CENTRIFUGAL PUMPS

THE GLOBAL COMPACT

Technip

04 Member of Dow Jones Sustainability Indexes

- THEORY
- SPECIFICATION
- CONSTRUCTION
- OPERATION/PERFORMANCE
- SEALING

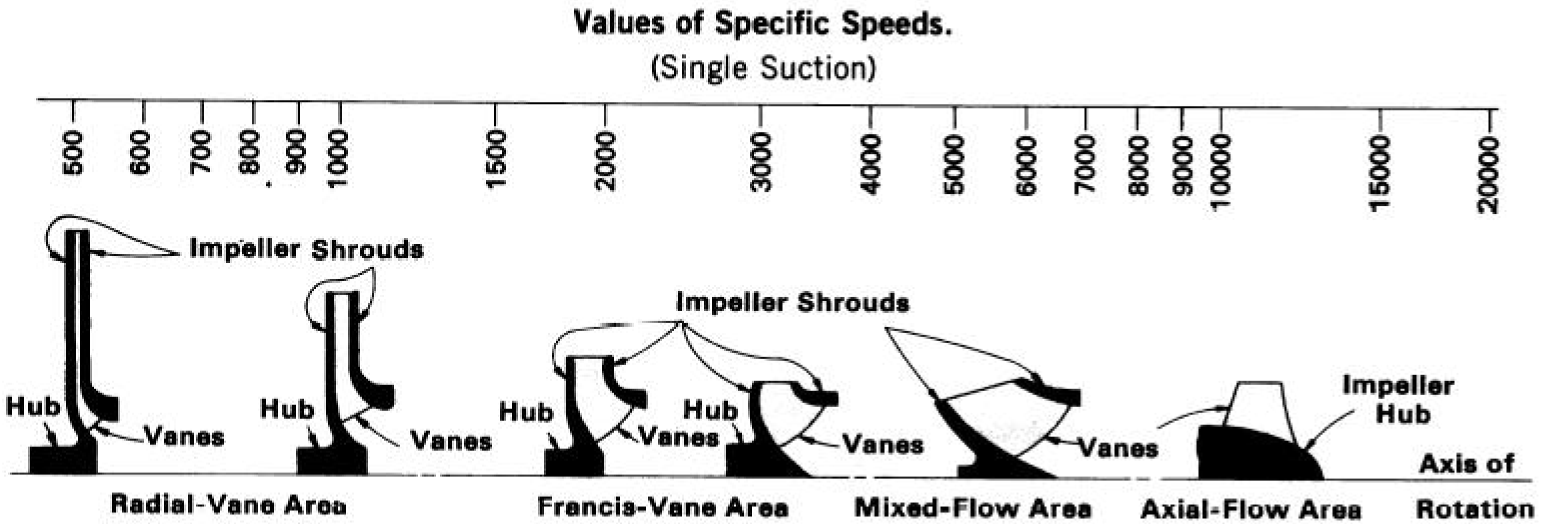
- **Principle of operation:**
  - ➔ **Fluid velocity transformed in pressure in the pump volute**
  - ➔ **Discharge pressure auto-limited: no relief valve required**
  - ➔ **Required enough suction charge: NPSH (Net Positive Suction Head)**

Pump Curve equation

$$H = aQ^2 + bQ + cst$$

Pump specific speed

$$Ns = \frac{NQ^{0.5}}{H^{0.75}}$$



Suction specific speed

$$N_{ss} = \frac{NQ^{0.5}}{(NPSHR)^{0.75}}$$

15100 in metric units (rpm, m3/h, m)
13000 in customary units (rpm, gpm, feet)

Hydraulic and brake absorbed power

➔ **Hydraulic power**

$$P = \frac{QHd}{367}$$

In kw with Q in m3/h, H in m, d fluid density,

Brake power

$$P = \frac{QHd}{367r}$$

In kw with Q in m3/h, H in m, d fluid density, r efficiency (dimensionless)

Temperature elevation in pump

$$\Delta t = \frac{H\dfrac{1-r}{r}}{427C_p}$$

Cp fluid specific heat in kcal/kg °C, H in m, r efficiency

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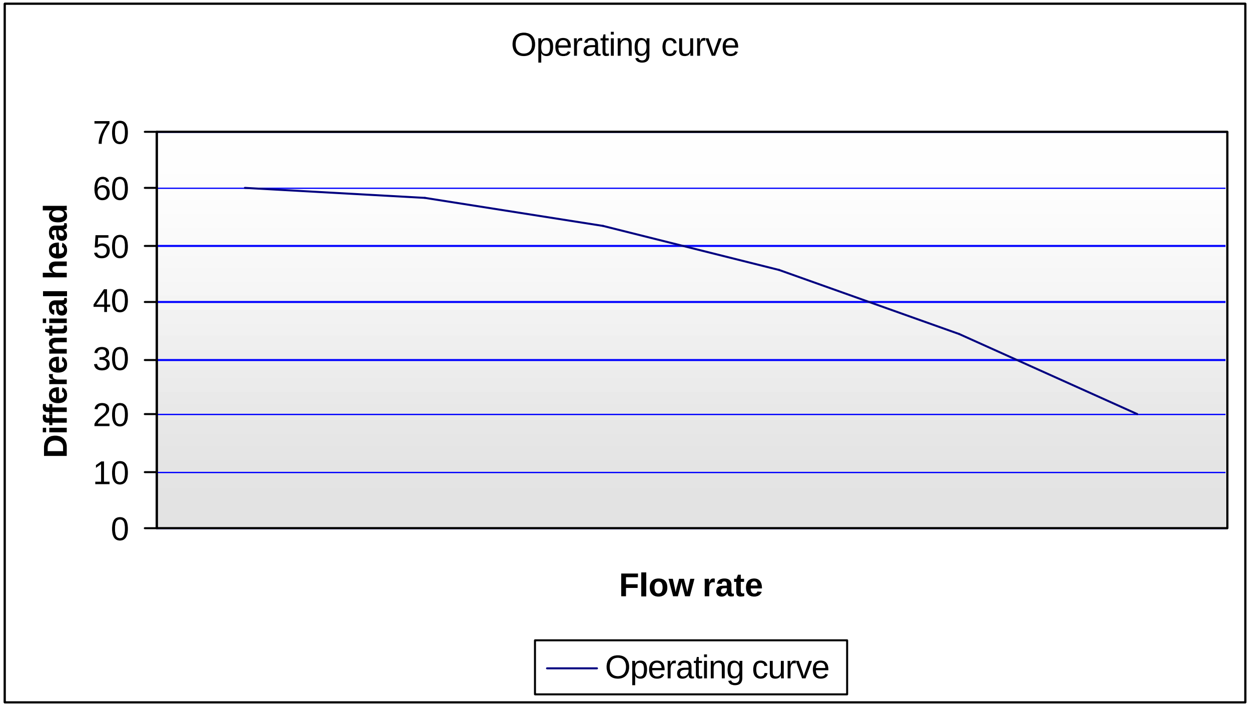
- **The curve has a form of parabola**
- **The differential head increases with flow**
- **The head at zero flow is in the range of 120%**



DIFFERENTIAL HEAD (OR HEAD)

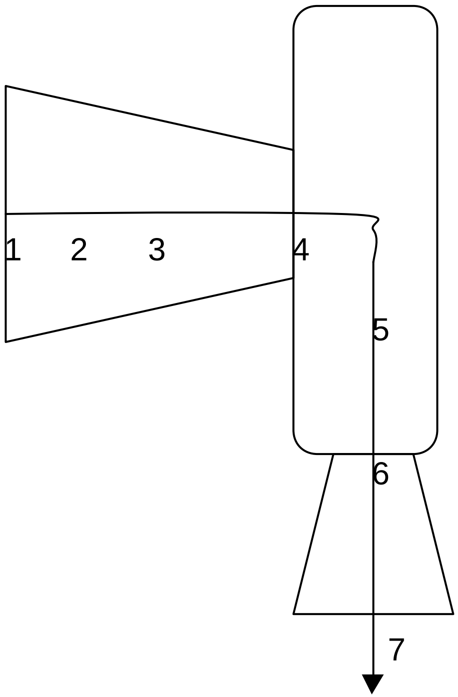
- **Expressed in m of liquid**
- **Independent of the nature of fluid**
- **A pump always develop the same head. The discharge pressure varies with the fluid density:**
  - As an example, the discharge pressure of a pump handling water (density 1)will be doubled than with LPG (density 0.5), as long as the motor power is sufficient

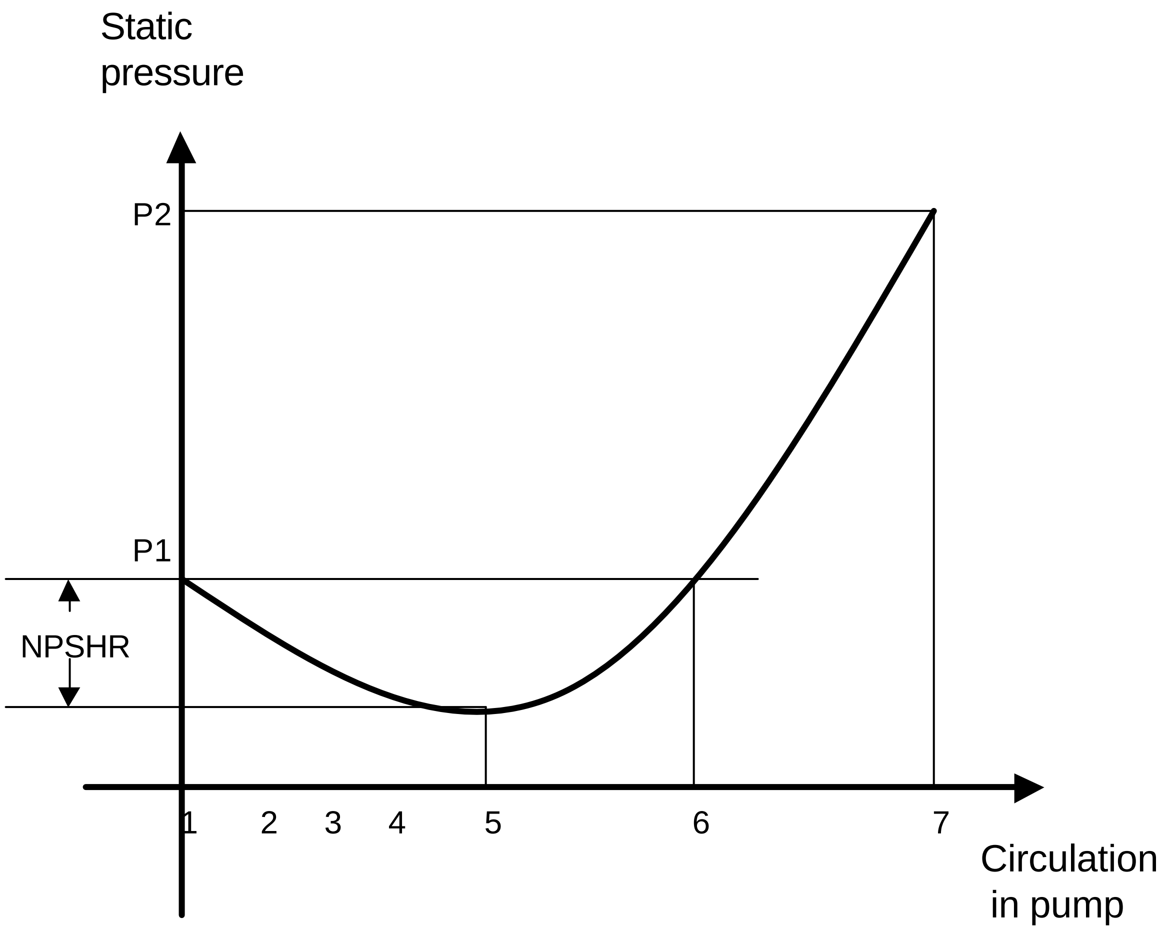
$$H = \frac{P_d - P_s}{d} 10.2$$

H in m
Pd, Pa in Bara
d density

- **How to select a pump handling two different fluids**
  - ➔ **The impeller diameter is selected for the fluid with the smallest density (i.e. with the highest head for a given discharge pressure)**
  - ➔ **The motor is sized for the fluid of the highest density**
  - ➔ **When operating with the fluid of the highest density, the discharge pressure will be higher and the discharge control valve has to throttle more.**

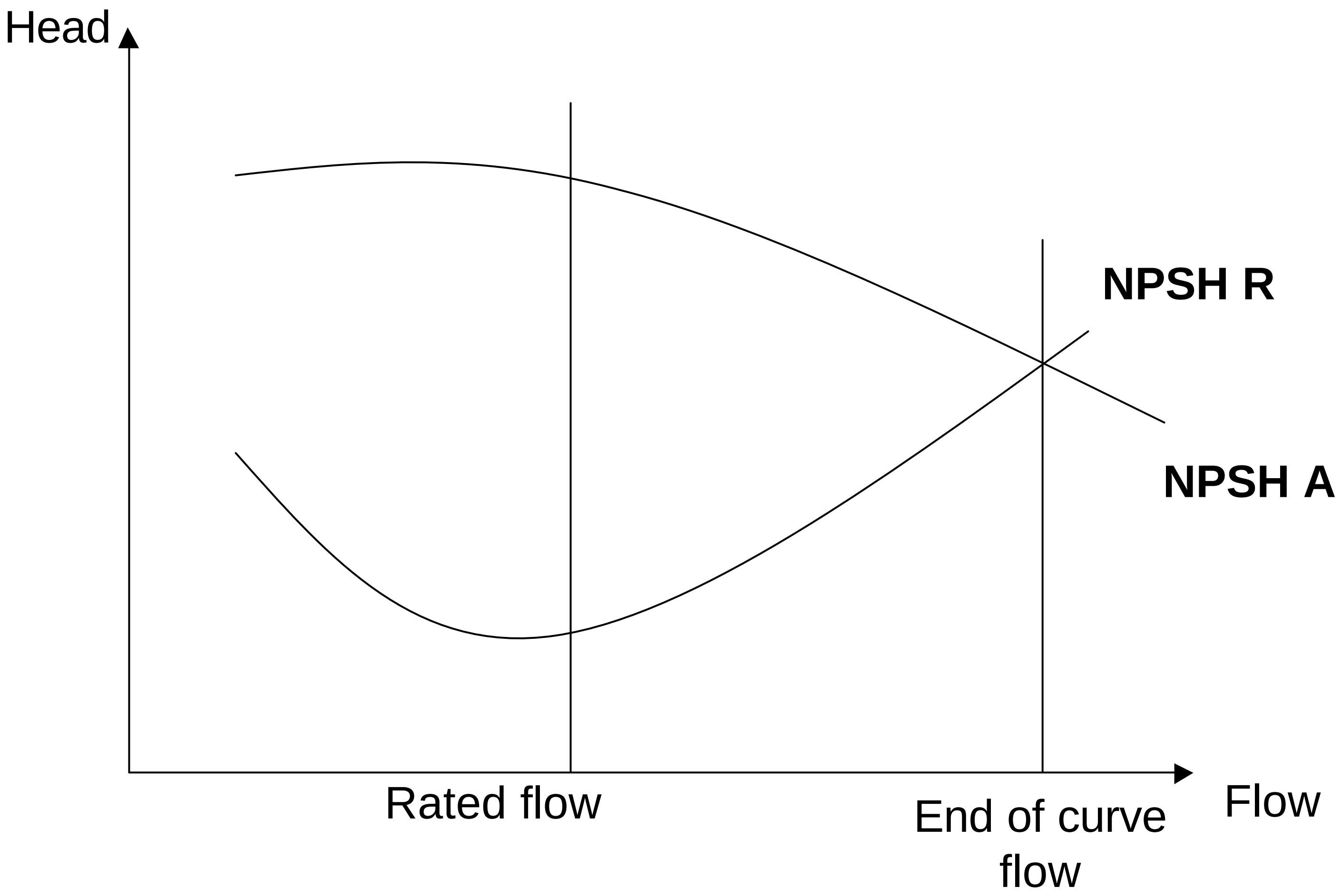
- **NPSHR**


1
2
3
4
5
6
7


Static
pressure
P2
P1
NPSHR
1
2
3
4
5
6
7
Circulation
in pump

- **Available NPSH**

  NPSHA = $P_a - P_{vp} + Z_a + v^2/2g$ - deltaP



- **Affinity laws**

  - **In function of diameter**

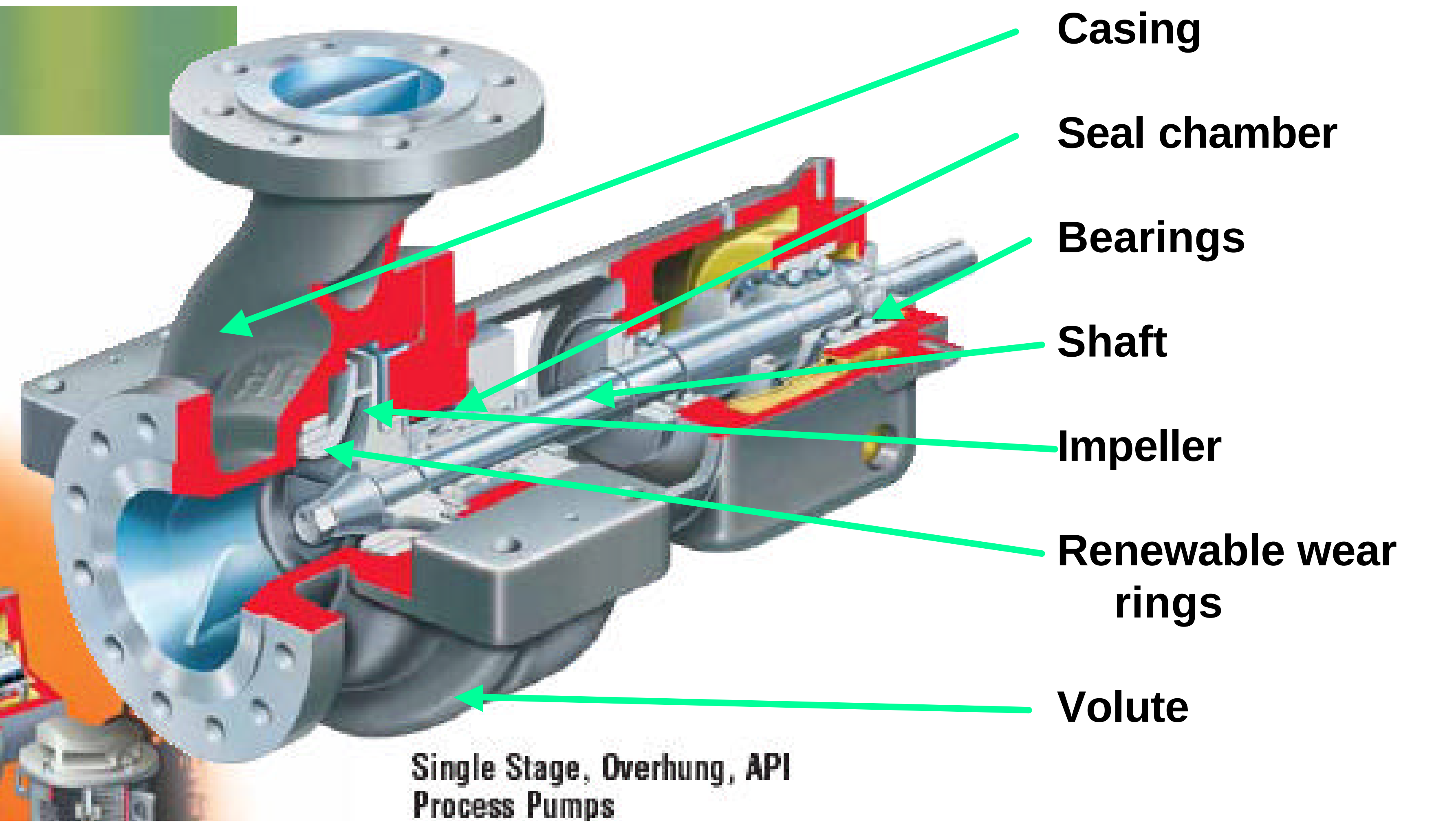
    - $Q_2/Q_1 = D_2/D_1$
    - $H_2/H_1 = (D_2/D_1)^2$
    - $P2/P1 = (D_2/D_1)^3$

  - **In function of speed**

    - $Q_2/Q_1 = N_2/N_1$
    - $H_2/H_1 = (N_2/N_1)^2$
    - $P2/P1 = (N_2/N_1)^3$

- **Effect of viscosity on pump characteristics**
  - ➔ **Reduction of flow, head and efficiency**
  - ➔ **Qvis- viscous pump capacity**
  - ➔ **Hvis – Viscous head**
  - ➔ **Rvis – Viscous efficiency**

- **Maximum viscosity for centrifugal pump**
  - ➔ **400 cst**
- **Below 10 cst no correction necessary**


Casing
Seal chamber
Bearings
Shaft
Impeller
Renewable wear rings
Volute
Single Stage, Overhung, API Process Pumps

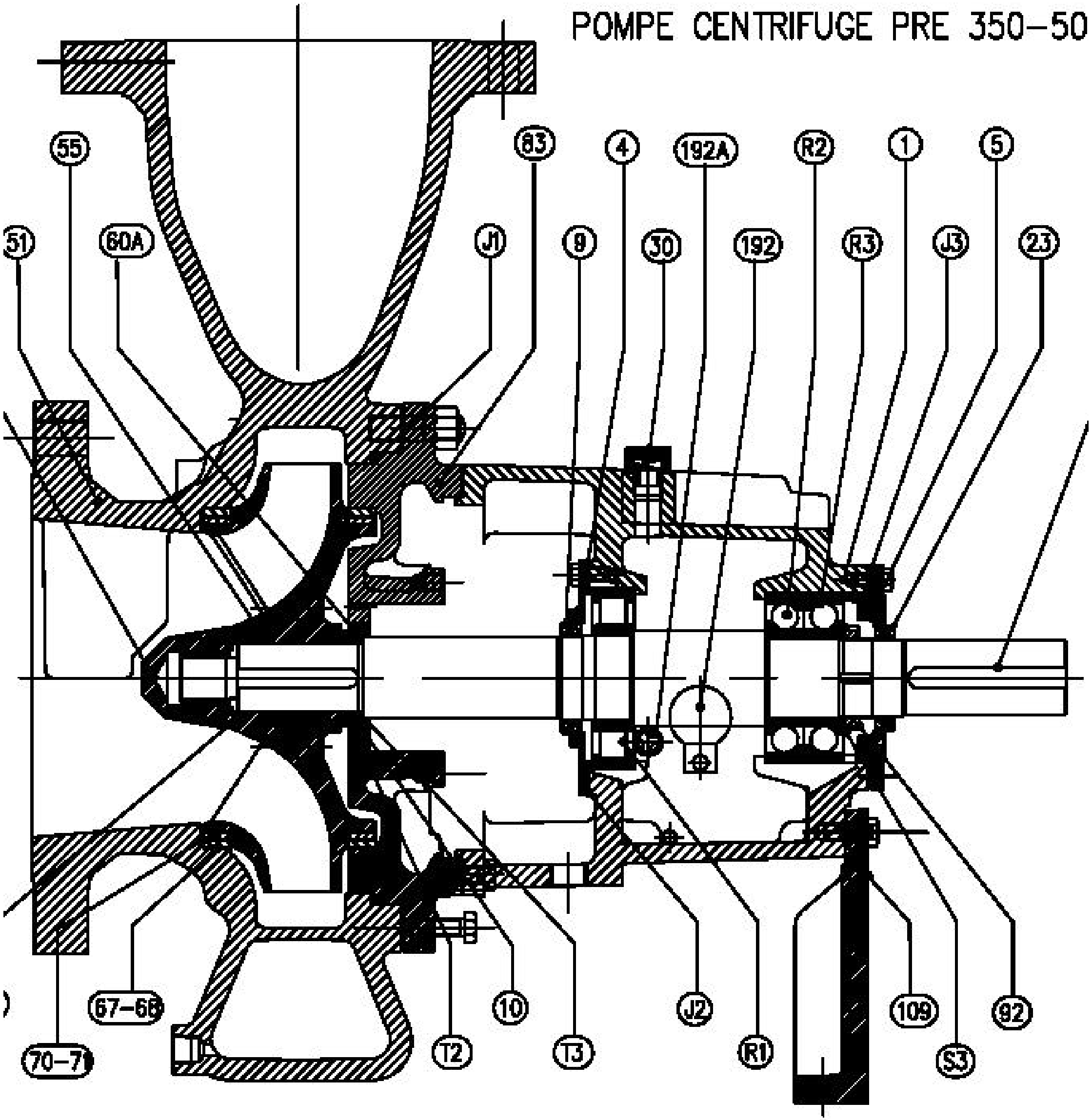
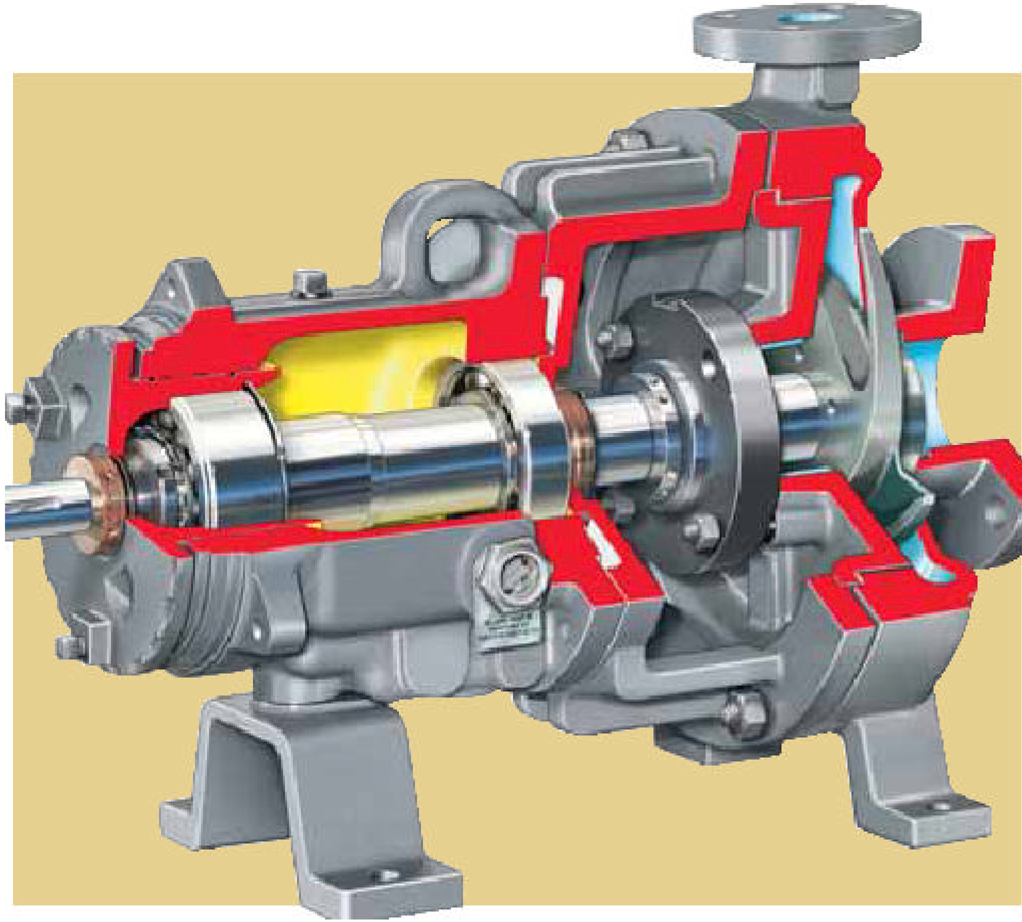

POMPE CENTRIFUGE PRE 350-50
55
83
4
192A
R2
1
5
51
60A
J1
9
30
192
R3
J3
23
67-68
70-71
10
T2
T3
J2
R1
109
S3
92

Table 1 — Pump classification type identification

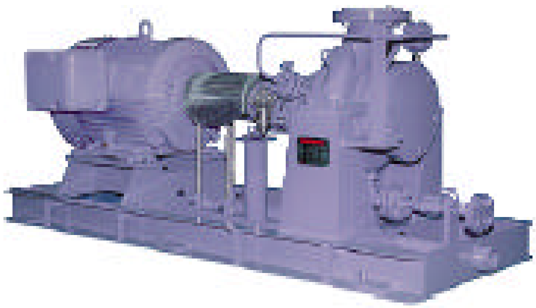
Centrifugal pumps	Overhung	Flexibly-coupled	Horizontal	Foot-mounted	OH1
				Centreline-supported	OH2
			Vertical in-line with bearing bracket		OH3
		Rigidly-coupled	Vertical in-line		OH4
		Close-coupled	Vertical in-line		OH5
			High-speed integrally-geared		OH6
	Between-bearings	1- and 2-stage	Axially-split		BB1
			Radially-split		BB2
		Multistage	Axially-split		BB3
			Radially-split	Single-casing	BB4
				Double-casing	BB5
	Vertically- suspended	Single-casing	Discharge through column	Diffuser	VS1
				Volute	VS2
				Axial-flow	VS3
			Separate discharge	Line-shaft	VS4
				Cantilever	VS5
		Double-casing	Diffuser		VS6
			Volute		VS7

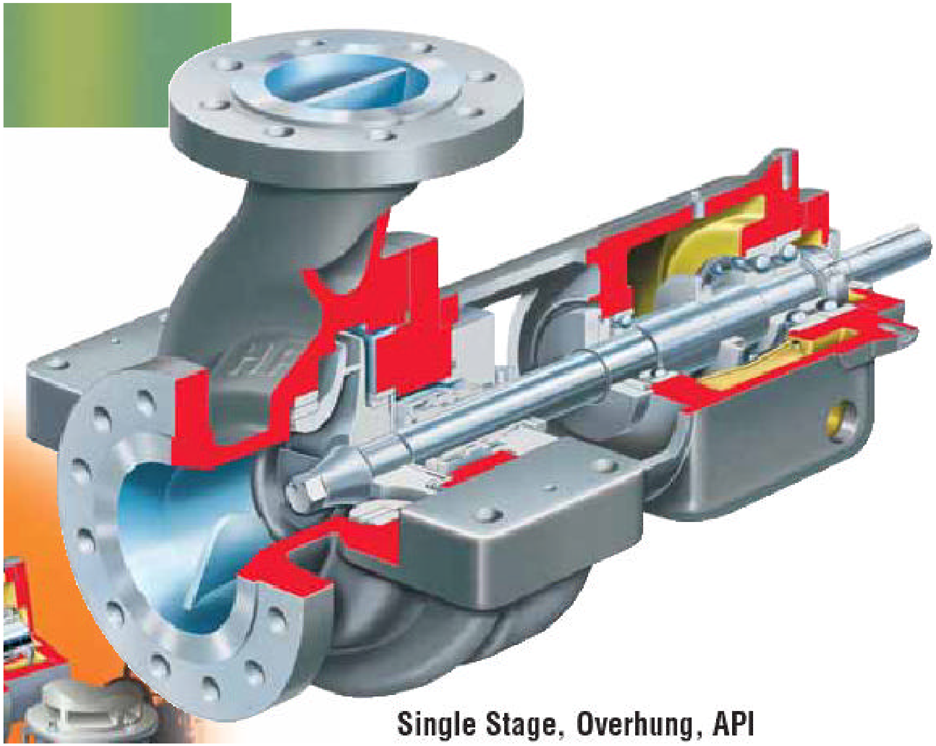
NOTE Figures of the various types are given in 4.1.

- **Overhung - Single stage - foot mounted (OH1)**



- **Overhung - single stage - Centre line mounted (OH2)**





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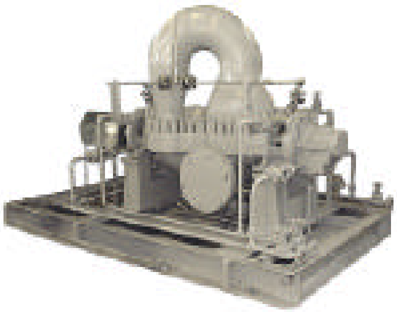
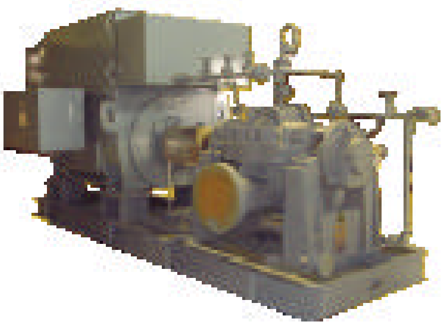
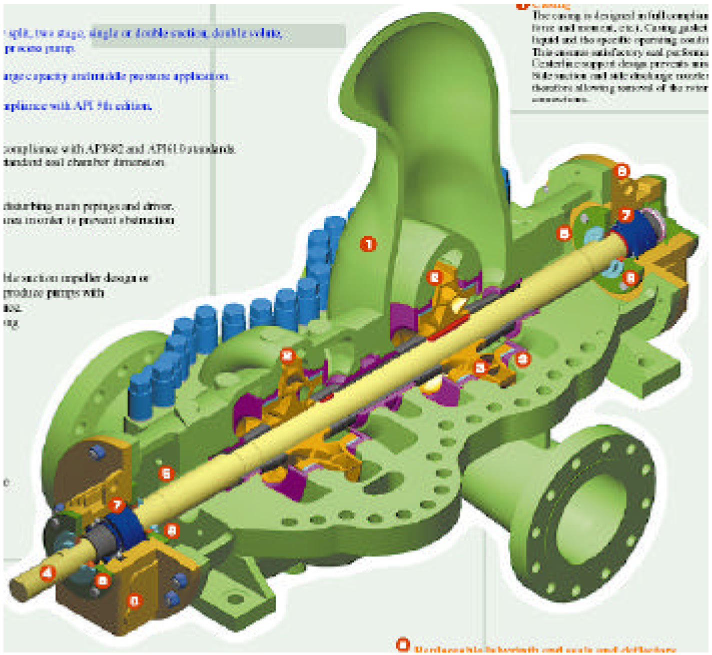
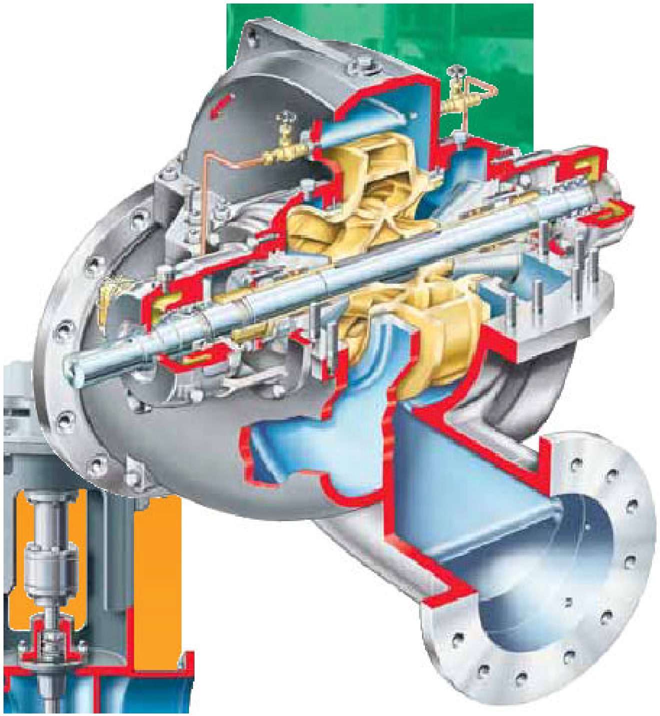
- **Between bearing - One and two stages - axially split (BB1)**

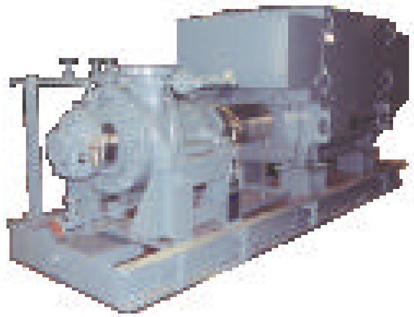


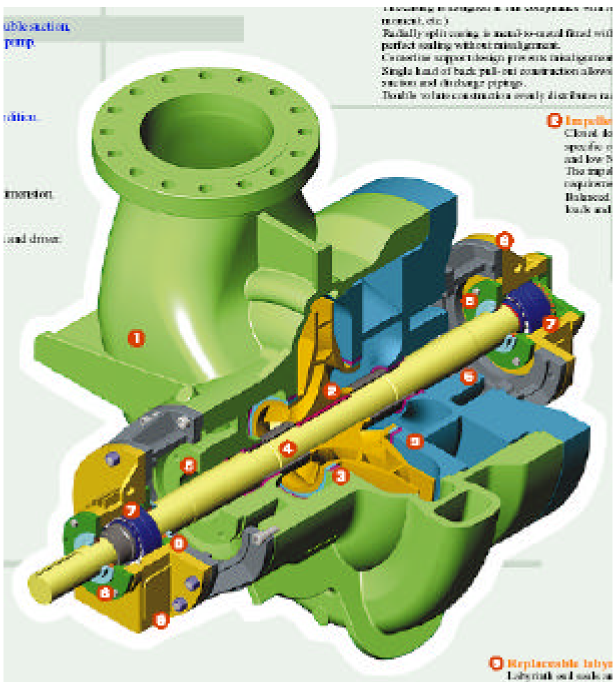


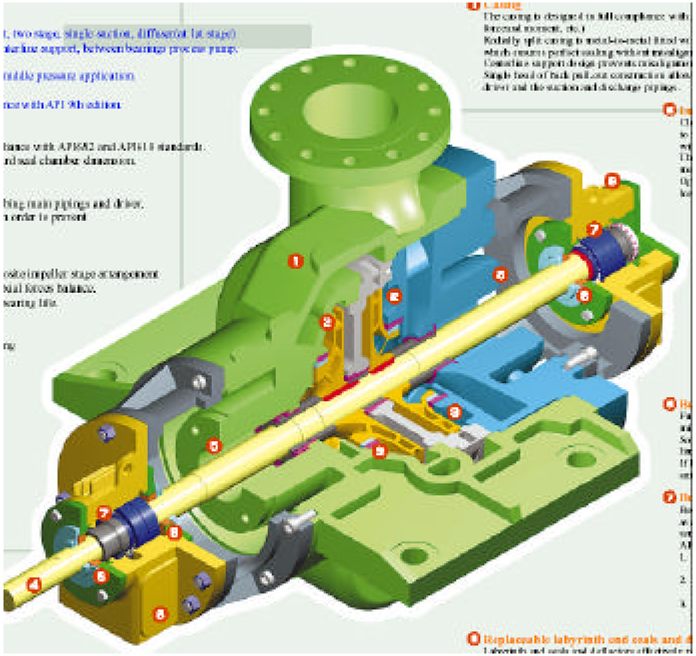




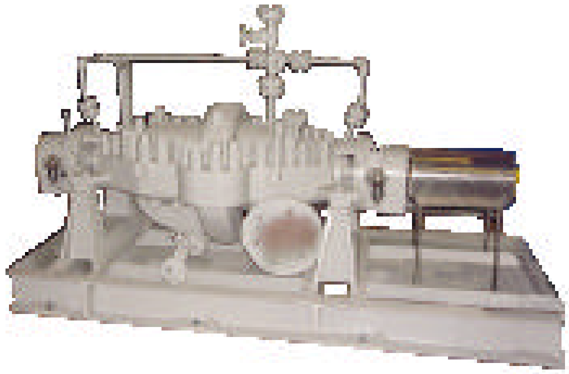
- **Between bearing - One and two stages - Radially split - (BB2)**

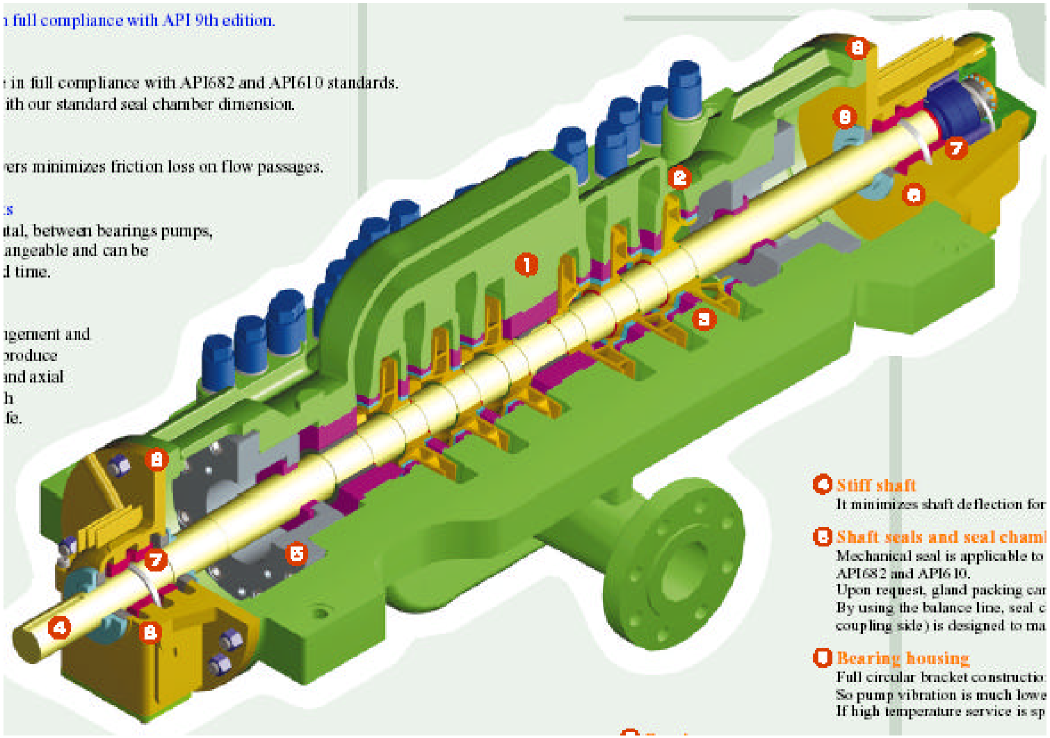




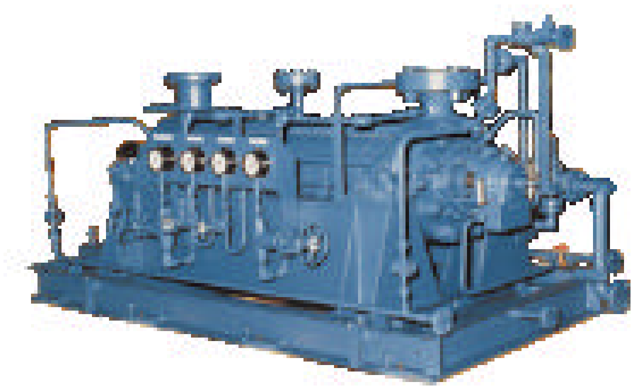


- **Between bearing – Multi stage – axially split (BB3)**

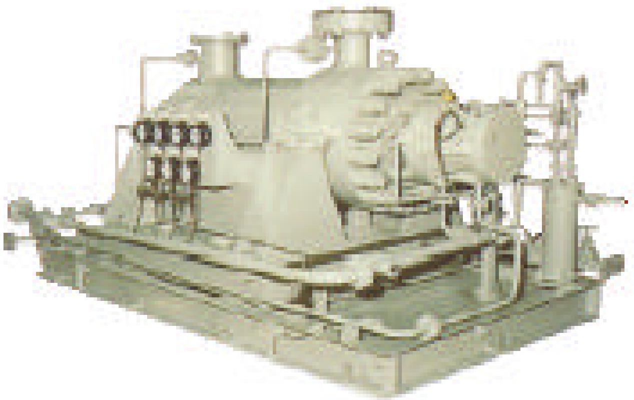


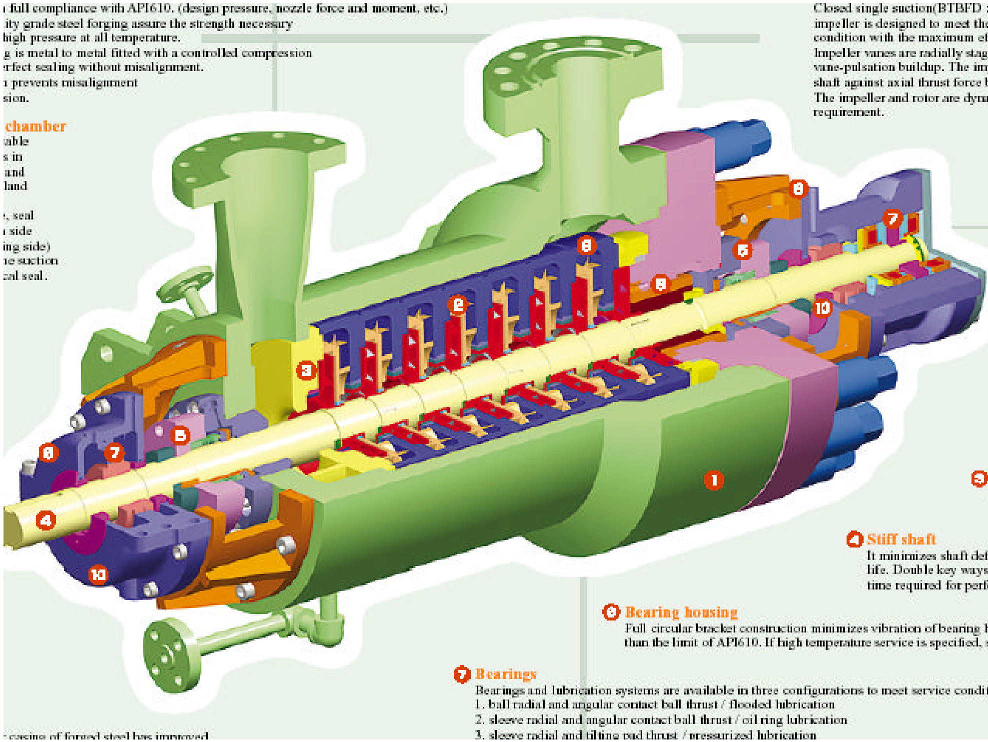


- **Between bearing – Multi-stage – Radially split – Single casing (BB4)**

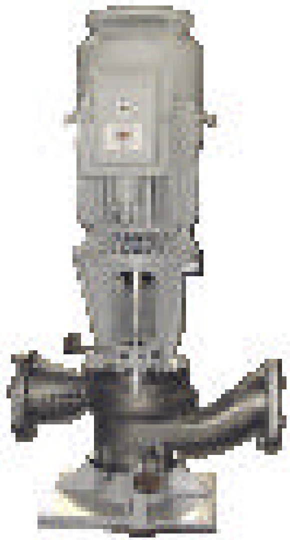


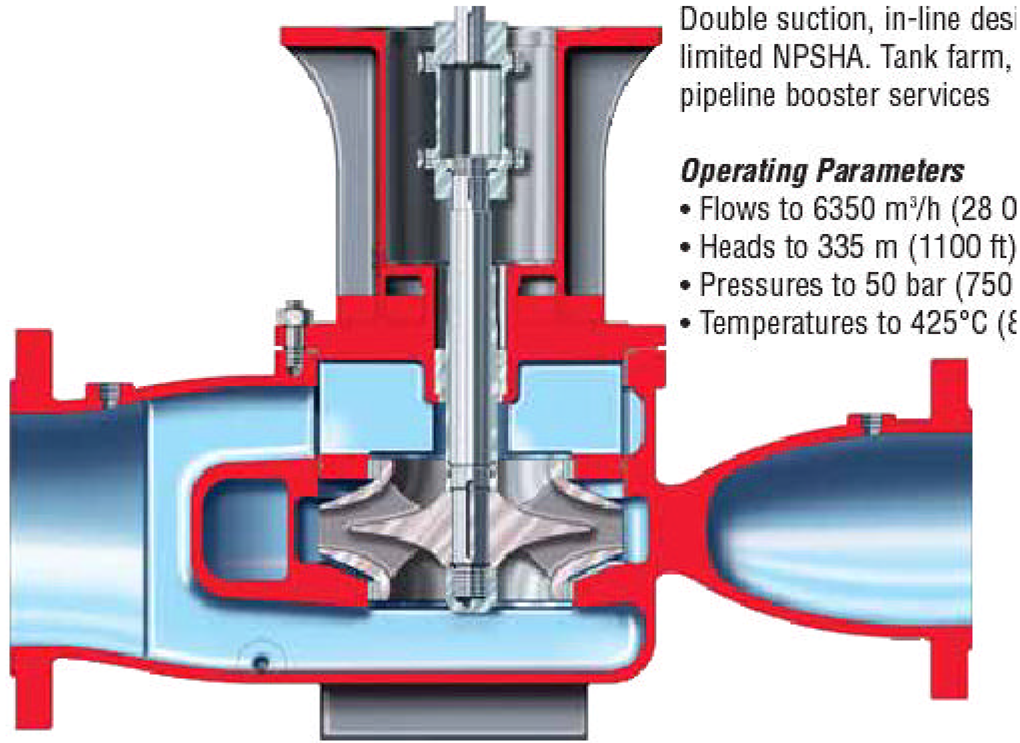
Between bearing – Radially split – Double casing (BB5)



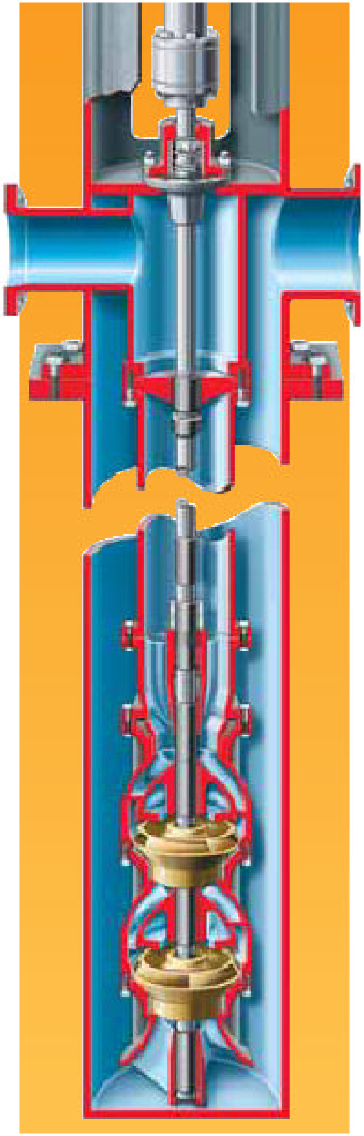


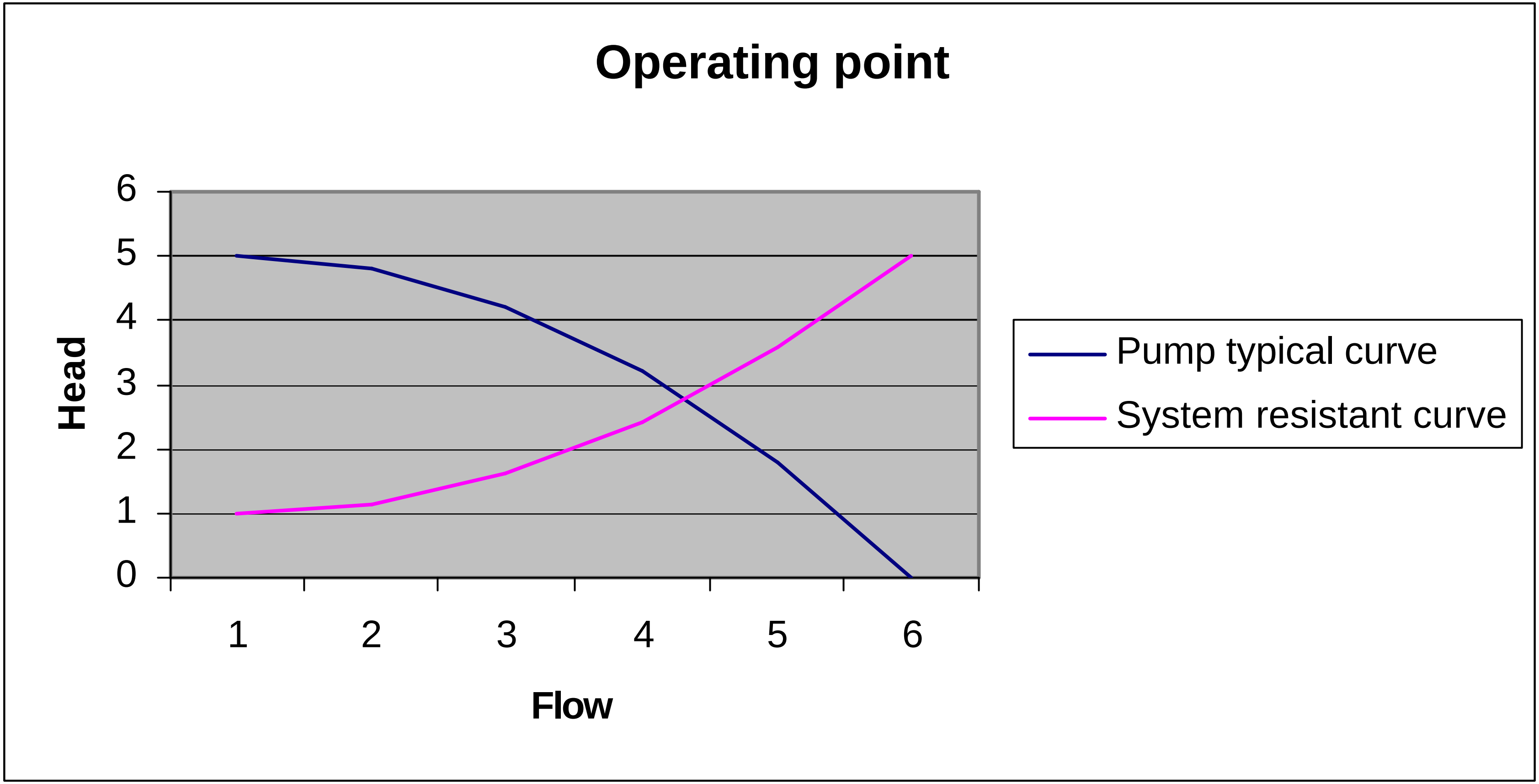
- **Vertical in line (OH4)**





- **Vertical suspended double casing (VS6)**





- **The system curve intersects the pump curve at the operating point**
- **The control is made by a valve at discharge**

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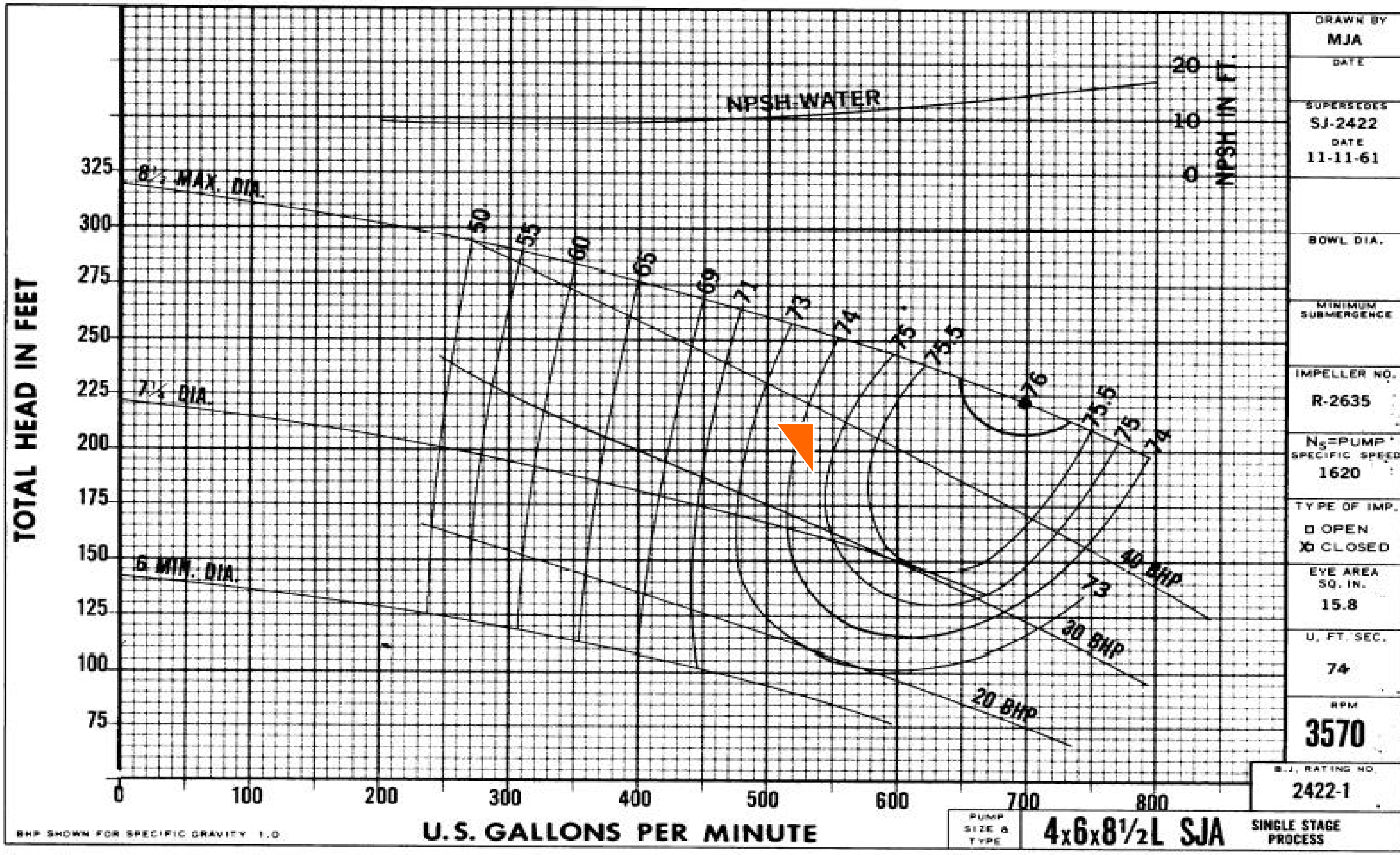
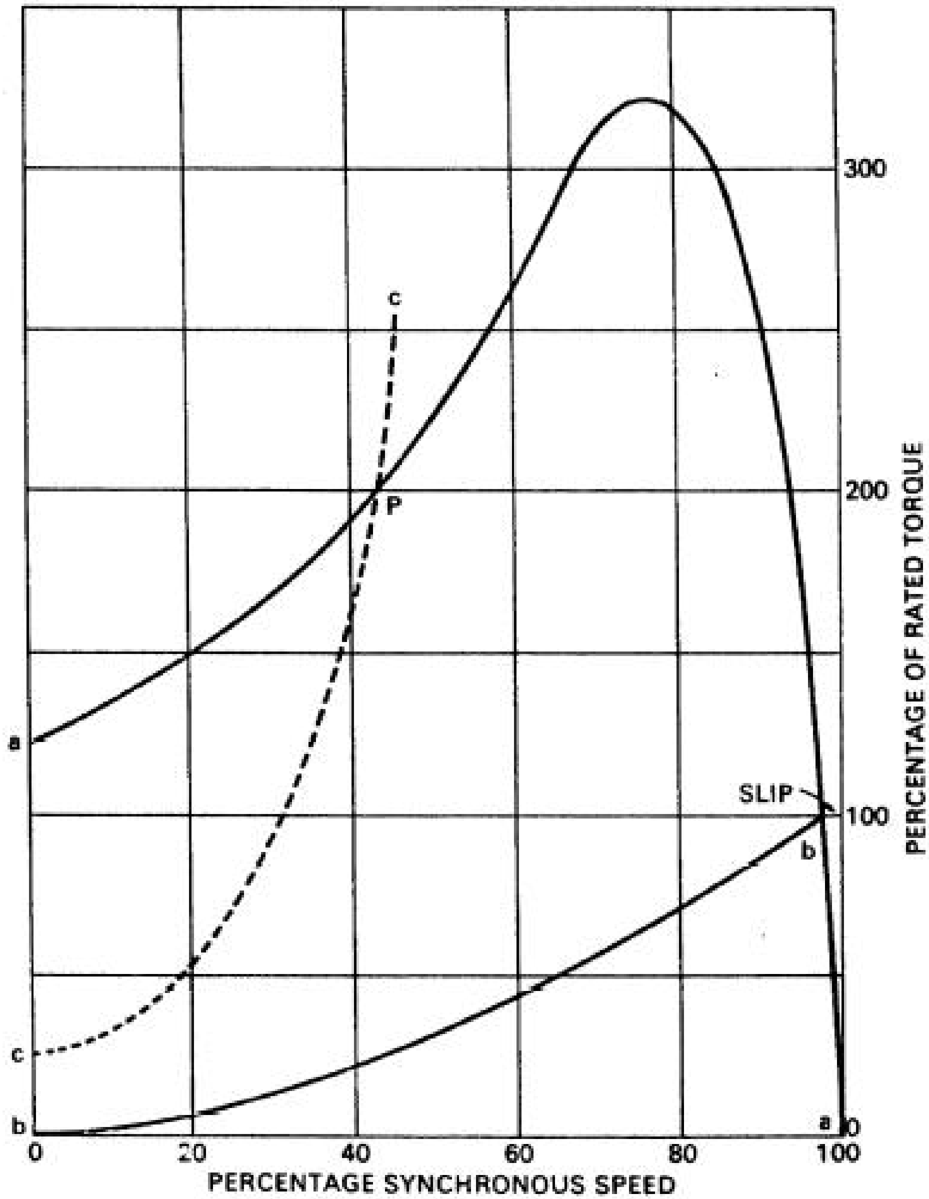
TYPICAL CURVE NETWORK



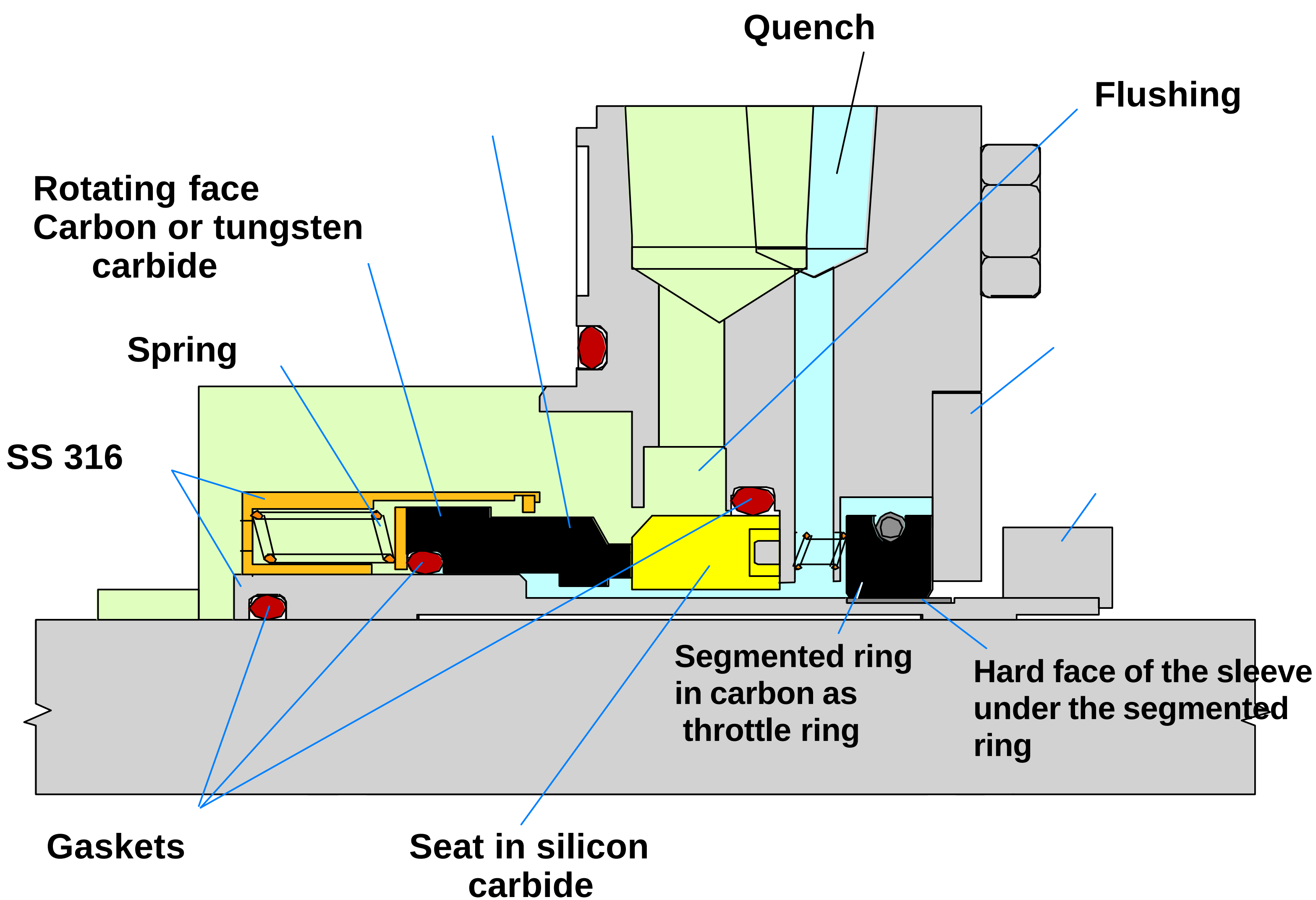
PUMP RESISTANT TORQUE CURVE

- The pump resistant torque is a parabola
- The curve cc intersect the motor curve at P: the pump cannot start.
- The motor torque must be greater that the pump torque up to full speed
- Full speed is lower than synchronous speed
- Equation

$$Cm - Cr = \frac{dv}{dt}$$

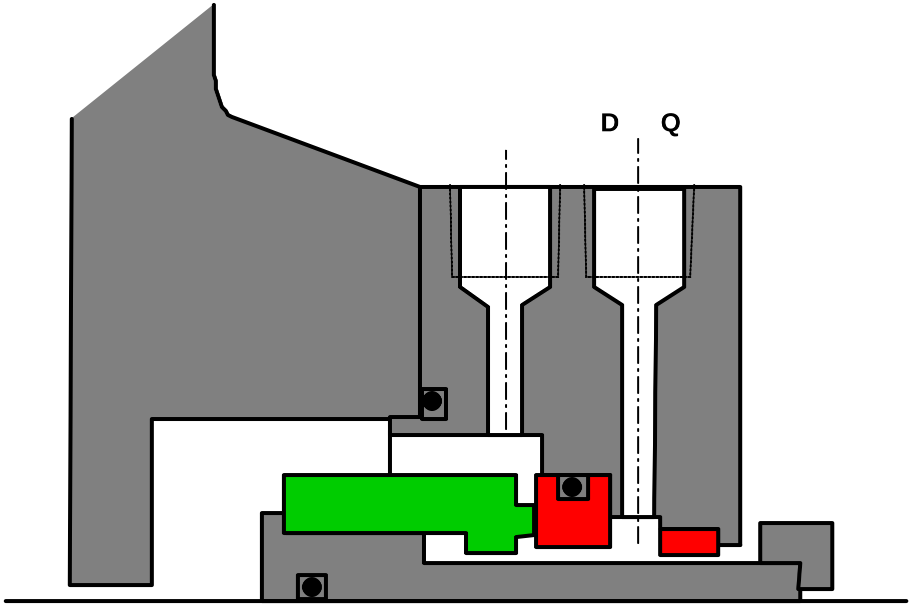


Technip


Quench
Flushing
Rotating face
Carbon or tungsten
carbide
Spring
SS 316
Segmented ring
in carbon as
throttle ring
Hard face of the sleeve
under the segmented
ring
Gaskets
Seat in silicon
carbide

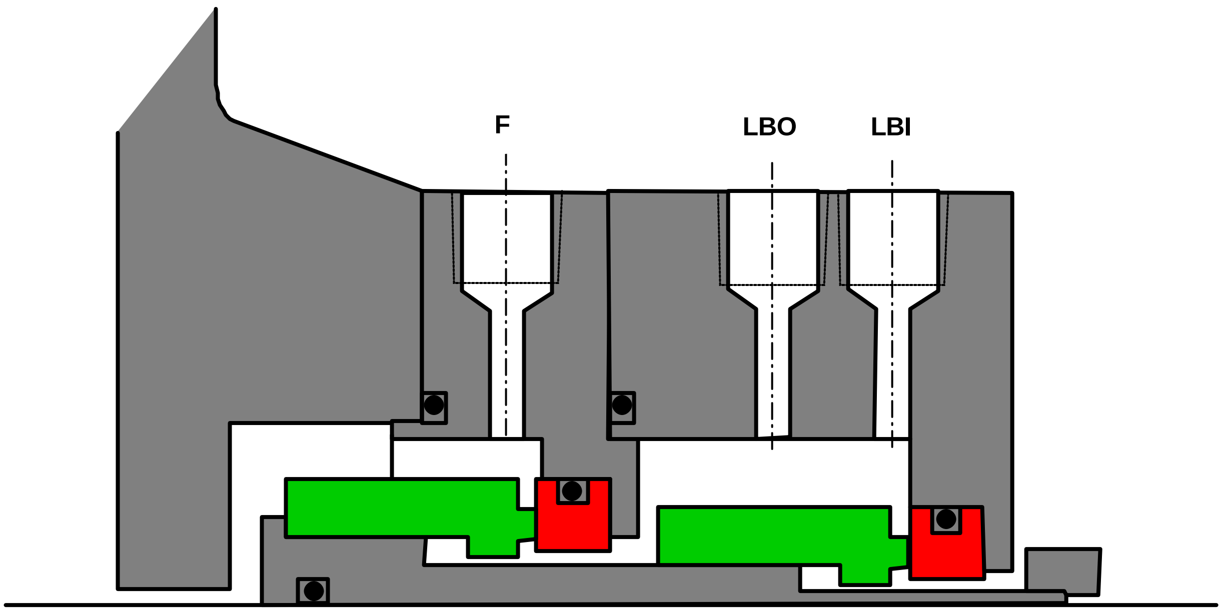
1CW-FX

Configuration / Arrangement



- **2CW-CW**

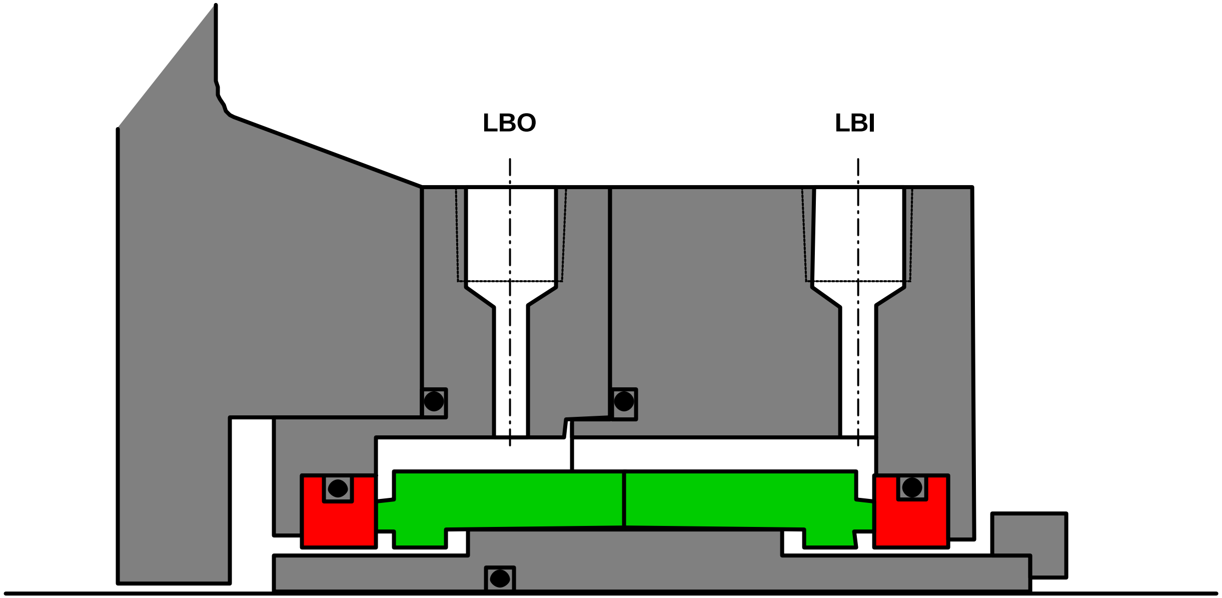
Configuration / Arrangement 2



Technip

- **3CW-BB**

Configuration / Arrangement 3



Technip

- **Plan 53A**

External flushing with seal pot
Forced circulation with pumping ring