pressure decrease over the sealing width

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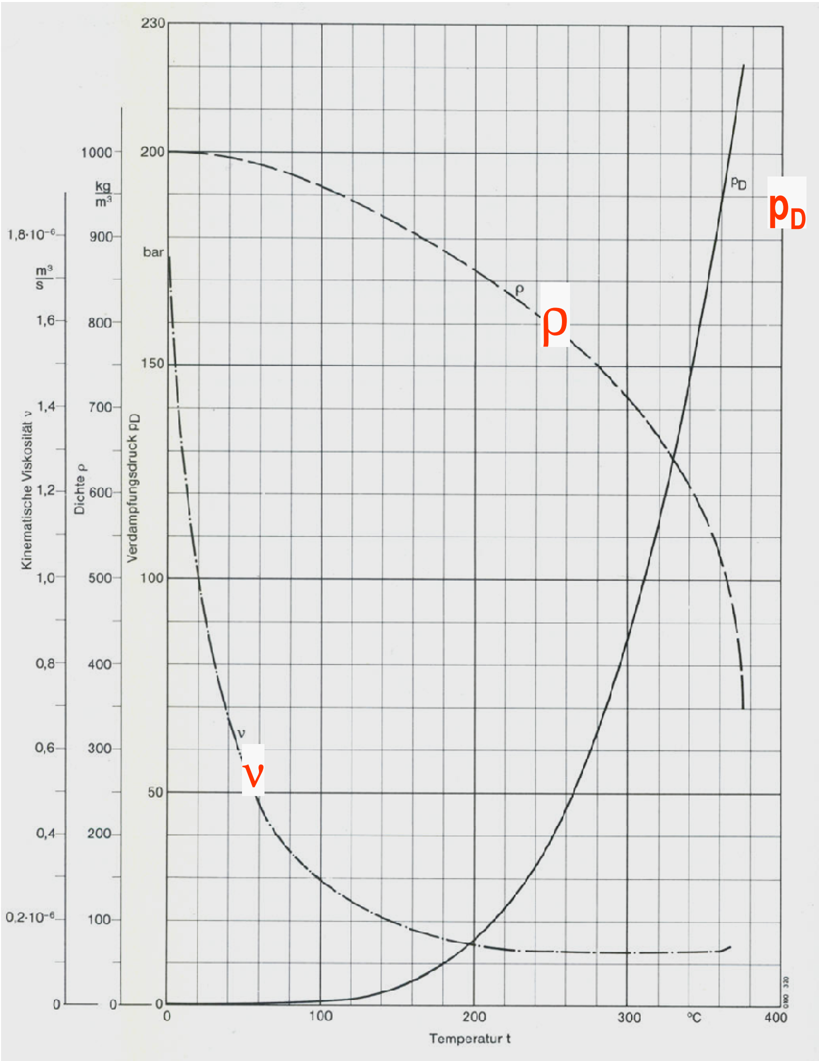
# Vapor Pressure, Density & Kinematic Viscosity




Vapour pressure $p_D$, density $\rho$
und kinematic viscosity $\nu$ of
**Water**
as function of the temperature t

(Consider application of a
balanced mechanical seal!)

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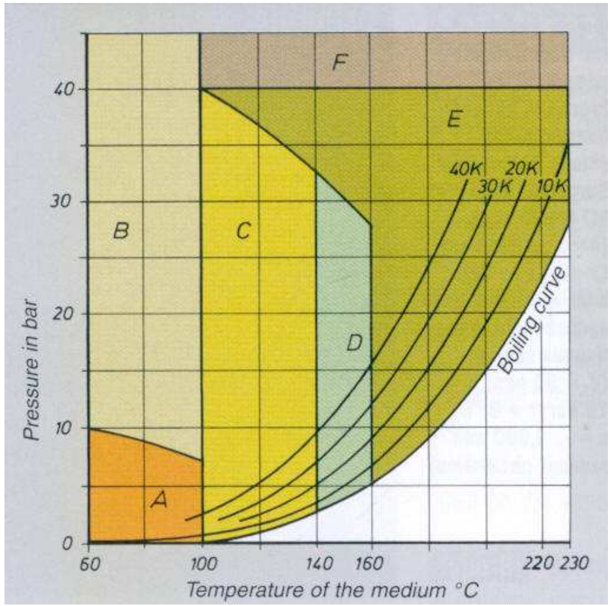
# Seal recommendations and operating limits for B750 and SBF seals in hot water

(It also includes recommendations for non – power hot water services:ex.: buildings, hospitals, etc.)




| Area | $v_g$ [m/s] | $p \cdot v_g$ [bar m/s] | Materials to DIN 24960 | Mode of operation[1]: Without cooling | Product circulation[3] | Stationary seal cooling | Jacket cooling | External cooling | Temperature °C at the seal |
|---|---|---|---|---|---|---|---|---|---|
| A | <10 | <100 | SAEGG | ● | ● | | | | <100 |
| B | <20 | <400 | $Q_1$AEGG | ● | ● | | | | <100 |
| B | <20 | <800[5] | A$Q_1$EGG | ● | ● | | | | <100 |
| C | <10 | <250 | $Q_1$AEGG / A$Q_1$EGG | ● | ● | | | | <140 |
| C | <20 | <250 | A$Q_{12}$EGG | | | ● | | | <120 |
| C | <20 | <400 | $Q_1$AEGG / A$Q_1$EGG | | | | ● | | <100 |
| C | <20 | <800[5] | A$Q_1$EGG | ● | ● | | | | <100 |
| D | <10 | <200[2] | A$Q_1M_2$GG / $Q_1AM_2$GG | ● | ● | | | | <160 |
| D | <20 | <250 | A$Q_{12}$EGG | | | ● | ● | | <120 |
| E | <10 | <250 | A$Q_{12}$EGG | | | ● | ● | | <140[6] |
| E | <20 | <400 | $Q_1$AEGG / A$Q_1$EGG | | | | ● | ● | <100[6] |
| F | <50 | <2500 | A$Q_{12}$EGE | | | | ● | ● | <75[7] |

[1] Boundary condition: Δ t erf. ≧ 10 K minimum differential to boiling point
[2] $p_1$ ≧ 16 bar
[3] Product circulation rate ≧ 0,4 m³/h
[4] See HTS system
[5] $p_1$ ≦ 80 bar; $d_w$ ≦ 50 mm
[6] Temperature at standstill max. 150 °C
[7] Temperature at standstill max. 75 °C

How to calculate sliding velocity ($v_g$):

$$Vg = \frac{\text{Mean seal face dia. (mm) x 3,14 (phi) x rpm}}{60000}$$

How to get the mean seal face diameter for a rough calculation:

B750 = Shaft diameter in mm + 10 mm

SBF = Shaft diameter in mm + 20 mm

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# Seal Cooling

- **Recirculation of the medium** *(uncooled seals)*
  - *API Plan 1*
  - *API Plan 11*
  - *API Plan 13*
- ***Air cooling***
  - *Air Cooler*
- ***Water cooling***
  - *Direct*
    - *Direct injection API Plan 32*
    - *Fluid circu-lation via heat exchanger API Plan 23*
  - *Indirect*
    - *Seat and jacket cooling API Plan 2 Dead end*

***In all cases a constant lubricant film in the sealing gap has to be ensured***

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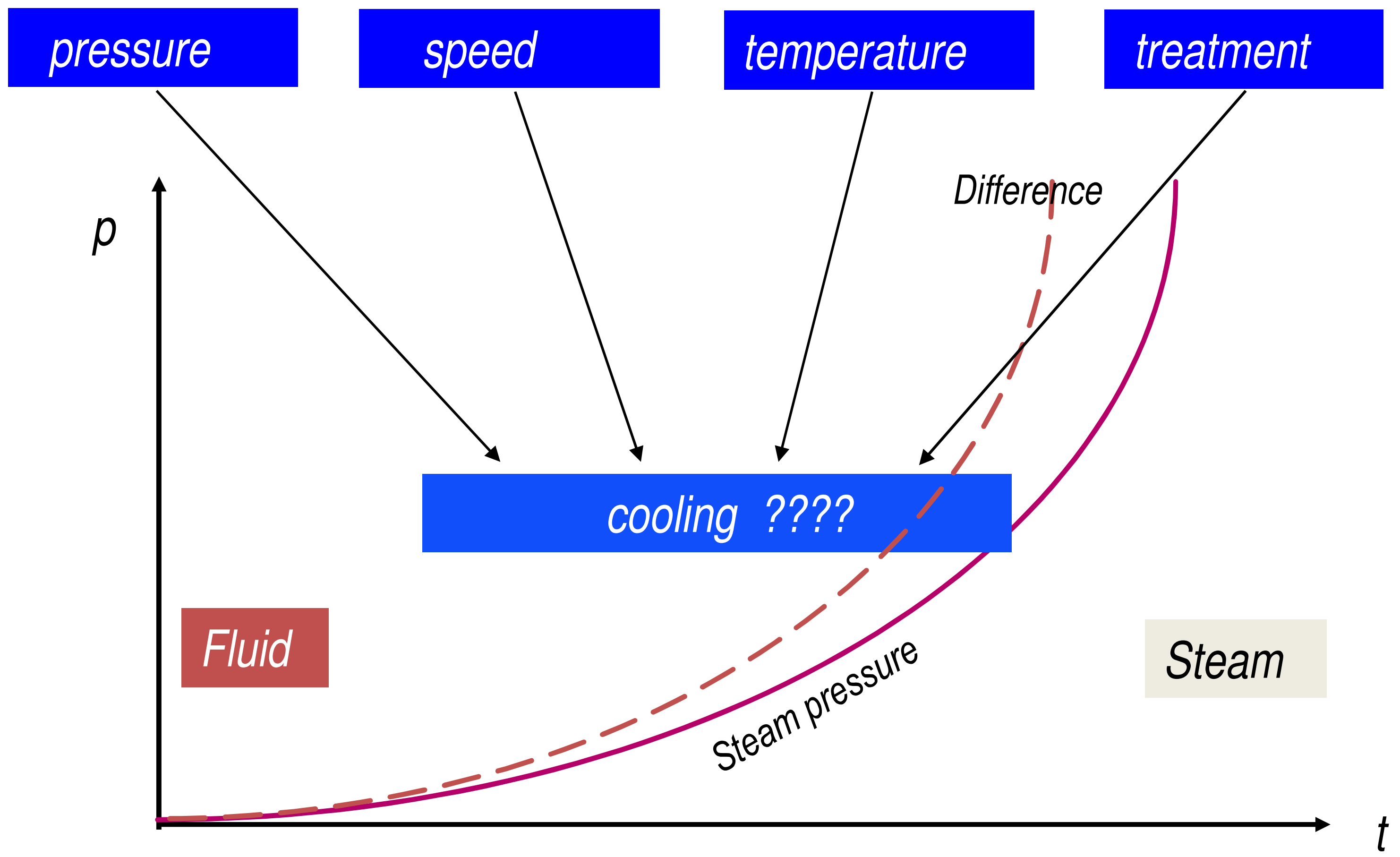
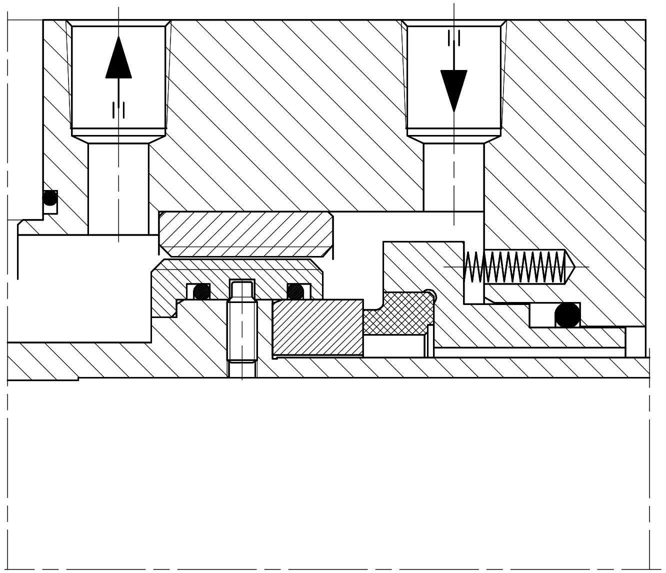
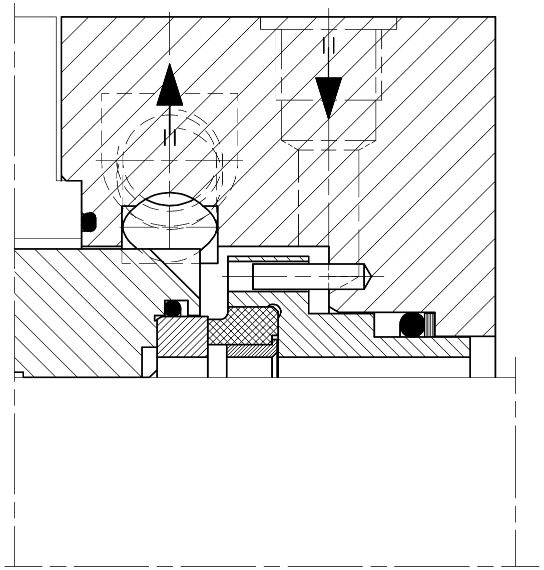
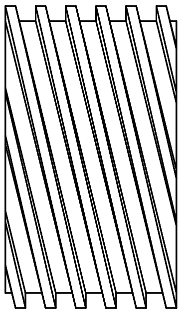
# Effects On Cooling

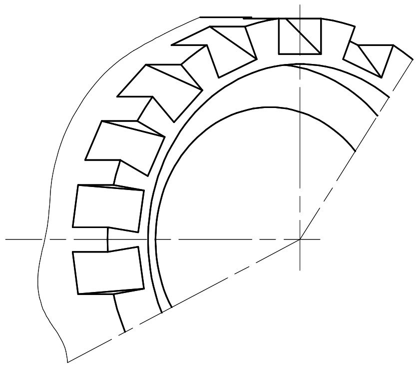



# Pumping Devices



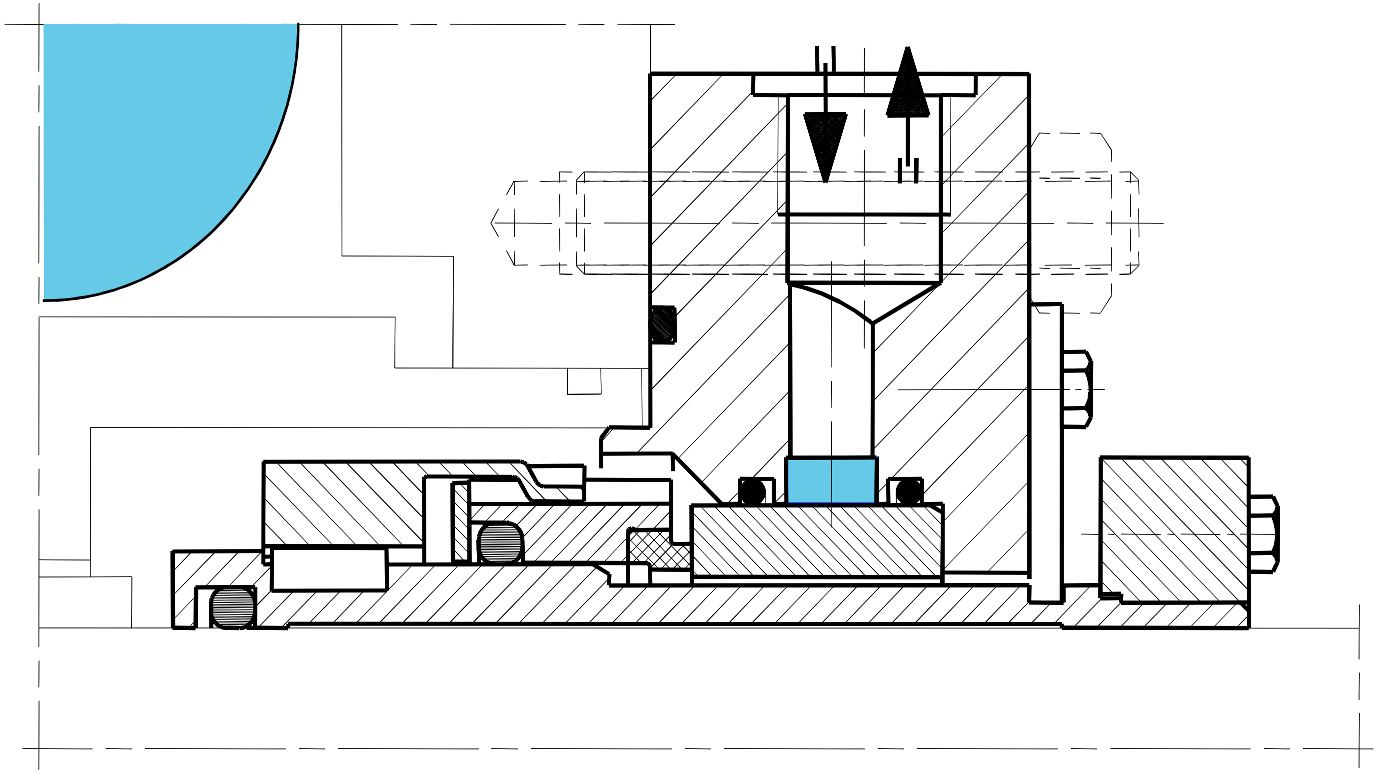








# Seat Cooling

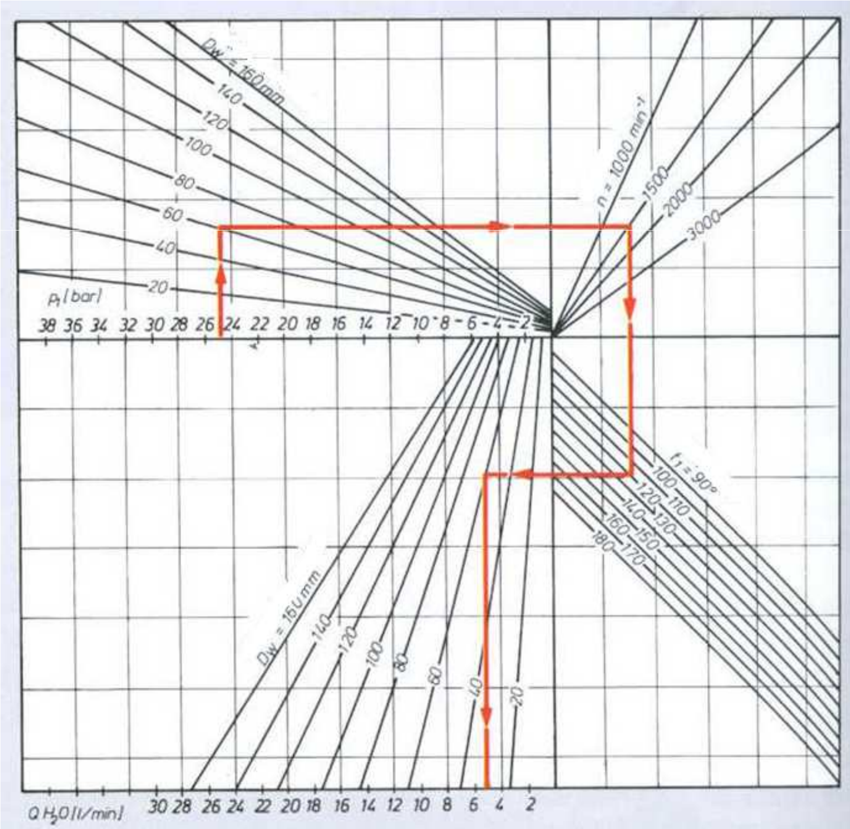


(With seat and jacket cooling)

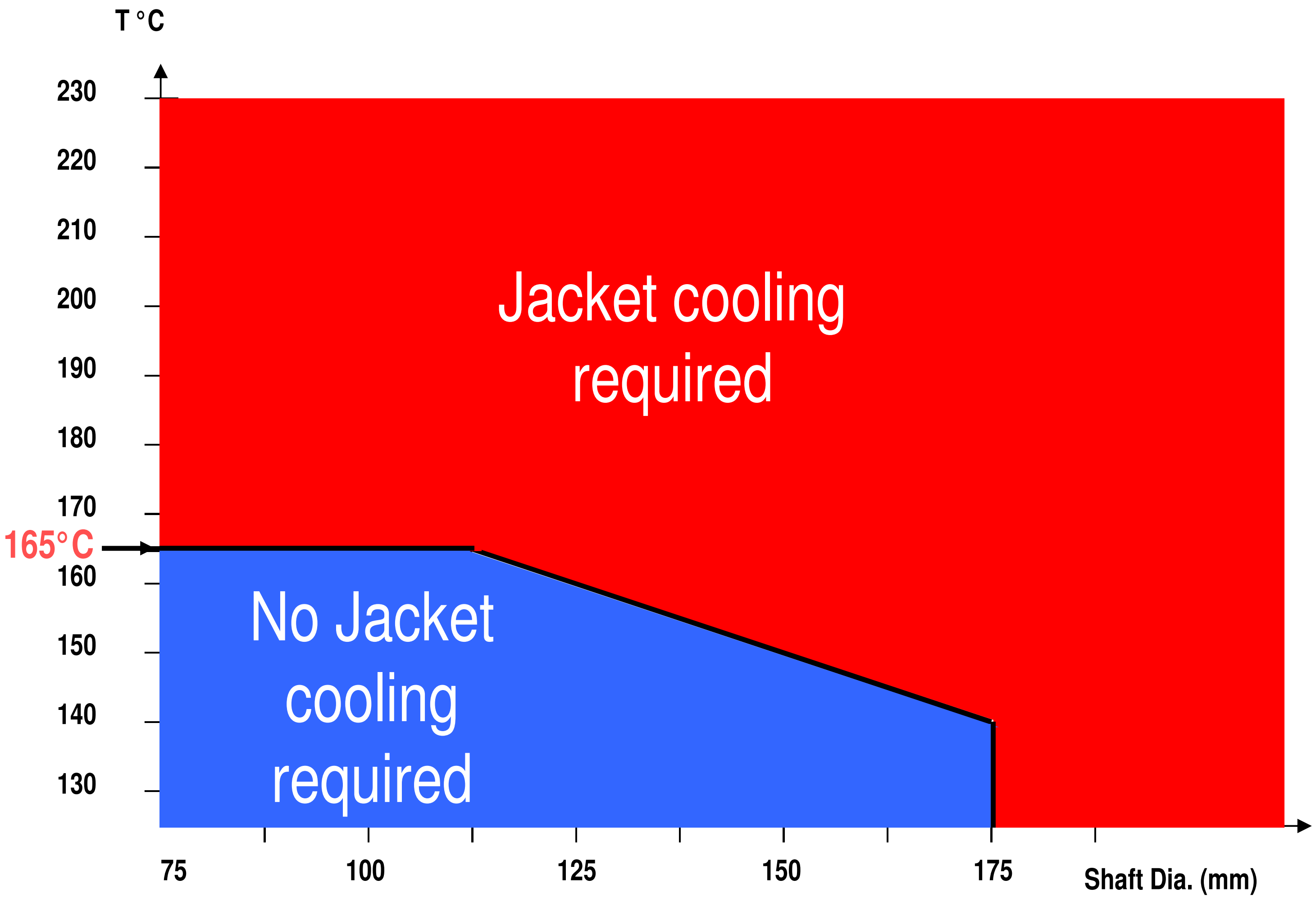
# Cooling Water (for e.g. seat cooling)

- Water quality:
  Preferable treated cooling water or condensate with max. 30 – 40°C

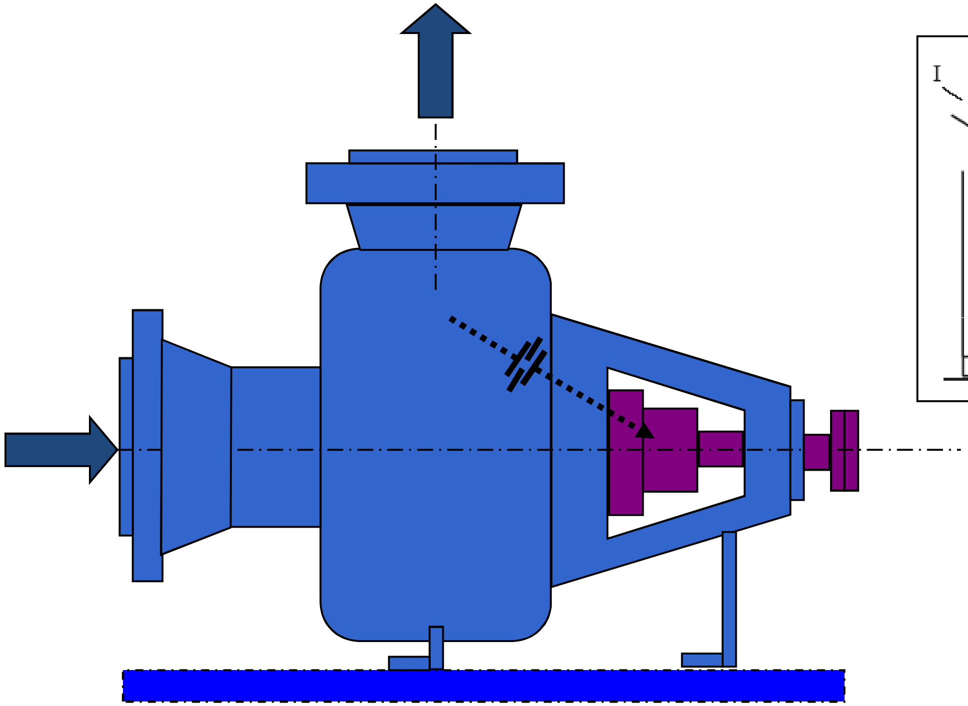
- Cooling water rate:



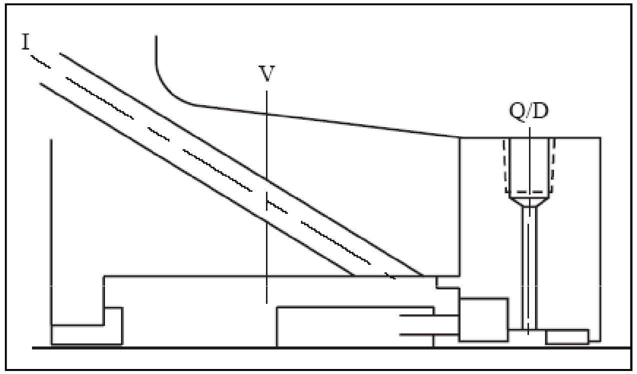

# Selection / Application of cooling jackets: only for seals operated according to API Plan 23 !!




# API Plan 01



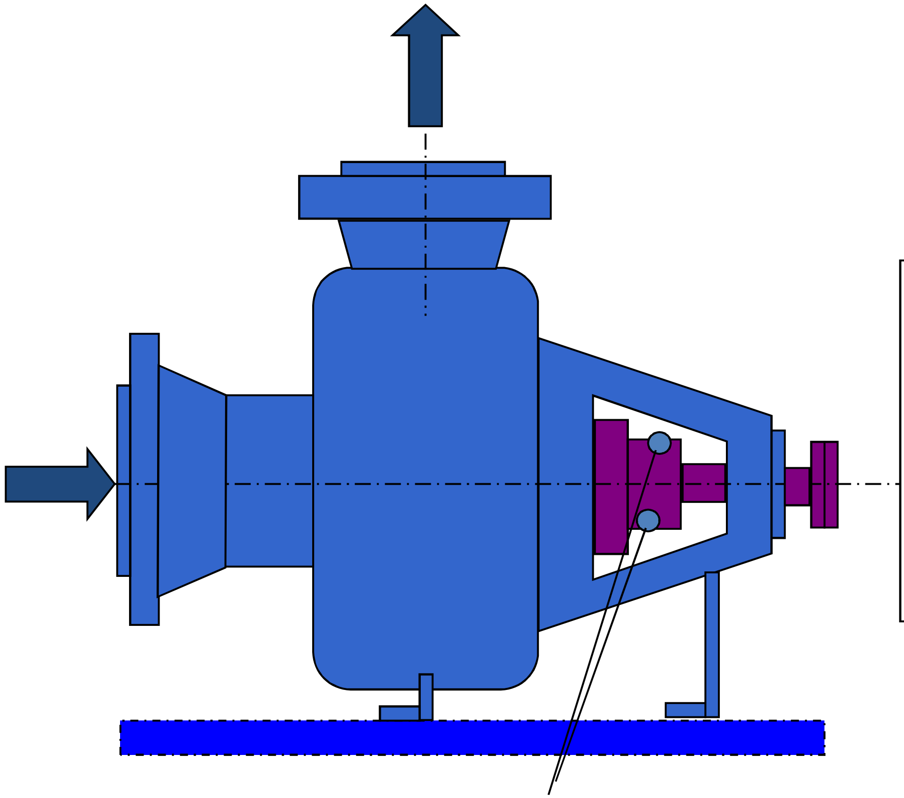
- Internal circulation from pump discharge to seal chamber




**Use**:
for clean media
in general service

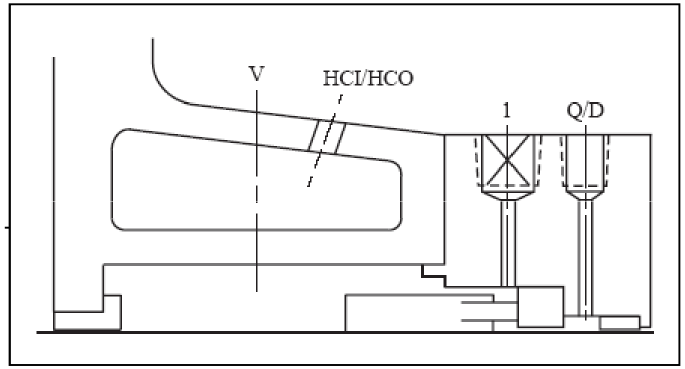


# API Plan 02



Plugged connections
for possible future circulating
fluid

- No circulation of flush fluid




**Use**:
for clean media in general service

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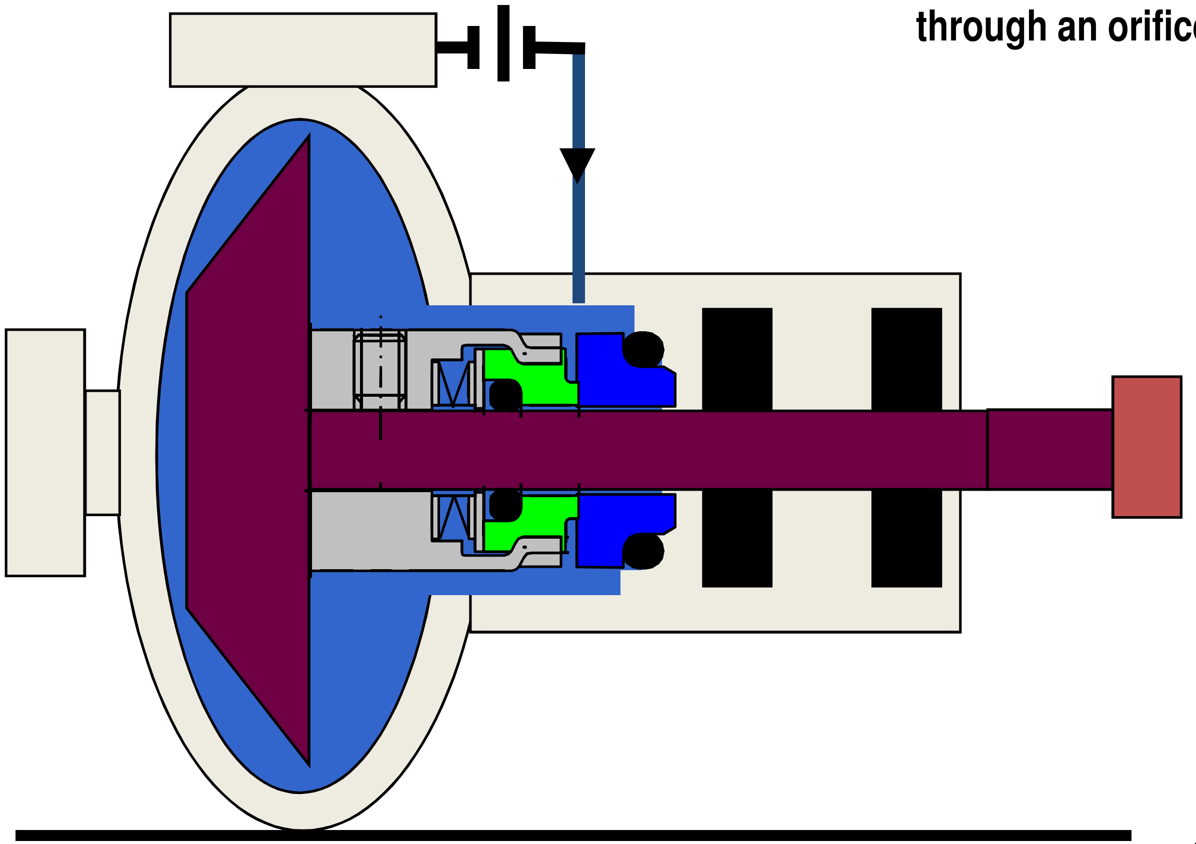
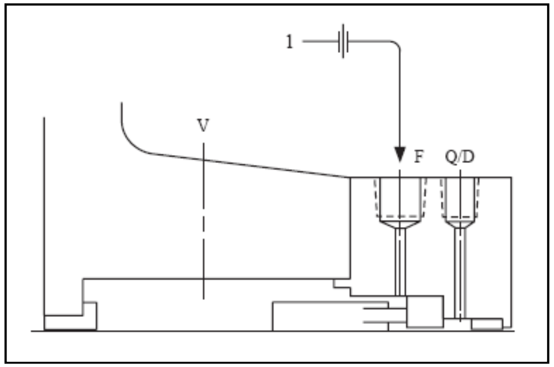
# API Plan 11



**Circulation from the pump discharge through an orifice to the seal**

- Seal flush for single seals
- Product flow from discharge to seal chamber
- Orifice for flow restriction




**Use**:
for clean media in general service

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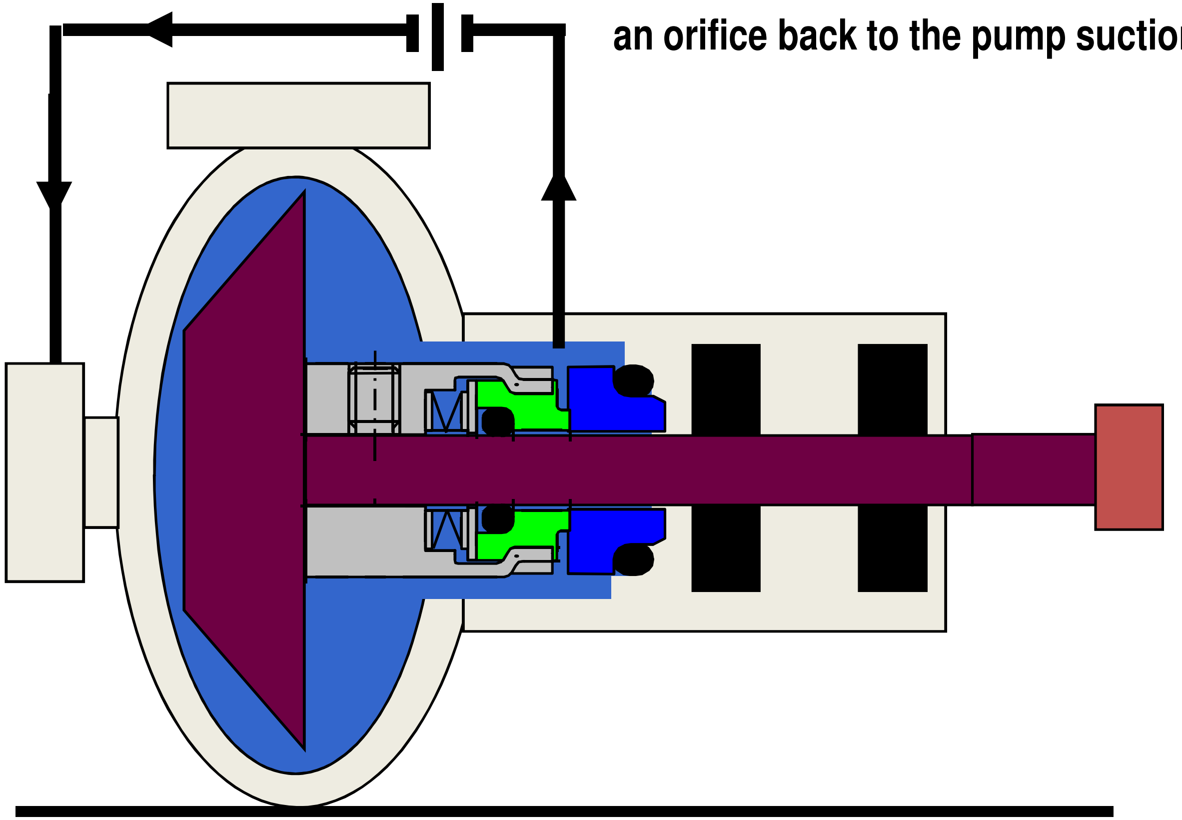
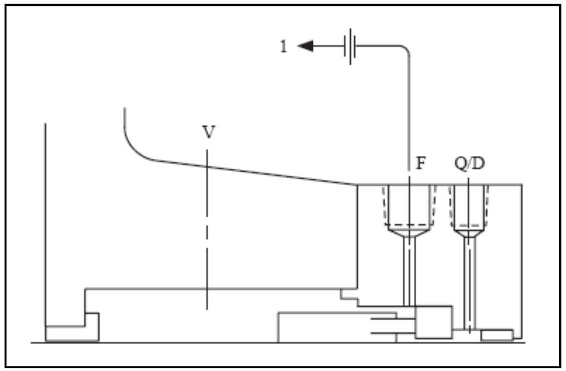
# API Plan 13

**Circulation from the seal chamber through an orifice back to the pump suction**



- Seal flush for single seals
- Product flow from seal chamber to suction
- Orifice for flow restriction




**Use**:
for clean media,
often in vertical pumps



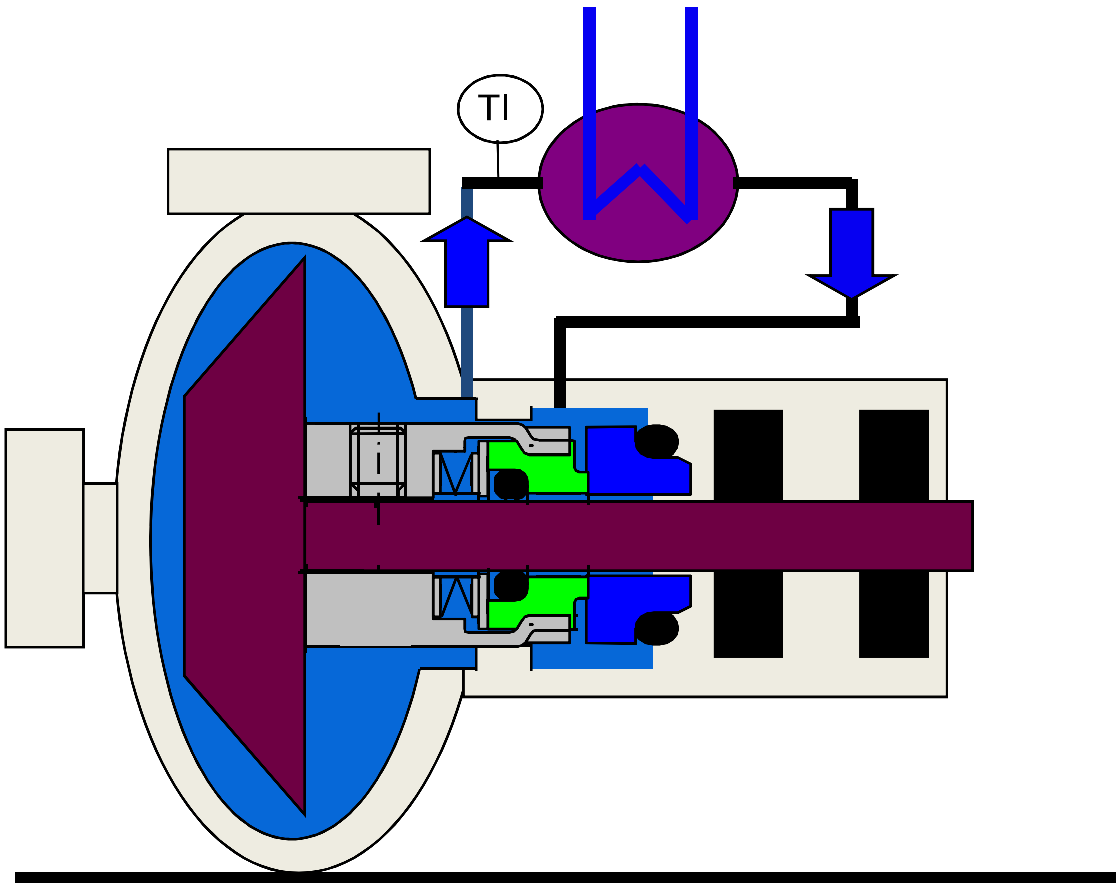




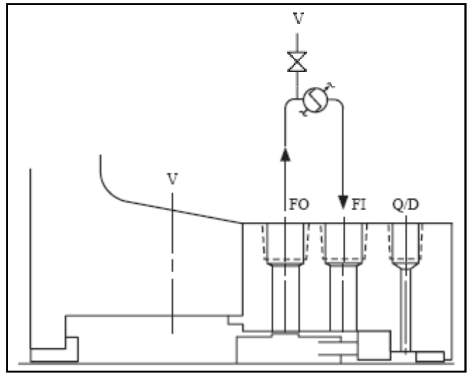



# API Plan 23

**Circulation by means of a pumping device from the seal through a heat exchanger back to the seal**




- Circulation from pumping device through cooler back into seal chamber
- Heat exchanger for cooling

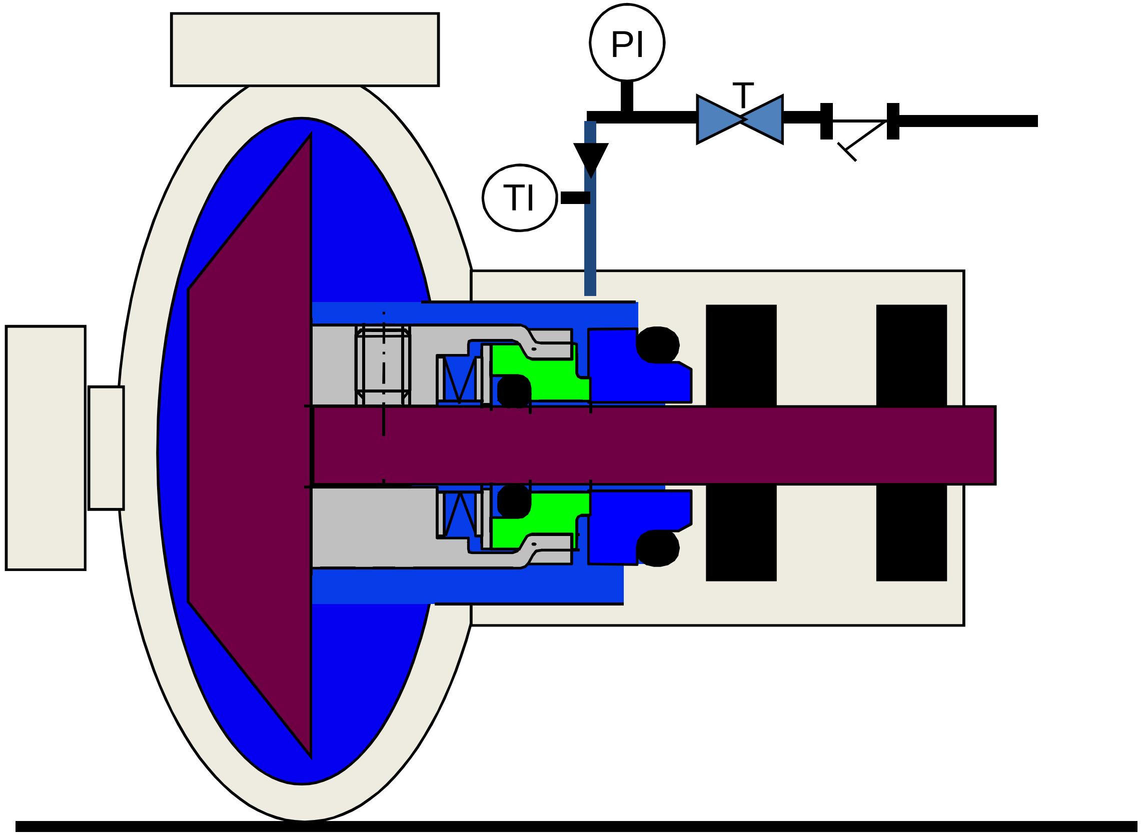



**Use**:
for clean media
in hot services minimizing the heat load on the cooler

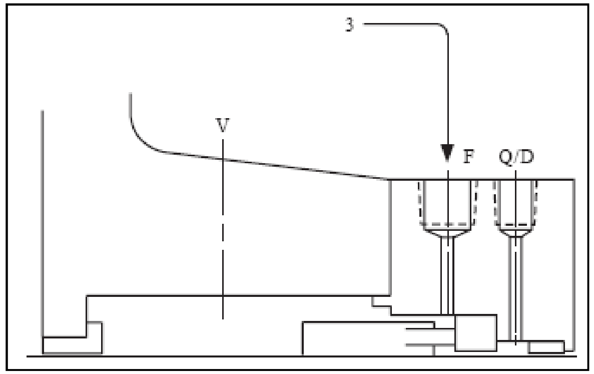


# API Plan 32

**Injection of clean fluid (condensate) into the seal chamber**




- Seal flush from external source for single seal
- normally used with a closed clearance throat bushing




**Use**:
services containing solids or contaminants

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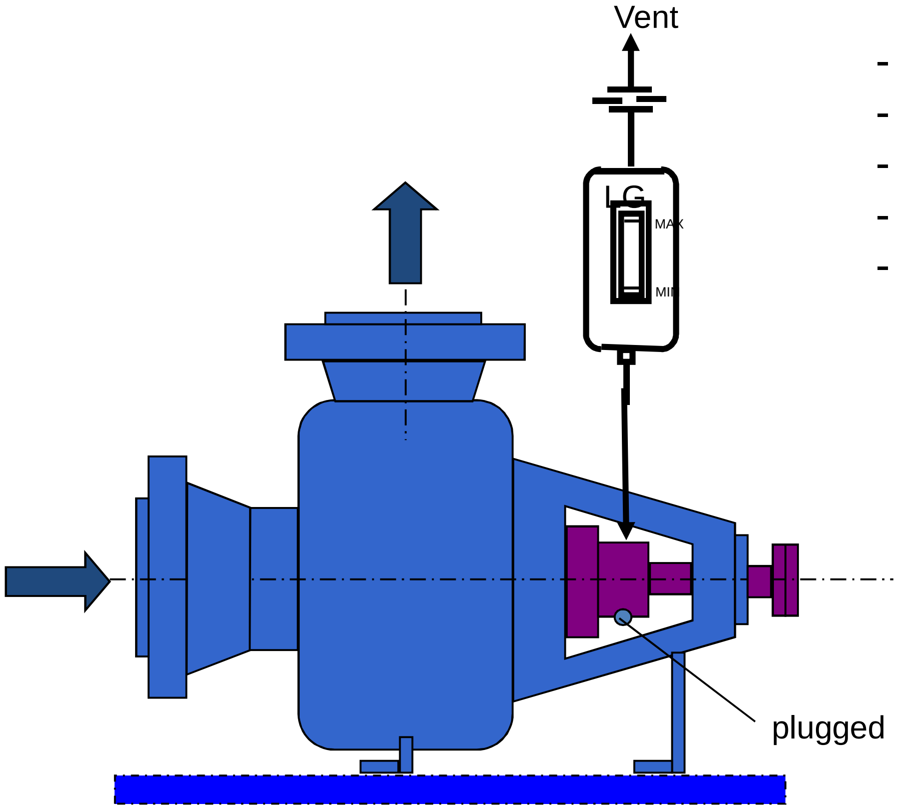
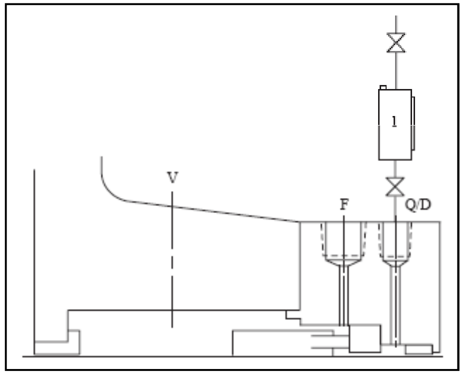
# API-Plan 51



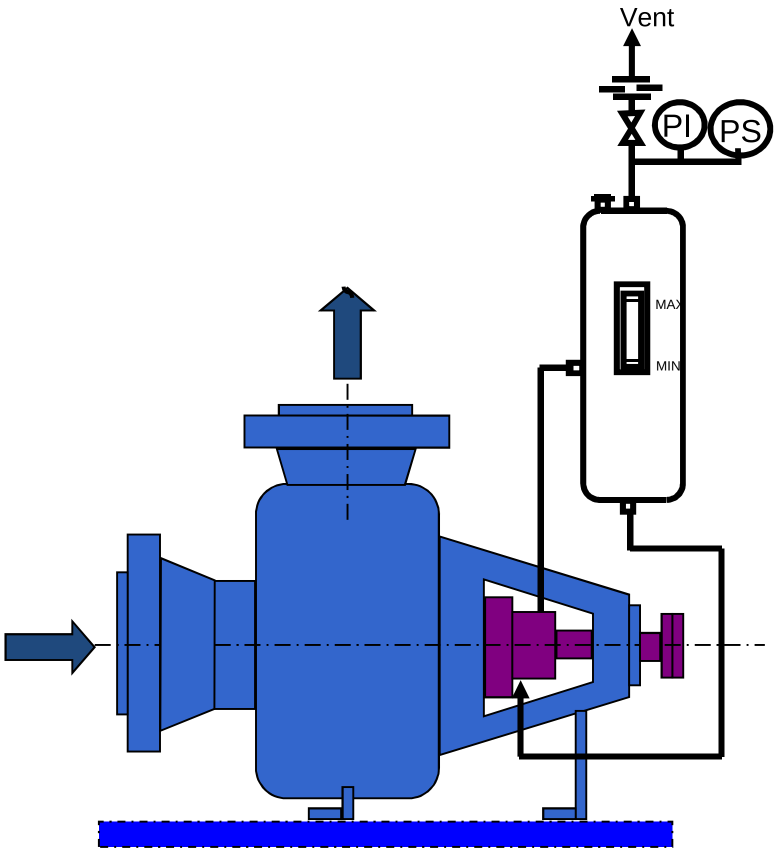

- External reservoir providing
- dead end quench (typically Methanol )
- Unpressurized vaporizing leakage
- escapes through vent line
- no circulation



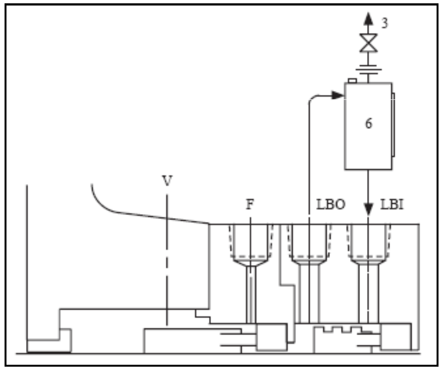

**Use**:
Services where leackage to atmosphere can not be tolerated clean, non-polymerizing products at low temperature



# API-Plan 52




- External reservoir providing buffer fluid
- Unpressurized
- Product leakage in to buffer fluid
- vaporizing leakage escapes through vent line




**Use**:
Services where leakage to atmosphere can not be tolerated clean, non-polymerizing products





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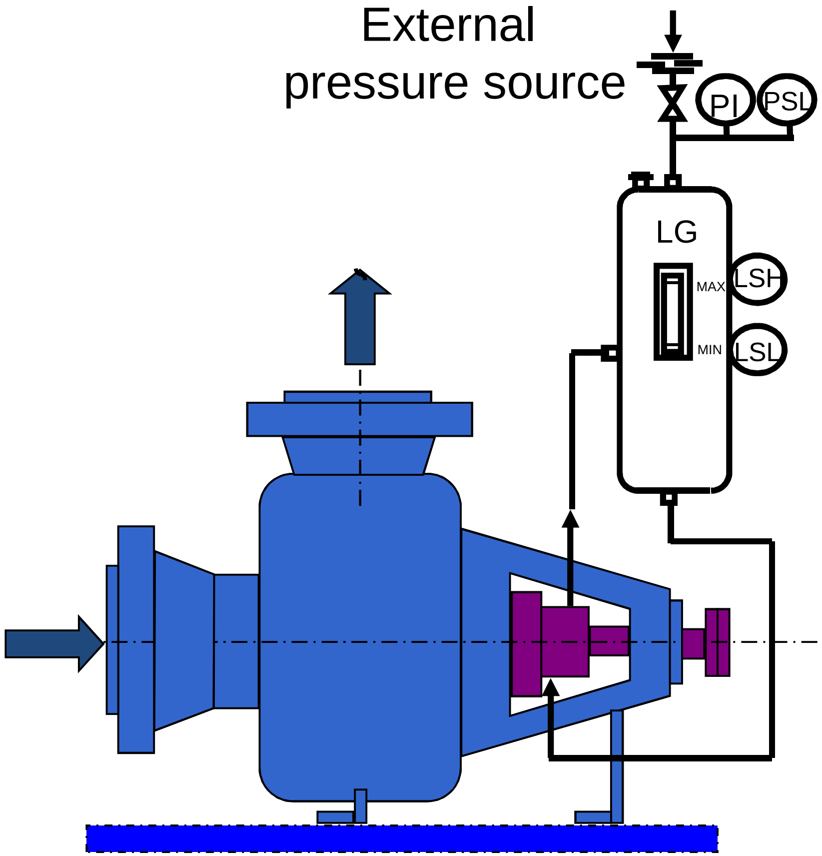
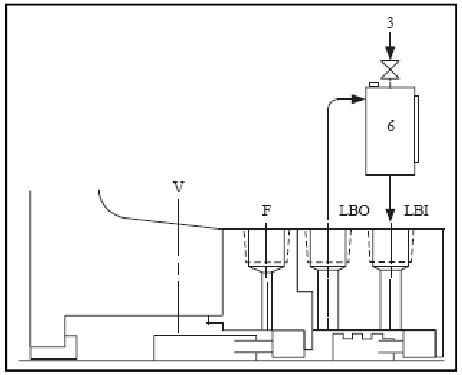
# API-Plan 53A




- External reservoir providing buffer fluid for dual mechanical seal
- Barrier fluid pressure 2 bar above sealed pressure
- pressurized with nitrogen -Barrier fluid leakage into product




**Use**:
Services with abrasive, dirty, or polymerizing products

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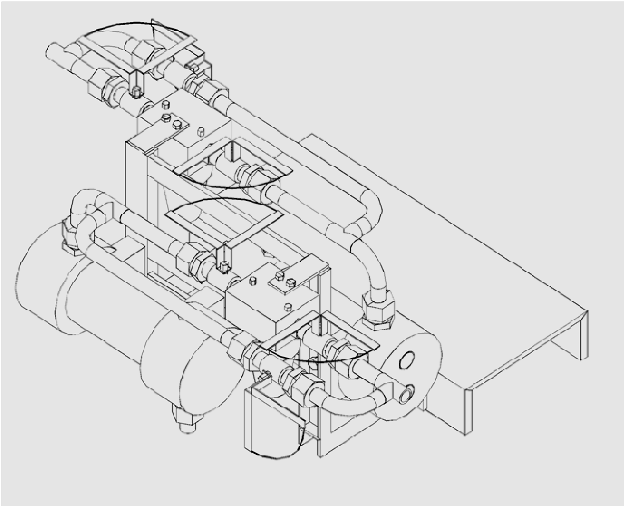
# Closed Loop Flush System



**Preassembled cooling unit**

**Consisting of:**
**heat exchangers, magnetic filters, valves and internal piping for API Plan 23**

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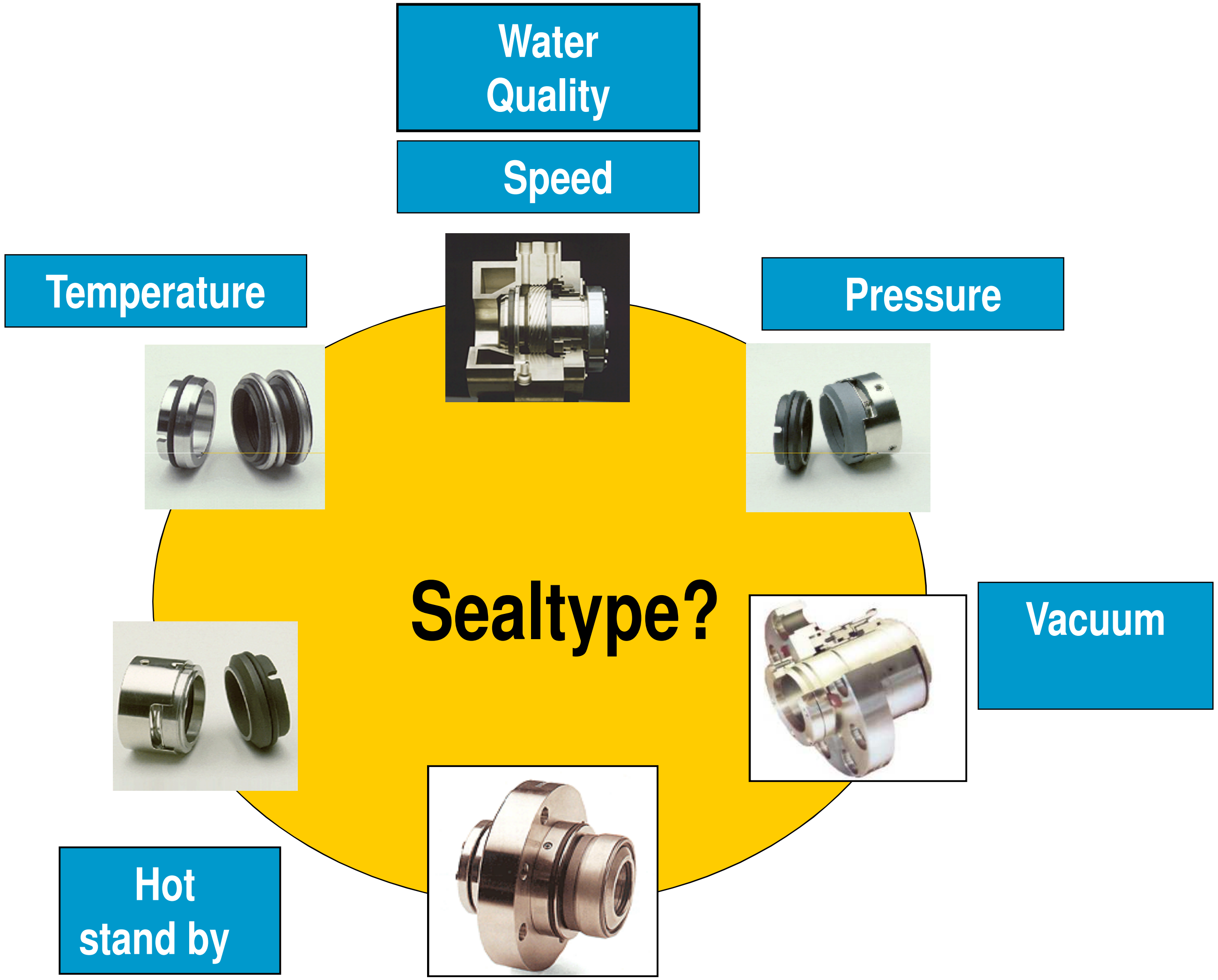
# Seal Types for Power Plants




# Material-Selection

**Sliding Materials**
- Carbon vs. SiC
- SiC vs. SiC (only up to 110°C) and vg < 10 m/s

**Secondary Sealing Elements**
- EP Rubber

**Springs**
- 1.4571 (316Ti)

**Construction materials**
- 1.4571/1.4122 shaft sleeve gland
- 1.4462/1.4122 face carrier (318LN,410SS)

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# Conditions of application for different Power Plant Pumps

| Pumps | Seal type | Conditions | | | | Remarks |
|---|---|---|---|---|---|---|
| | | Shaft diameter dw [mm] | Sliding velocity vg [m/s] | Medium pressure p [bar] | Medium temp. t [°C] | |
| | | | | | | |
| Hot water circulation pump | B750 | 20...200 | < 15 | < 25 | <140 | Without cooling |
| Feed water booster pump | B750G115 | 20...200 | < 20 | < 40 | < 230 | Seat cooling with pump jacket cooling |
| Feed water pump | B750F | 20...200 | < 20 | < 40 | < 180 | Plan 23 with pump jacket cooling |
| Main feed water pumps | SBF,SBPV | 30...200 | < 65 | < 40 | < 220 | Plan 23 with pump jacket cooling |
| Boiler circulation pump | SBP(F)V | 25...120 | < 15 | < 150 | < 335 | Plan 23 with pump jacket cooling |
| Condensate pump | B750K | 25...150 | < 20 | < 16 | < 100 | Plan 11 or 13 or Plan 2 + Quench |

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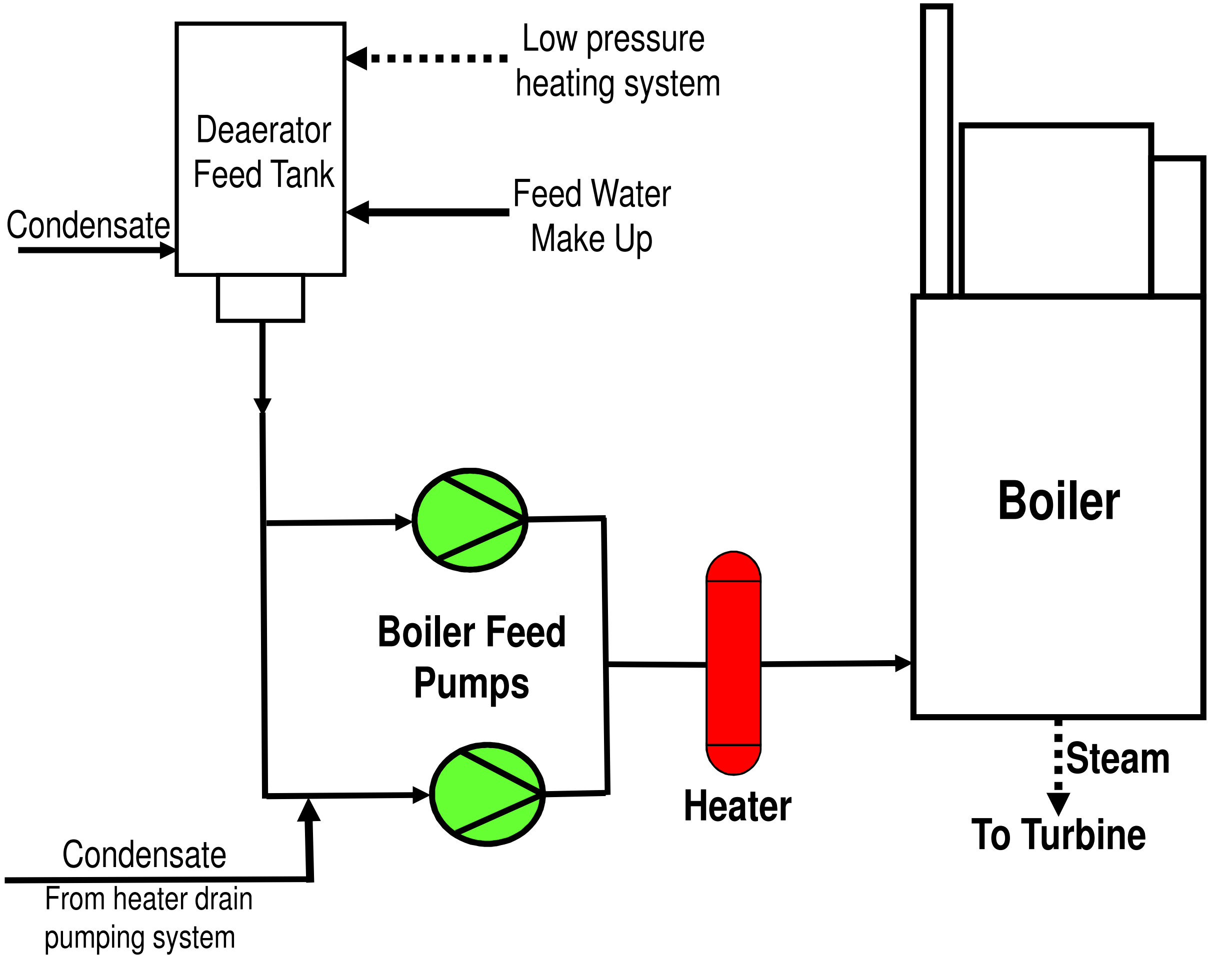
# Feed Pumps

## Main Feed System











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# Main Feed Pump

**Typical operating conditions:**

**Speed: 4000 ... 7000 rpm**
**(sliding velocity up to 65 m/s)**

**Pressure: 15 - 30(40)bar**

**Temperature: 150 - 230°C**

(pump turbine driven 32 MW)



# BOILER FEED PUMPS

*Mechanical seals with cooling circulation*

*Typical operating conditions which require mechanical seals with a cooling circulation according to API 610, plan 23 are:*

*Sliding speed > 20 m/s*
*Pressure < 40 bar*
*Temperature 150-230$^{o}$C*

*The normally used mechanical seal is the type SBF(V),SBP(V) balanced, single, heavy duty seal with pumping screw.*
*The design provides low distortion of the faces. This results in a low leakage and long seal life*

*A heat exchanger type, HED reduces the temperature in the sealing circulation to avoid evaporation between the seal faces respectively to increase the seal life.*

*The magnetic filter, MF or the magnetic separator, MS clean the circuit, especially during the start up of the power plant.*










# Boiler Feed Pumps

- Typical mech. seals depending on RPM, pressure, operating temp. and water quality:
- ➢ B750N in AQ1EGG, API Plan 11 (up to 140°C, vg less than 10 m/s)
- ➢ B750G115, AQ1EGG, API Plan 2 with jacket cooling (vg less than 20 m/s)
- ➢ B750F, AQ1EGG, up to max. 20 m/s vg or higher:
- ➢ SBP-, SBF/dw-EX in AQ2EGG/E
- API Plan 23 and higher than 160°C with jacket cooling

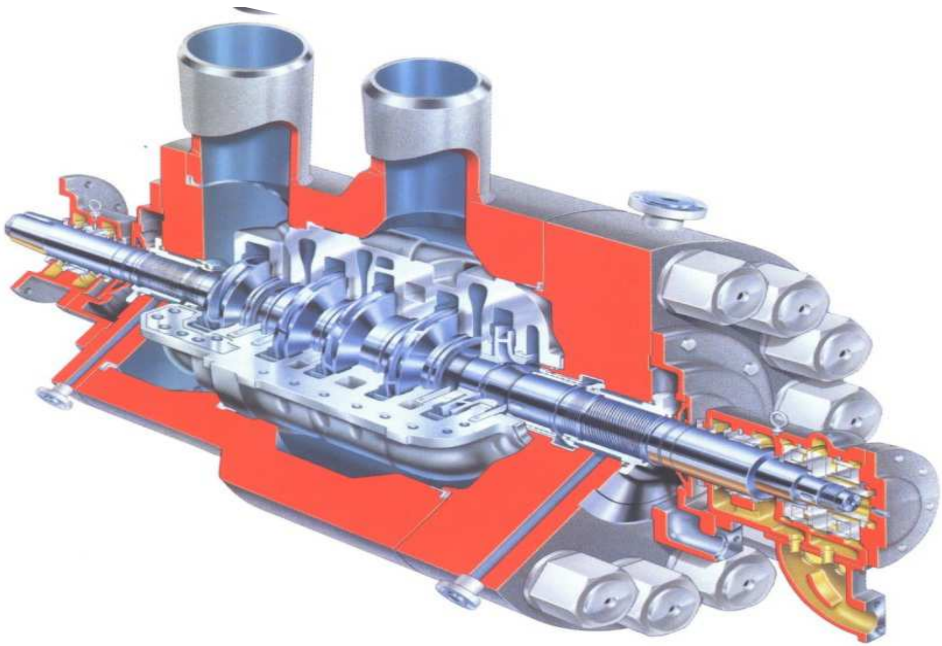









# Boiler Feed Pumps – Main Pump

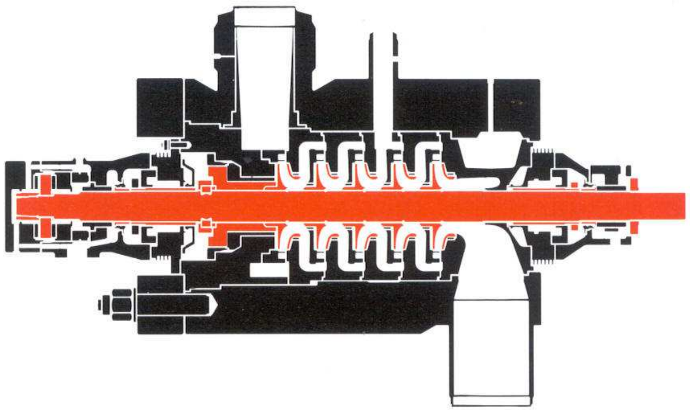


Multi-stage pumps with ring-section or barrel type casings are commonly used.

# Boiler Feed Pumps

The boiler feed pump, also known as a feeder, supplies the proper amount of feed water which the steam generator needs to generate a given amount of steam. Mass flows can be as high as 4000 t/h on systems with drive power exceeding 30 MW. Multi-stage pumps with ring-section or barrel-type casings are used in these applications.

| | |
|---|---|
| medium: | boiler feed water |
| temperature: | 160-230°C |
| temp. at mech. seal: | max. 75°C |
| suction pressure: | 15-40 bar = pressure at mech. seal |
| discharge pressure: | up to 400 bar |
| RPM: | up to 7000 1/min (can be up to 65 m/s |
| mech. seal diameter: | 50 mm to about 220 mm |

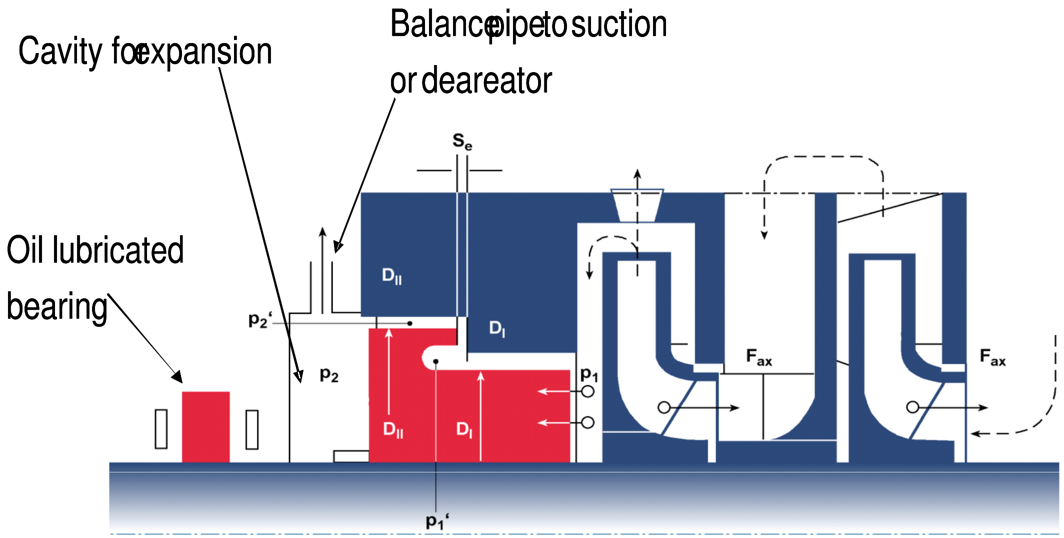


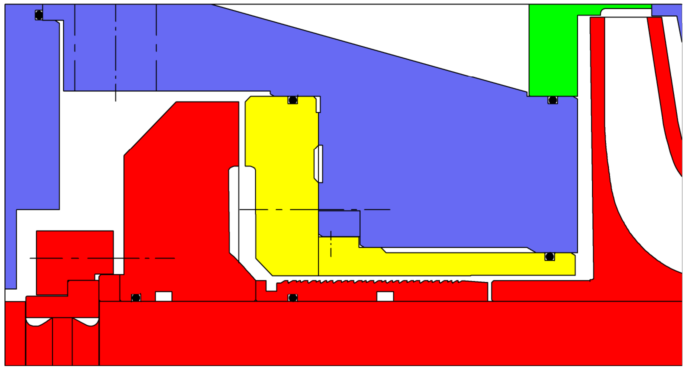


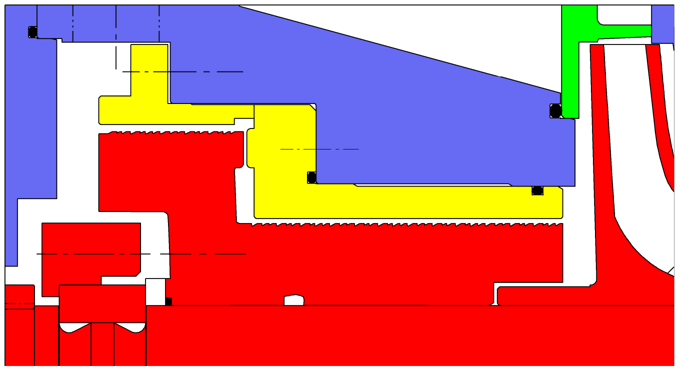





# Boiler Feed Pumps



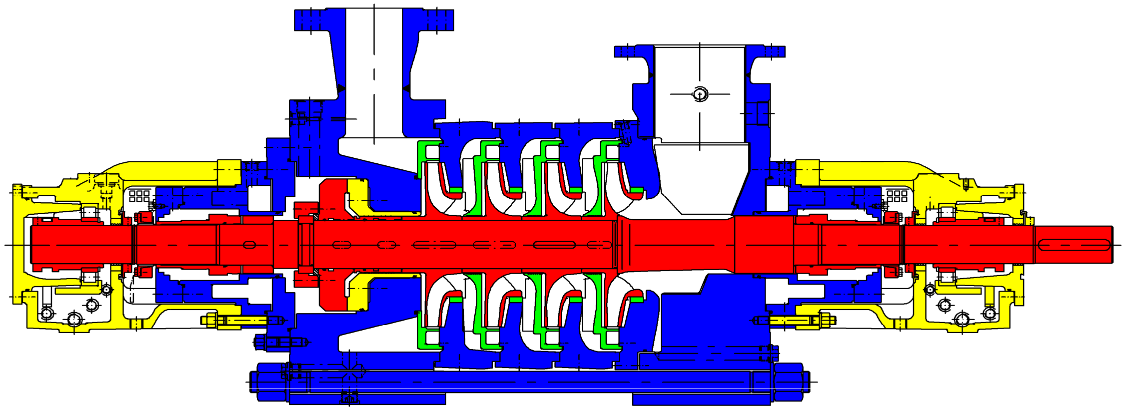


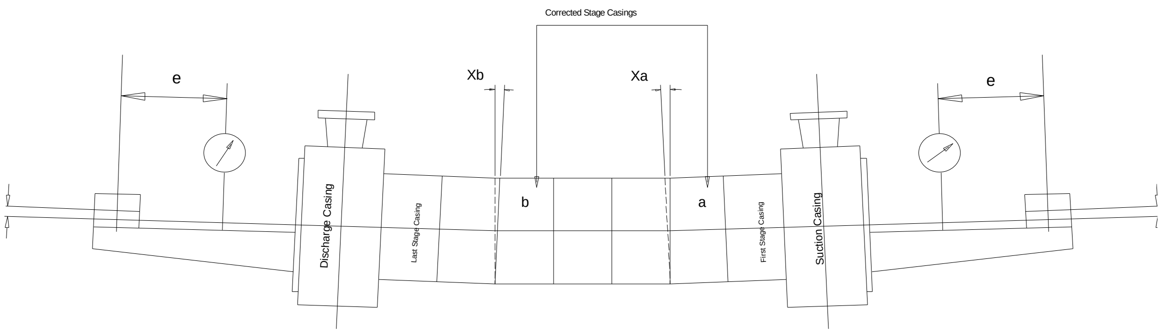







# Potential problem in peak stations or during hot stand-by of any feed pump





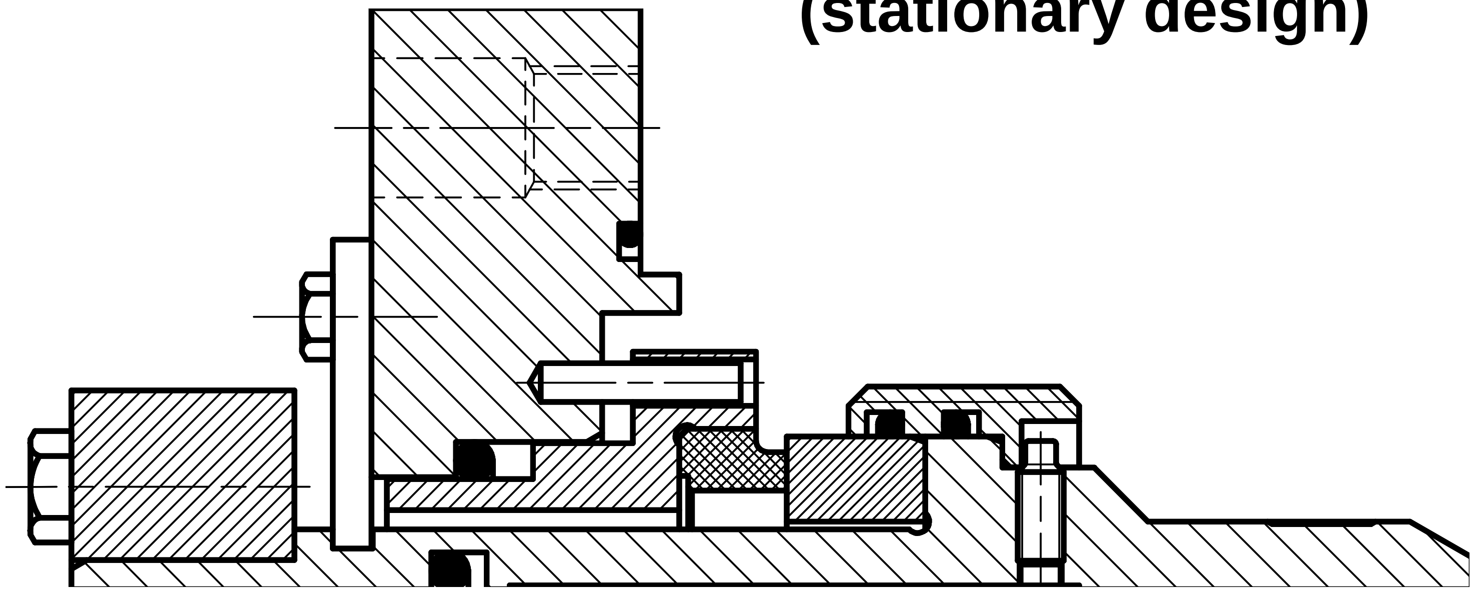

**Formation of thermal layers during hot static condition**

**Causes damage to bushing seals**



# Mechanical Seal for Boiler Feed Pumps

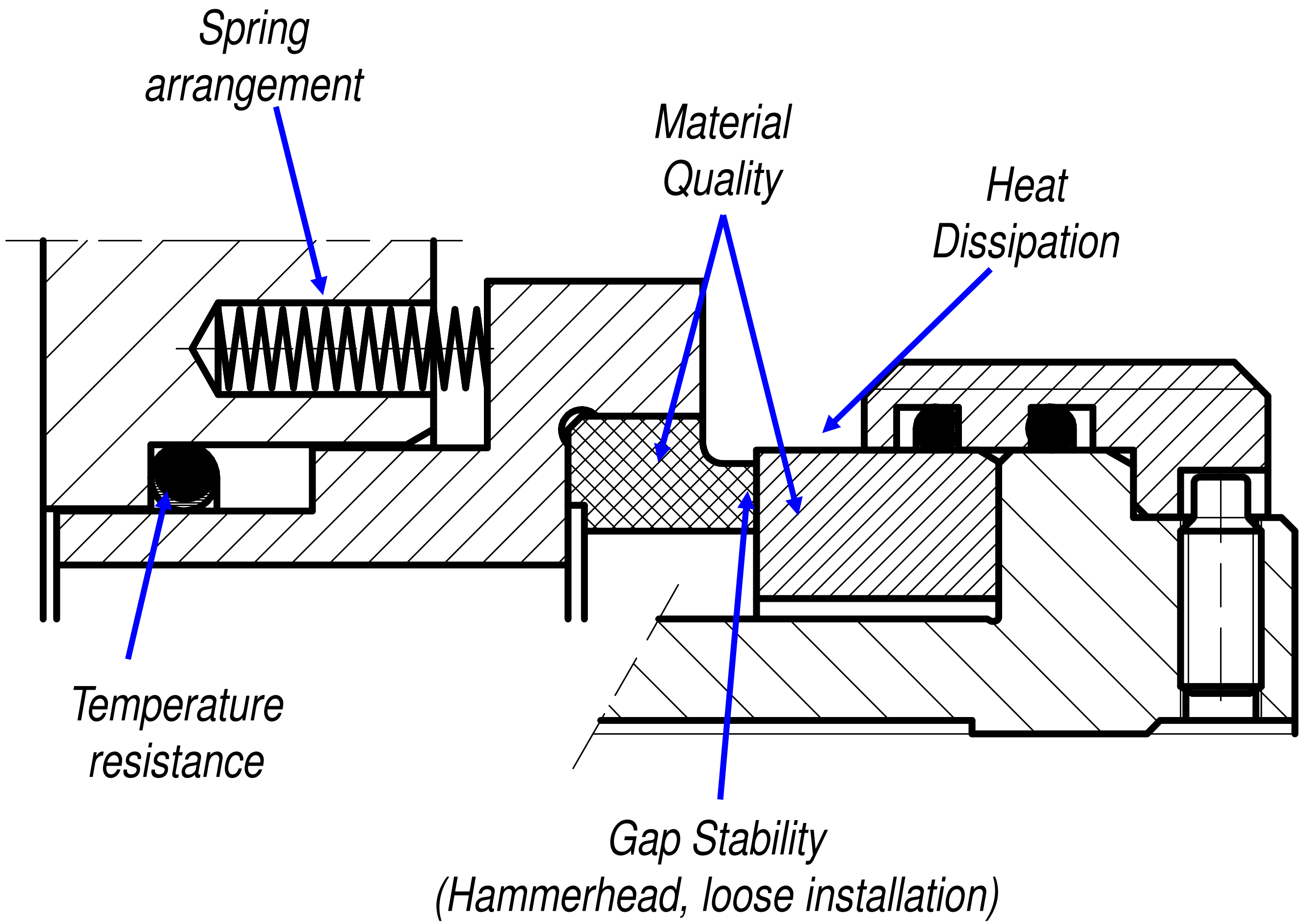
**SBFX/dw for Boiler Feed pumps**
**vg > 20 m/s**
**(stationary design)**



**SBF seal-cartridge for quick and easy assembly**

# Face design


Spring arrangement
Material Quality
Heat Dissipation
Temperature resistance
Gap Stability
(Hammerhead, loose installation)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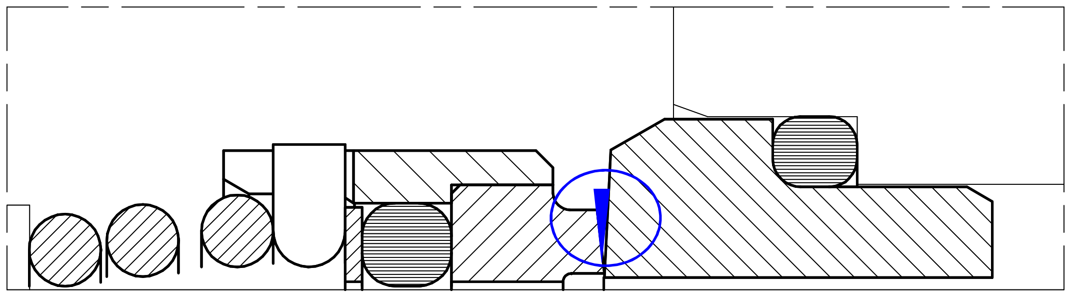
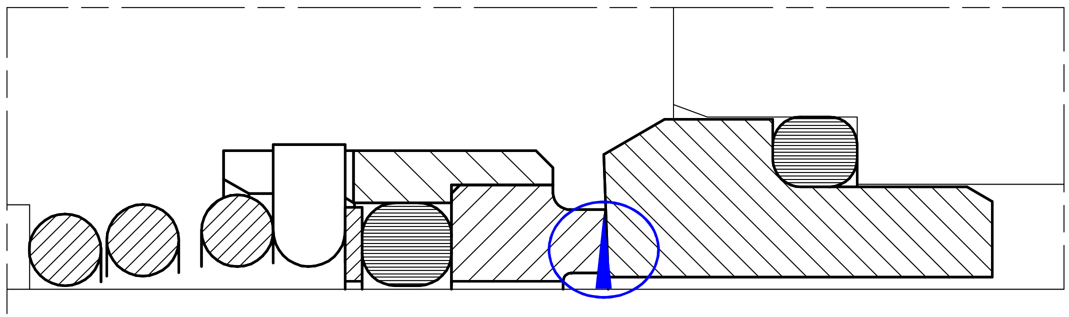
# Seal Gap Stability

### *V - Gap*



### *A - Gap*



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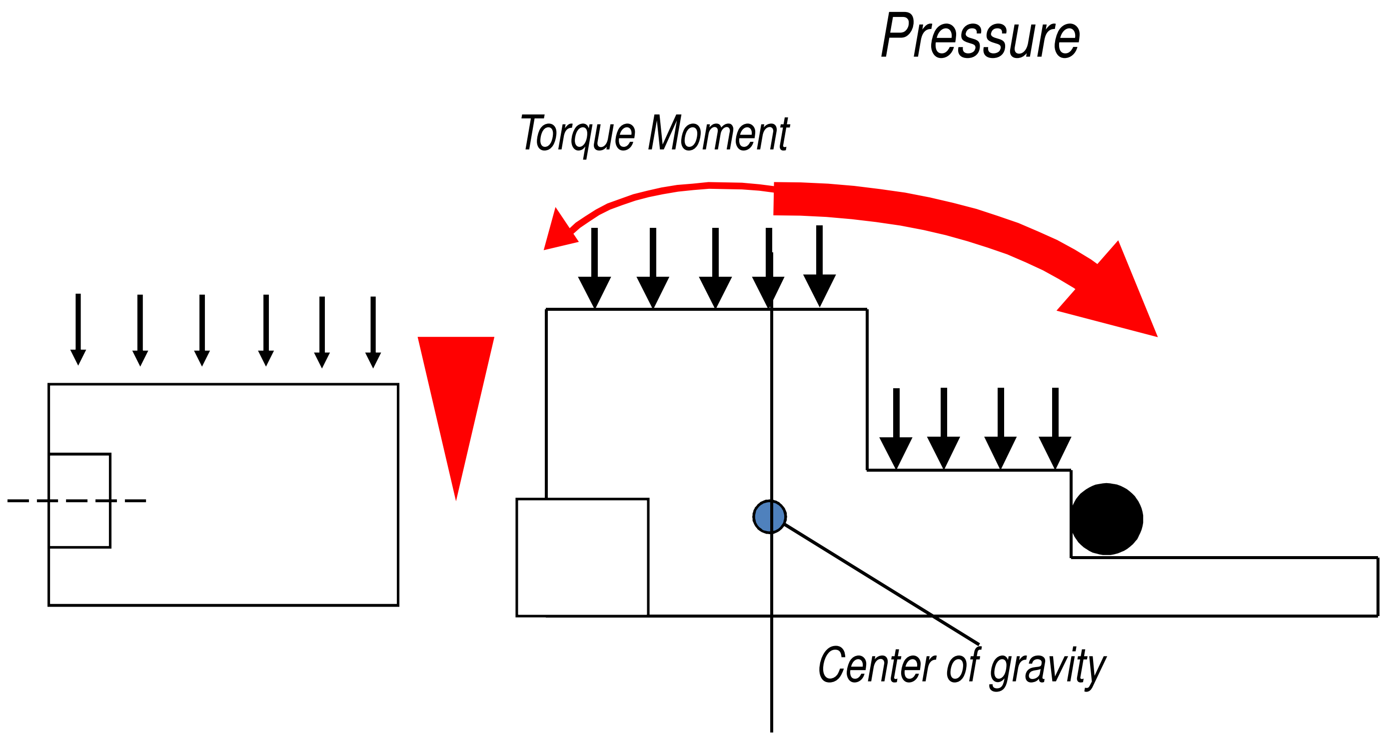
# Hammerhead - Design




# Feed Water Treatment

## Example

| | Processing | Alkaline Processing | Neutral Processing | Combined | Unit |
|---|---|---|---|---|---|
| General requirements | | clear and colorless | | | |
| Conductivity at 25°C, directly and continuousely measuring at the testing site | μS/cm | not specified | < 0,25 | 0,4 - 1,0 | |
| pH-value at 25°C | | > 9 | 6,5 NH3) | 8-8,5 (20-70ppb | |
| Oxyen ($O_2$) | mg/l | not specified | >0,05 | 0,15 -0,3 (no $Co_2$ ) | |
| Total iron (Fe)<br>Total copper (Cu)<br>Silicic acid (Si $O_2$) | mg/l<br>mg/l<br>mg/l | | <0.02<br><0.003<br><0.02 | | |

SBF

SBF /
SAPV (vg>40 m/s)

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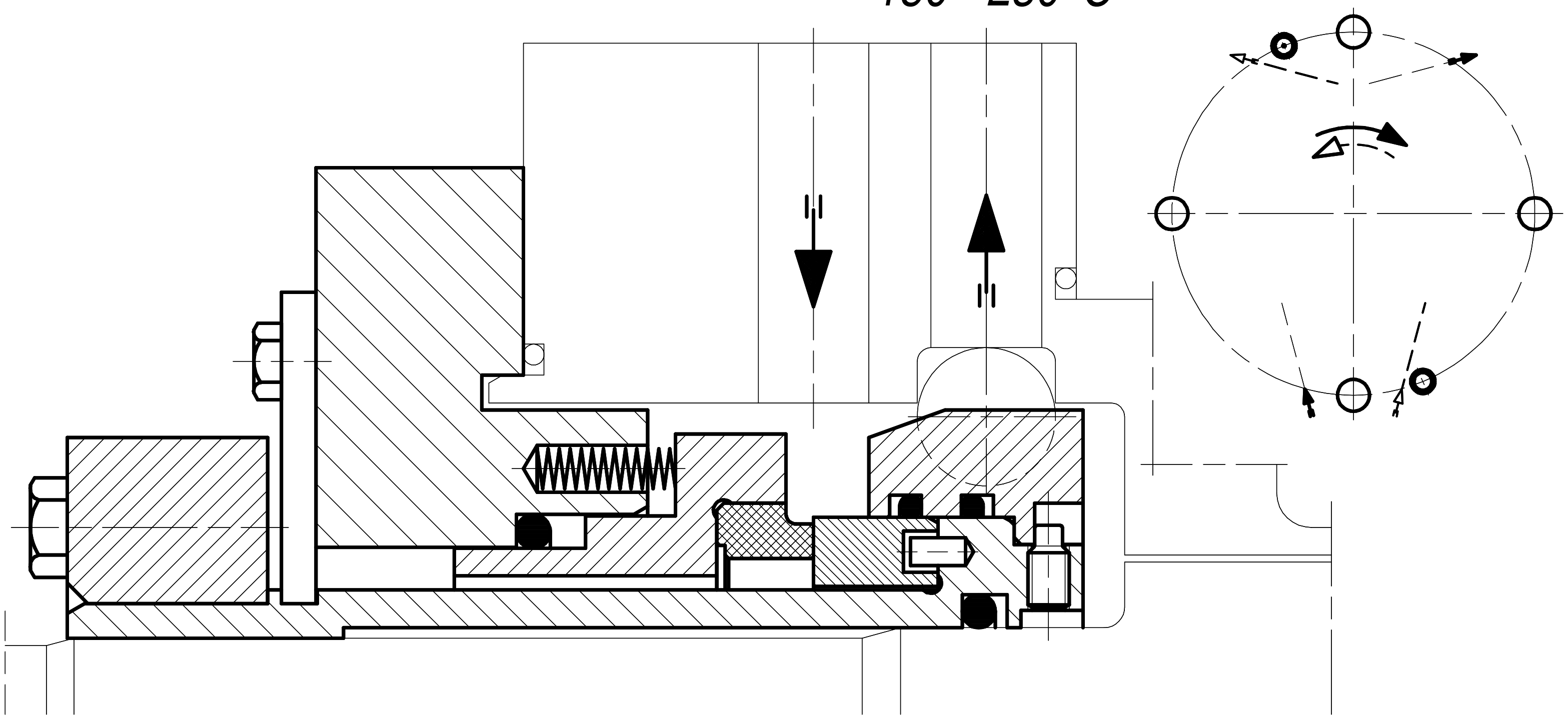
# Mechanical Seal for Boiler Feed Pumps

*for Boiler Feed Pumps*
*Type SBF / SBP*

*20 - 70 m/s*
*15 - 40 bar*
*150 - 230° C*



*Engineered Balanced, Single, Heavy Duty Seal*

# Mechanical Seal for Boiler Feed Pumps

## SBF/SBP

**Mechanical Seals for Pumps · Engineered Seals**

**Product Description**

1. Balanced
2. Cartridge design
3. Dependent of direction of rotation
4. Integrated pumping device
5. Multiple springs
6. Shrink-fitted seal face
7. Single seal
8. Stationary spring loaded unit

**Technical Features**

1. Suitable for high sliding velocities and medium pressures
2. Accommodates shaft deflections due to stationary design
3. Cost effective due to standardized inner components
4. High flexibility due to adaptation of the connection parts to the pump seal chamber
5. Optimum heat dissipation due to integrated pumping device and optimized seat design
6. Pre-assembled unit for quick and easy installation
7. Versatile application for OEM or retrofits of boiler feed water pumps





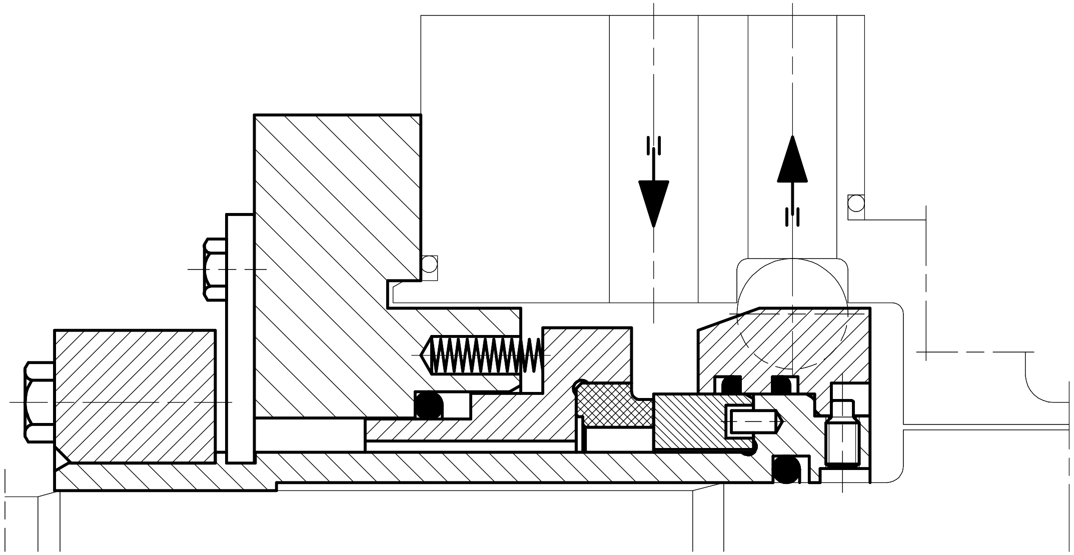


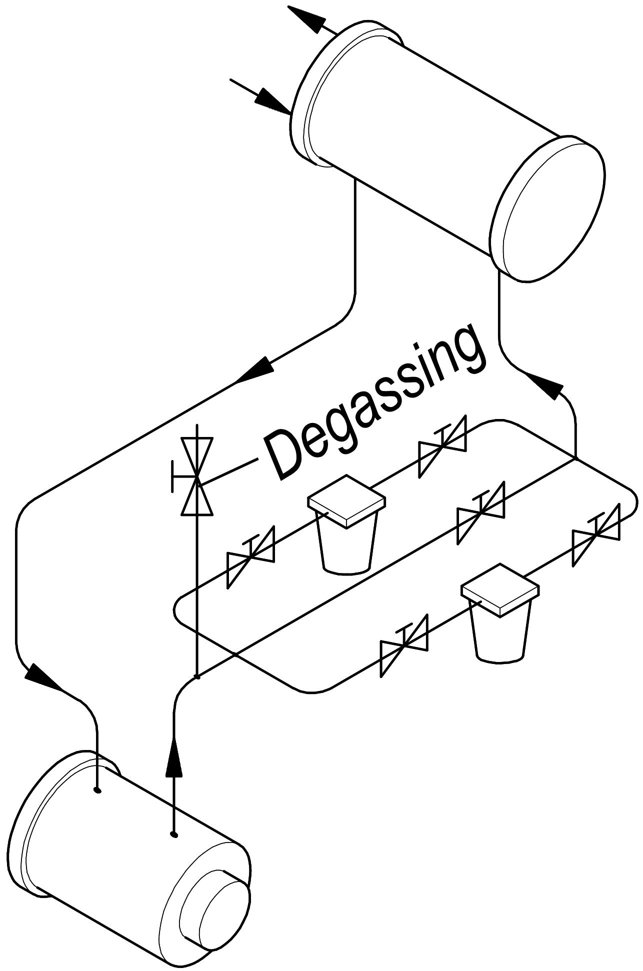



# Mechanical Seal for Boiler Feed Pumps

*for Boiler Feed Pumps*
*Type SBF / SBP*

*according to API 610, PLAN 23*





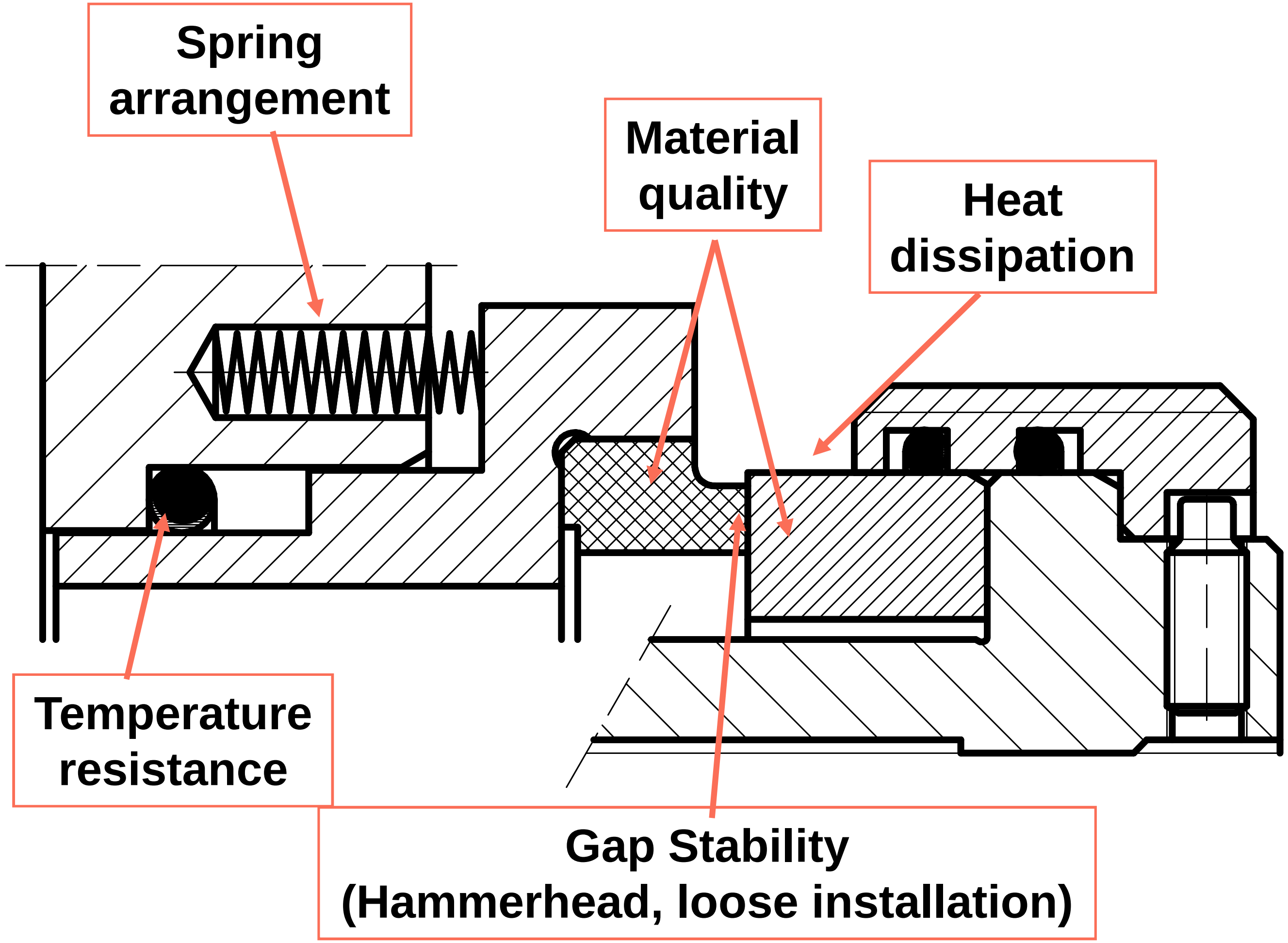

*+ Heat exchanger HED or HDK*
*+ Magnetic filter MF or Magnetic separator MS*
*Forced circulation (pumping device)*



# SB-Face Design

Mechanical Seal for Boiler Feed Pumps



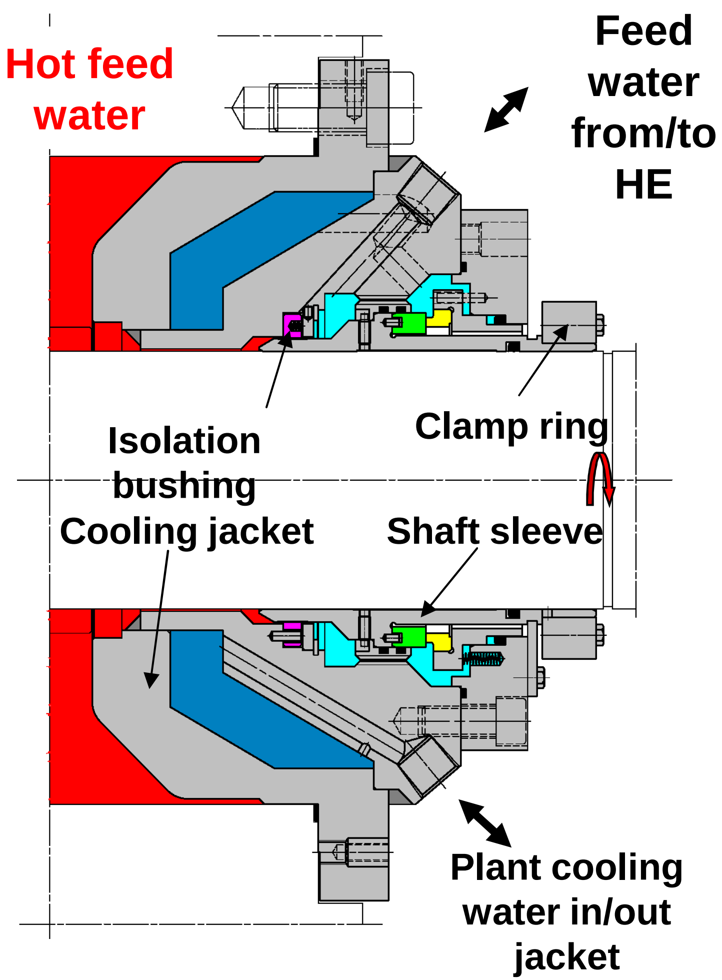


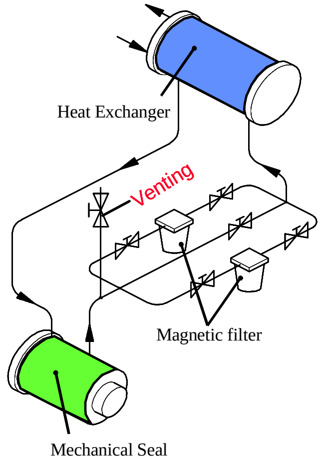


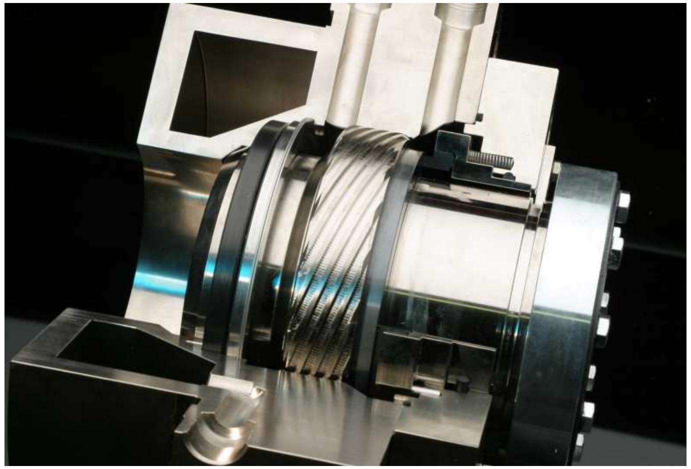




# SBF(V) seal with plan 23 (typical for main boiler feed pumps in fossil plants)



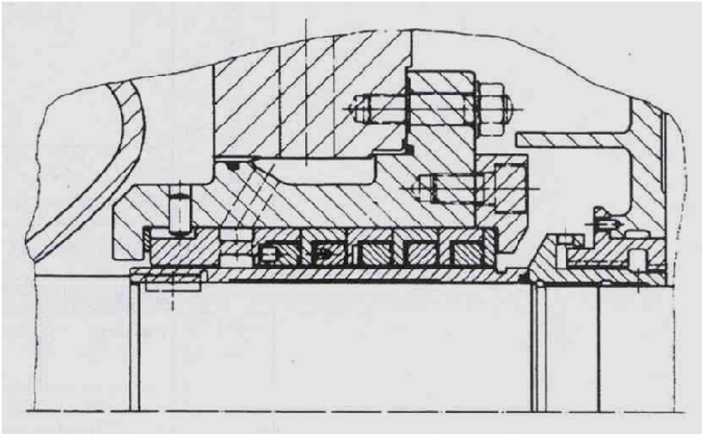


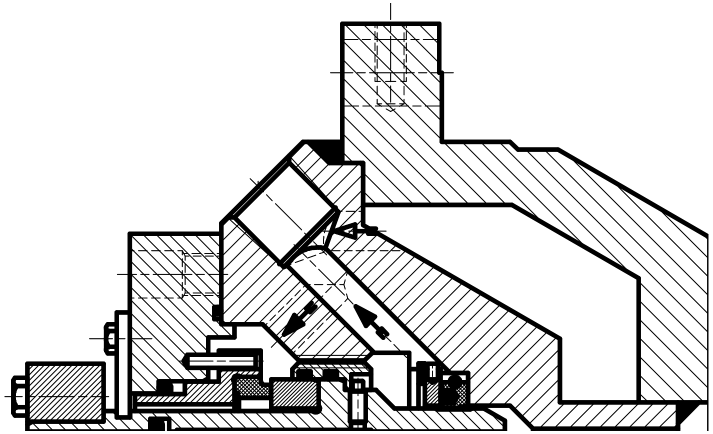


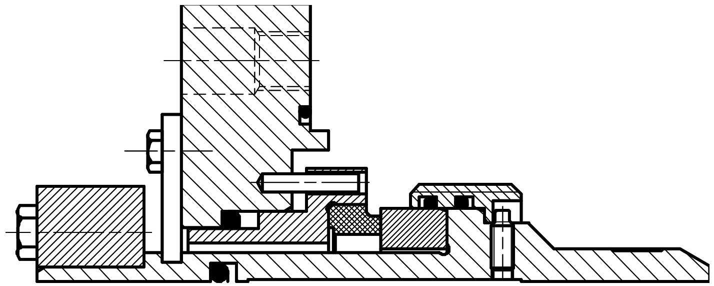



# Boiler Feed Pump

## Retrofit example of boiler feed pump with floating rings







**Benefits for the customer:**

- ➢Elimination of heat and hydraulic losses
- ➢Elimination of injection system
- ➢Independent operation (stand alone piece of equipment)
- ➢No potential for bearing oil contamination

**SBF seal cartridge for quick and easy installation and removal, simple to refurbish, low repair costs**

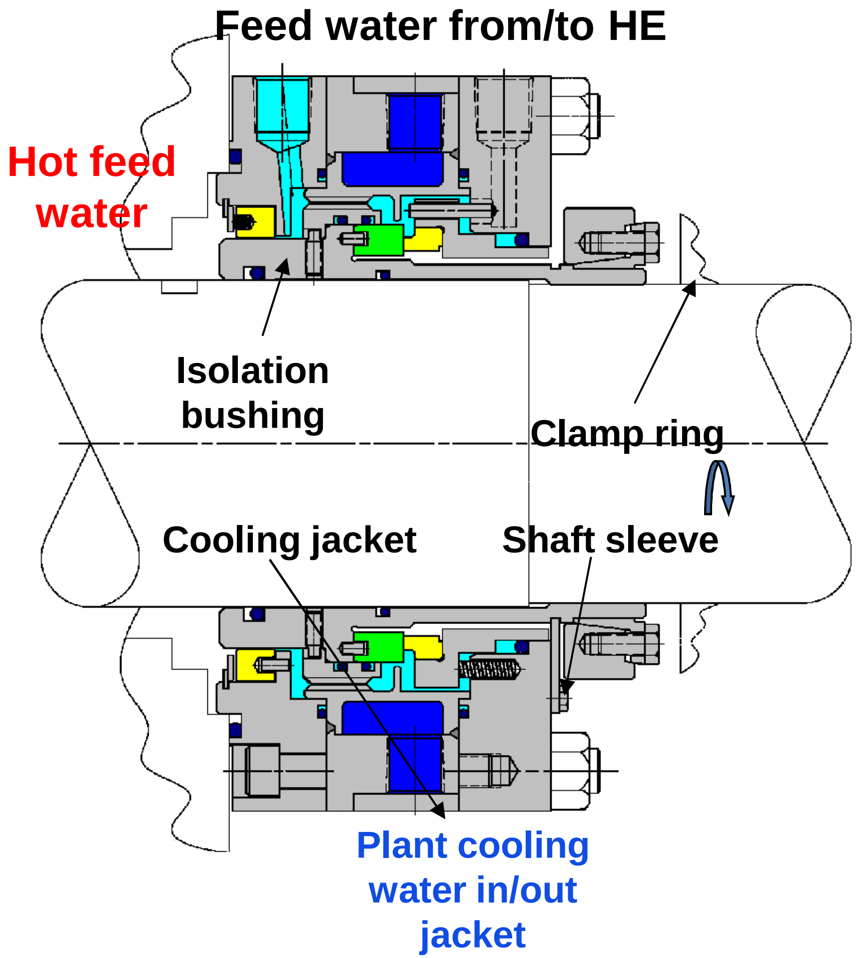


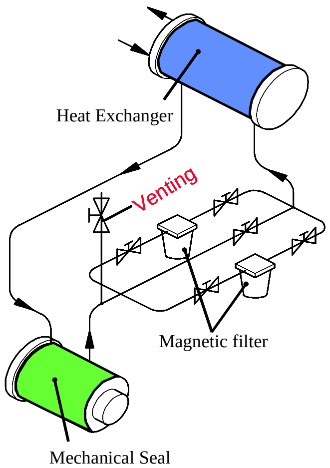







# Boiler Feed Pump Seal (SBF) with plan 23, for main feed pumps (fossil and nuclear) with limited axial and radial space

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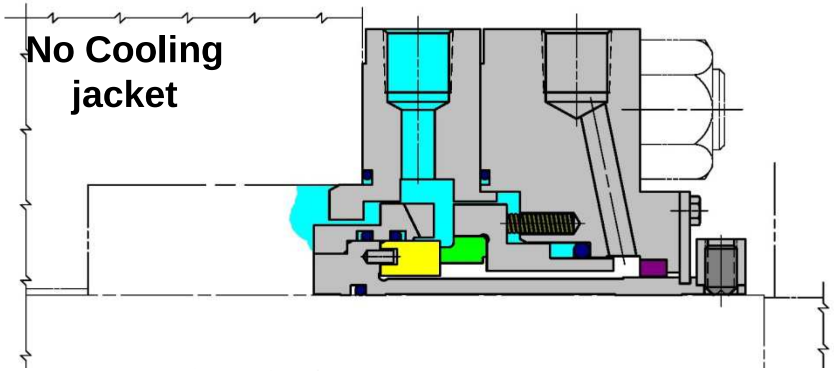
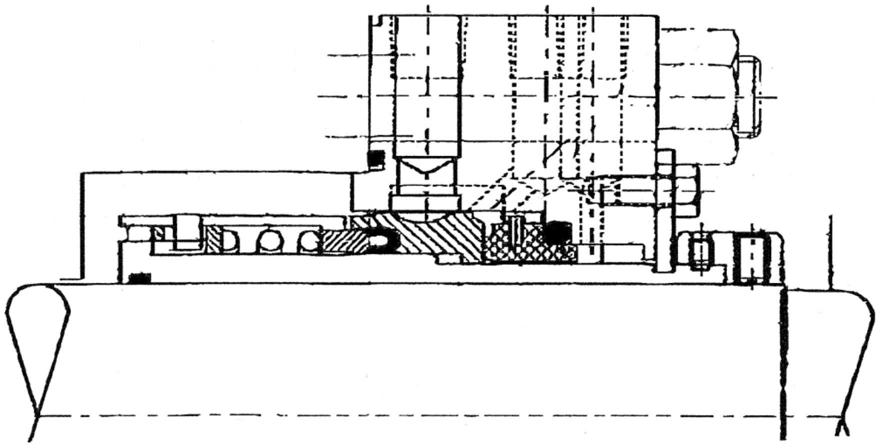
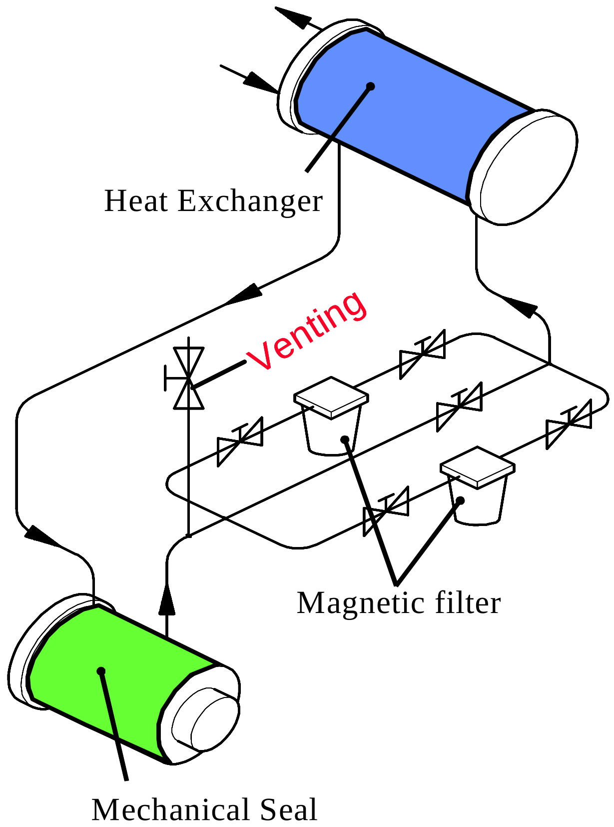
# Boiler Feed Pump Seal (SBP) with plan 23 to replace Type D seals from BWIP (Flowserve)

**Feed water from/to HE**











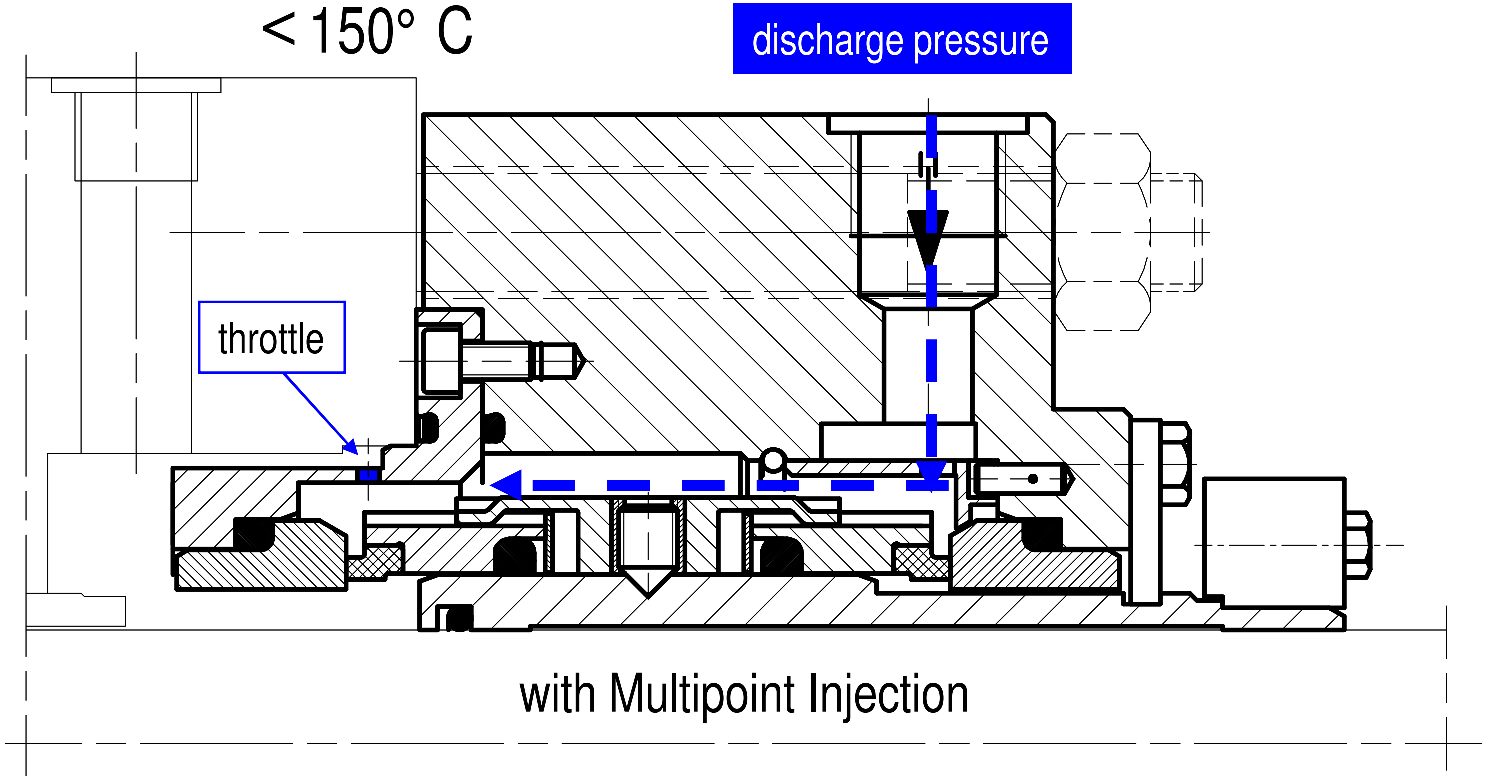




# Mechanical Seal for Boiler Feed Pumps

Uncooled mechanical seal for Boiler feed pumps

Type BTS < 20 (25) m/s
< 25 bar
< 150° C

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# Sealmatic type – HED for Boiler Feed Pumps

## HED

## Seal Supply Systems · Heat Exchangers

### Product Description

Heat exchangers of the HED range are used to cool process/barrier fluids in seal supply circuits. Designed as a tubular heat exchanger with integrated guide plates, the process/barrier medium is directed through the shell of the HED and the cooling medium through the tubes.

Circulation in accordance with API 682 / ISO 21 049: Plan 21 , Plan 22, Plan 23, Plan 41

### Technical Features

1. Tubular heat exchanger design with integrated guide plates, extremely efficient cooling capacity yet very compact dimensions
2. Cooling capacity up to 36 kW*
3. Universal usage: parts in contact with the medium are made of stainless steel
4. It can be installed either in vertical or horizontal position
5. The heat exchanger can be dismantled: easy to clean

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# Sealmatic type – HEK for Boiler Feed Pumps

## HEK

## Seal Supply Systems · Heat Exchangers

**Product Description**

HEK5120 heat exchangers are used to cool process/barrier fluids in seal supply circuits. The heat exchanger has a wound double helix around the guide tube. Process/barrier medium in the tubes, cooling medium around the tubes.

Circulation in accordance with API 682 / ISO 21049: Plan 21 , Plan 22, Plan 23, Plan 41

**Technical Features**

1. Effective cooling: with wound double helix around a guide tube
2. Cooling capacity up to 10.5 kW Excellent value for money
3. Vessel can be dismantled: for optimum cleaning of the cooling water side
4. Universal usage: parts in contact with the buffer medium are made of stainless steel

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# Sealmatic type – MF for Boiler Feed Pumps

## MF

## Seal Supply Systems · Magnetic Filter


### Product Description

1. **MF** filters are inline filters for installation inside pipelines.
2. The combination of magnetic rod and filter element guarantees a high level of efficiency.
3. Magnetic filters are used in seal supply systems and any other such systems in which a liquid has to be cleaned of magnetic and non-magnetic impurities up to a certain size.

### Technical Features

1. Combination device: magnetic filter and filter element Internal mesh to protect the filter element for reverse currents.
2. Venting screws in the filter inlet and outlet can be used as connections for maintenance or differential pressure indicator.
3. Housing can be dismantled: simple maintenance and cleaning.
4. All pressure-loaded parts are forged components.










# Sealmatic type – MS for Boiler Feed Pumps

## MS

## Seal Supply Systems · Magnetic Separator

**Product Description**

Magnetic separators of the CS range consist of a pressure casing with integrated magnetic rod. Magnetic separators are used in seal supply systems and any other such systems in which a liquid has to be cleaned of magnetic impurities.

**Technical Features**

1. For operating pressures of up to 150 bar
2. Housing can be dismantled: simple maintenance and cleaning
3. Reliable and rugged technology

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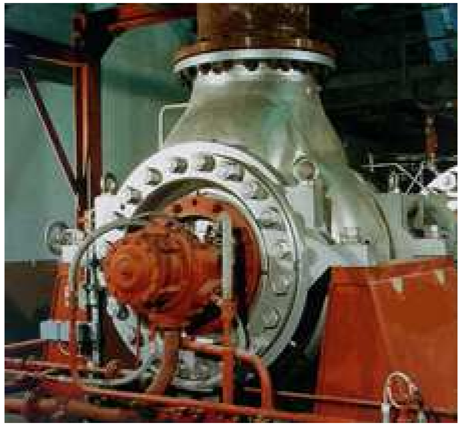
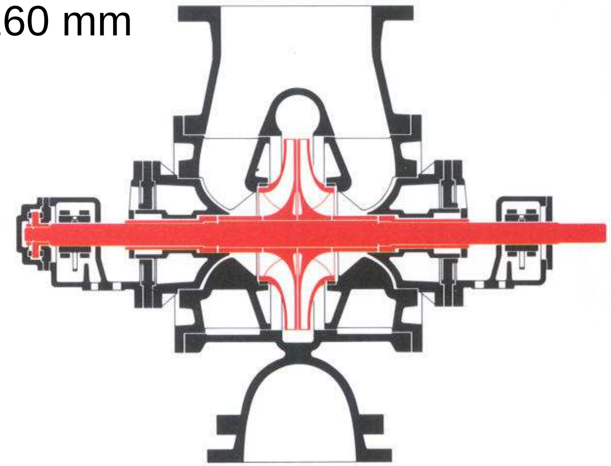
# Booster Pumps

The booster pump creates the required suction pressure to ensure problem-free operation of the main pump. These pumps increase pressure and are usually single or double flow centrifugal pumps.  Usually they are packed with cooled stuffing boxes or already have mechanical seals from our competitors.

| | |
|---|---|
| medium: | boiler feed water |
| temperature: | 160-230°C |
| temp. at mech. seal | max. 80°C |
| suction pressure: | 8-20 bar = pressure at mech. seal |
| discharge pressure: | up to 40 bar |
| RPM: | 1500 - 1800 1/min |
| mech. seal diameter: | 35 mm up to about 160 mm |














# Booster Pumps

*Mechanical seals with seat cooling.*

*These are mechanical seals for booster pumps or other feed pumps with lower duty.*

*Typical operating conditions are:*

| | |
|---|---|
| *Sliding speed* | *< 20 m/s* |
| *Pressure* | *< 15 bar* |
| *Temperature* | *150-230$^{o}$C* |

*The commonly used mechanical seal is the balanced seal type B750G115. This seal type normally is operated with seat and jacket cooling.*

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# Booster Pumps

## Uncooled mechanical seals

These are boiler feed pump seals in the lower range of speed and temp (e.g. booster pumps). They are operated without any cooling, only a product circulation from the pump case to the mech. seal has to be provided

Typical operating conditions are:

| | |
|---|---|
| Sliding speed | $<$ 10 m/s |
| Pressure | $<$ 25 bar |
| Temperature | $<$ 150 $^{o}$C |

It is very important to avoid dry-running of the mechanical seal.

Attention has to be given to the water chemistry. Deposits out of the feed water or precipitations of salts in the sealing gap have to be avoided.

The seal type can be a standard mechanical seal B750N, if the pressure is sufficient high → (>16 bar) a sufficient distance to the steam pressure has to be ensured.

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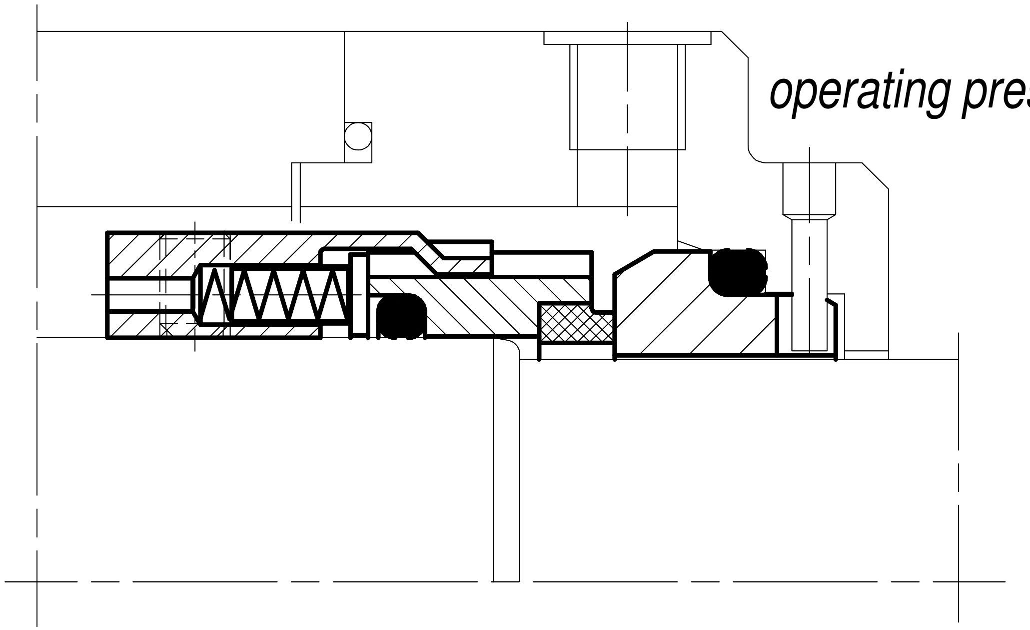
# Booster Pumps

*Uncooled mechanical seal for Boiler feed pumps*
*(plan 1 or 11)*
*(product circulation)*

*Type B750N*

*< 10 m/s*
*< 25 bar*
*< 150° C*



*Required :*
*operating pressure > steam pressure*








# Booster Pumps

## B700N

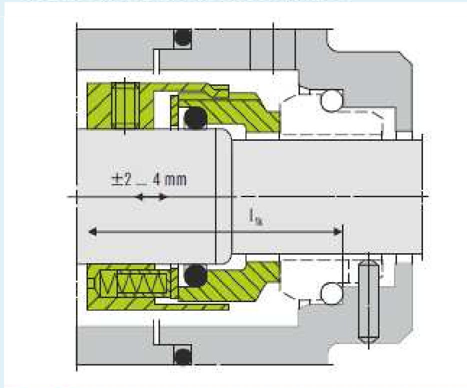
## Mechanical Seals for Pumps · Pusher Seals

**Product Description**

1. Balanced
2. Crest to Crest Wave spring or multiple springs rotating
3. For stepped shafts
4. Independent of direction of rotation
5. Integrated pumping device available (B700F, B750F)
6. Single seal
7. Variant with cooled stationary seats available

**Technical Features**

1. Flexibility in torque transmissions
2. Self cleaning effect
3. Short installation length also possible
4. Versatile application possibilities




**B750**

Shaft diameter: d1 = 28 ... 200 mm (1.10" ... 7.87")
As B700N, but with multiple springs in sleeves (Item no. 1.5)
Axial movement: ± 2 ... 4 mm, dependent on diameter

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# Seal Selection for Booster Pumps

*Example:* $t = 150°$
$p = 5{,}5$ bar
$n = 3.000$
$d_w = 50$

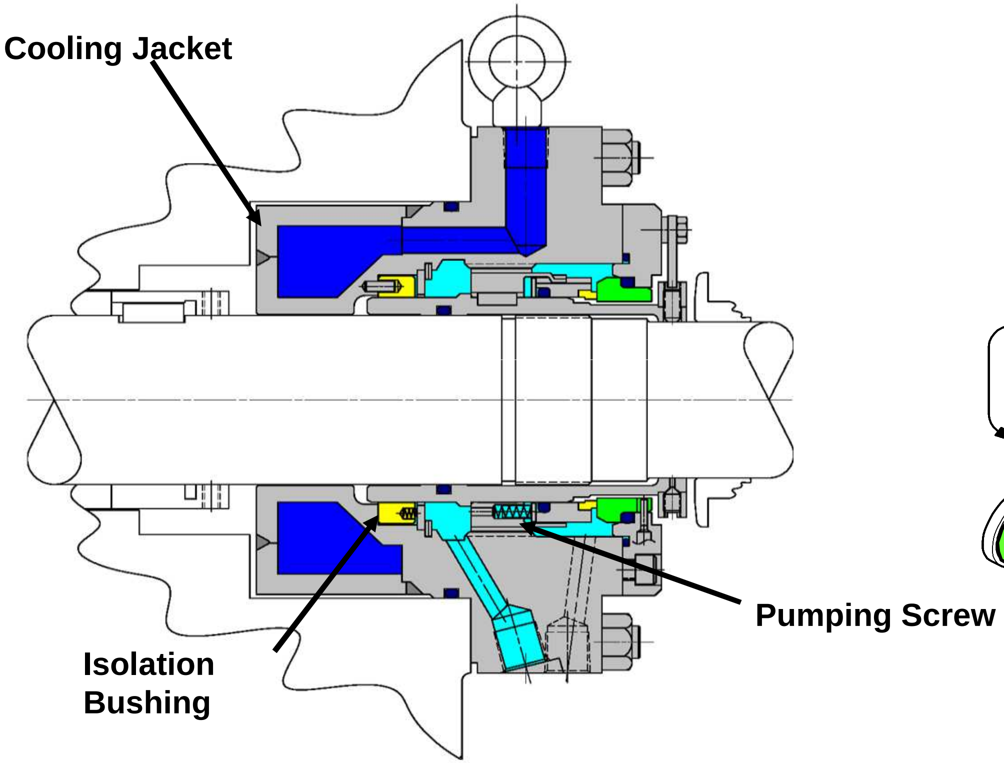
| *Seat and jacket cooling* | *No cooling* |
|---|---|
| *B750S2G115/50*<br>*API plan 02*<br>*70°* | *B750N/ 50*<br>*API plan 11*<br>*150°* |
| *Fluid film between the seal faces* | *Evaporation between the seal faces possible* |
| *Longer seal life* | *Dry run / high wear* |

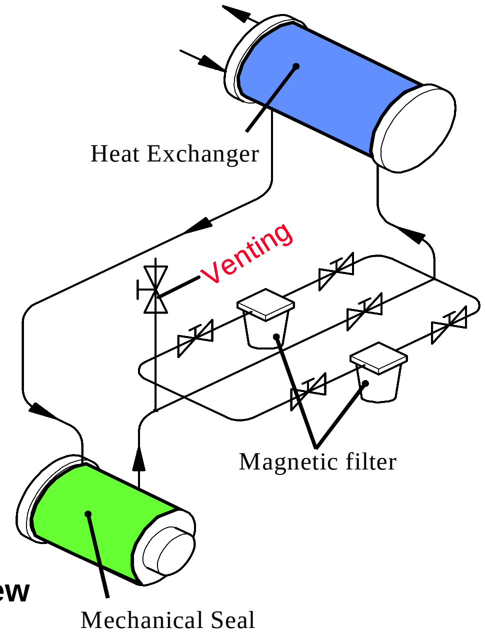




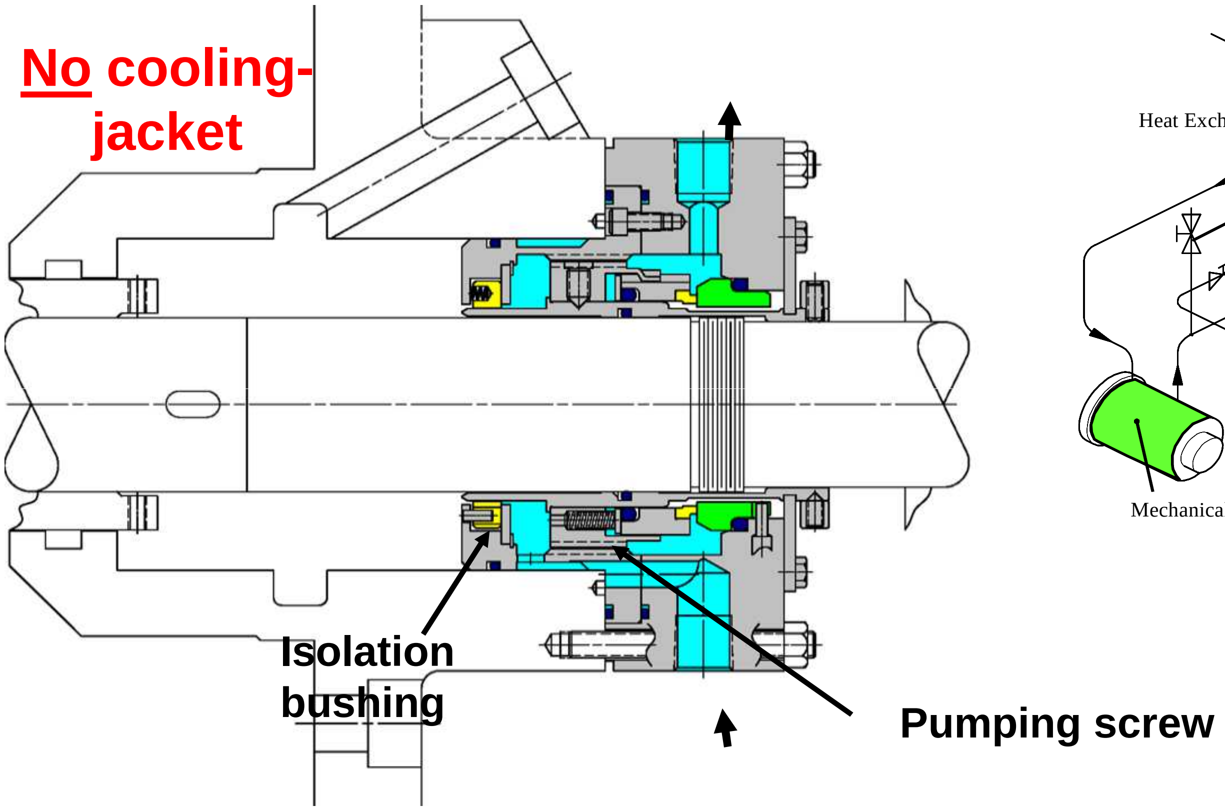


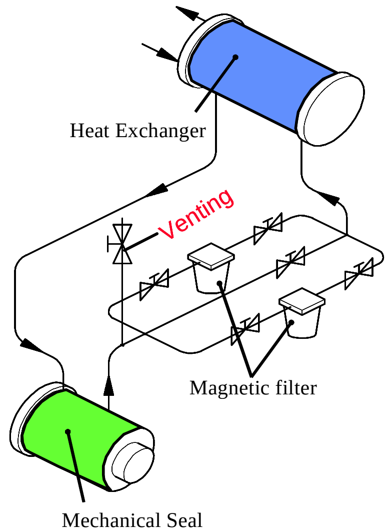

# B750F seal with Shaft dia. < 3.500 inch @ 3600 rpm, feed water temp. > 165°C




# B750F with shaft dia. < 3.5 inch@3600 rpm, feed water temp. < 330 F













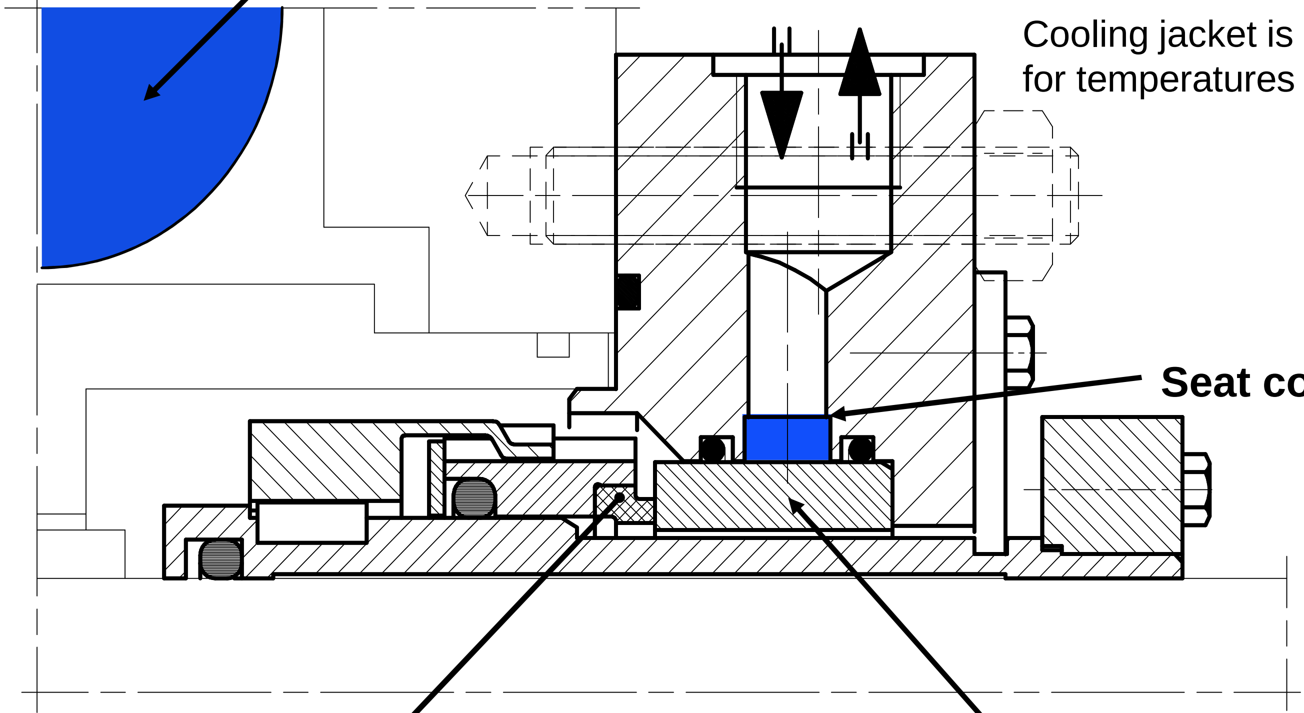
# B750G115 with seat cooling for booster pumps or small feed pumps

Max speed < 20 m/s

Max pressure < 20 bar

Max temperature < 200°C

Cooling jacket is imperative for temperatures above 120°C

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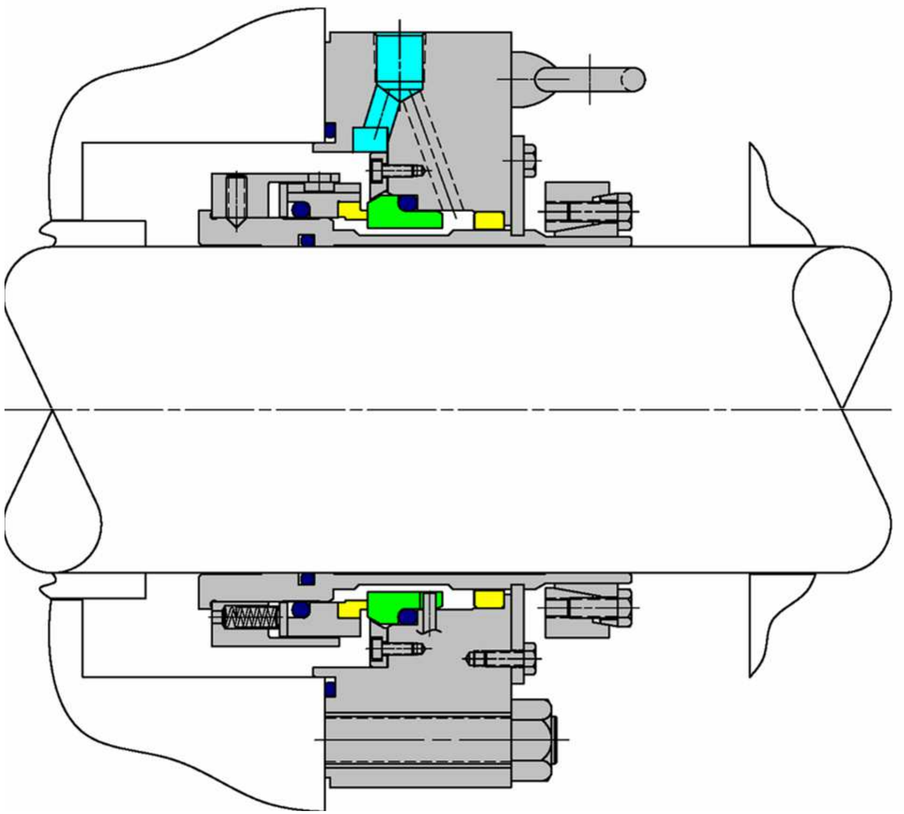
# B750 single seal, un-cooled with plan 11



**Max speed < 10 m/s**

**Max pressure < 20 bar**

**Max temperature < 140°C**

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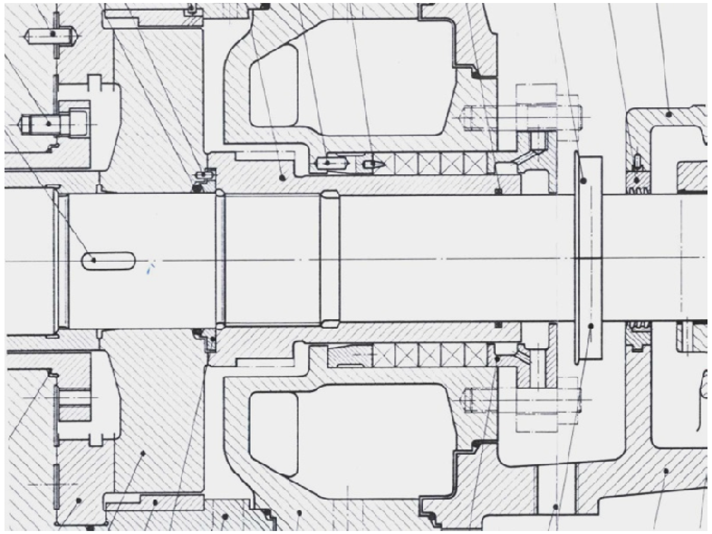
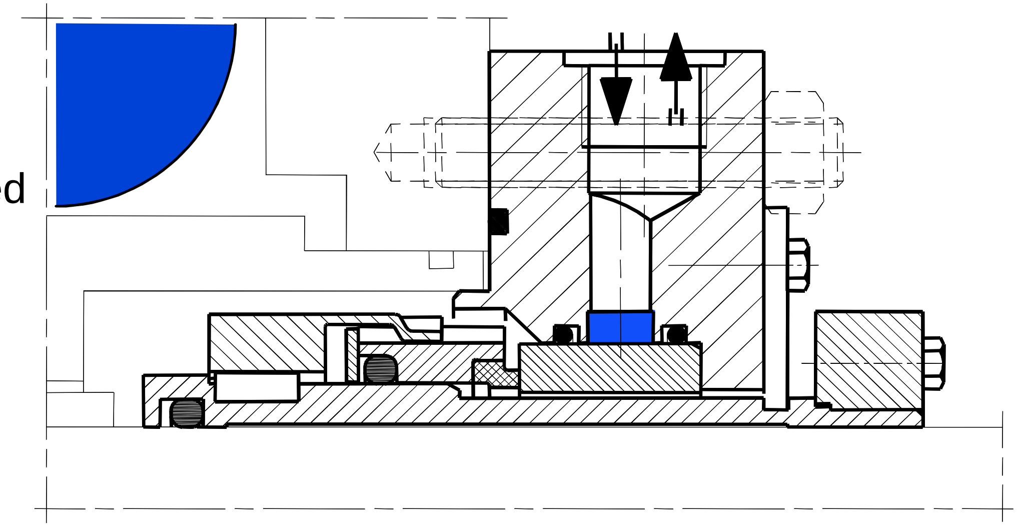
# Retrofit example of packed Booster Pump



Benefit for customer:
•Less cooling water required
•No packing maintenance
•Cleaner environment



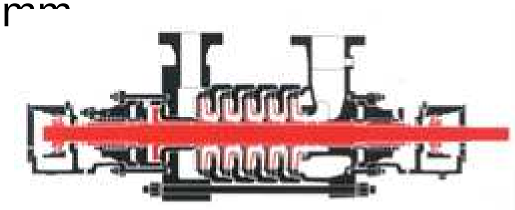


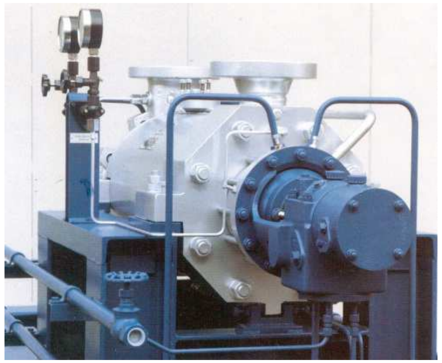
# Auxiliary start up and shut down pump

The start-up and shut-down pump in the feed water circuit of a pressurized water reactor does the following:

- feeds water from the feed water tank to the steam generator while the system heats up to operating temperature and reactor power output reaches about 3%
- feeds water from the feed water tank to the steam generator while the system is shutting down and reactor power output falls to below about 3% and during the cooling down phase until the nuclear residual heat removal system takes over the cooling function
- emergency supply of water to the steam generator from the feed water tank in emergency power mode or if a pipe ruptures in the water/steam circuit.

| | |
|---|---|
| medium: | boiler feed water |
| temperature : | up to about 200°C |
| temp. at mech. seal: | max. 80°C |
| suction pressure: | 10-16 bar = pressure at mech. seal |
| discharge pressure: | up to about 120 bar |
| RPM: | 3000 to 3600 1/min |
| mech. seal diameter: | 50-80 mm |





typical mech. seal:
B750G115/dw-EX



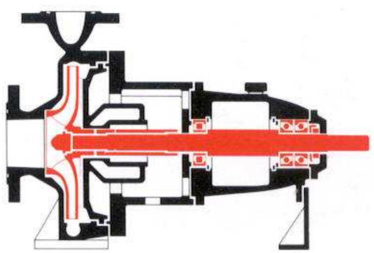


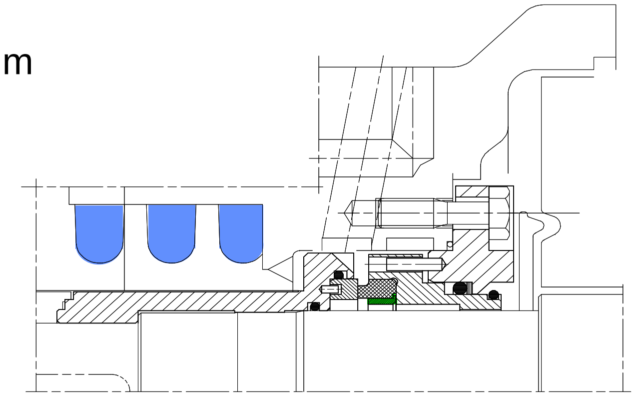



# Boiler Circulating Pumps

The (boiler) circulation pump creates forced circulation in a closed system such as a heating system, forced circulation boiler, etc. The design of these pumps is determined by high medium temperatures and head which is low compared to system pressure due to high pressure losses in the circulation system. Horizontal, single-stage pumps with a volute casing are often used. Vertical IR-inline pumps (VEH/VEM) are often used in the USA.

| | |
|---|---|
| medium: | heating or boiler feed water |
| temperature: | up to 350°C |
| temp. at mech. seal: | max. 75°C |
| design pressure: | up to 150 bar = pressure at mech. seal |
| RPM: | up to 3000 1/min |
| mech. seal diameter: | 25 mm up to about 125 mm |





A cooled high-pressure mechanical seal is used to seal the pump shaft against full system pressure. This is accomplished with a single stage up to 150 bar of pressure and a maximum vg of 10 m/s.

typical mech. seal:

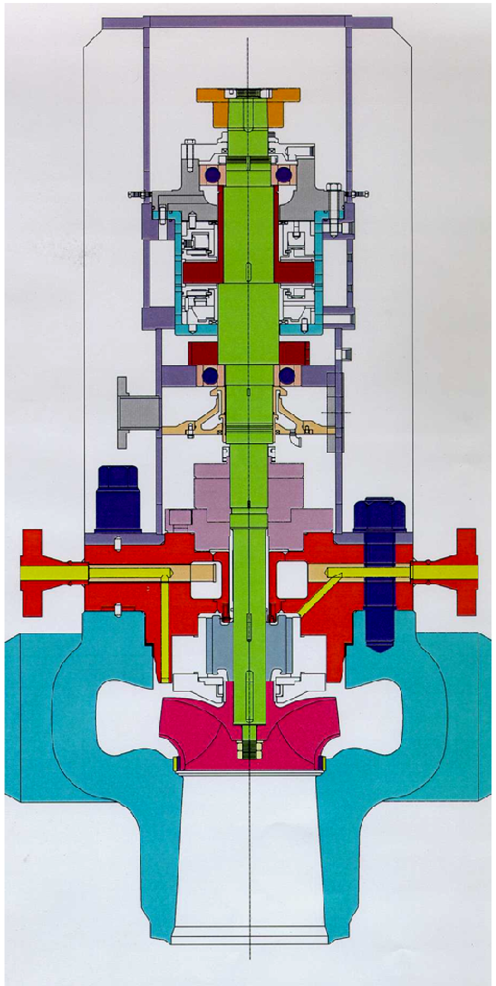
SBPV or SBFV in AQ2EGE API Plan 23 (with jacket cooling)

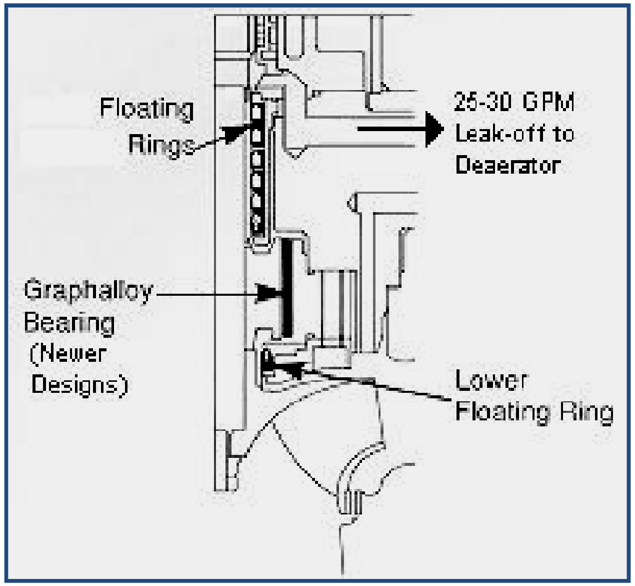


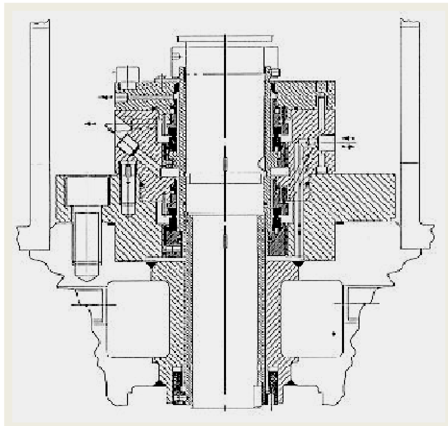





# IR Boiler circulating pumps type VEH/VEM on CE boilers





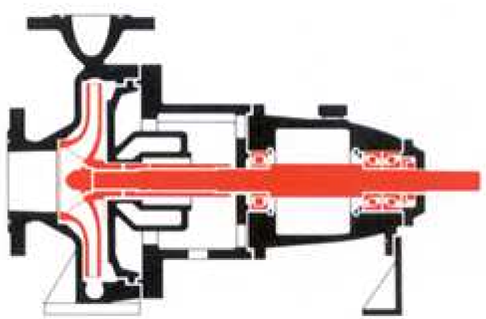









# Boiler Circulation Pump



Typical conditions

Temperature: up to 350°C
T at seal:   max. 75°C

Suction pressure: up to 150 bar = seal pressure

Speed: up to 3000 1/min

Seal diameter: 25 to approx. 125 mm

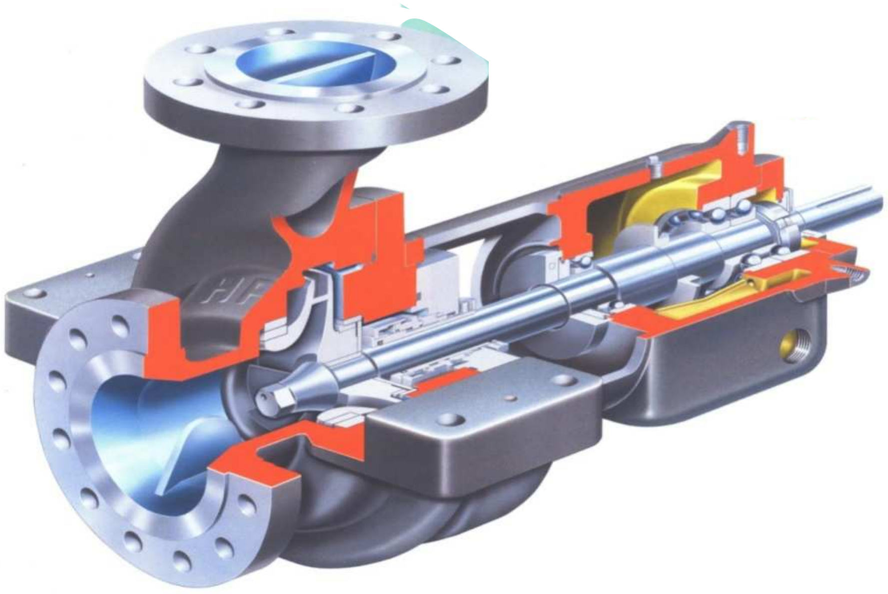









# Boiler Circulating Pumps



Horizontal, single stage pumps with volute casing are often used.
Canned motor pumps are also common.



# BOILER CIRCULATION PUMPS

The outstanding conditions are the high temperature and the high pressure of these pumps. The speed is normally low, approximately 1500 rpm. Due to the temperature an effective cooling system is necessary, consisting a intensive jacket cooling and circulating through a heat exchanger.

Sliding speed < 15m/s
Pressure < 220bar
Temperature max $350^{o}C$

Mechanical seal types can be:
SBFV or SBPV with pumping screw or pumping ring
SBFV-TA (>150 bar)
The high pressure requires metal support rings at the inner diameter of the carbon face to prevent distortions.



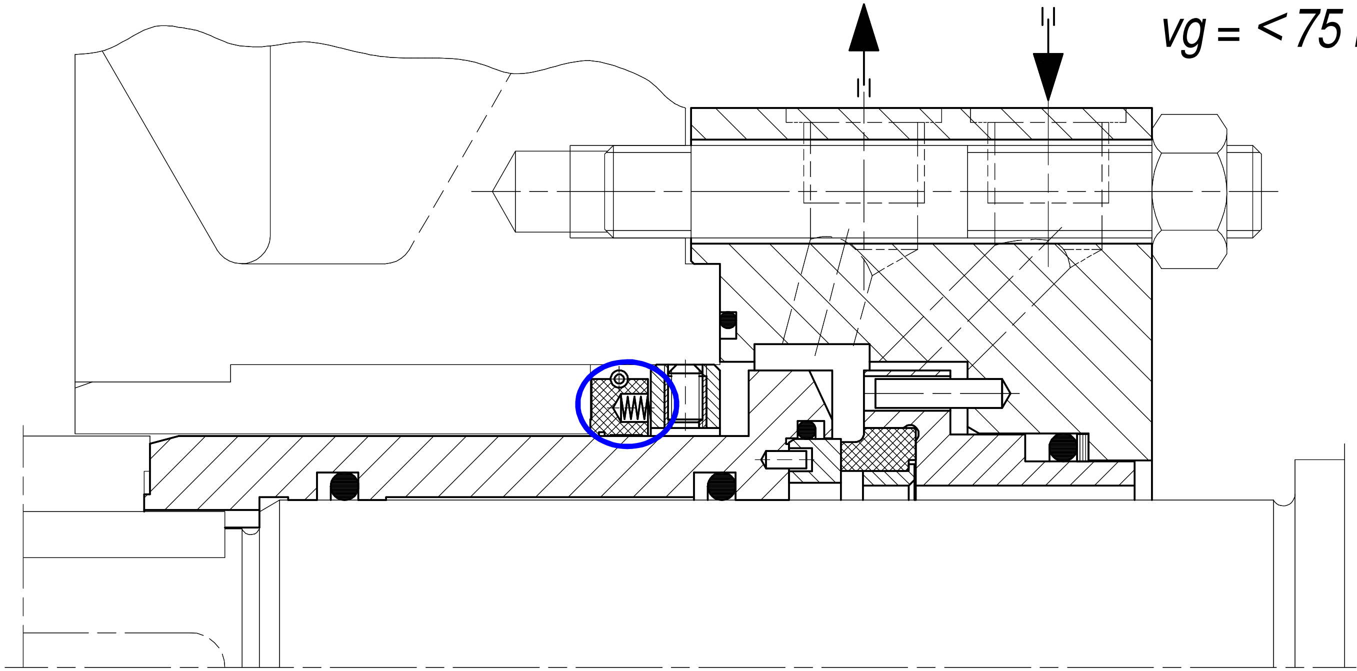





# BOILER CIRCULATION PUMPS

*for Boiler Circulation Pumps*
*with Thermo stop (clearance seal)*
*Type SBPV1*

*d1 = 30-240 mm*
*t = < 350° C*
*vg = < 75 m/s*



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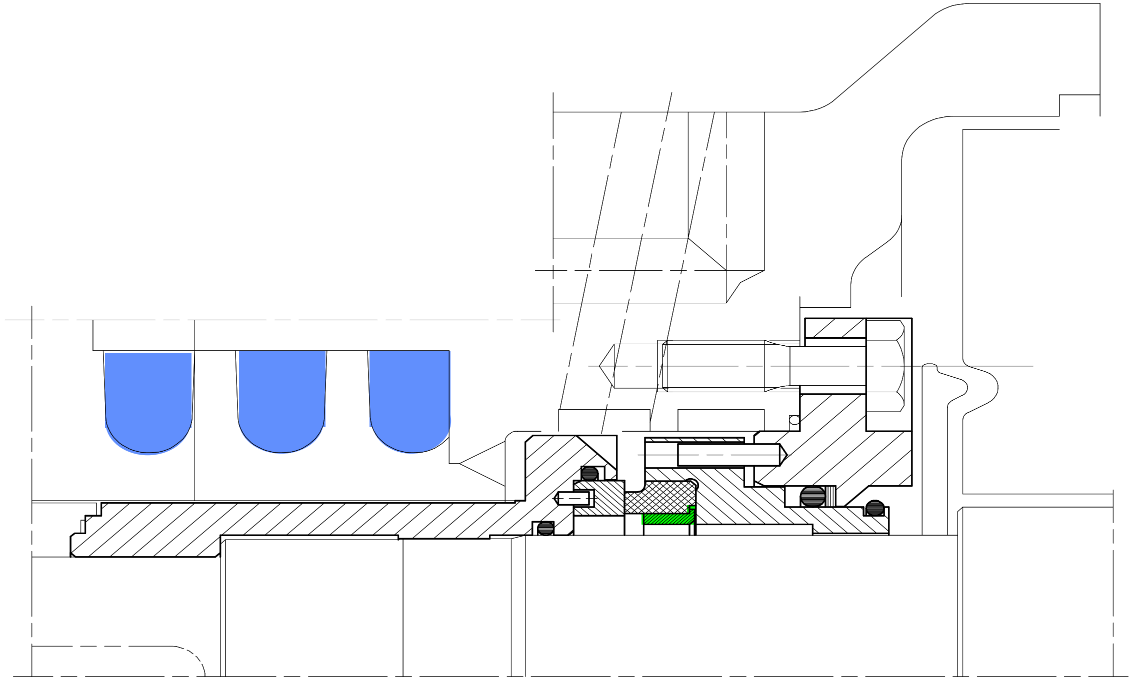
# Boiler Circulating Pumps



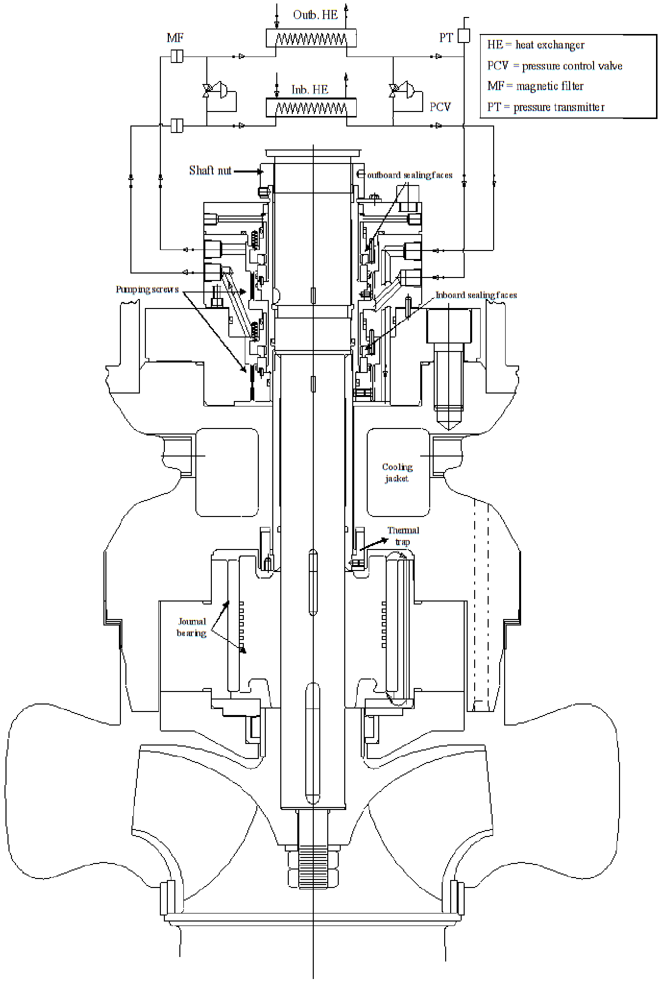
A cooled high-pressure mechanical seal is used to seal the pump shaft against full system pressure. This is accomplished with a single stage up to 150 bar of pressure and a maximum vg of 10 m/s.
typical mech. seal:
SBPV or SBFV in AQ2EGE API Plan 23 (with jacket cooling)



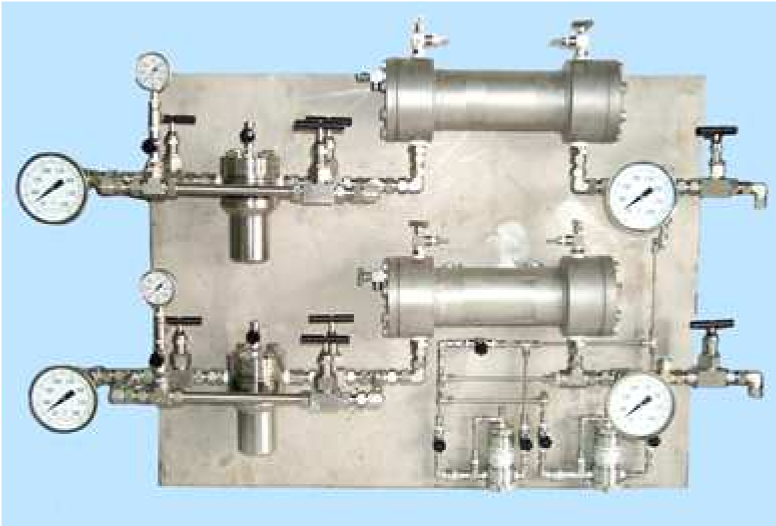





# Sealmatic sealing system for Boiler Circulating Pumps IDP VEM/VEH P = 220 bar, T= 370°C, N = 1800 rpm, D = 125 mm




- ➢ **Staged high pressure seal with automatic pressure break down**
- ➢ **Very good operating results**
- ➢ **Excellent paybacks**



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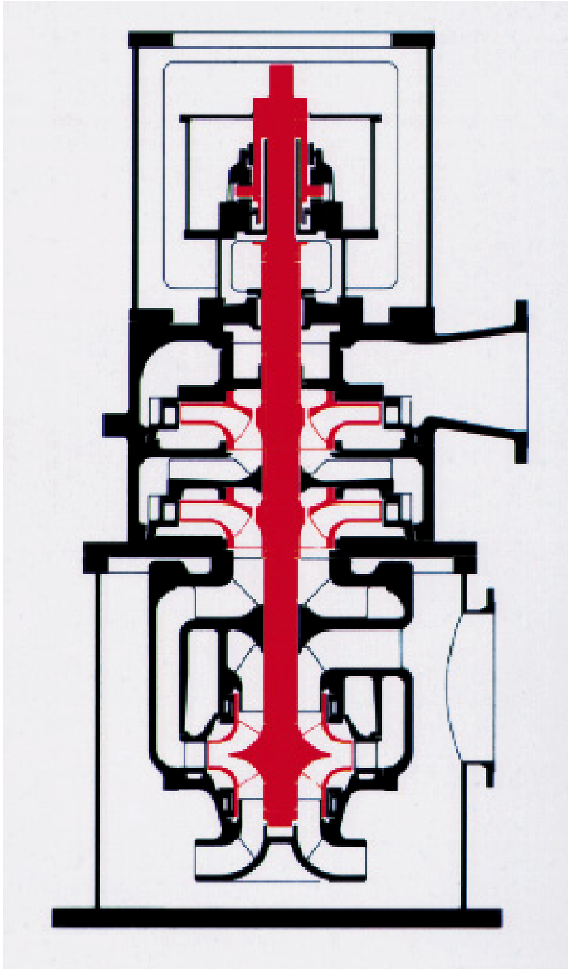
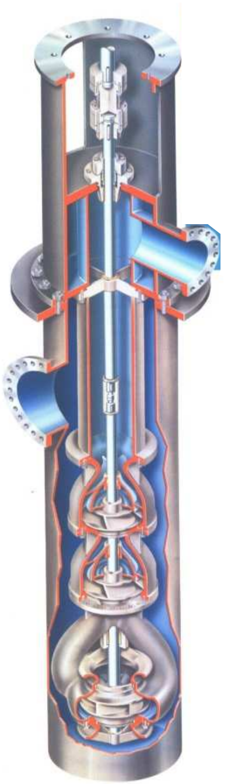
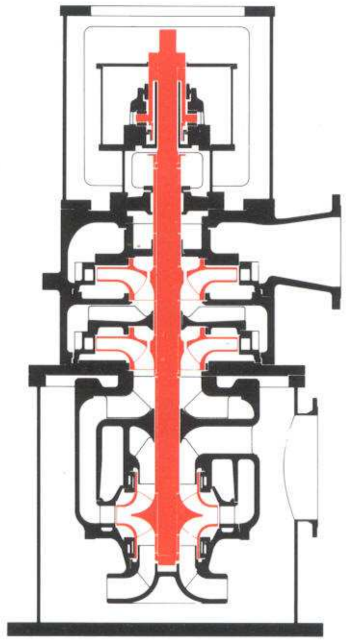
# Vertical Condensate Pump



# Condensate Pumps





Because stringent demands are placed on suction characteristics, vertical, multi-stage barrel-type pumps with dual-flow first stage, sectional barrel-type pumps or two-stage vertical pumps with an auxiliary rotor are used. .









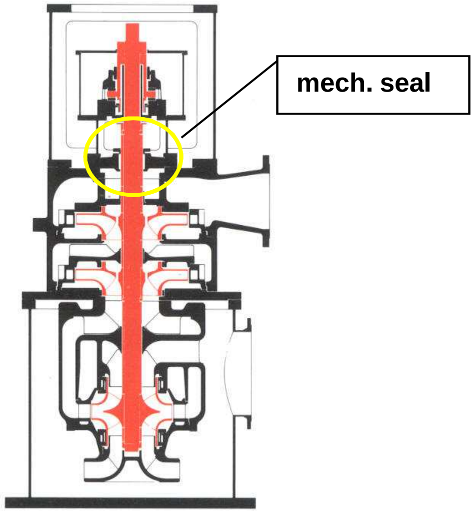

# Condensate (condenser hot well) pumps

The condensed steam pump removes steam, which has precipitated as water in the condensers, under vacuum. (→suction pressure = vacuum). In open circulation systems, the condensed steam (hot well) pump moves the condensate into a tank (for example a feed water tank). On closed circulation systems, the condensate is pumped via a low-pressure preheater directly to the boiler feed pump. Because stringent demands are placed on suction characteristics, vertical, multi-stage can-type pumps with a dual-flow first stage are commonly used.

The pump suction intake is positioned near the bottom of the vessel to maximize the suction pressure.

| | |
|---|---|
| medium: | condensate (pure water) |
| temperature: | normally 35-40°C = temp. at mech. seal |
| suction pressure: | 0.5 to 1 bar = pressure of medium at mech. seal |
| discharge pressure: | up to 30 bar |
| RPM: | 1500 - 3000 1/min |
| mech. seal diameter: | 50 mm up to about 180 mm |

Note:
In some plants the condensate pumps can be horizontal.













# CONDENSATE PUMPS

These are pumps for lower duty with the following operating conditions:

| | |
|---|---|
| Sliding speed | <15m/s |
| Pressure | <10 bar |
| Temperature | <100$^{o}$C |

The normally used seal type is B750N, a single balanced seal with throttle and quench at the atmosphere side.

In case of vacuum during standstill it is necessary to use it in tandem arrangement with quench or as double seal with pressurized buffer medium.

➔ To avoid dry-run after start up

➔ To avoid penetration of air into the pump





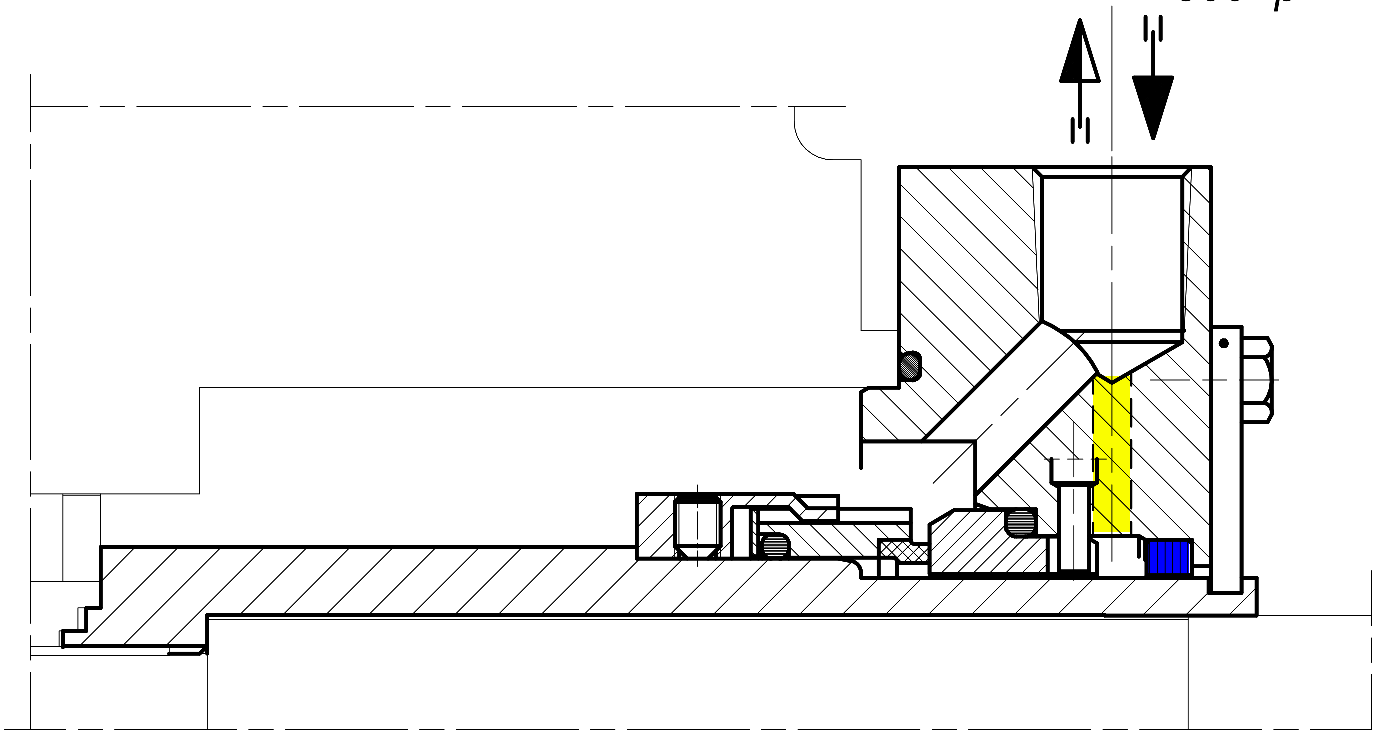





# CONDENSATE PUMPS

*for Condensate Pumps*
*Type B750N*
*with throttle and quench*

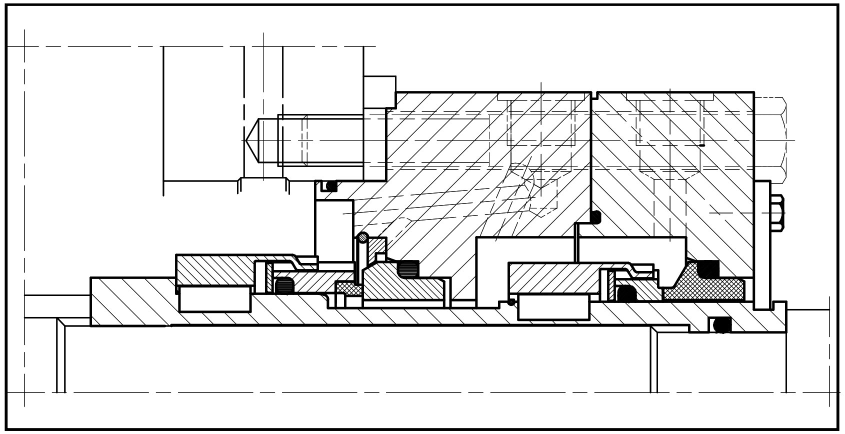
*< 100° C*
*< 10 bar*
*< 1500 rpm*

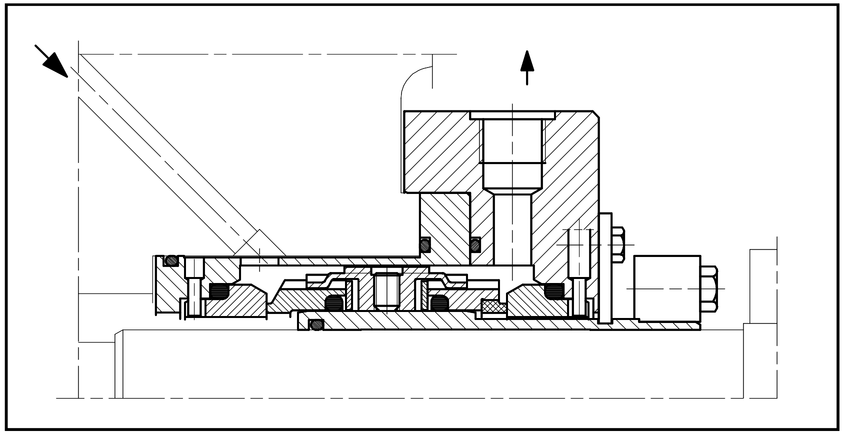


# CONDENSATE PUMPS

*VACUUM at STAND STILL*

*B750N Tandem Seal* *or* *Double Seal*





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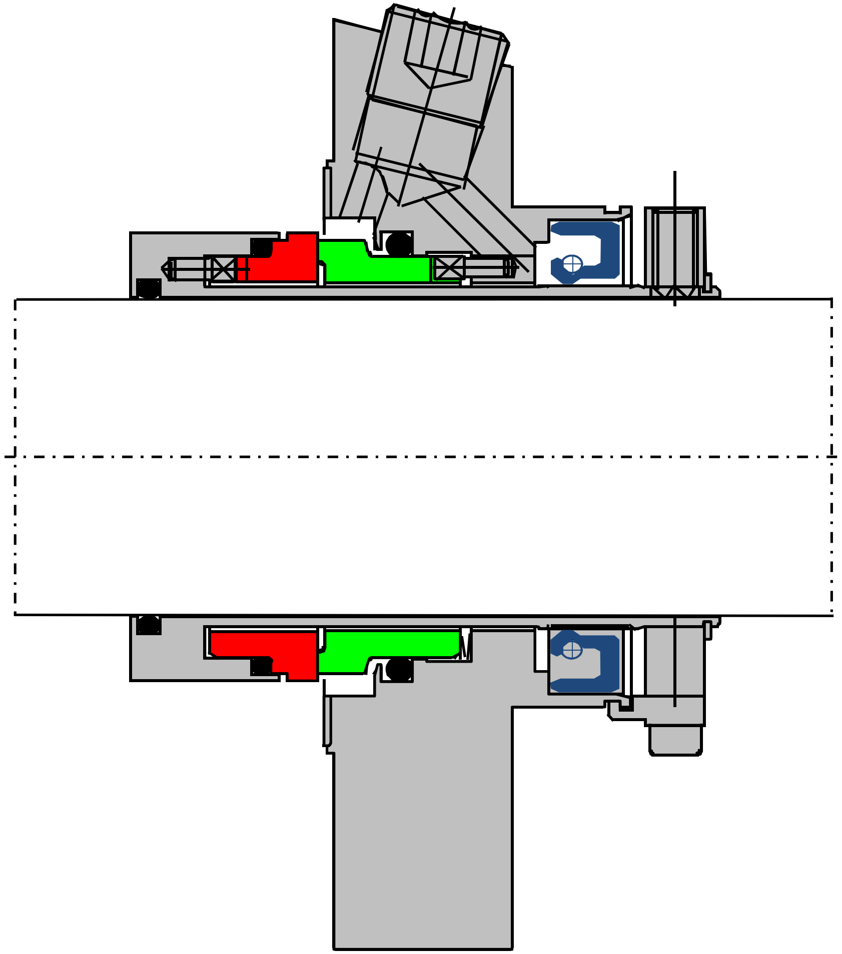
# Condensate Pumps



## Type 1

**CTX-QN**
Single seal (with optional quench)
Plan 11 for horizontal pumps
Plan 13 for vertical pumps

A possibly vacuum influence
has to be considered!

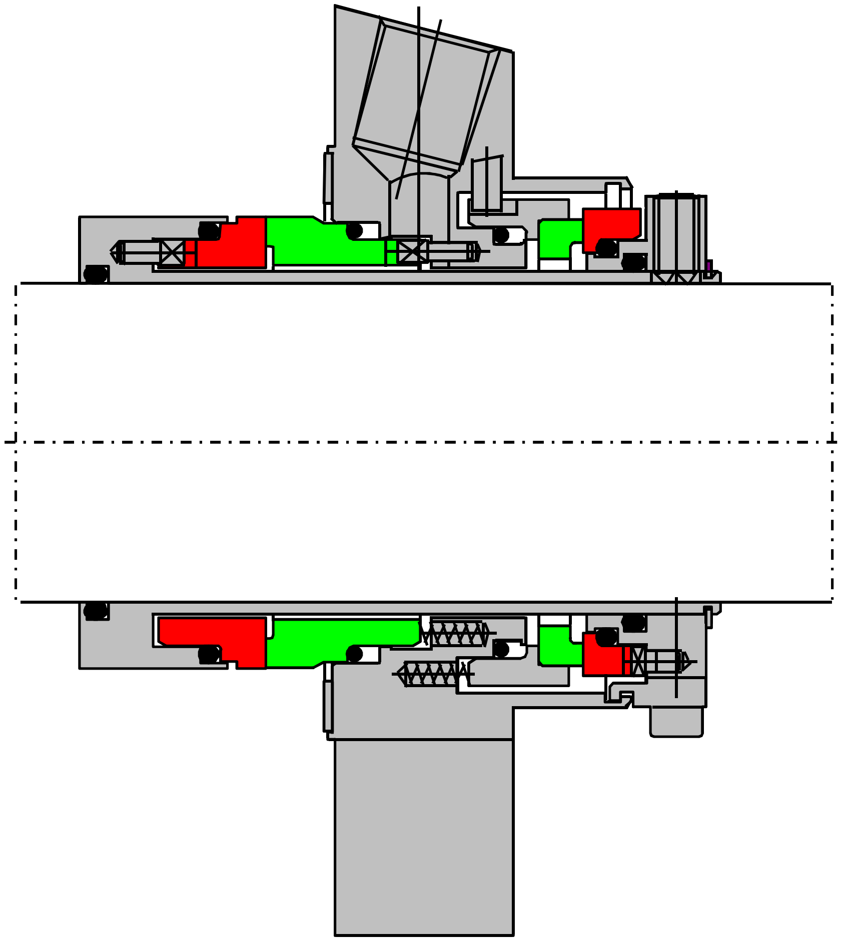








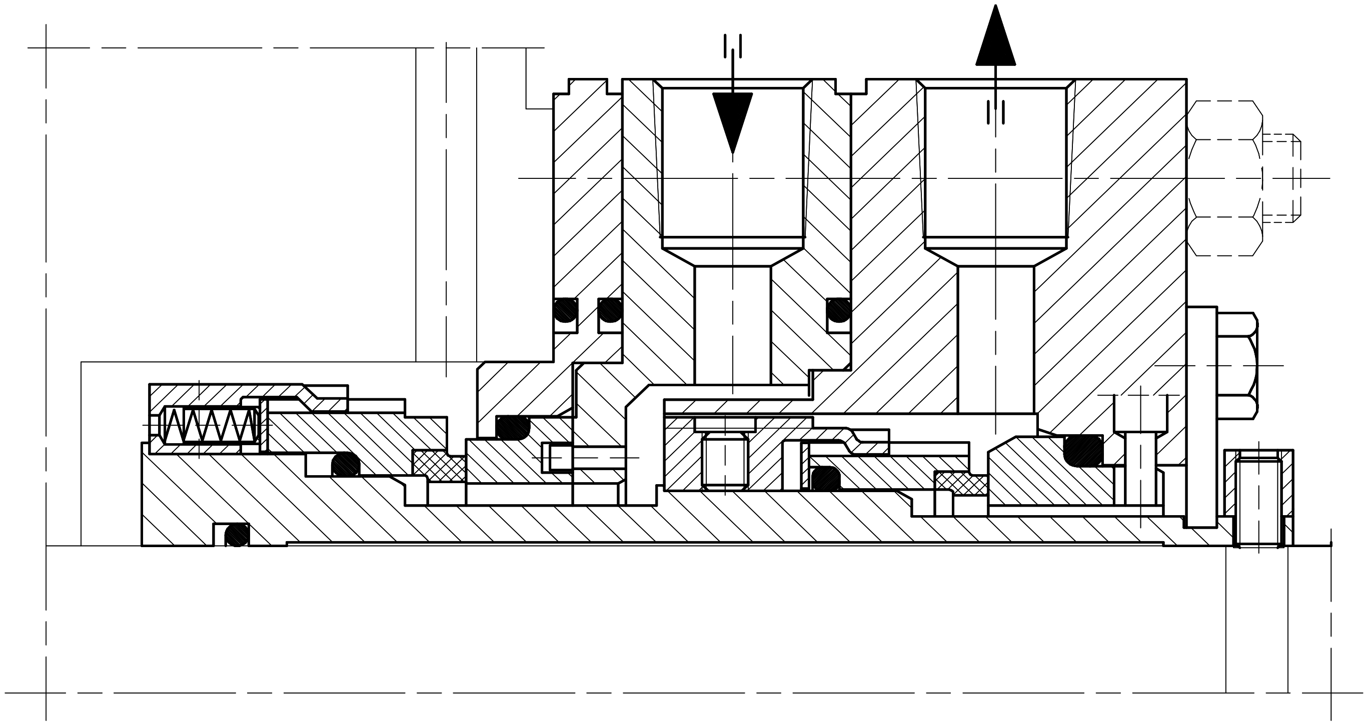

# Condensate Pumps



**Type 2**

**CTX-DN**
Double seal
(pressureless or prezurized)

# Condensate (condenser hot well) pumps



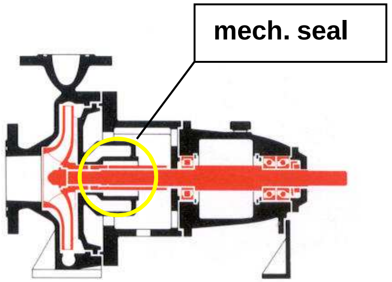
**Type 3**
Tandem seal
(pressureless quenched)

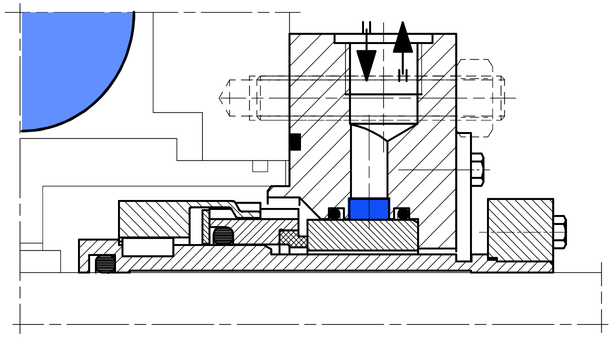
Preferably: B750K/..-Ta

# Intermediate condensate pumps

This pump returns the intermediate condensate (for example from a water separator/intermediate super heater) which is generated in the steam/water circulation system at a power station to the circulation system. Single-stage, horizontal centrifugal pumps with jacket cooling are normally used in this application.

| | |
|---|---|
| medium: | condensate |
| temperature: | up to 200°C |
| temp. at mech. seal: | max. 80°C |
| suction pressure: | 10-15 bar = pressure at mech. seal |
| discharge pressure: | up to 20 bar |
| RPM: | 1500 - 3000 1/min |
| mech. seal diameter: | 40 up to about 100 mm |



Typical mech. seal: B750 Type 2, 3 or 4 seals with direct or indirect cooling

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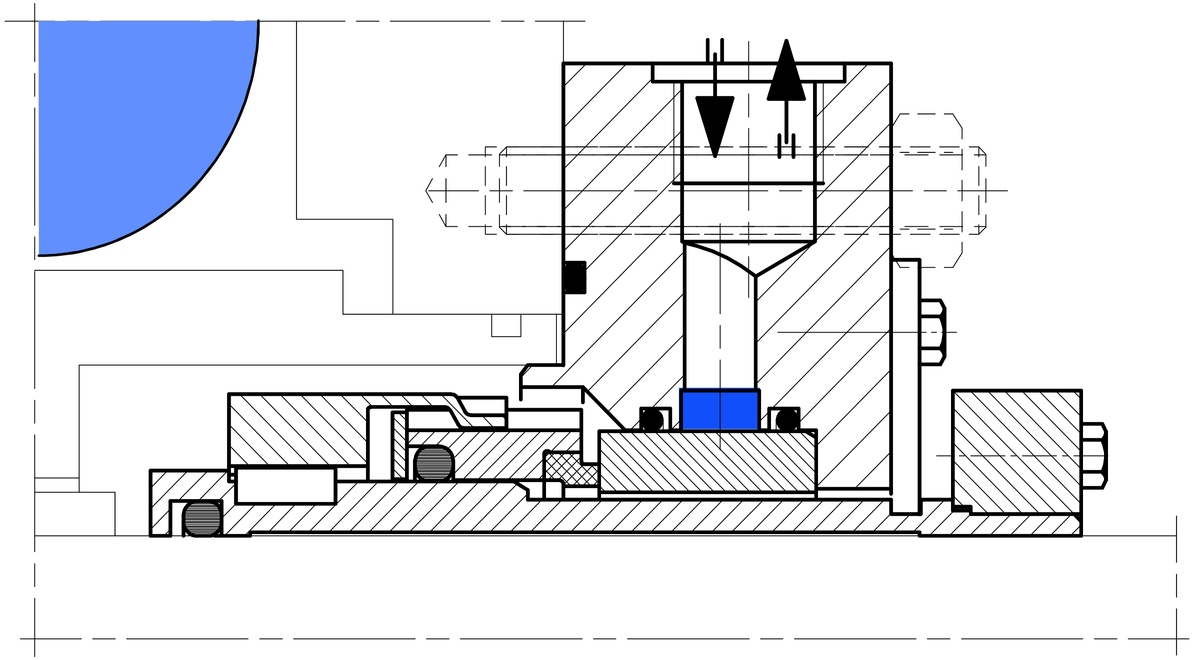
# Intermediate Condensate Pumps



Typical mech. seal: B750...

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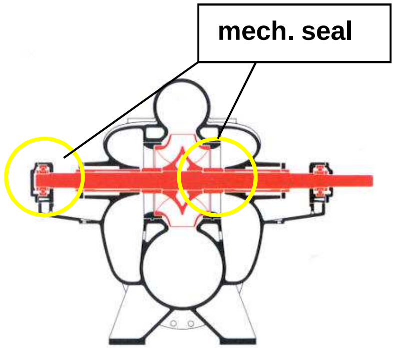
# Auxiliary Cooling Water Pump

This pump feeds auxiliary cooling systems (oil coolers, cooling machines, etc.) in the power station. When used as nuclear auxiliary cooling water pumps, they ensure that heat is removed from stand-by power diesel generators, cooling equipment with power back-up and the intermediate cooling circulation systems. Split-case, horizontal pumps in a volute casing or vertical tubular casing pumps are normally used. Both of these types pump large volumes at low differential pressure.

| | |
|---|---|
| medium: | cooling water |
| temperature: | 10 to 35°C = temp. at mech. seal |
| suction pressure: | 1-2 bar = pressure at mech. seal |
| discharge pressure: | 5-8 bar |
| RPM: | up to 1500 1/min |
| mech. seal diameter: | 50 mm up to about 150 mm |




Typical mech. seal:
B700, U700, UG100, etc. Plan 11
or BGH210/dia.-EX, Plan 11

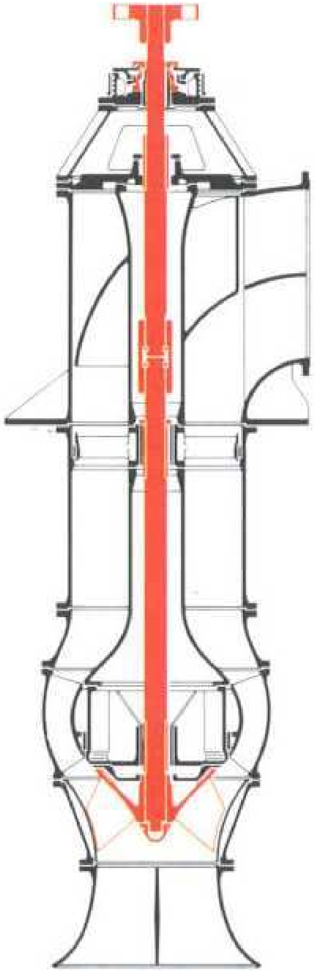









# Vertical Cooling Water Pump

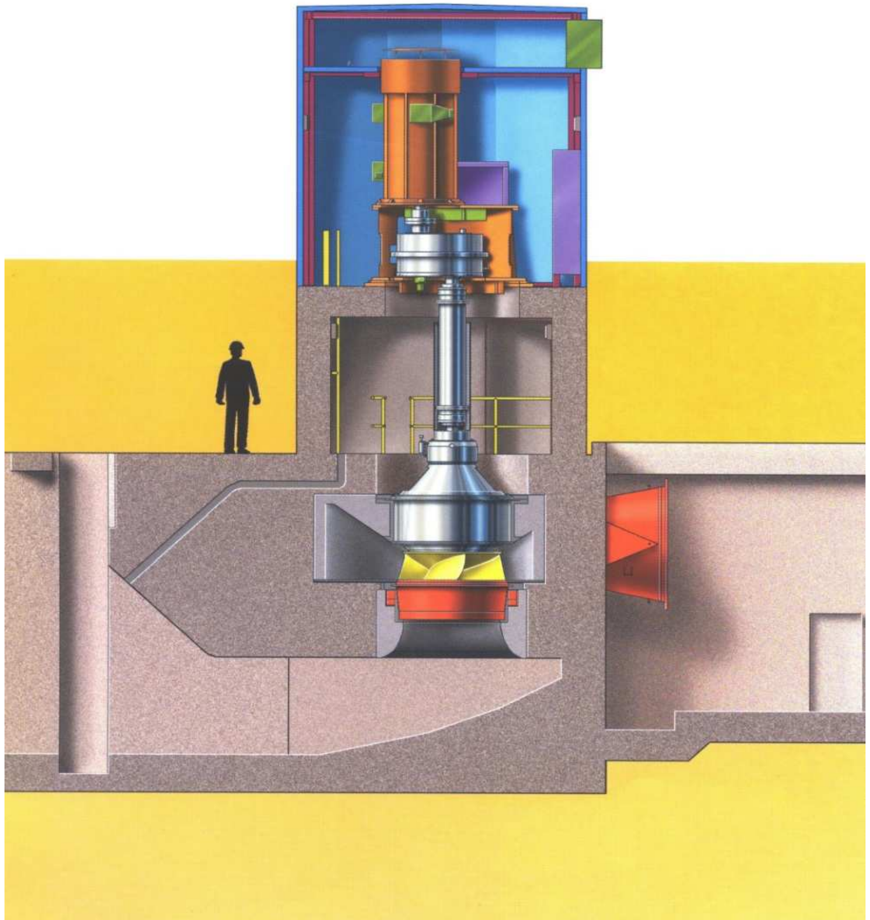









# Cooling Water Pumps



Tubular casing or concrete casing pumps with high pumping volumes at low differential pressure are commonly used.








# COOLING WATER PUMPS

*For big cooling water pumps it is necessary to install split seals to reduce down times and costs.*

| | |
|---|---|
| *Sliding speed* | $< 10 m/s$ |
| *Pressure* | $< 5(10)$ bar |
| *Temperature* | $< 40^{o}C$ |

*Split seals type BGH210/211 and SPX allow a quick replacement of seal parts for maintenance.*



# Cooling Water Pumps

| | |
|---|---|
| Medium: | Water (river-, sea-, brackish-, or treatet water) |
| Temperature: | up to appr. 40°C |
| T at seal: | up to appr. 40°C |
| Design pressure: | 0-10 bar = pressure at seal |
| RPM: | up to appr. 1000 1/min |
| Seal dia.: | 50 up to appr. 350 mm |

Commonly used seal design:
Single, balanced mechanical seal in fully split or semi split design.

Type BGH oder Splitex

Materials: Q2Q2PGG
Q2Q2PMG1 (Duplex-steel)
Q2BPGG

Operation: API plan 13 (circulation from the seal through an orifice back to pump suction)
Quench or rinsing recommended.





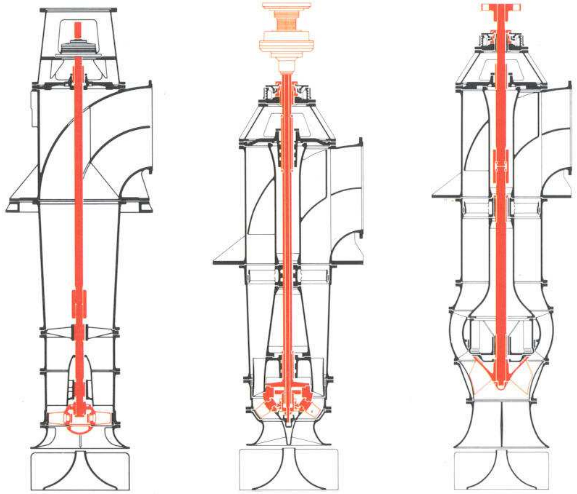





# Cooling Water Circulating Pumps

Cooling water pumps supply cooling water to condensers or heat exchangers.
The pumps usually have a vertical pipe housing and transfer large volumes at low differential pressure.

| | |
|---|---|
| medium: | cooling water (river, sea, brackish or treated water) |
| temperature: | up to about 40°C |
| temp. at mech. seal: | up to about 40°C |
| design pressure: | 0-10 bar = pressure at mech. seal |
| RPM: | up to about 1000 1/min |
| shaft diameter: | 50 mm to about 350 mm |



PNZ PHZ SNZ/SER

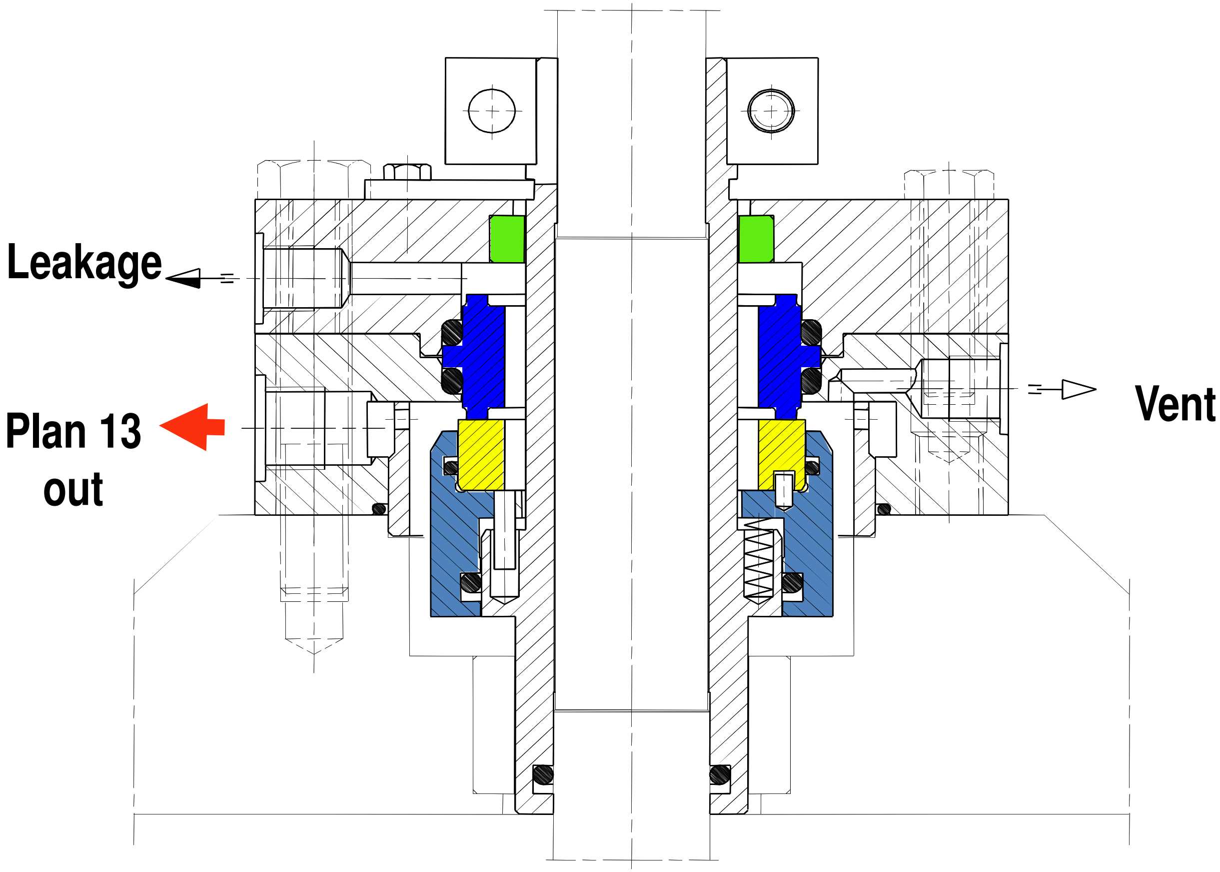







# Cooling Water Circulating Pumps

Typical mechanical seal:
BGH210/dia.-EX in Q2APMG, Q2BPUG100 or Q2Q2PUG100
API plan 13, preferably with quench or flushing




# Cooling Water Circulating Pumps

## BGH201

## Mechanical Seals for Pumps · Split Seals

### Product Description

1. Balanced
2. For plain shafts
3. Independent of direction of rotation
4. Multiple springs rotating
5. Semi split single seal

### Technical Features

1. Economical: no complete dismantling of pump necessary
2. Reduction of down-times and installation times
3. Robust seal design
4. Split seat can be used on both sides
5. Springs are protected from the product

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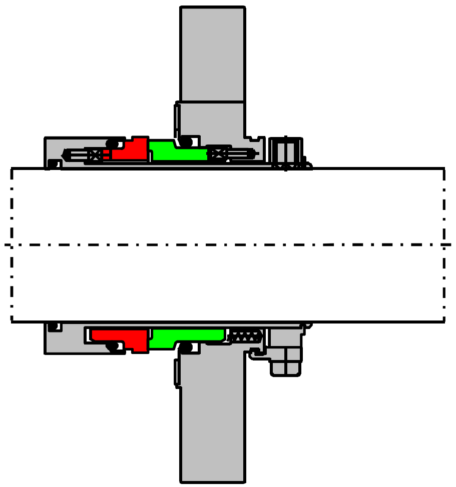
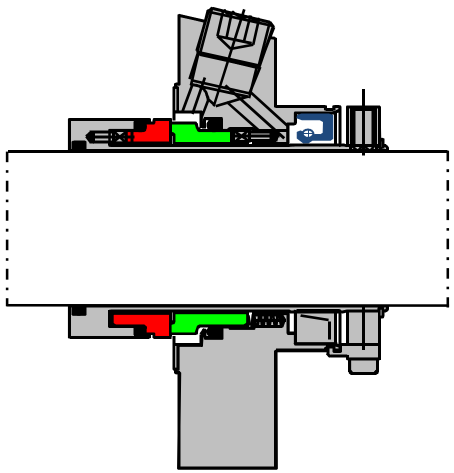
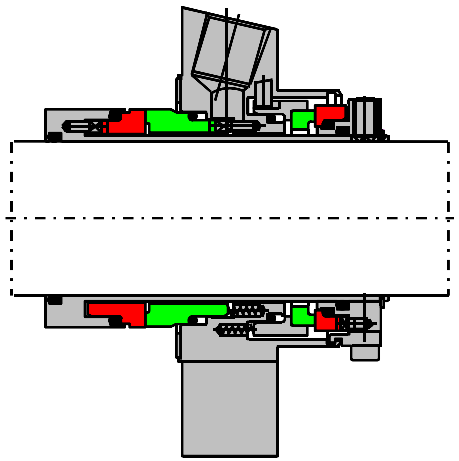
# Seals for Small Pumps

•Small pumps are mostly ANSI type overhung, single stage and are used for a variety of auxiliary services, pumping oil, water, chemicals or slurries.

•The CTX seal in any of its typical configurations can be used to seal these pumps.

•The selection of the proper arrangement will be driven by the fluid properties, possibly quality requirements and the operating conditions of the machine.





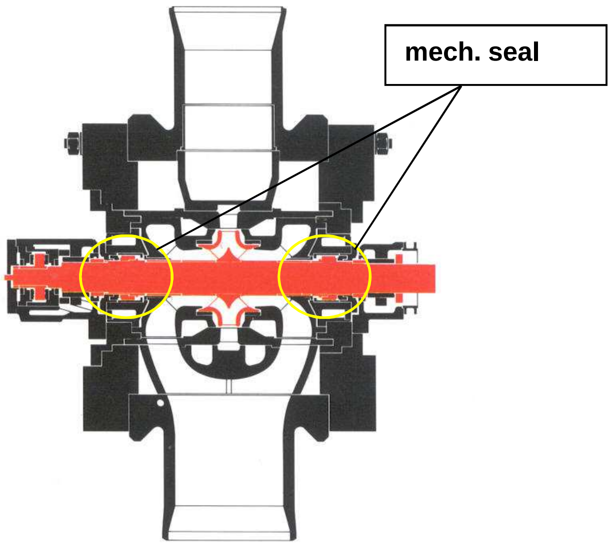





# Reactor Feed Pumps, Generator Feed Pumps

The reactor feed pump supplies the proper amount of feed water to a steam generator. This takes place either directly in the reactor vessel (boiling water) or in a steam generator (pressurized water). Single-stage feed pumps with dual-flow impellers and double volute casing are commonly used in nuclear power plants.

| | |
|---|---|
| medium: | boiler feed water (neutral or alkaline) |
| temperature: | 160-200°C |
| temp at mech. seal: | max. 75°C |
| suction pressure: | 20-30 bar (max. 40 bar) = pressure at mech. seal |
| discharge pressure: | 70-90 bar |
| RPM: | up to about 6000 1/min (vg < 60 m/s) |
| mech. seal diameter: | 100 mm up to about 200 |



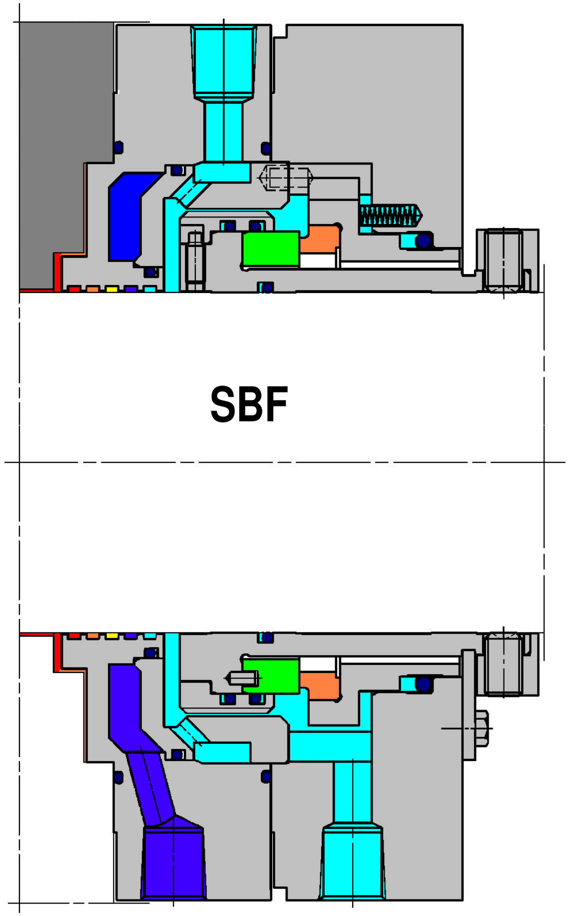


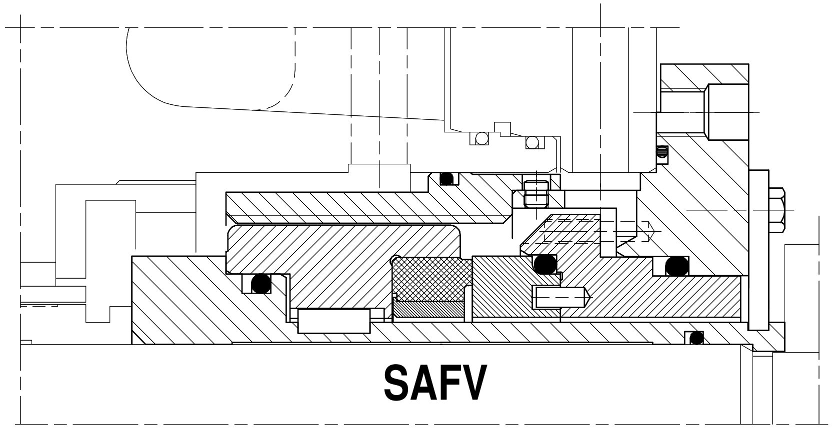






# Reactor Feed Pumps, Generator Feed Pumps



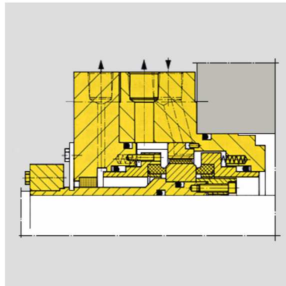

Typical mechanical seals:
PWR – SBF/dia.-EX AQ2EGG
BWR – SAFV/dia.-EX Q2B3EGG
API plan 23 with jacket cooling

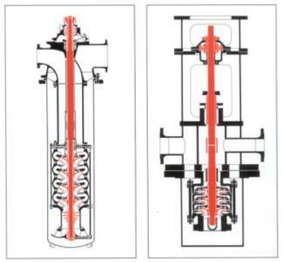


# Residual Heat Removal Pump

The residual heat removal pumps in a nuclear power plant remove heat during a scheduled reactor shut down. They extract coolant from the main lines that lead away from the reactor or from the sump and feed the coolant via the after coolers into the reactor cooling lines that lead back into the reactor. In case coolant is lost when a fault occurs, they provide emergency coolant to the core after pressure has been reduced.

| | |
|---|---|
| medium: | reactor water |
| temperature: | 50-200°C |
| temp. at mech. seal: | max. 75°C |
| suction pressure: | 5-30 bar = pressure at mech. seal (often designed for higher pressure) discharge pressure: up to 35 bar |
| RPM: | normally about 1500 1/min |
| mech. seal diameter: | 80 mm up to about 150 mm |





Typical mech. seal:
SBF(V)-D/dia.-EX
AQ2EGG-AQ2EGG
API plan 53

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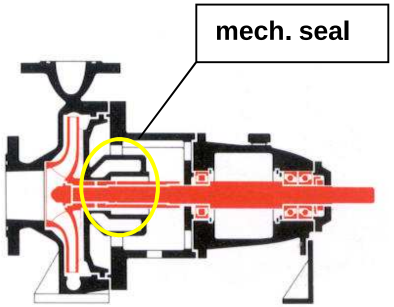
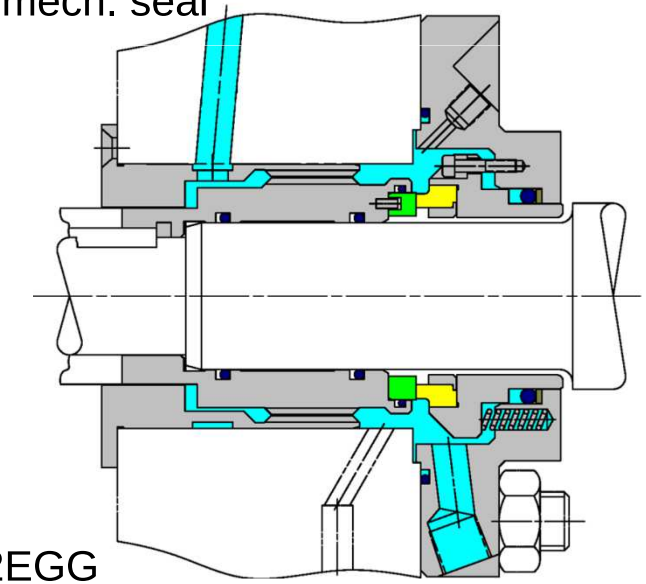
# Reactor water cleanup pump (RWCU)

The cleanup recirculation pump is used to inject cleaned demineralized water into the pimary system. The design of these pumps is determined by high medium temperatures and head which is low compared to system pressure. Horizontal, single-stage pumps with volute casing are often used. (But mainly canned motor pumps!)

| | |
|---|---|
| medium: | reactor water |
| temperature: | up to 350°C |
| temp. at mech. seal: | max. 75°C |
| design pressure: | up to 150 bar = pressure at mech. seal |
| RPM: | up to 3600 1/min |
| mech. seal diameter: | 30 – 75 mm |



Typical mech. seal: SBPV or SBFV in AQ2EGG
API plan 23 with jacket cooling





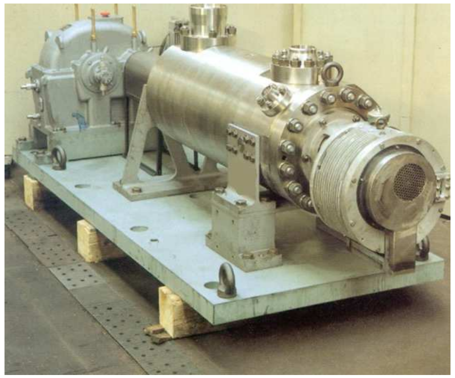


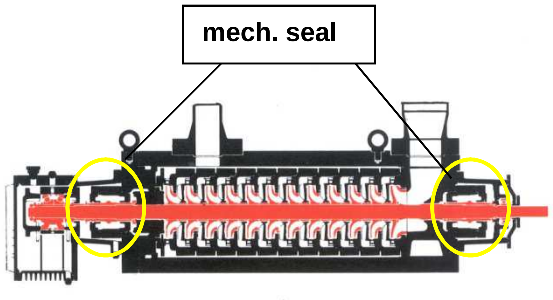



# Safety feed/ pumps

Safety feed pumps are used at nuclear power plants to provide emergency cooling of the reactor core in case there is a loss of coolant. The pumps are capable of overcoming the highest level of reactor pressure to guarantee inflow of the cooling medium. They pump water from a reservoir, for example a reactor well, into the reactor cooling system until the pressure has fallen enough to trigger automatic switching to the low pressure feed system (→residual heat removal pump).

| | |
|---|---|
| medium: | reactor water |
| temperature: | up to 70°C = temp. at mech. seal |
| suction pressure: | up to 25 bar = pressure at mech. seal |
| discharge pressure: | up to 220 bar |
| RPM: | up to 6000 1/min |
| mech. seal diameter: | 50 mm up to about 100 mm |






typical mech. seals:
SH(V)/dw-EX in AQ2EGG, API Plan 11 or
SBF(V)-D/dw-EX in AQ2EGE-AQ2EGG, API Plan 53 or
SBF(V)/dw in AQ2EGG, API Plan 23, in case design temp. or pressure are high (depending on specification)





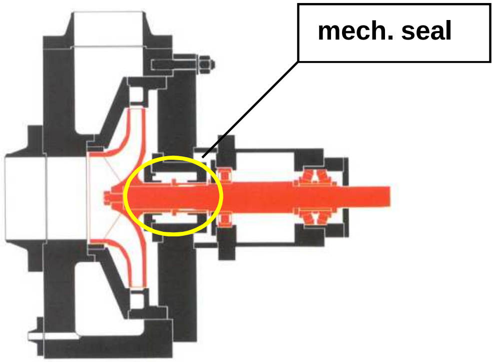





# Spent fuel pool cooling pump

This pump removes residual decay heat which is generated by spent fuel elements from a nuclear reactor. The fuel elements are stored in a spent fuel pit for about 1 - 2 years until radioactive decay ceases completely. The elements are then either reprocessed or moved to a final waste disposal site. The pump acts as a circulation pump which pulls water from the pit and pumps it to a heat exchanger. Because the pump is used in the nuclear industry, it along with the mechanical seal must meet very stringent quality requirements. The pumps usually have a special single-stage, horizontal centrifugal design.

| | |
|---|---|
| medium: | reactor water |
| temperature: | 50 to 200°C |
| temp. at mech. seal: | max. 75°C |
| suction pressure: | 5 -15 bar = pressure at mech. seal<br>(often designed for higher pressure) |
| discharge pressure: | up to 20 bar |
| RPM: | normally about 1500 1/min |
| mech. seal diameter: | 80 to about 150 mm |




typical mech. seal:
B750-D/dw-EX in
AQ1EGG-AQ1EGG or
SBF(V)-D/dw-EX in
AQ1EGG-AQ1EGG
API Plan 53+61





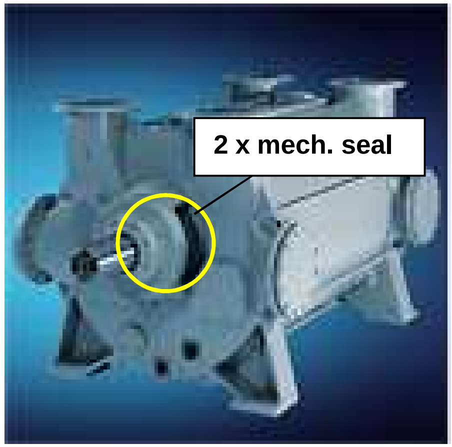


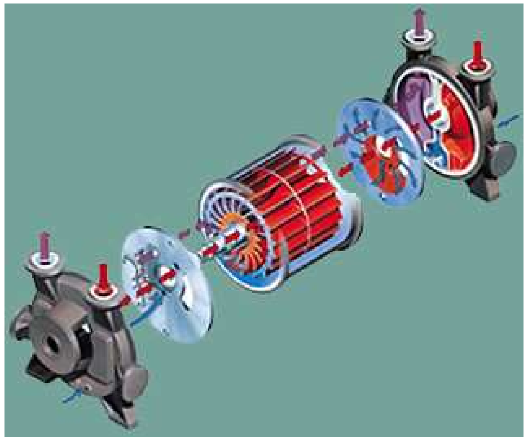



# Vacuum pump

This pump creates a vacuum in the steam condenser at a power station. The vacuum is needed to prevent premature condensation of the service steam until it has passed beyond the final stage of the low pressure turbine. This prevents drop erosion damage on the turbine guide blades and end blades, and it increases efficiency. Water ring pumps are normally used for this application, for example ELMO pumps.

| | |
|---|---|
| medium: | air, water, condensate |
| temperature: | 20-40°C = temp. at mech. seal |
| suction pressure: | 1 bar = pressure at mech. seal |
| RPM: | 1000-1500 1/min |
| mech. seal diameter: | 50 mm up to about 250 mm |



typical mech. seals:
U740/dw-EX in Q1BVGG (with external flushing, API Plan 32)
also CTX-DE/dw-00 in BQ1VMG-BQ1EMG ( closed, API Plan 53)

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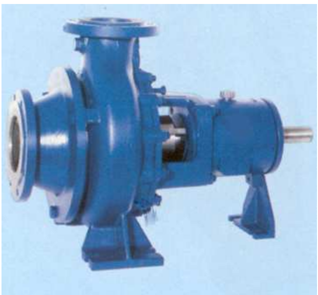
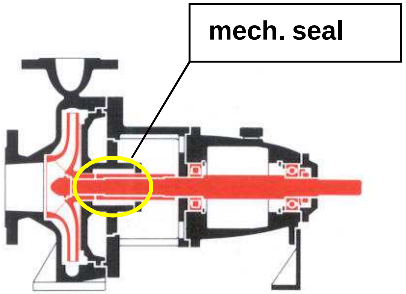
# Nuclear waste water pump

These pumps are installed in nuclear auxiliary and supplemental systems at nuclear power plants to handle radioactive waste water. Typical examples include dosing, resin flushing, pH measurement, evaporator feed, filling /circulation, precoat, precoated filter feed, sludge, circulation, discharge, concentrate and filter pumps. Pumps that comply with chemical standards and meet stringent quality requirements are normally used. Ideally, the pumps have double mechanical seals to prevent radioactive leakage.

| | |
|---|---|
| medium: | various types of water with abrasive contaminants |
| temperature: | up to 100°C |
| temp. at mech. seal: | max. 75°C |
| suction pressure: | 1-5 bar |
| buffer fluid pressure: | 2 bar greater than suction pressure |
| discharge pressure: | up to 16 bar |
| RPM: | 1500 - 3000 1/min |
| mech. seal diameter: | up to about 80 mm |





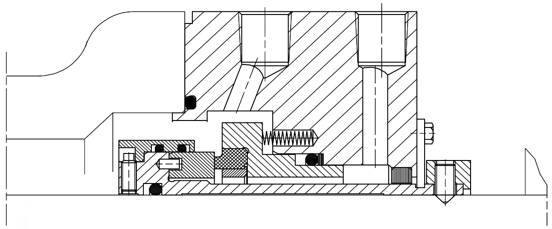

typical mech. seals:
B750-D/dw-EX in Q1Q1VGG-BQ1VGG/G1 or
BRKSX-D/dw-EX in Q1Q1VGG-BQ1EGG/G1
API Plan 53

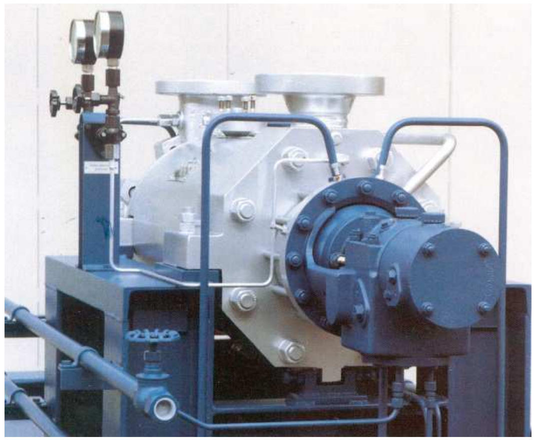


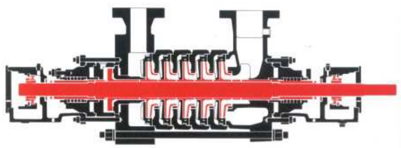
# Control rod drive pump

The control rod drive pump is used to hydraulically insert the control rods in case the electric control rod drive units fail, ensuring quick shut down of the reactor if a fault occurs. The discharge pressure of these pumps can exceed 200 bar depending on the reactor type. Multi-stage, ring-section pumps are used almost exclusively.

| | |
|---|---|
| medium: | reactor water |
| temperature: | 40-60°C = temp. at mech. seal |
| suction pressure: | 3-10 bar |
| pressure at mech. seal: | 3-10 bar (often designed for more than 100 bar) |
| discharge pressure: | about 200 bar |
| RPM: | 3500-8000 1/min |
| mech. seal diameter: | 50-125 mm |







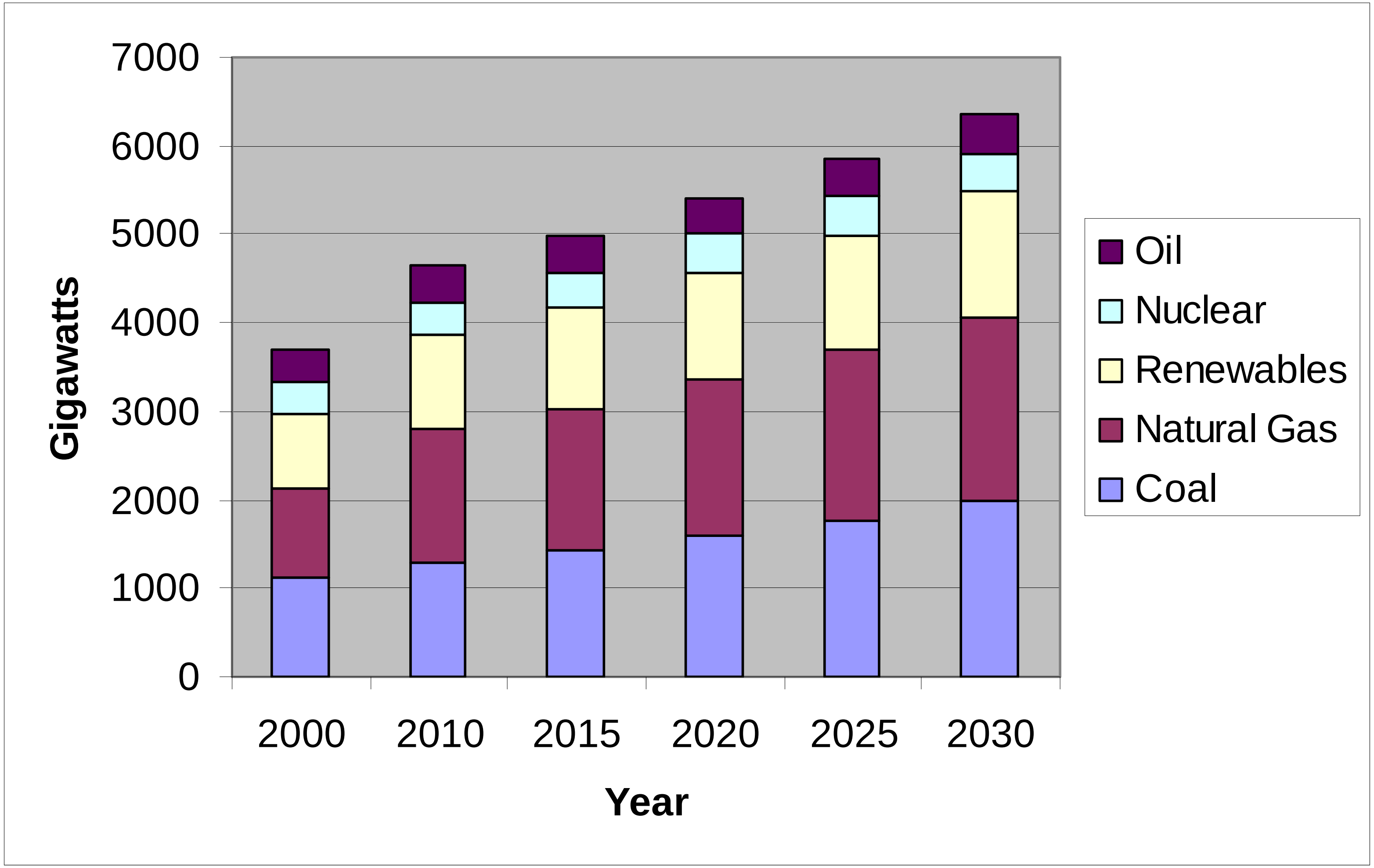
typical mech. seal:
SHV/dw-EX in AQ2EGG
API Plan 11








# World electricity generating capacity by fuel type, 2000-2030

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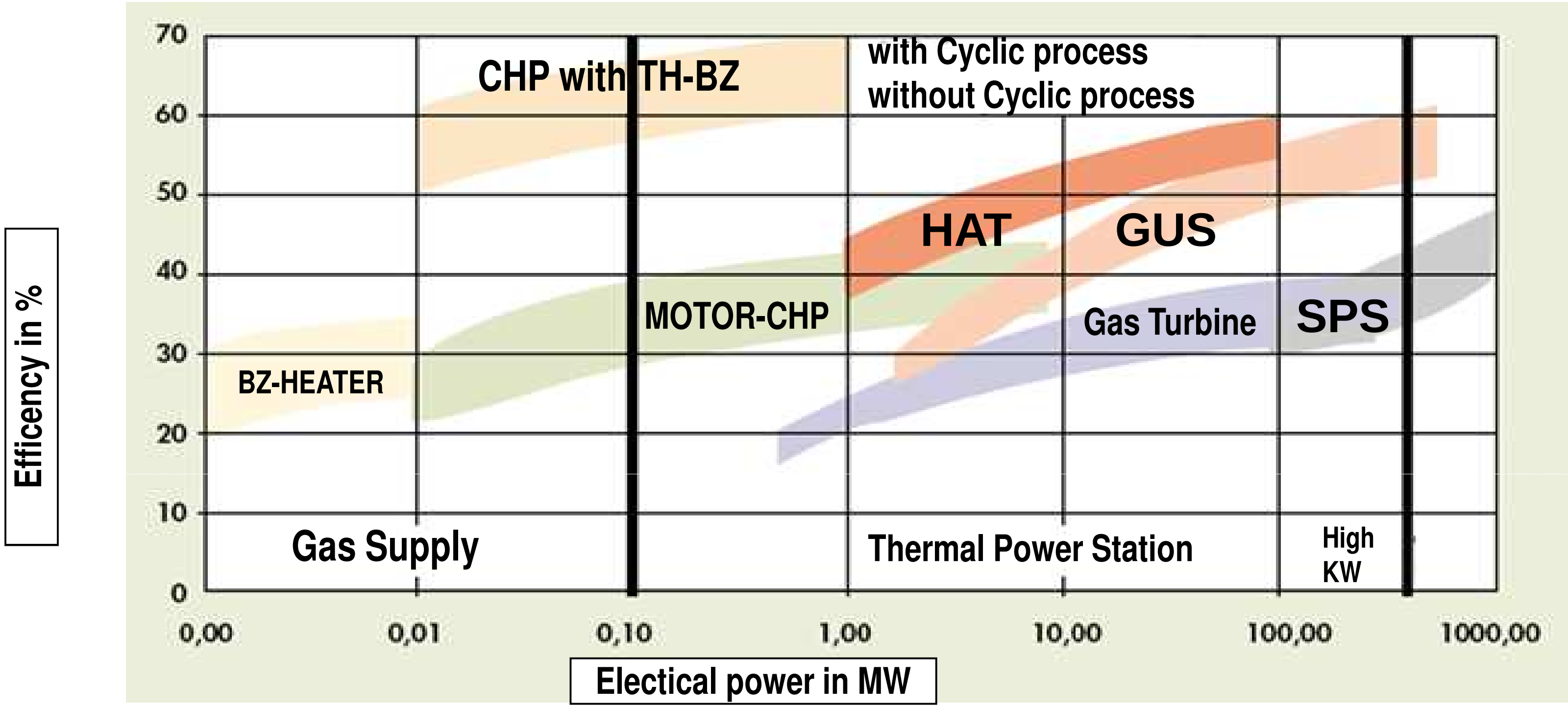
# Typical efficiency of power plants



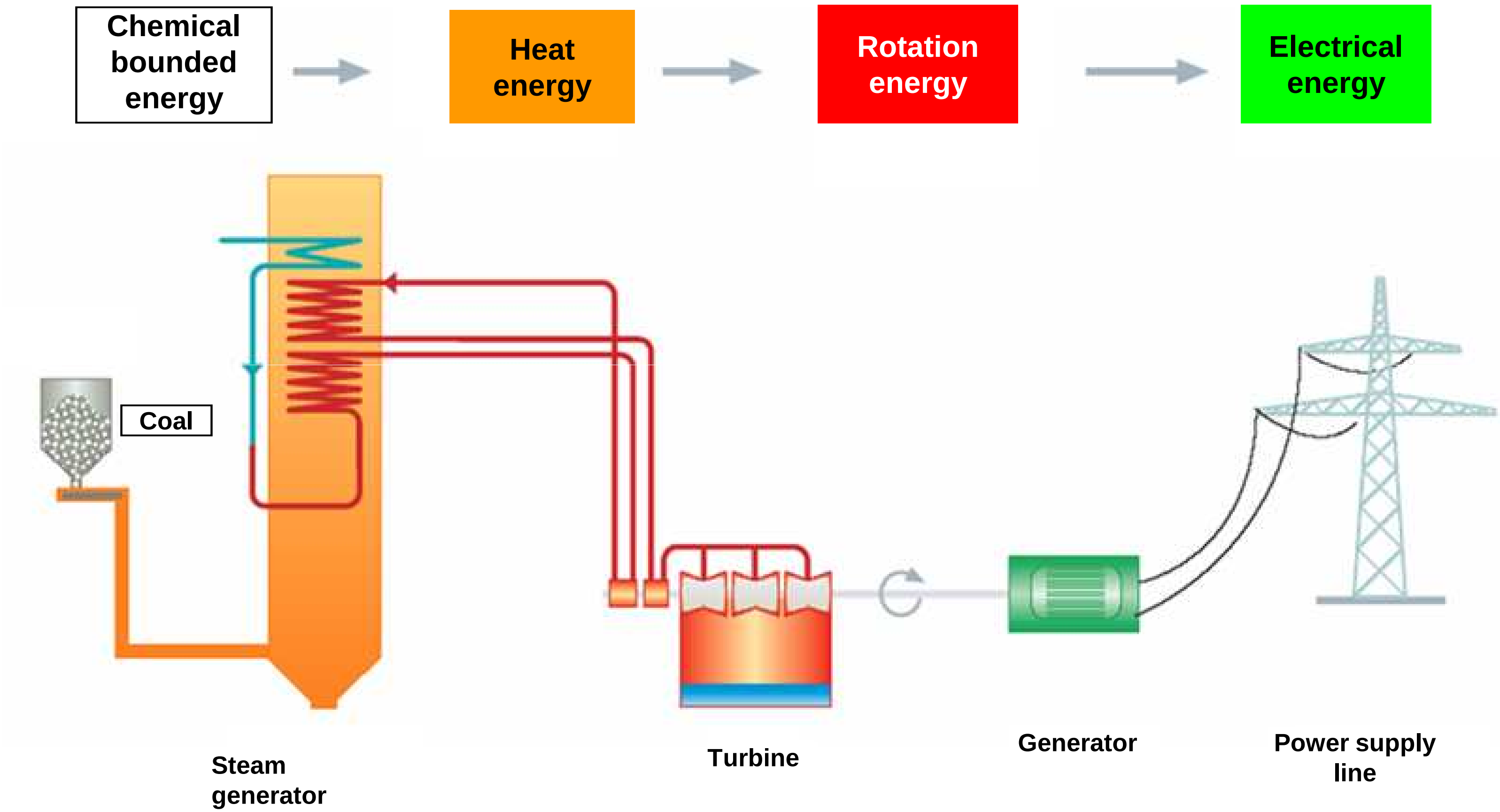

| | |
|---|---|
| **CHP with TH-BZ** | Combined heat and power unit with high temperature fuel cell |
| **BZ-HEATER** | Fuel cell heating unit |
| **MOTOR-CHP** | Combined heat and power unit with combustion engine |
| **HAT** | Humid Air Turbine |
| **GUS** | Gas and steam plant |
| **SPS** | Steam power station |
| **Groß-KW** | Large scale power plant |








# Overview about the transformation of energy

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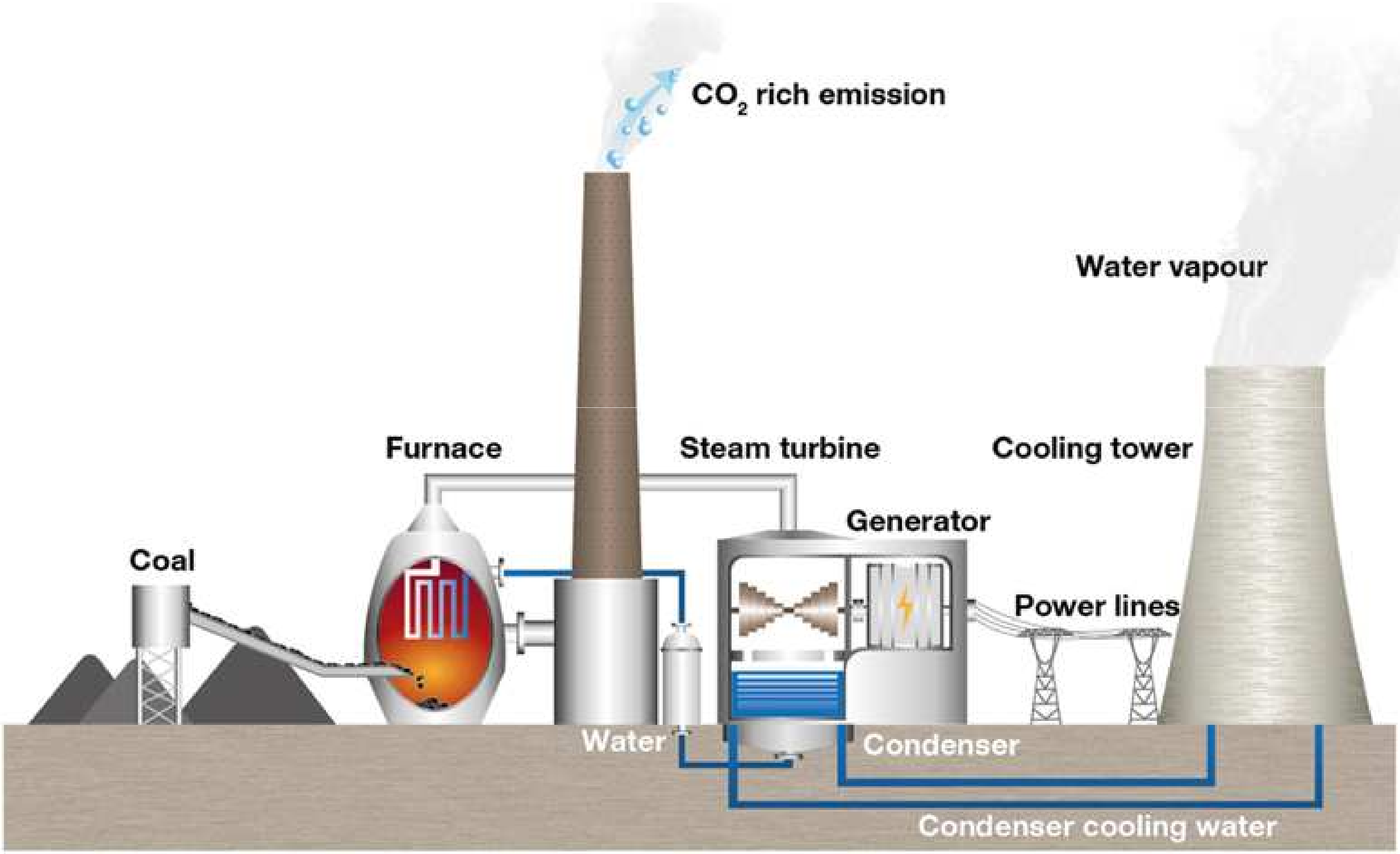
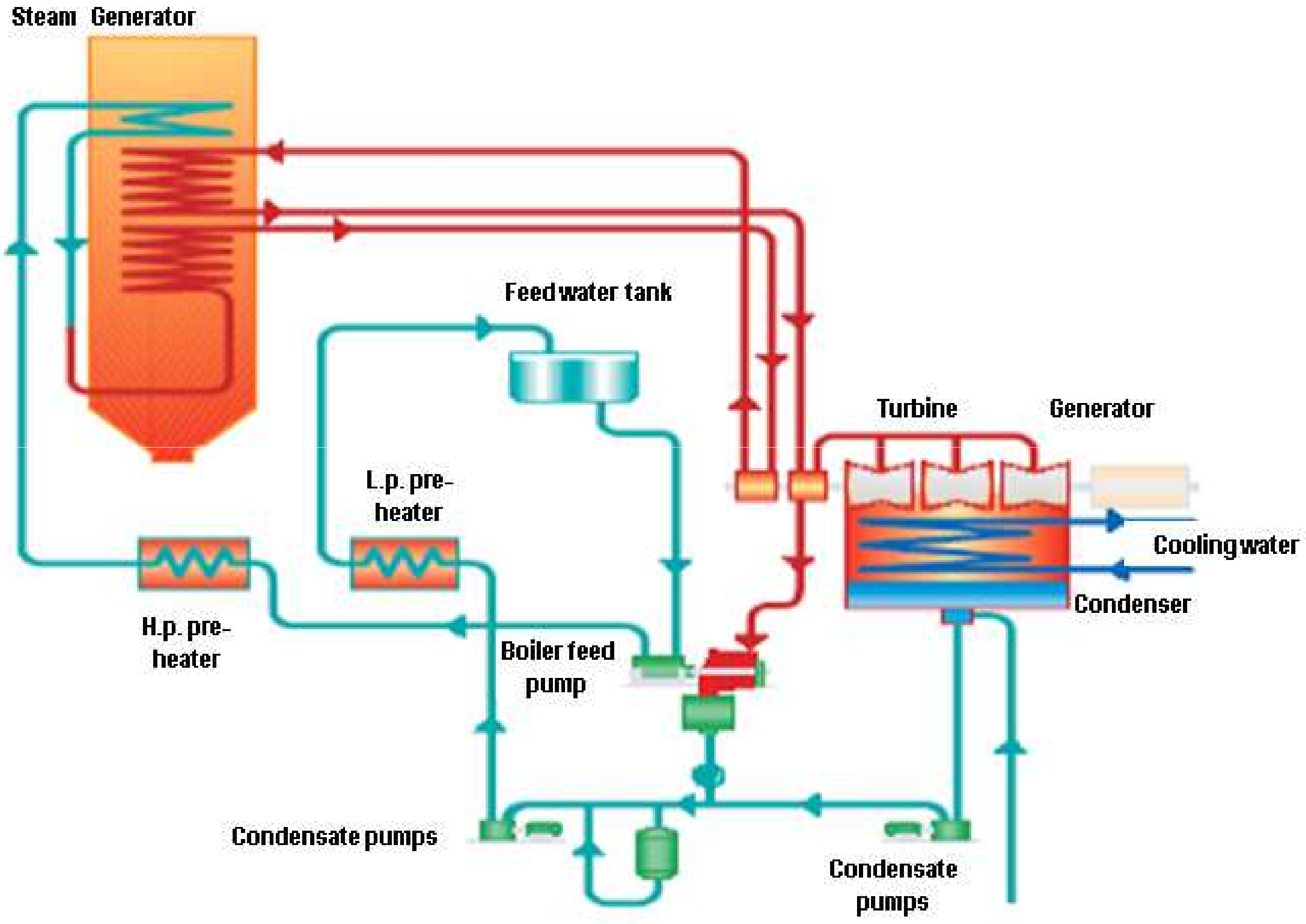
# Generall overview of a Coal Fired Plant






# Steam Circuit



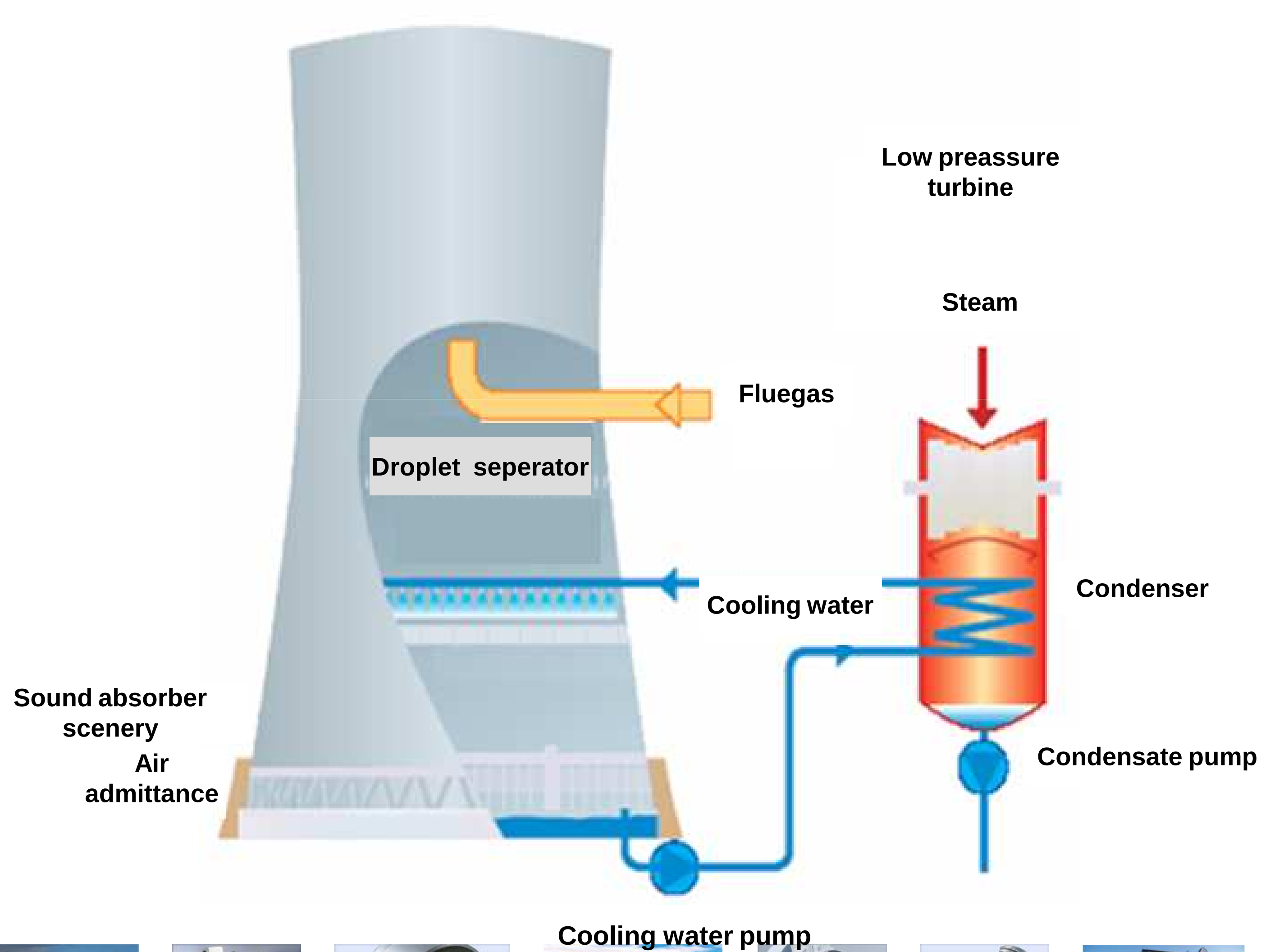








# Cooling Circuit

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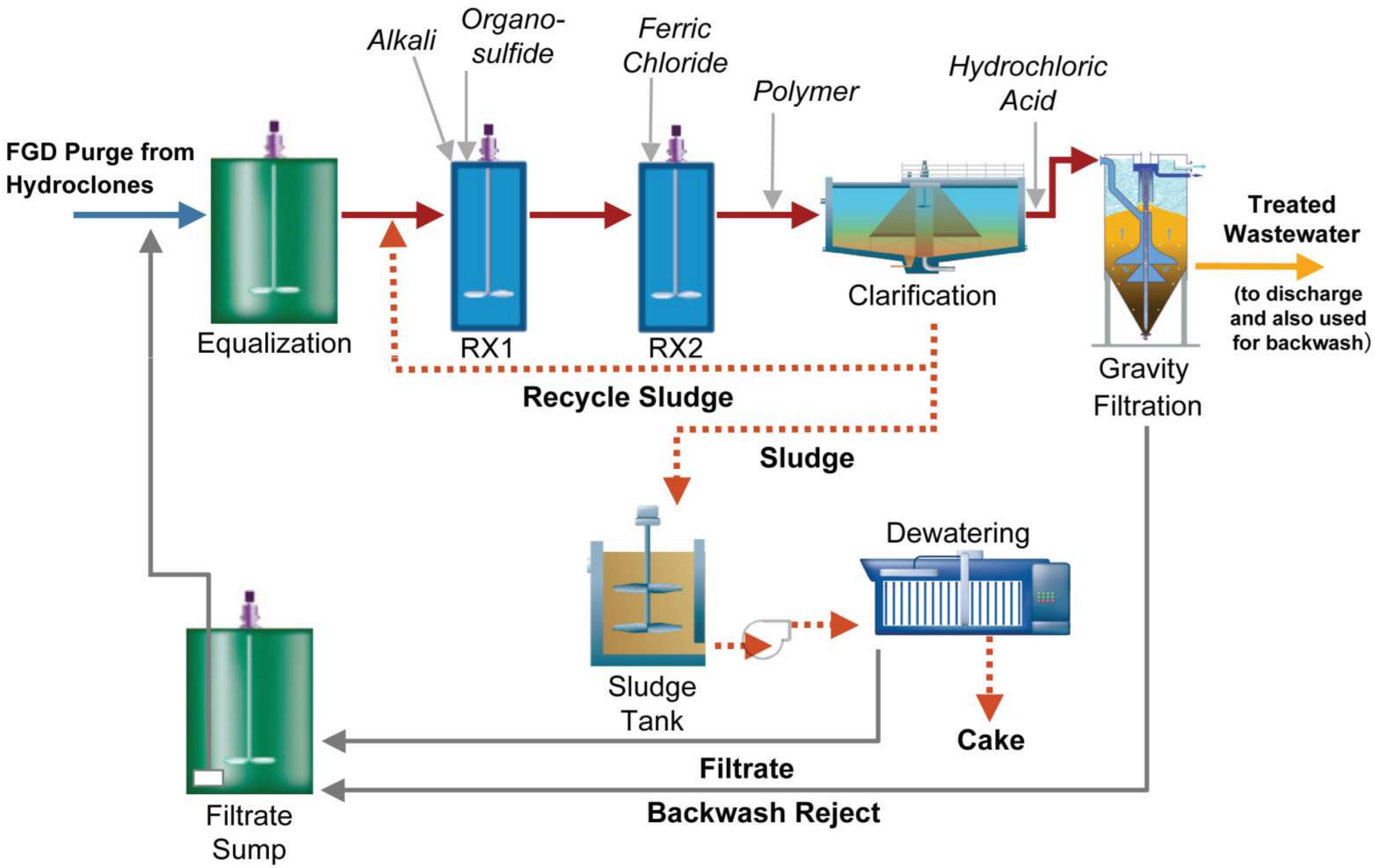
# FGD-process

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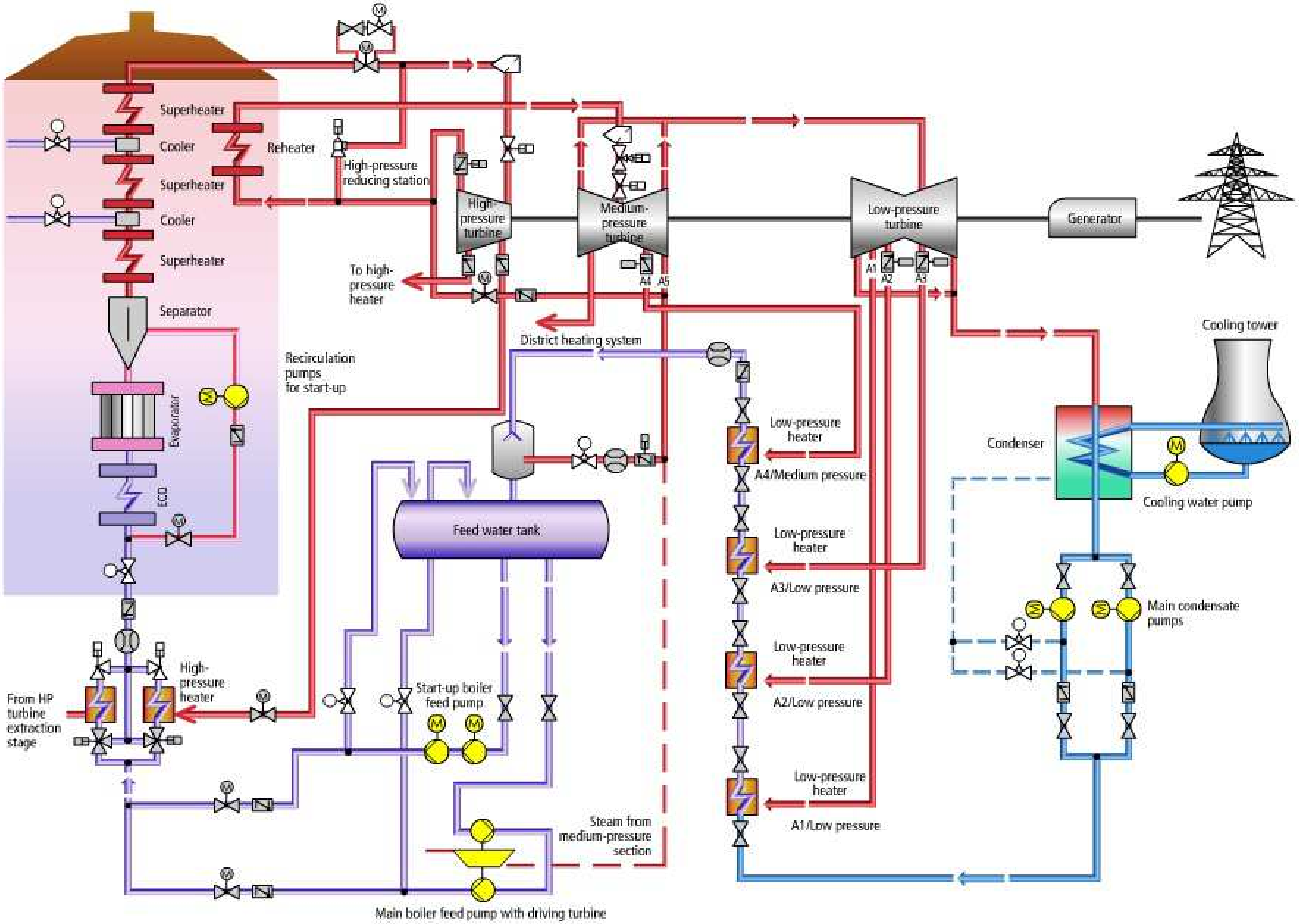
# General schematic of a coal fired plant

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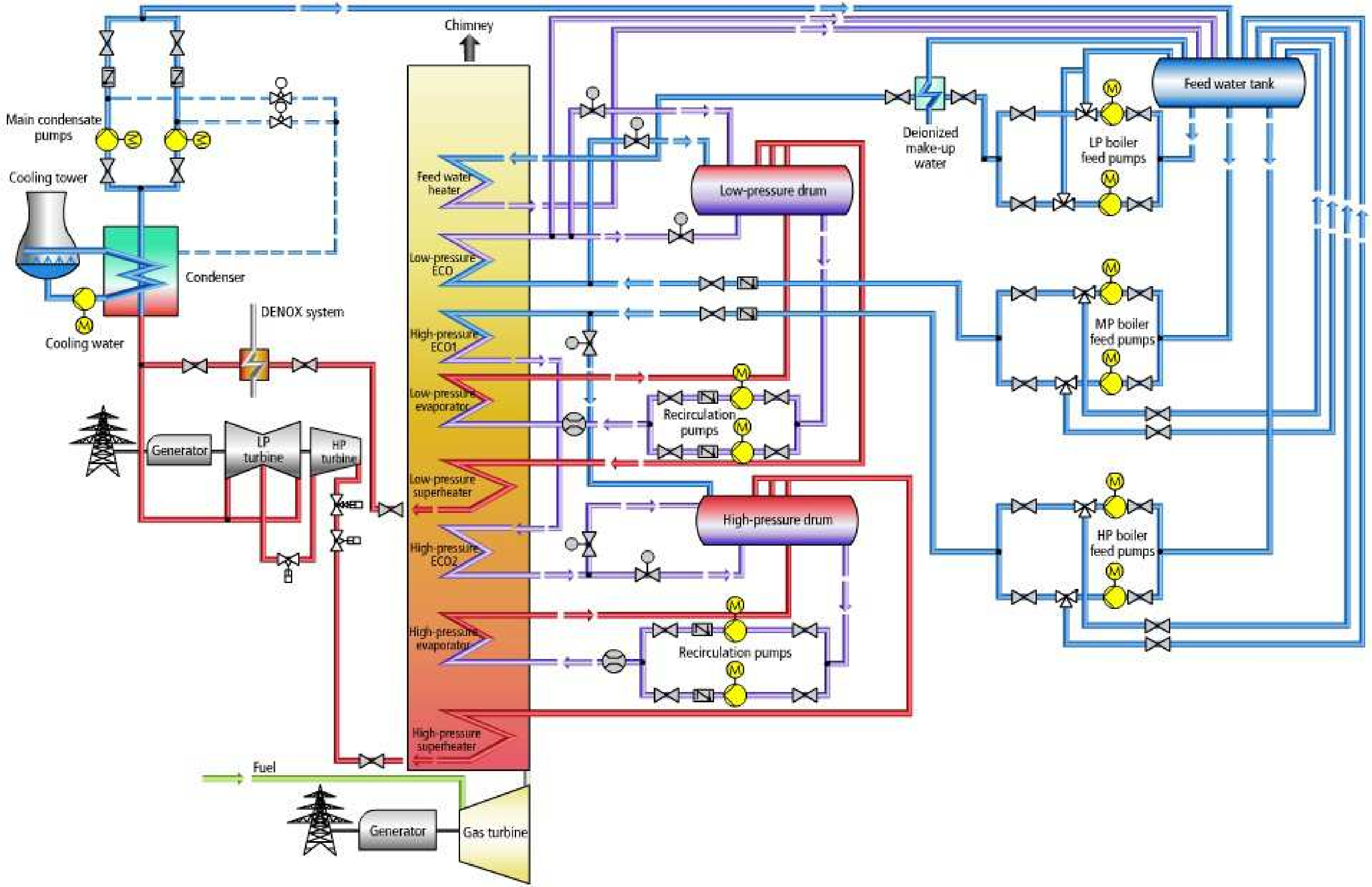
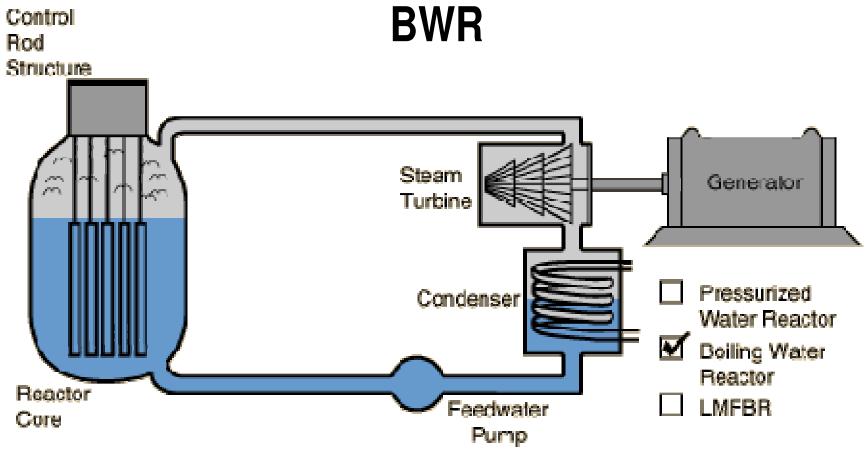
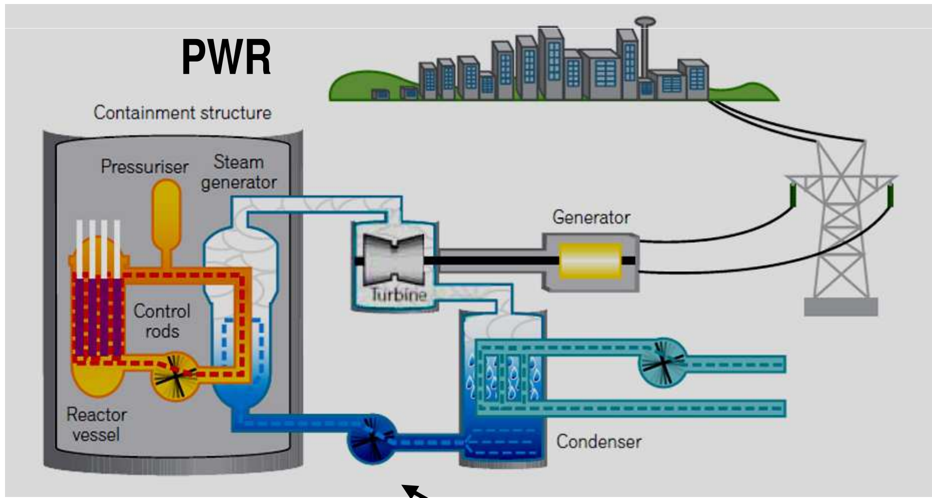
# General schematic of a COGEN-Plant



# Steam cycle in BWR and PWR plant




Feedpump

In BWR the feed water is radio active;
in PWR the water is not radio active.

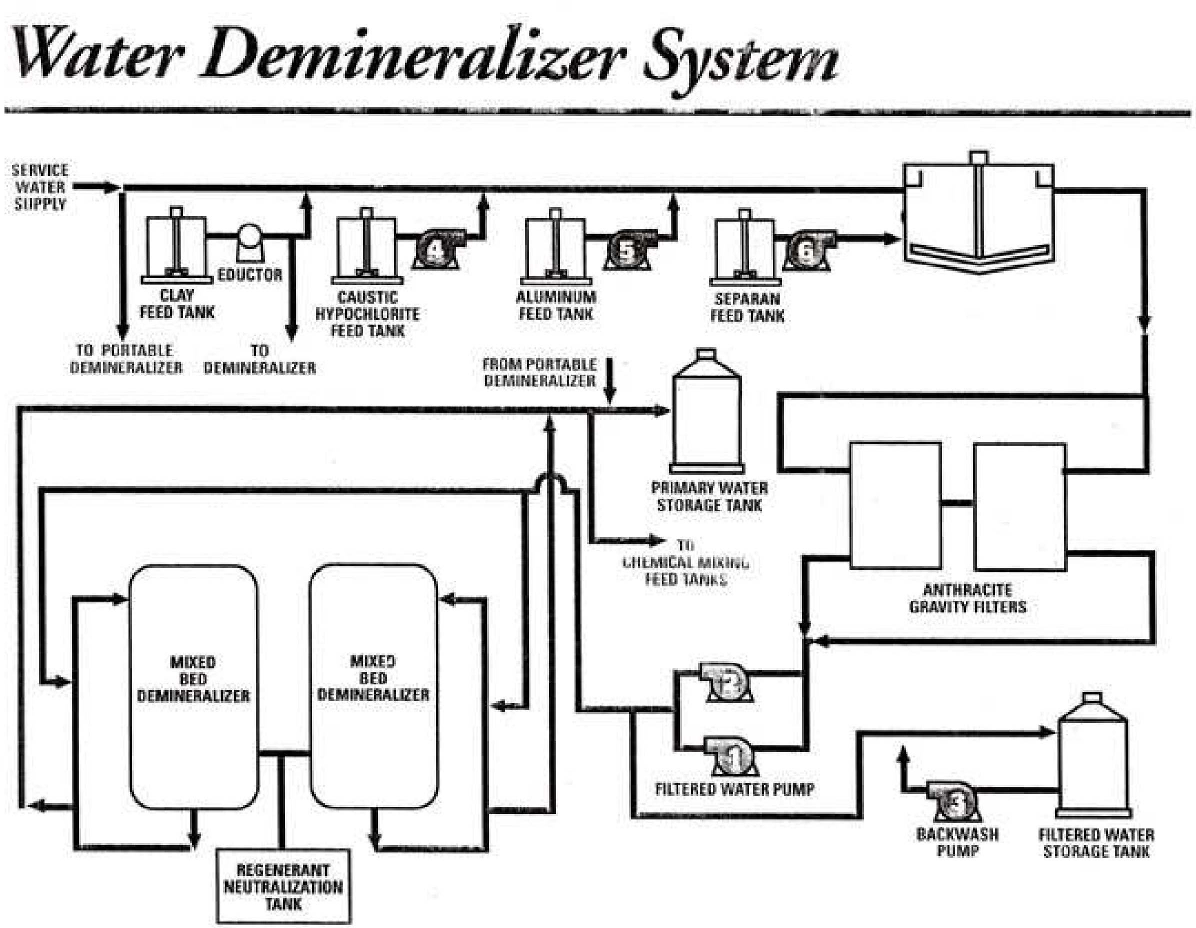









# Water Treatment Pumps





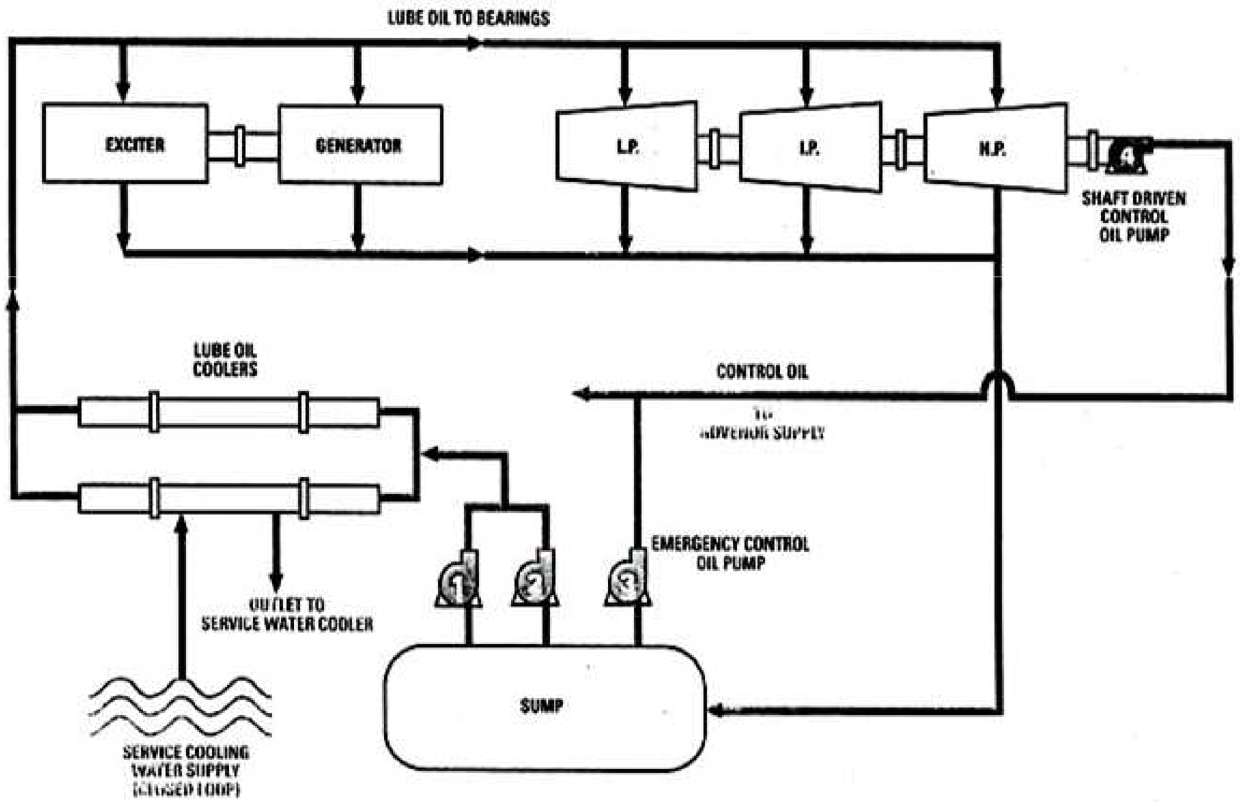







# Lube Oil Pumps

## Lubricating Oil System

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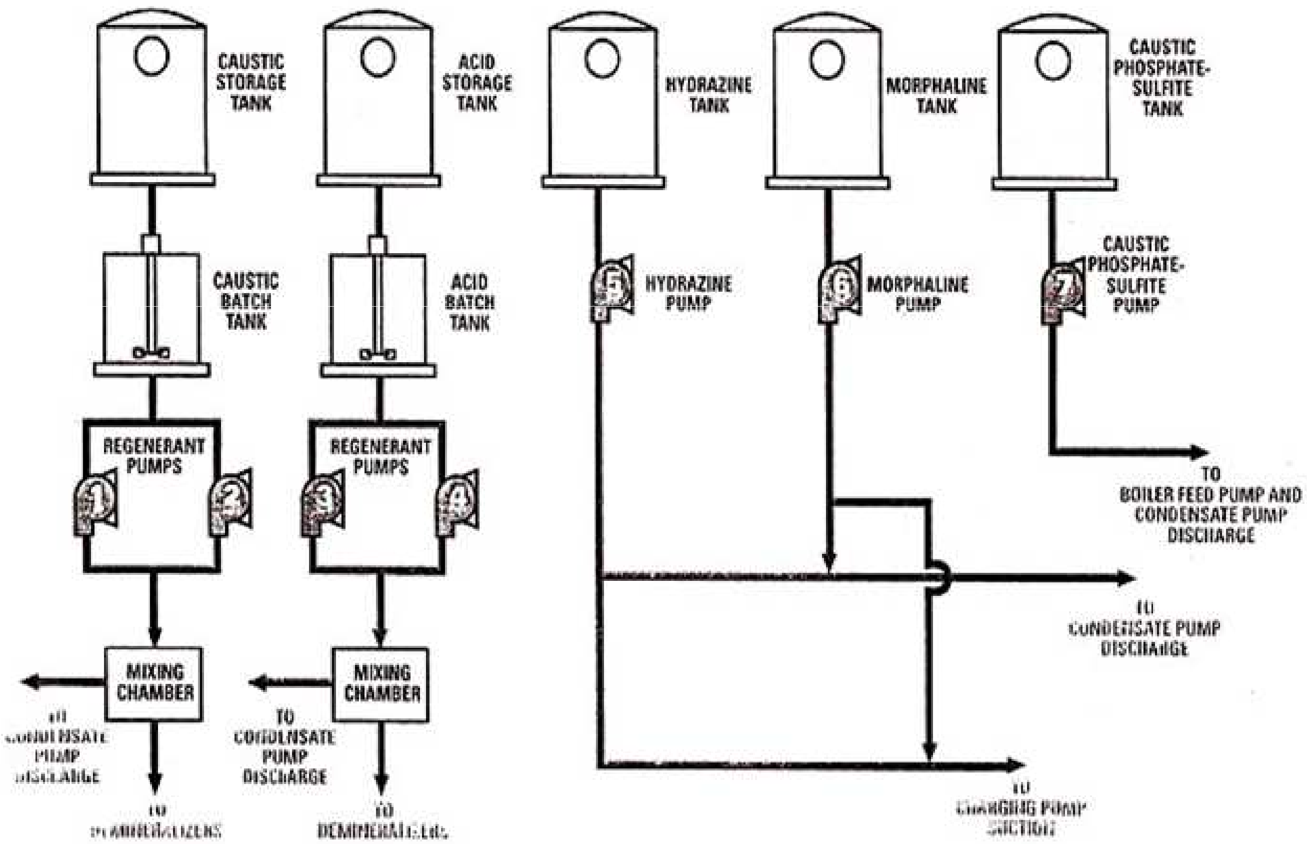
# Chemical Pumps

*Demineralizer Regenerant/Chemical Treatment System*











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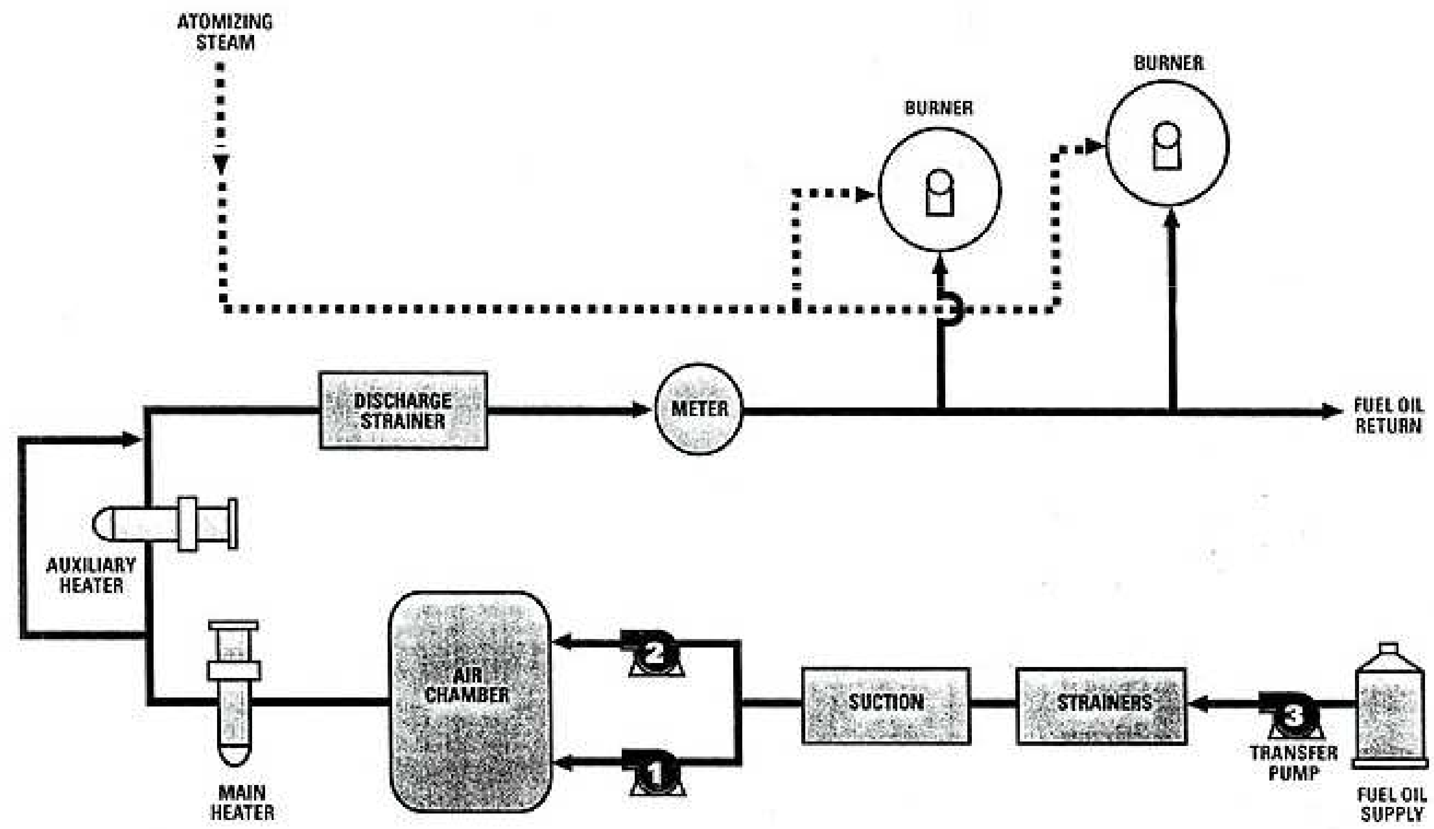
# Fuel Oil Pumps in Oil Fired Plants

## *Fuel Oil System*

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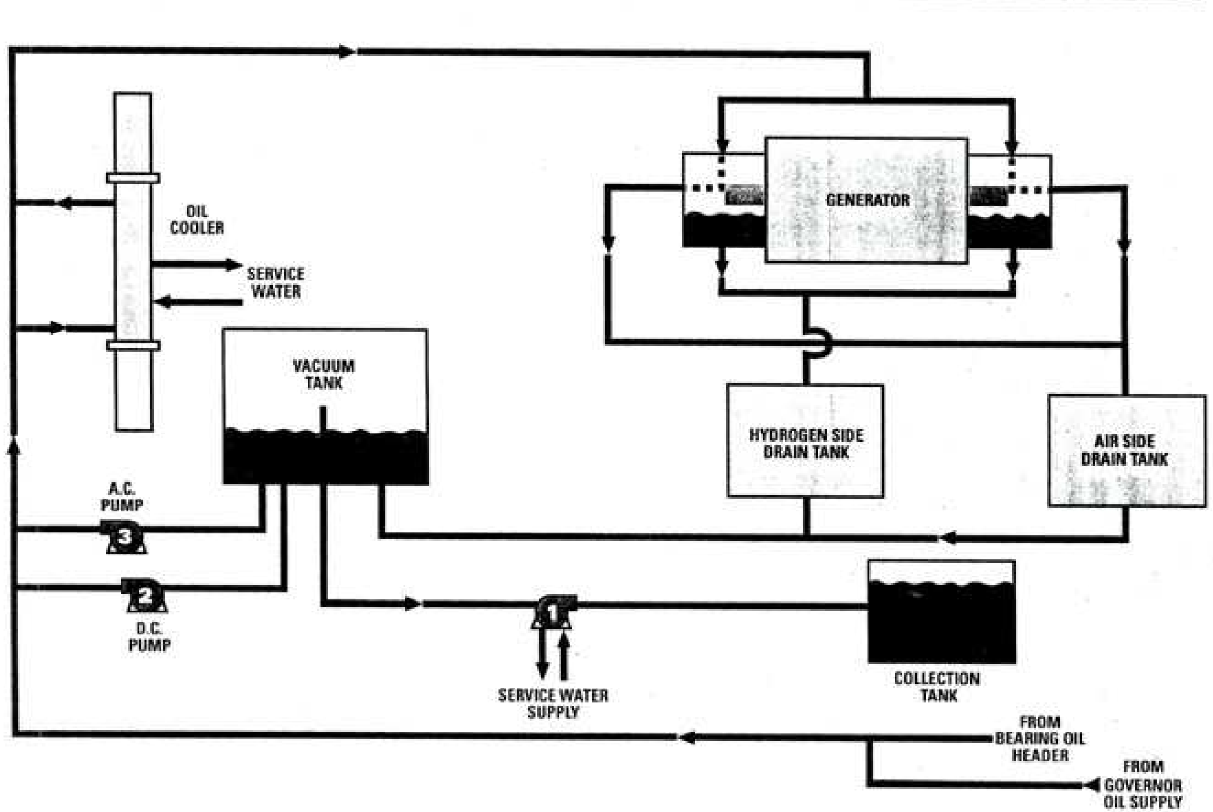
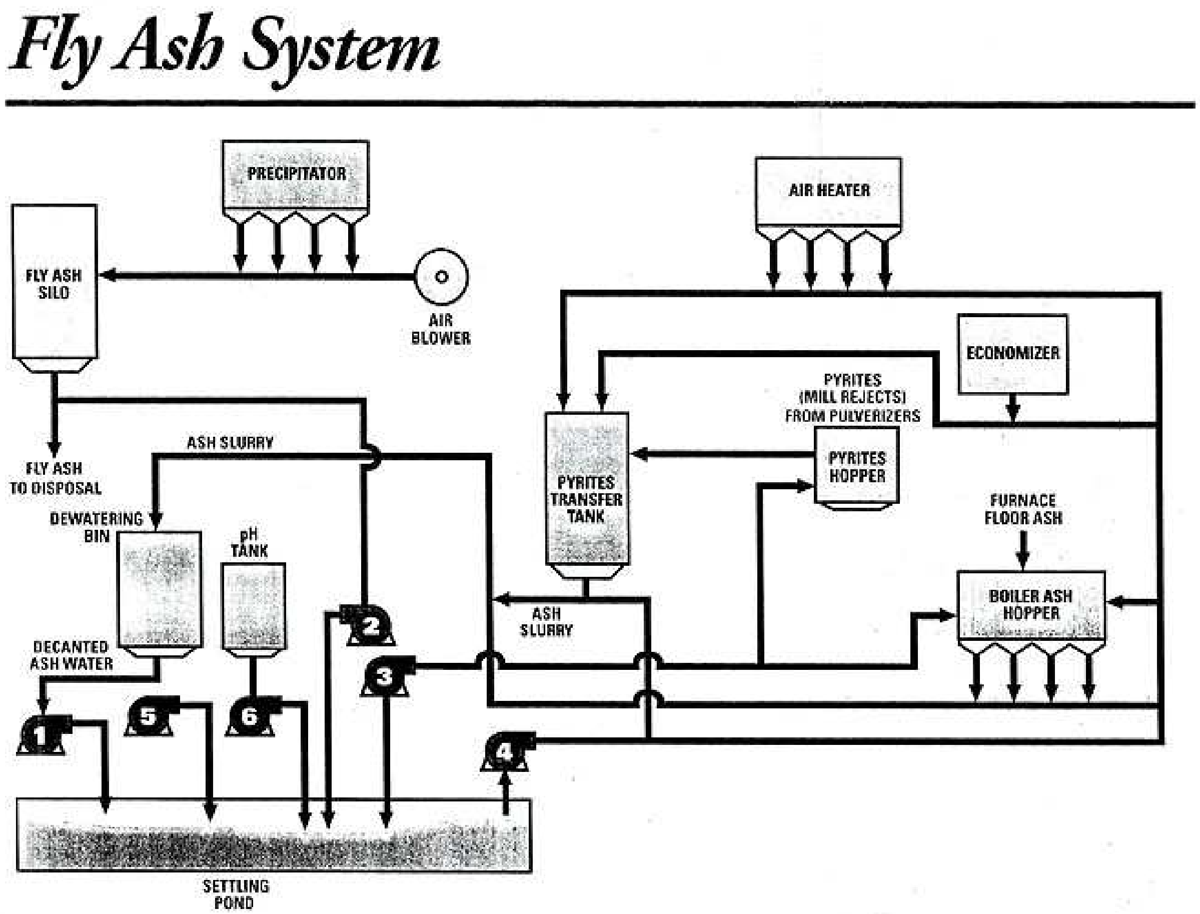
# Seal Oil Pumps for the Generator

## *Generator Seal Oil System*




# Ash Pumps in a Coal Fired Plant

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# Thank You