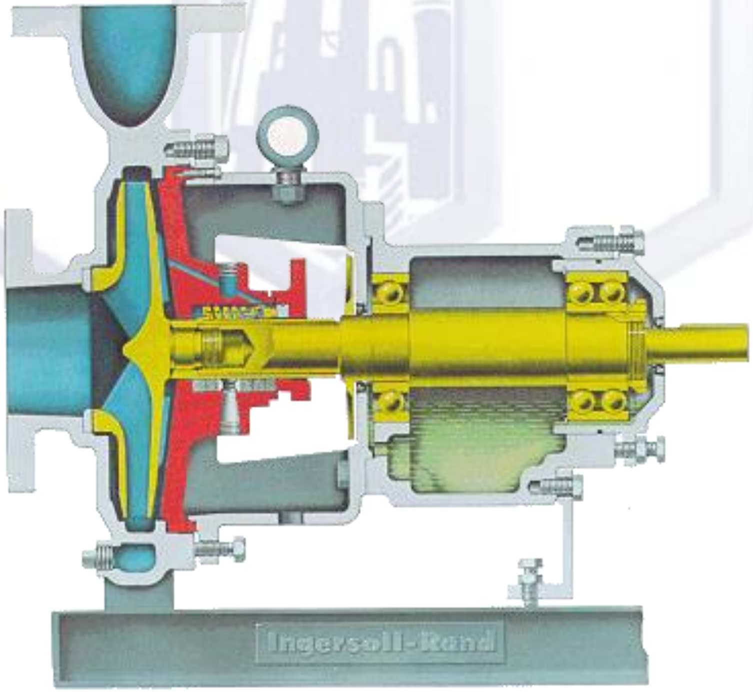
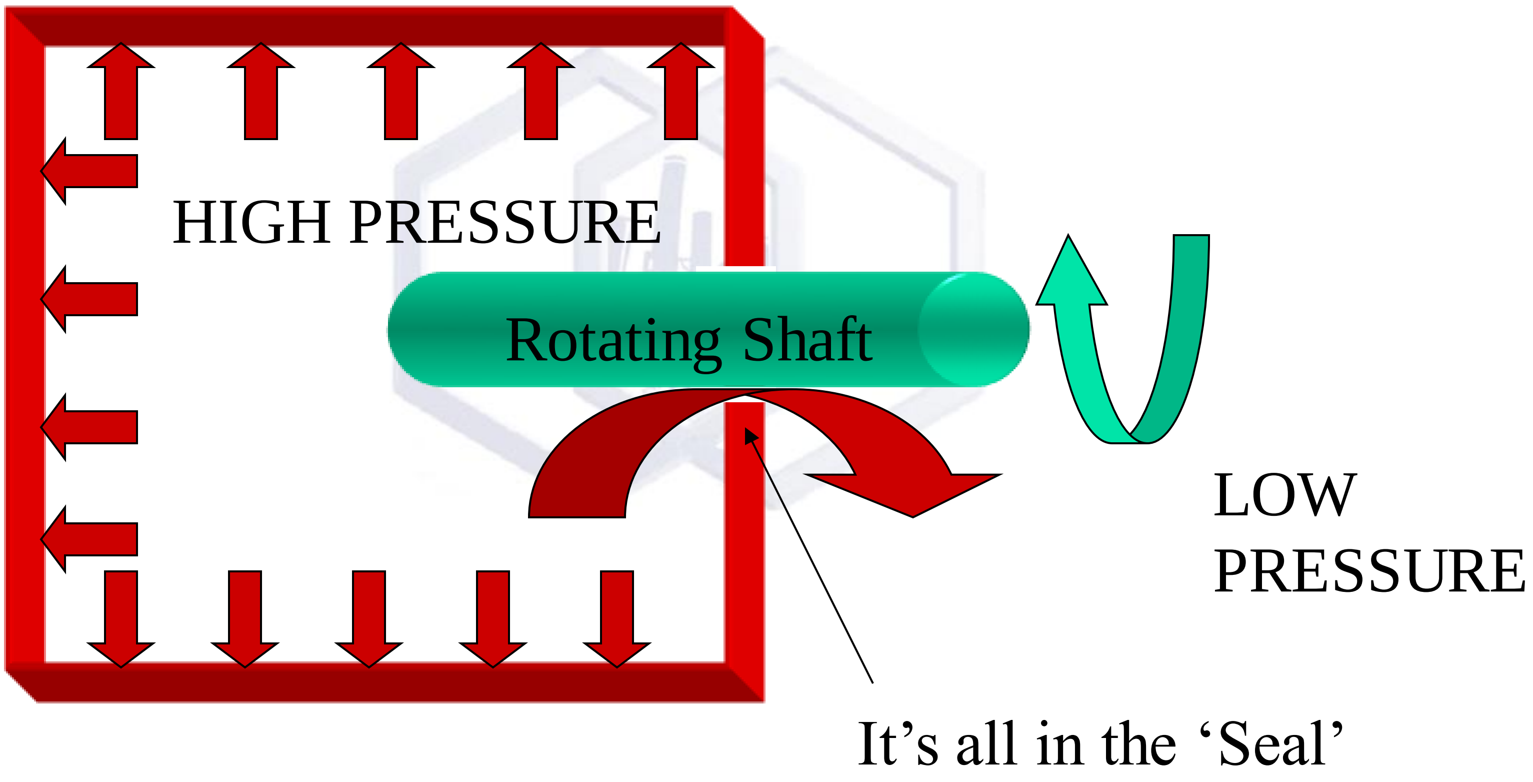
Rotating Equipment

PUMPS



Rotating Equipment



ROTATING EQUIPMENT

- PUMPS
- COMPRESSORS
- AGITATORS
- FANS / BLOWERS
- TURBINES
- VACUUM PUMPS
- VALVES

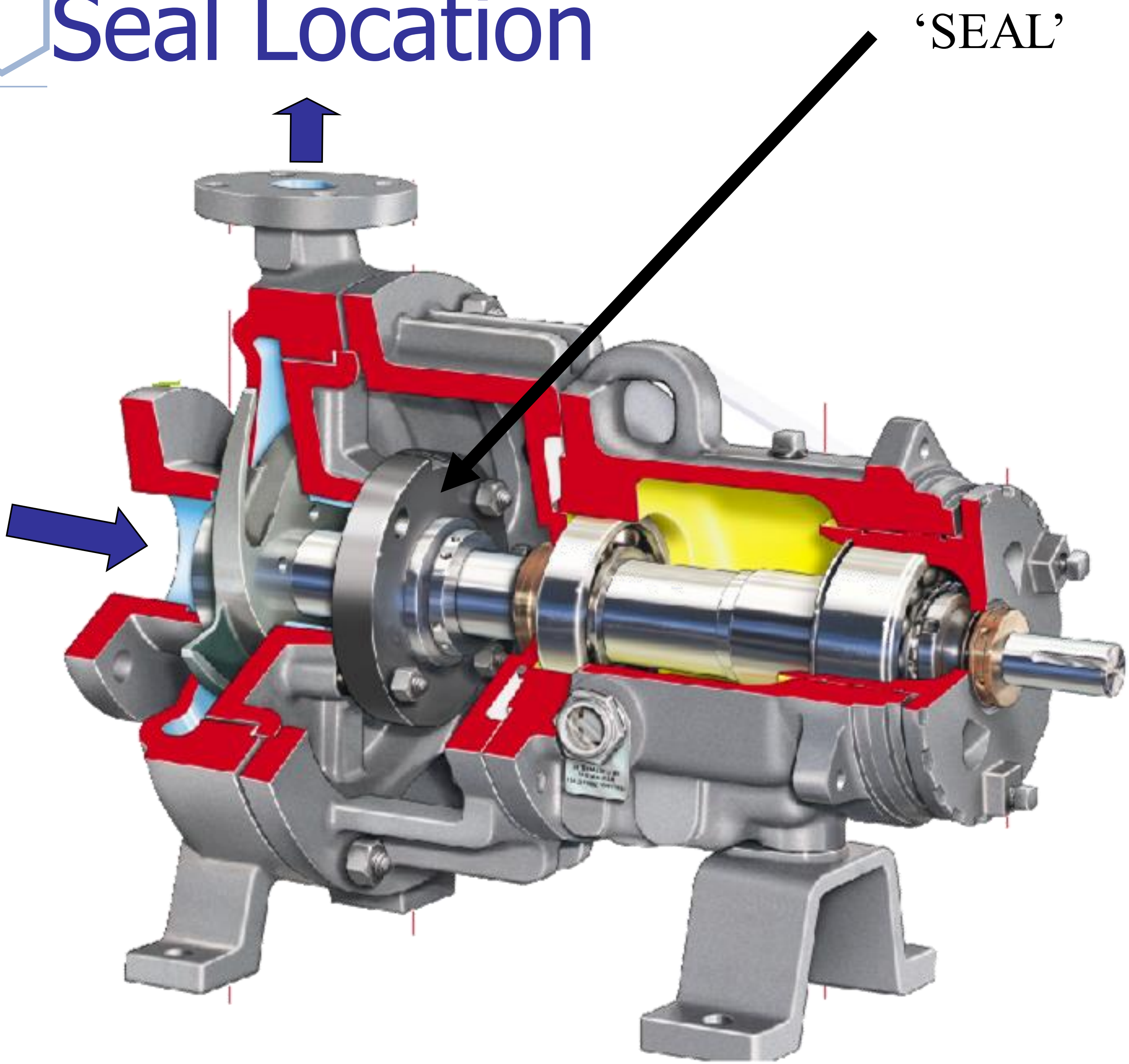
Type of Seals

Increasing
Leakage
Rate

- Stuffing
  - Cheapest
  - Leaks Continuously for cooling
- Mechanical Seal
  - More expensive
  - Trace amounts of leakage for cooling
- Double Mechanical Seal
- Sealess (Magnet Coupled, Canned)
  - Most Expensive

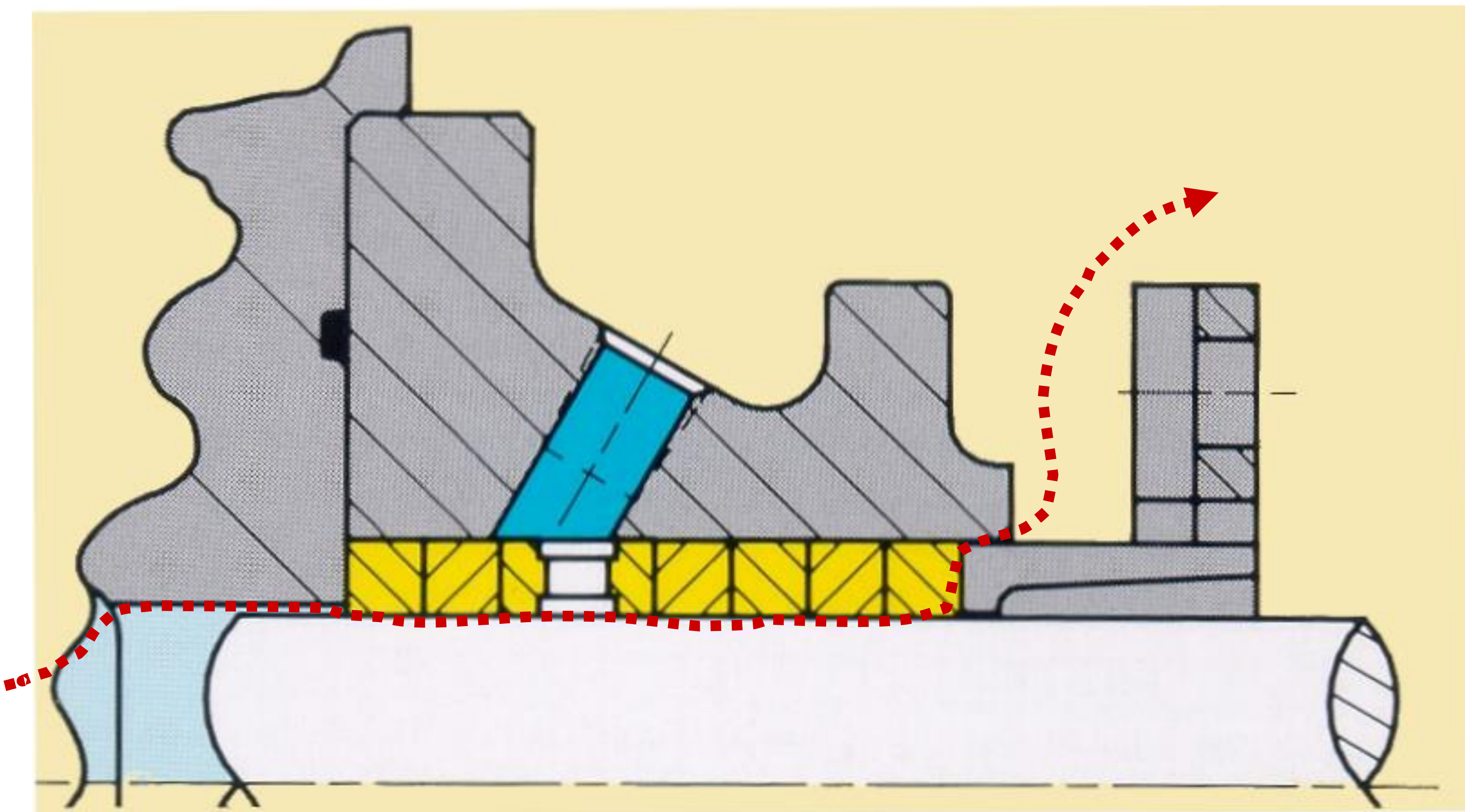
Increasing
Cost

Seal Location



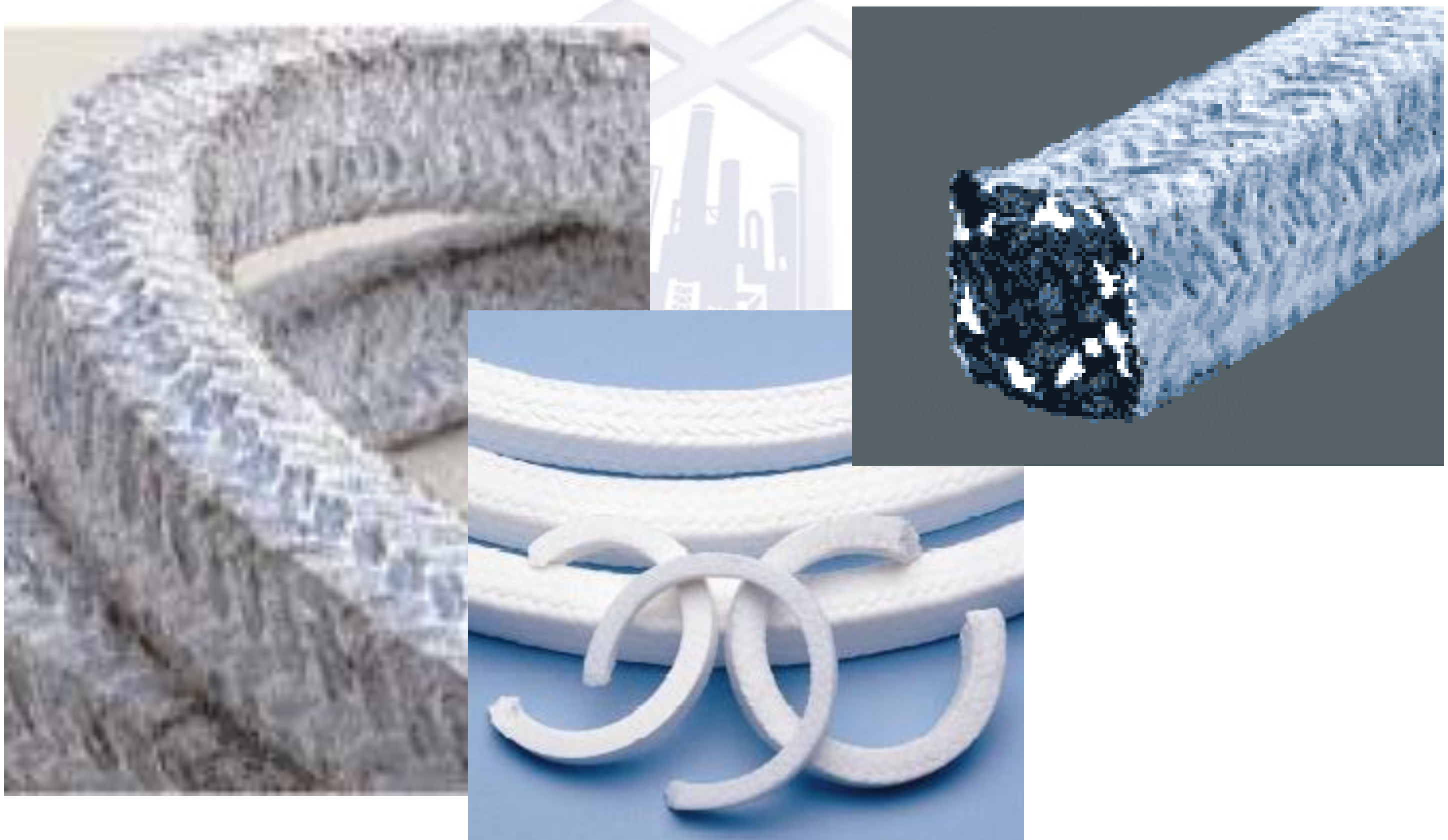
ROTATING EQUIPMENT

"STUFFING BOX"



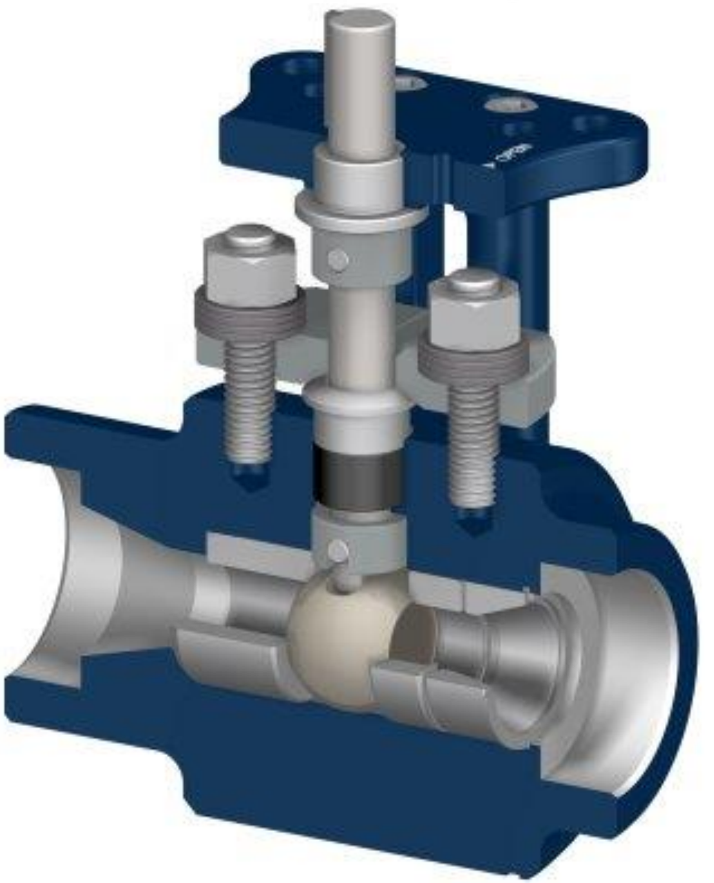
Rotating Equipment

- Packing Material



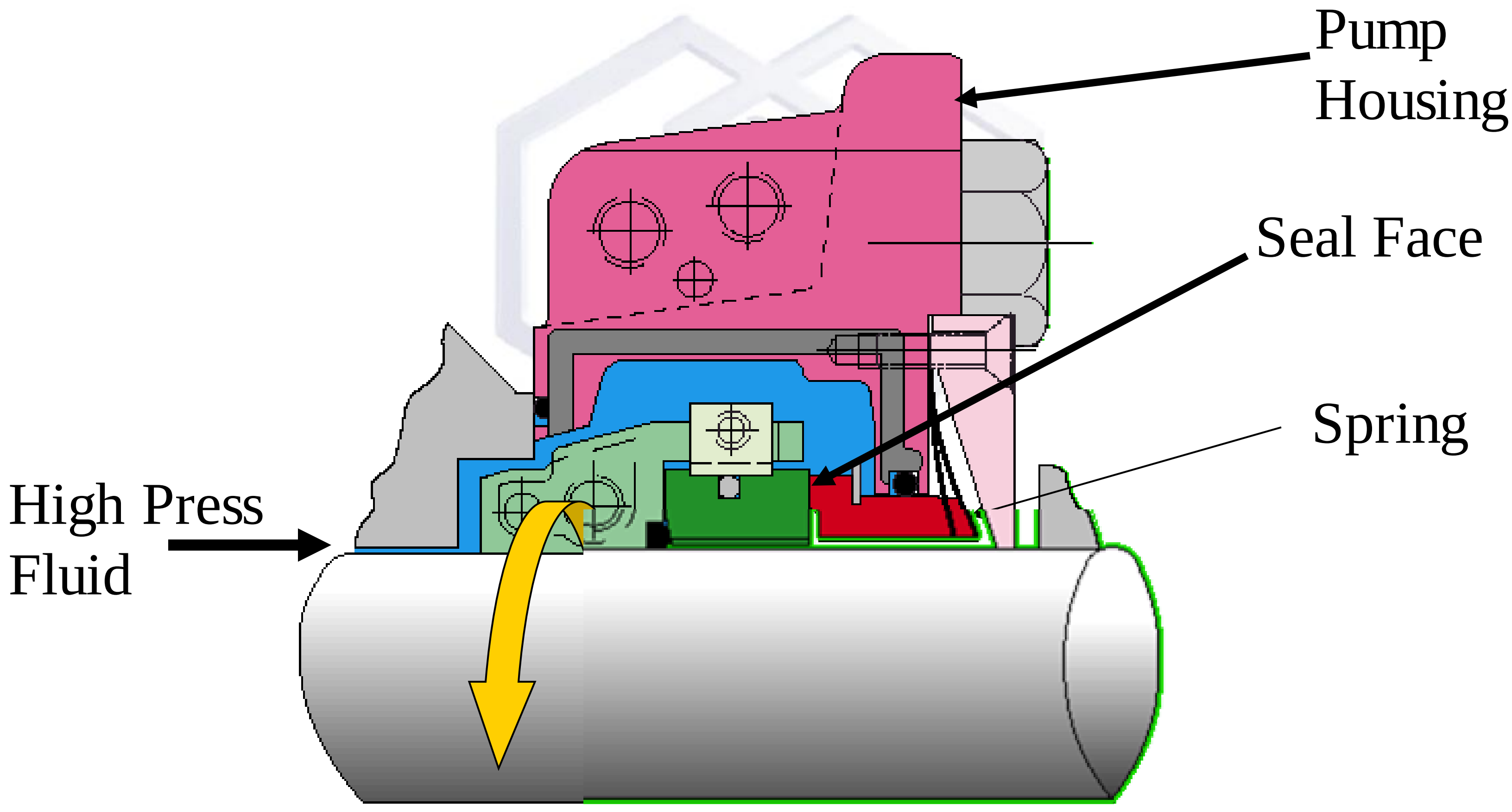
Rotating Equipment

- Valve Packing



ROTATING EQUIPMENT

- SINGLE MECHANICAL SEAL - Pusher Type



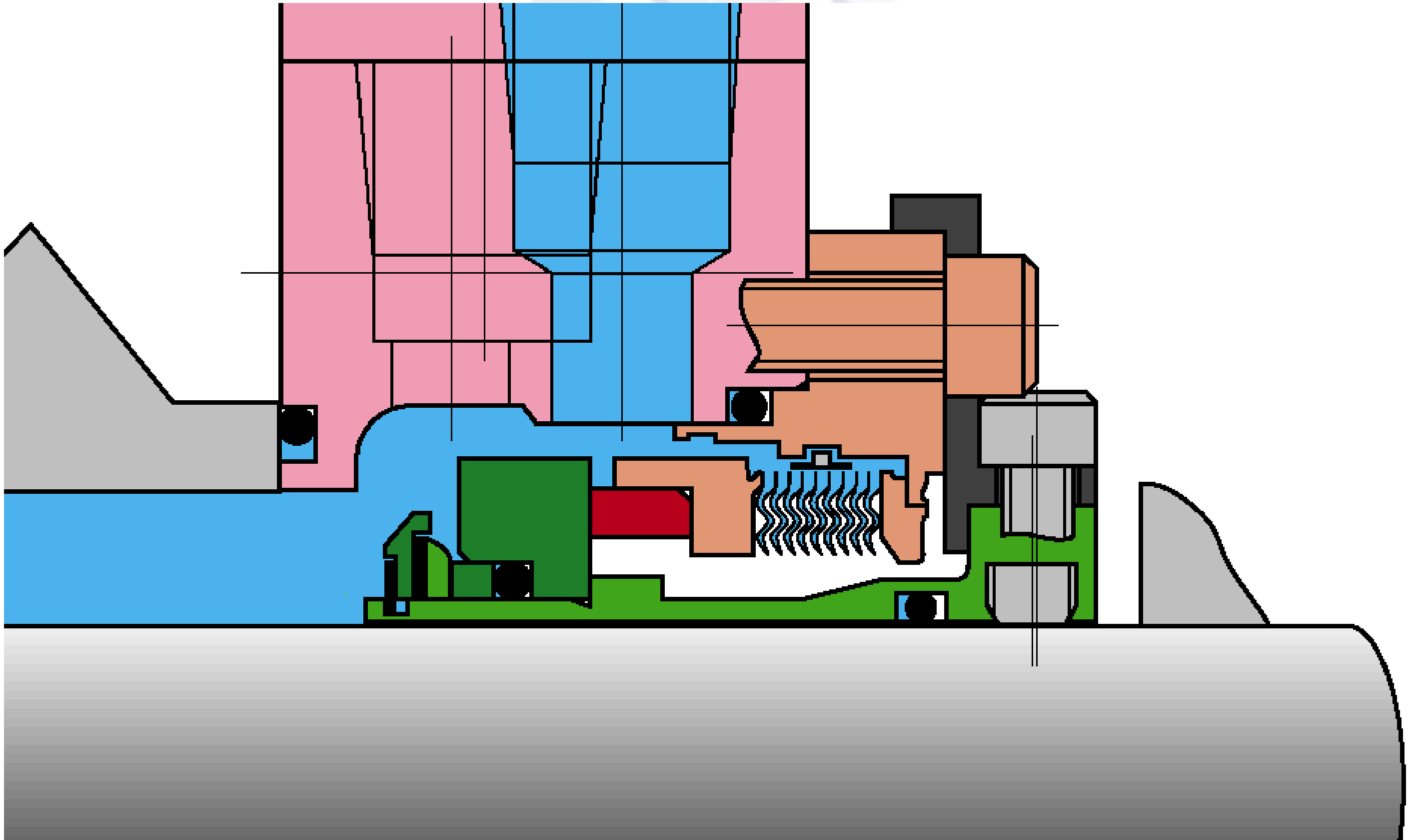
ROTATING EQUIPMENT

- John Crane EZ-1 Single Mechanical Seal

www.johncrane.com

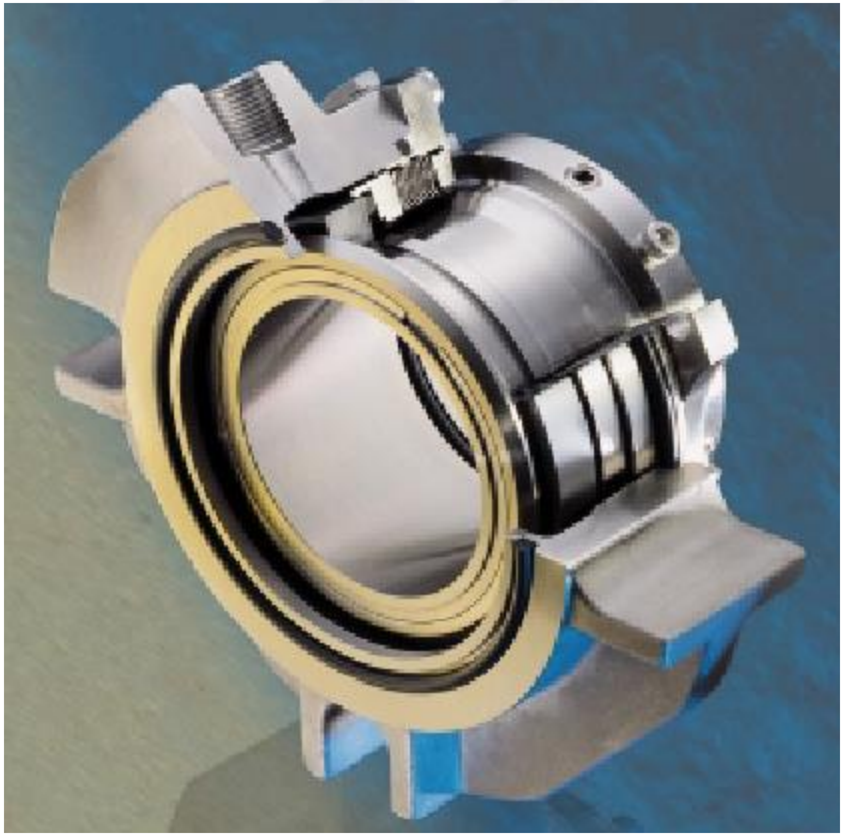
ROTATING EQUIPMENT

- Single Mechanical - Bellows Mechanical Seal



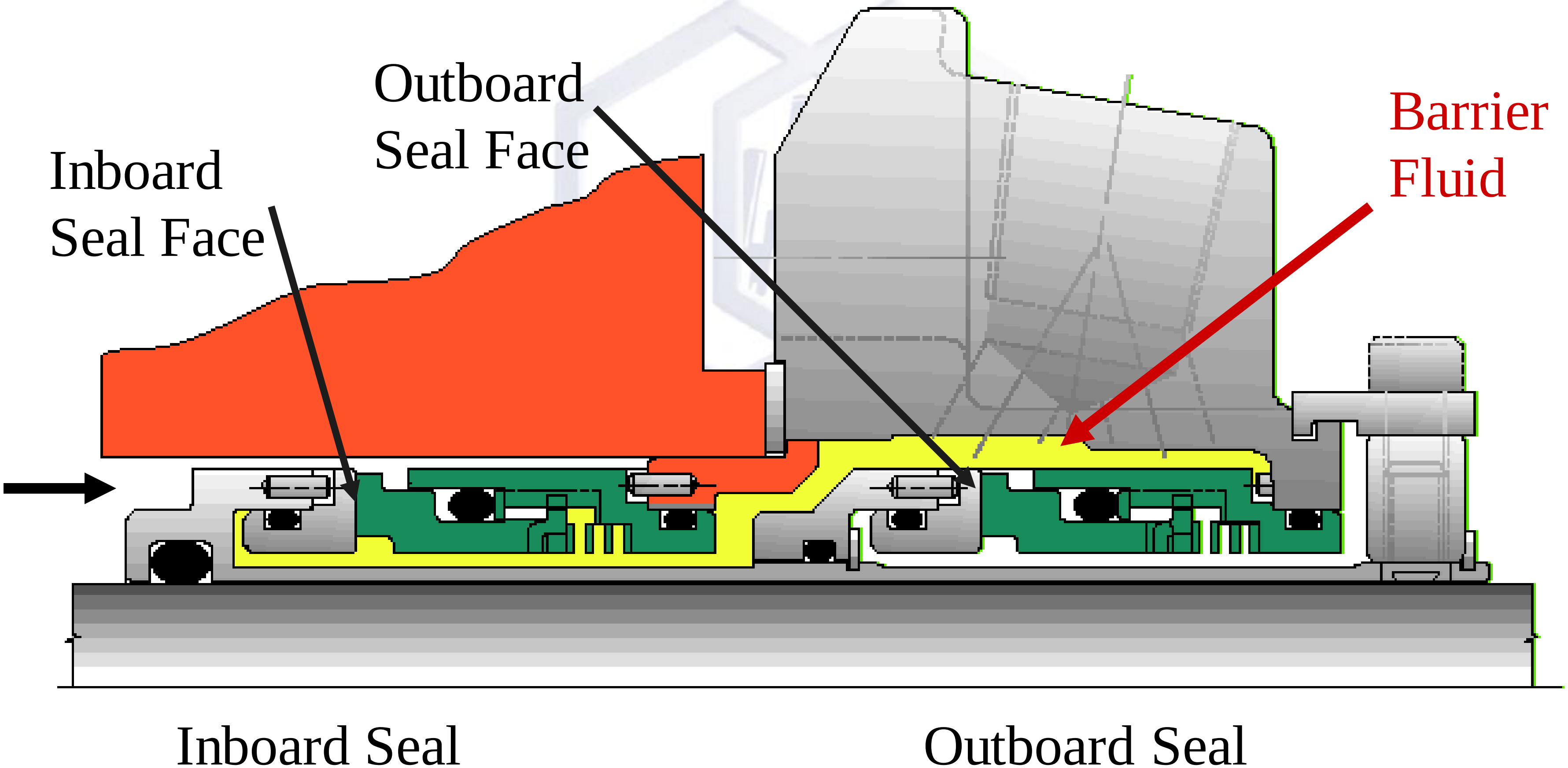
ROTATING EQUIPMENT

- Bellows Mechanical Seal

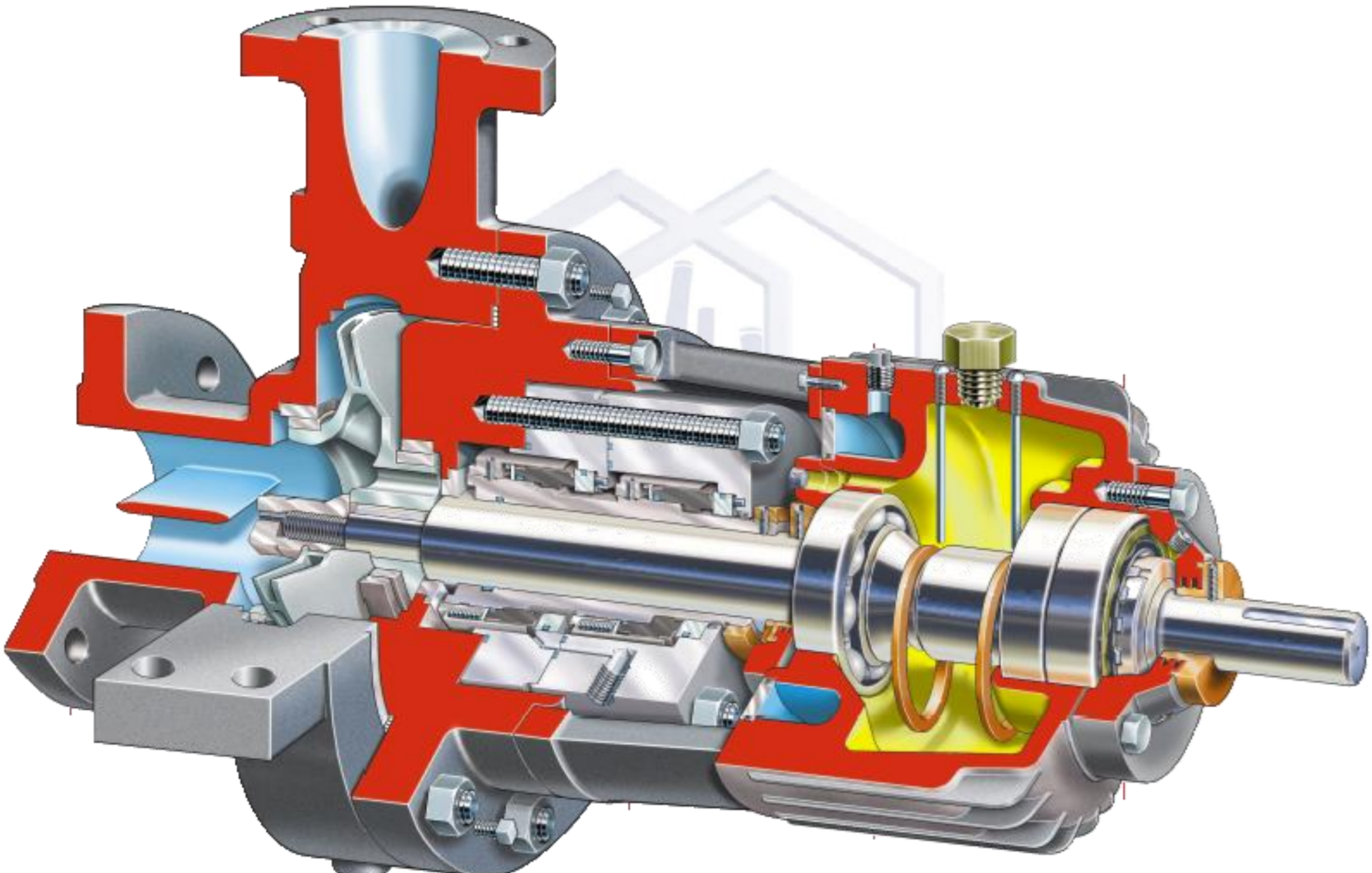


Rotating Equipment

- Double Mechanical Seal

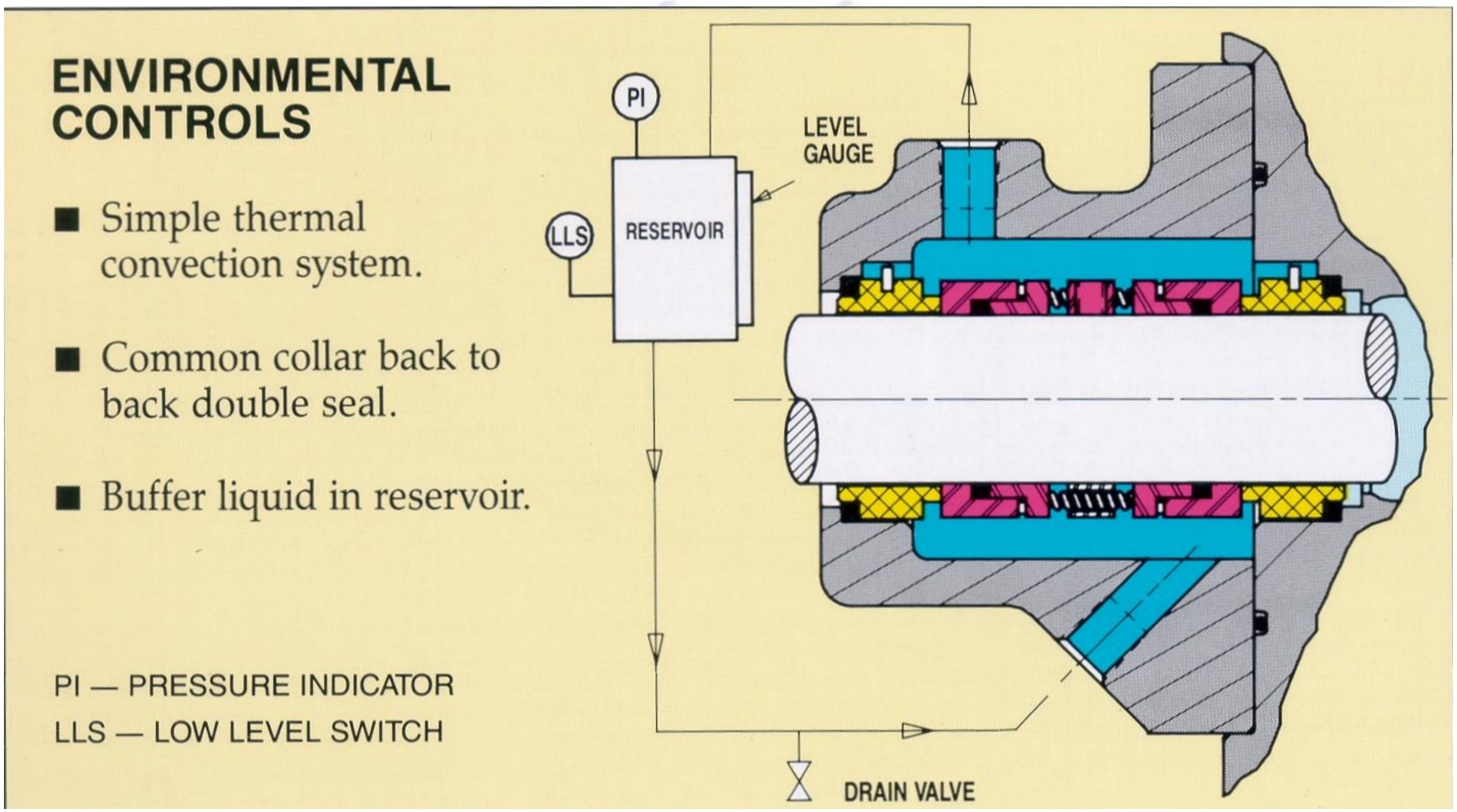


Rotating Equipment



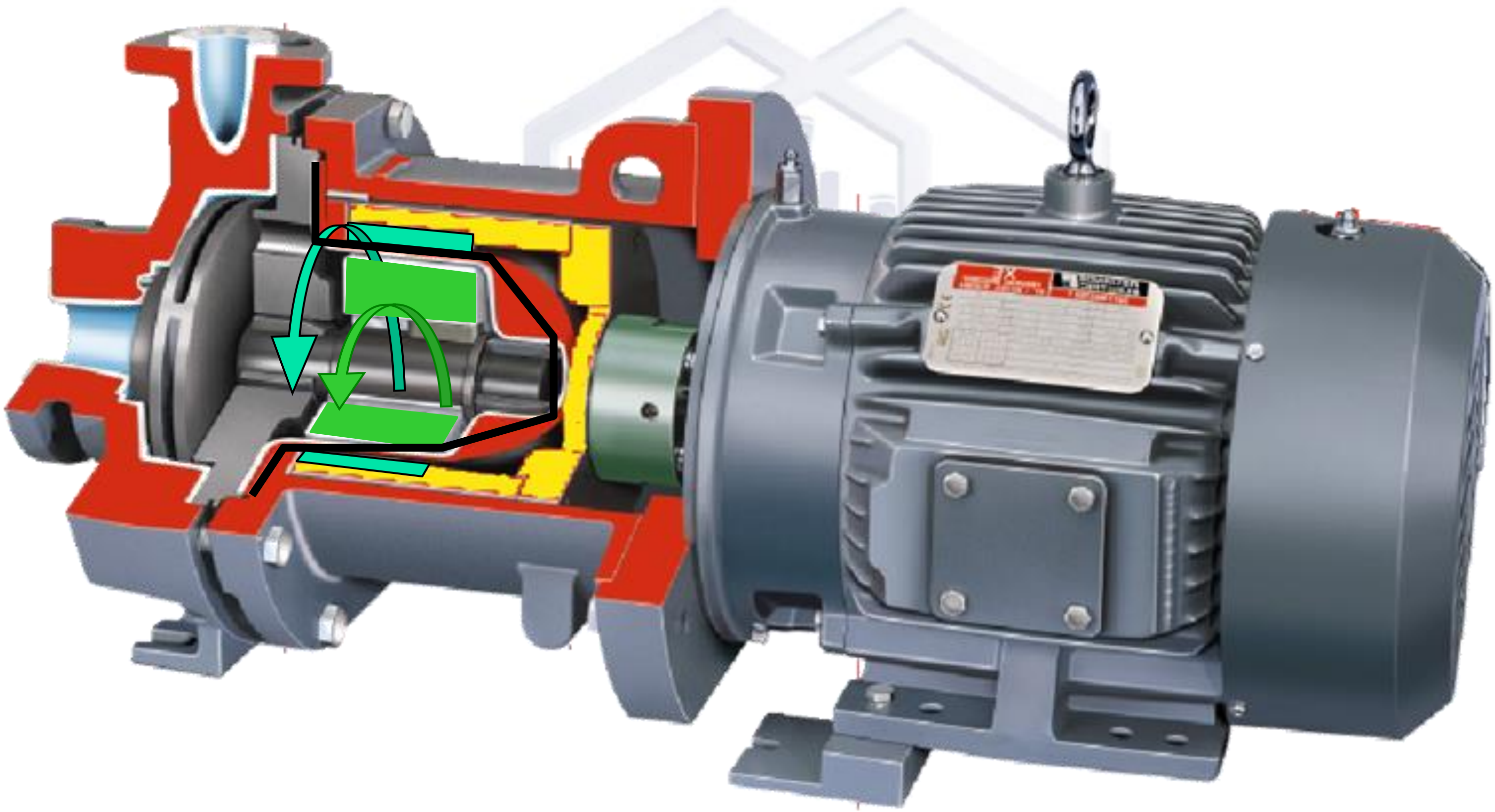
Rotating Equipment

- Double Mechanical Seal - Barrier Fluid



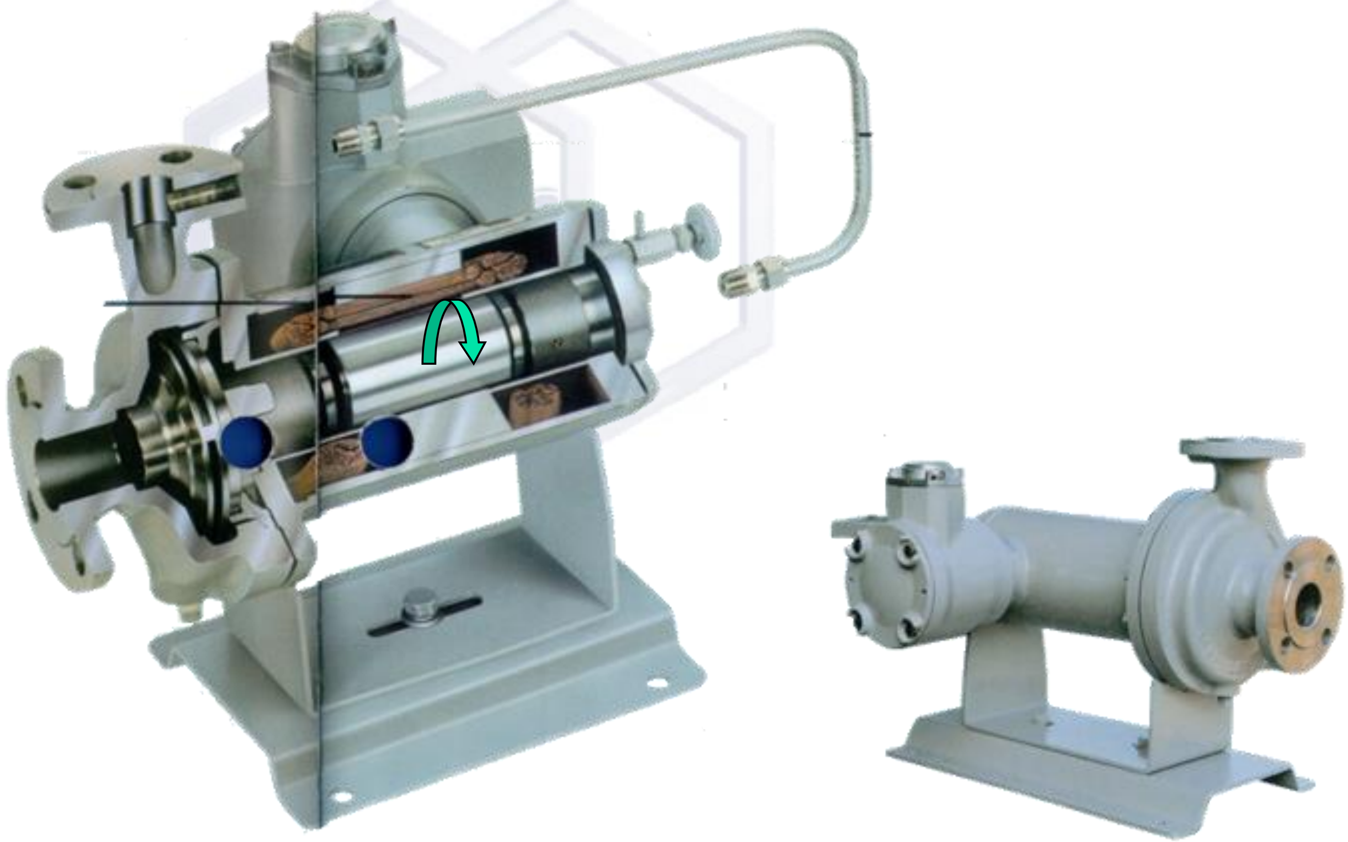
Rotating Equipment

- Sealless Pumps - Magnetic Drive



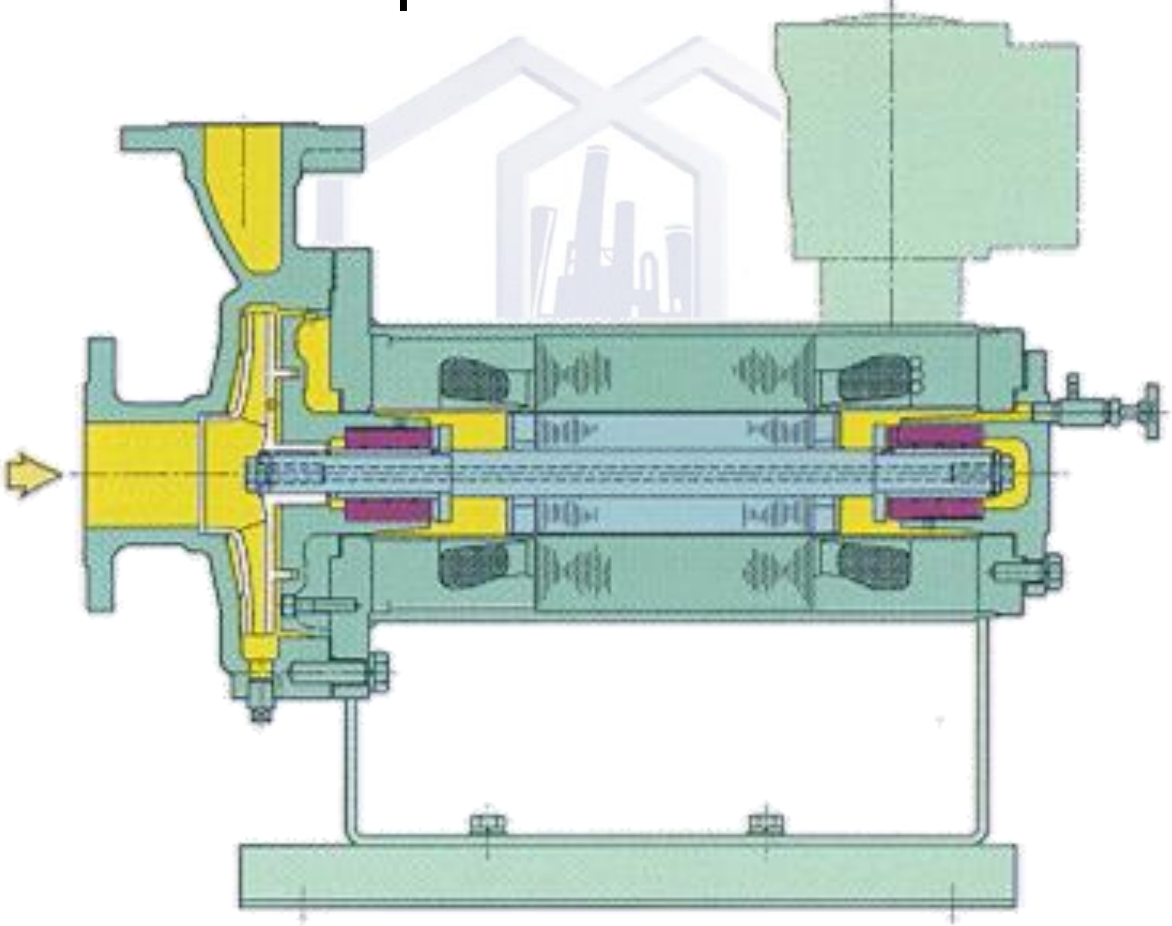
Rotating Equipment

- Sealless Pumps - Canned Motor



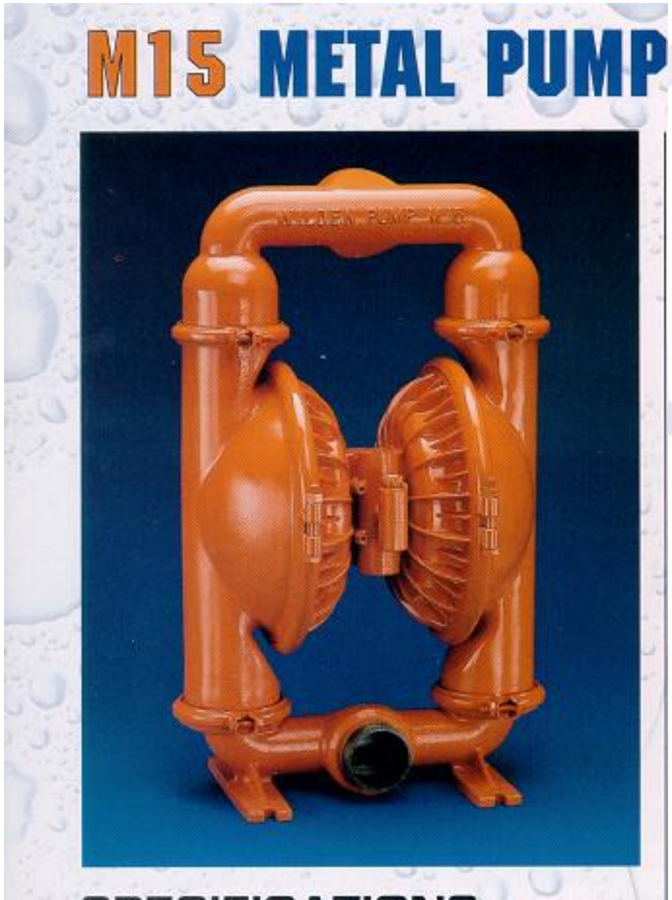
Rotating Equipment

- Sealless Pumps - Canned Motor Pump



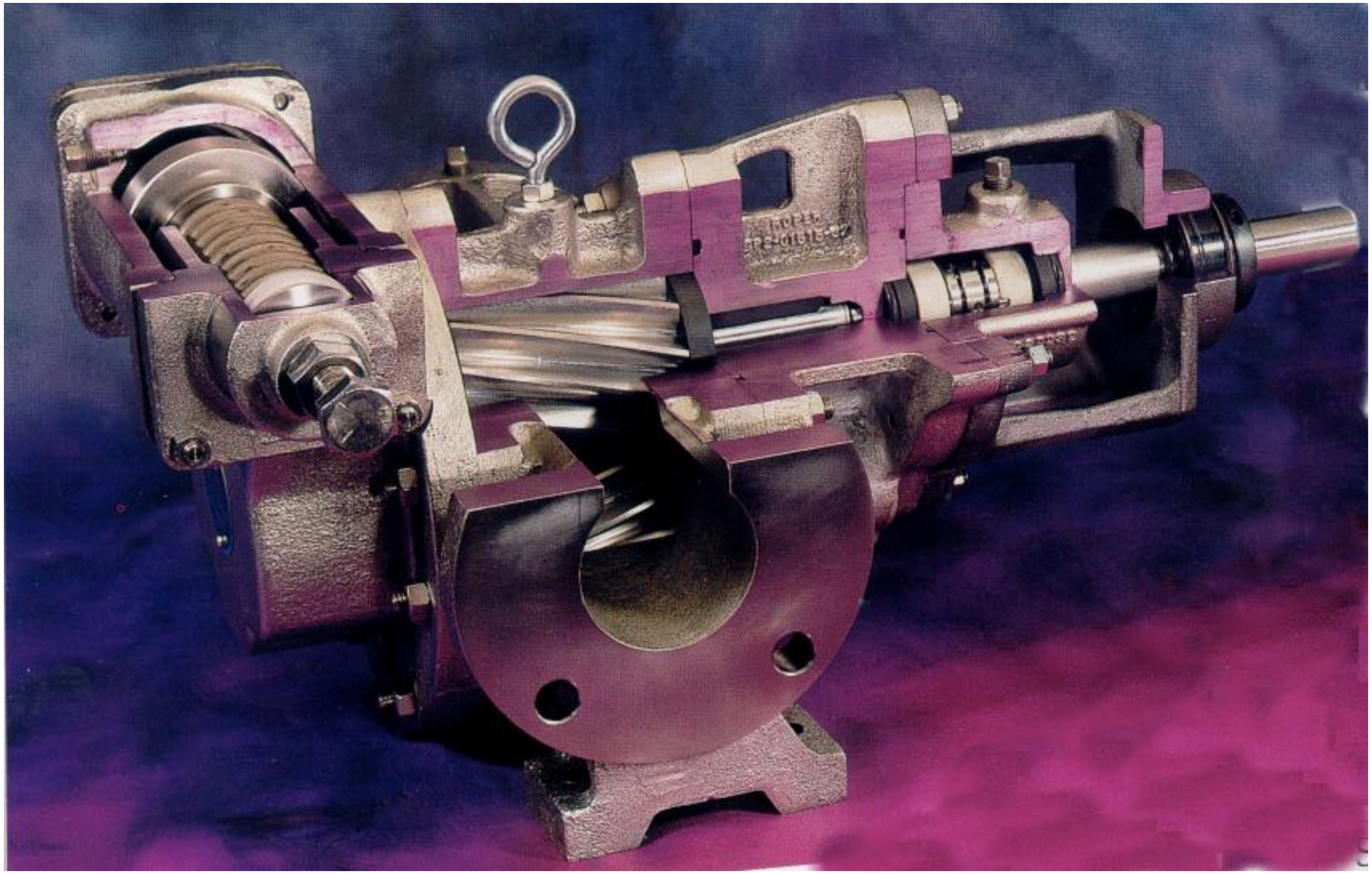
Rotating Equipment

- Pumps - Air Operated



Rotating Equipment

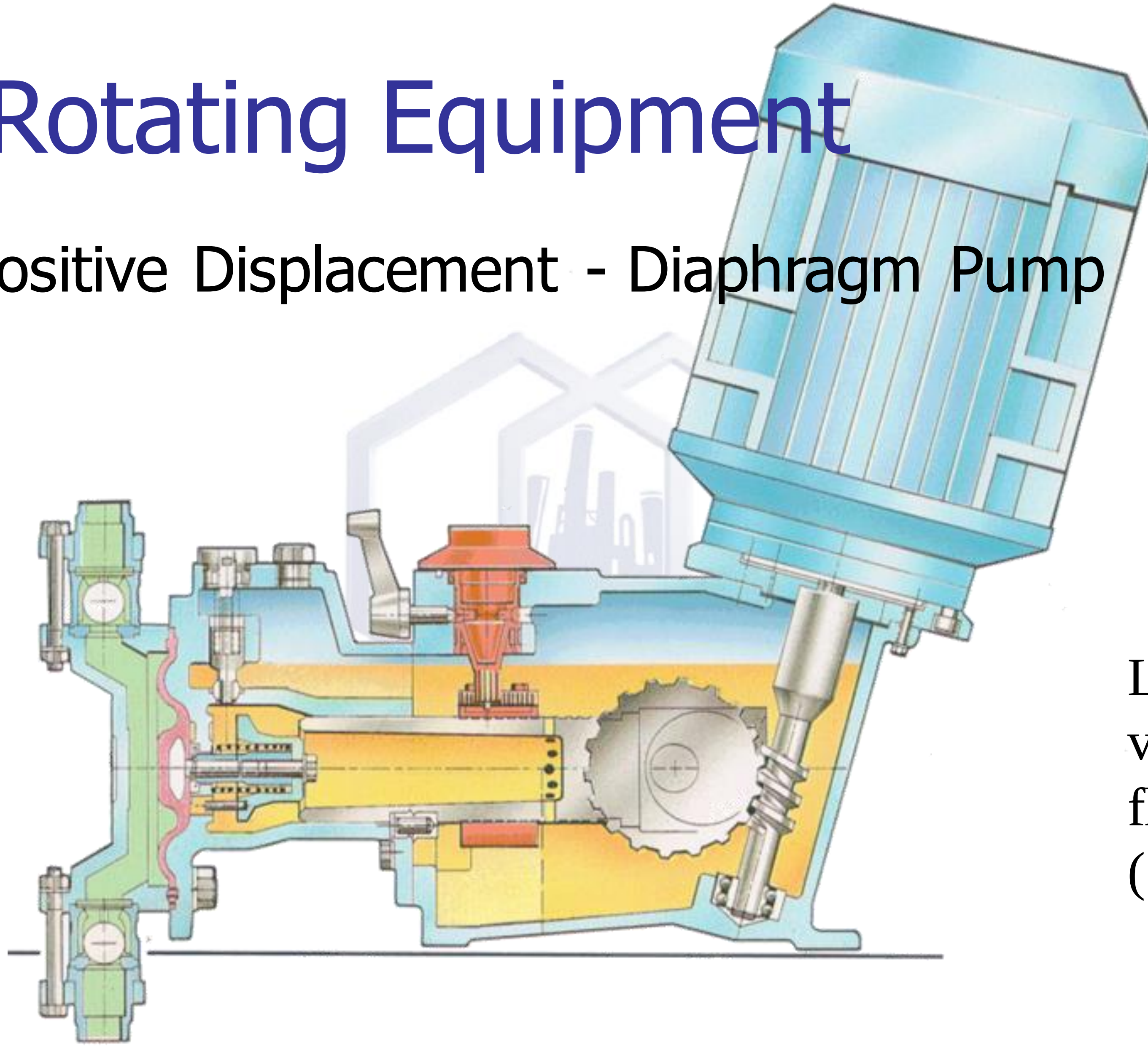
- Rotary Gear Pump



High viscosity fluids (> 10 cP)

Rotating Equipment

- Positive Displacement - Diaphragm Pump



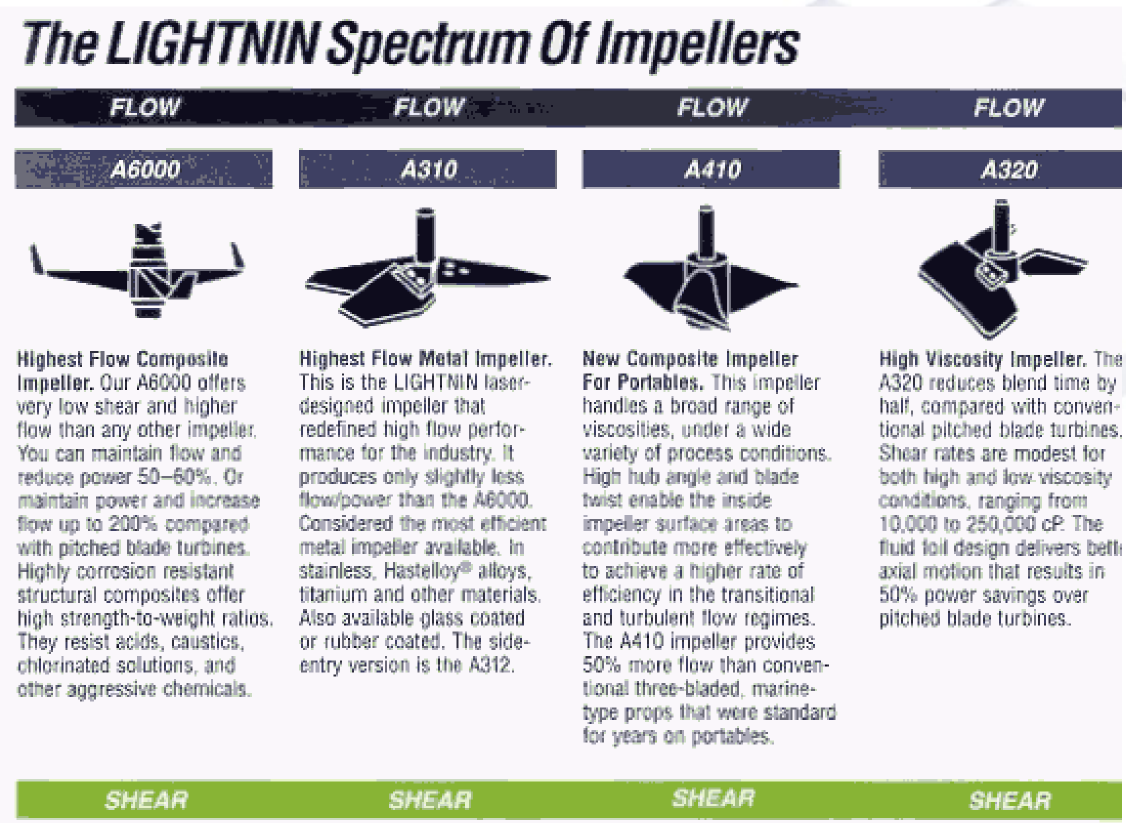
Low viscosity fluids (< 10 cP)

Rotating Equipment

- Positive Displacement - Diaphragm

Rotating Equipment

- Agitators



The LIGHTNIN Spectrum Of Impellers

FLOW — FLOW — FLOW — FLOW

A6000

Highest Flow Composite Impeller. Our A6000 offers very low shear and higher flow than any other impeller. You can maintain flow and reduce power 50–60%. Or maintain power and increase flow up to 200% compared with pitched blade turbines. Highly corrosion resistant structural composites offer high strength-to-weight ratios. They resist acids, caustics, chlorinated solutions, and other aggressive chemicals.

A310

Highest Flow Metal Impeller. This is the LIGHTNIN laser-designed impeller that redefined high flow performance for the industry. It produces only slightly less flow/power than the A6000. Considered the most efficient metal impeller available. In stainless, Hastelloy® alloys, titanium and other materials. Also available glass coated or rubber coated. The side-entry version is the A312.

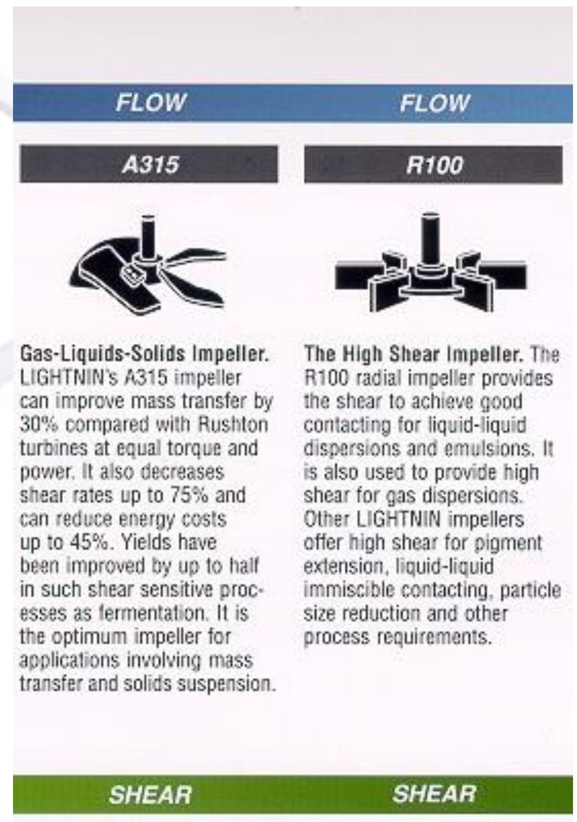
A410

New Composite Impeller For Portables. This impeller handles a broad range of viscosities, under a wide variety of process conditions. High hub angle and blade twist enable the inside impeller surface areas to contribute more effectively to achieve a higher rate of efficiency in the transitional and turbulent flow regimes. The A410 impeller provides 50% more flow than conventional three-bladed, marine-type props that were standard for years on portables.

A320

High Viscosity Impeller. The A320 reduces blend time by half, compared with conventional pitched blade turbines. Shear rates are modest for both high and low viscosity conditions, ranging from 10,000 to 250,000 cP. The fluid foil design delivers bett axial motion that results in 50% power savings over pitched blade turbines.

SHEAR — SHEAR — SHEAR — SHEAR



FLOW — FLOW

A315

Gas-Liquids-Solids Impeller. LIGHTNIN's A315 impeller can improve mass transfer by 30% compared with Rushton turbines at equal torque and power. It also decreases shear rates up to 75% and can reduce energy costs up to 45%. Yields have been improved by up to half in such shear sensitive processes as fermentation. It is the optimum impeller for applications involving mass transfer and solids suspension.

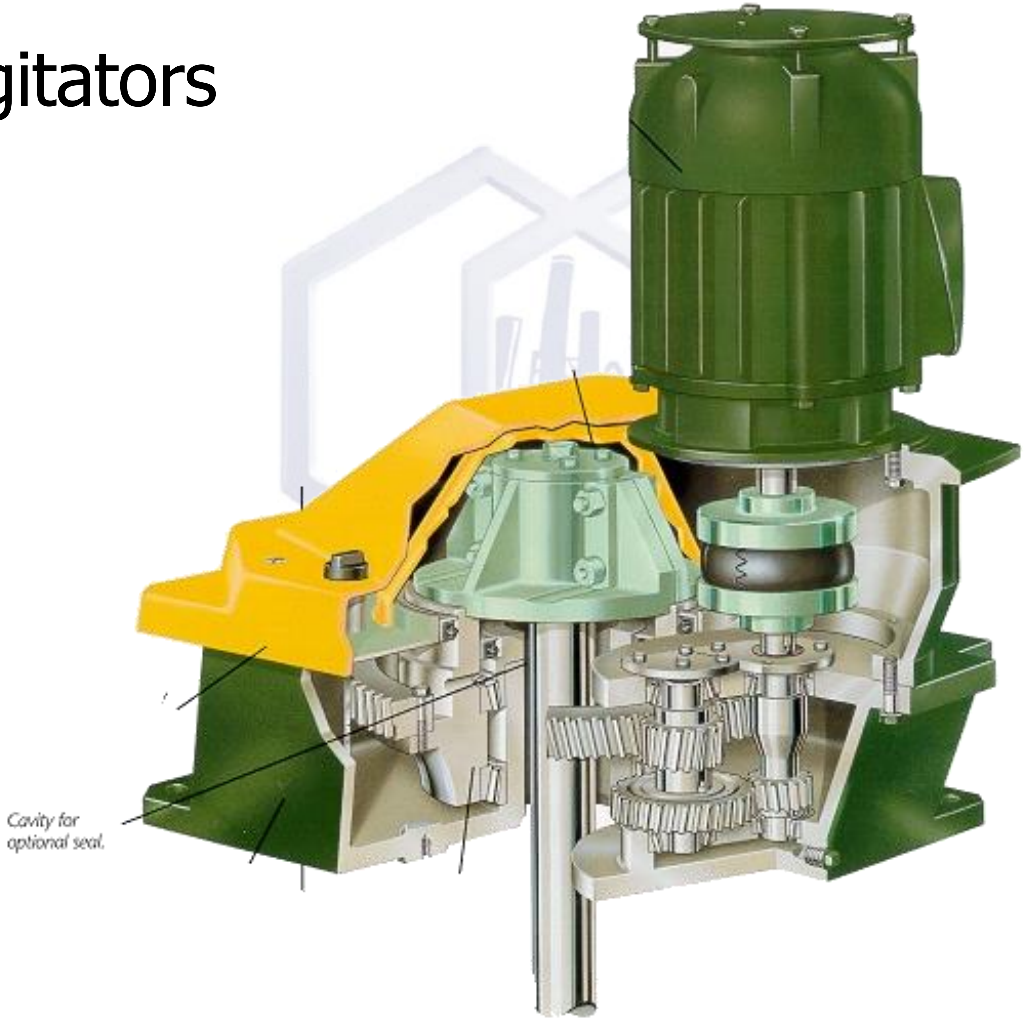
R100

The High Shear Impeller. The R100 radial impeller provides the shear to achieve good contacting for liquid-liquid dispersions and emulsions. It is also used to provide high shear for gas dispersions. Other LIGHTNIN impellers offer high shear for pigment extension, liquid-liquid immiscible contacting, particle size reduction and other process requirements.

SHEAR — SHEAR

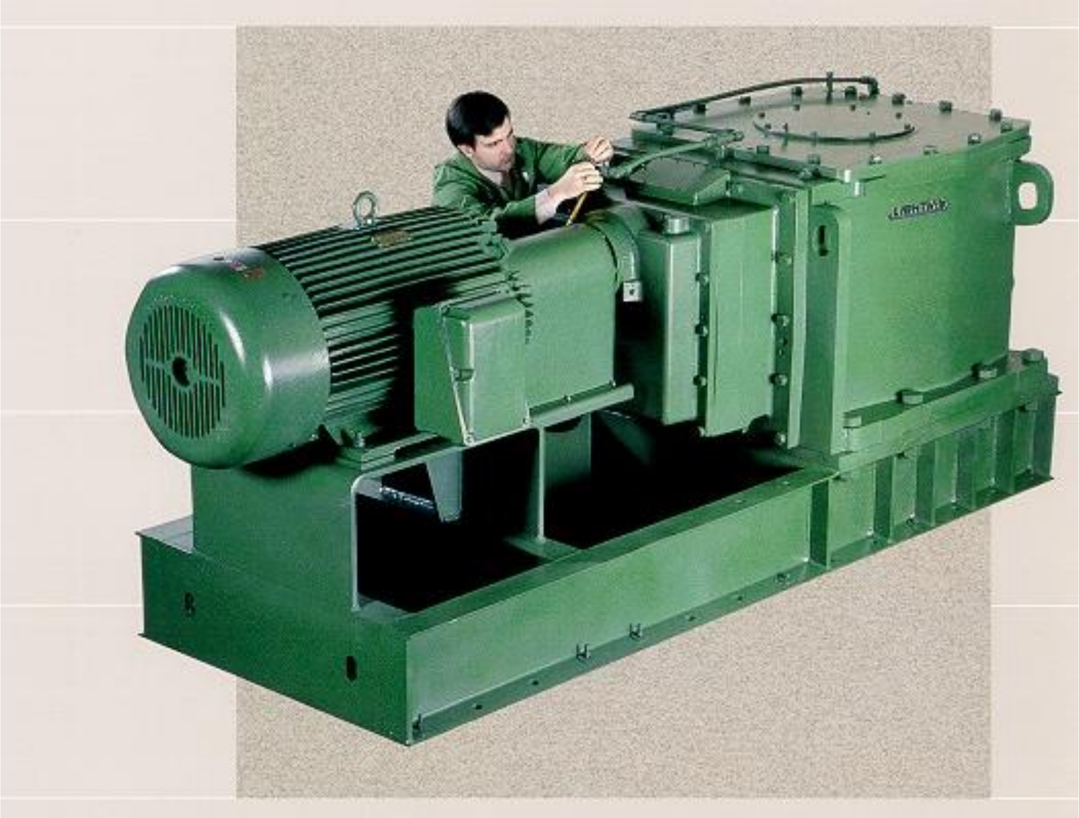
Rotating Equipment

- Agitators



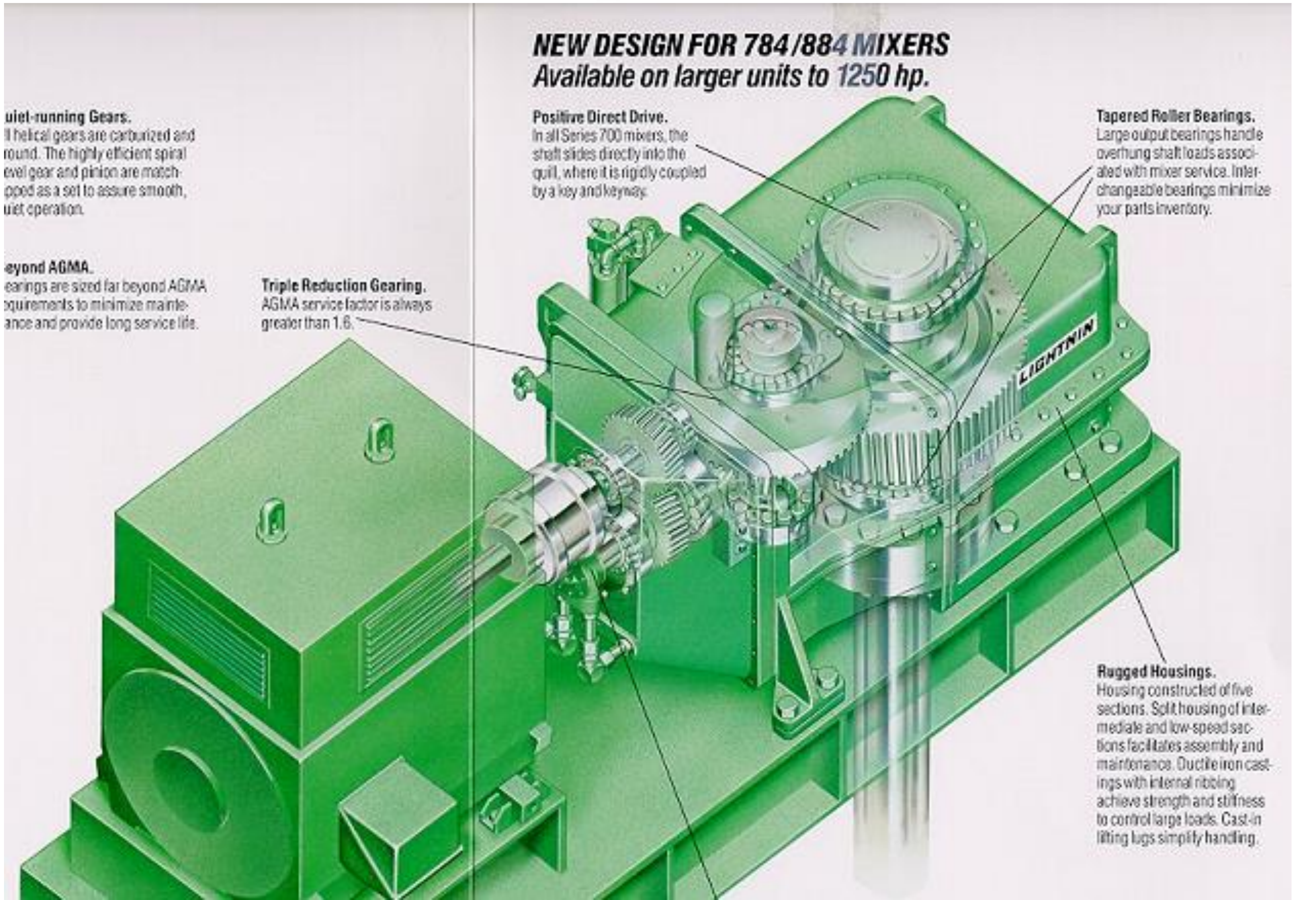
Rotating Equipment

- Agitators



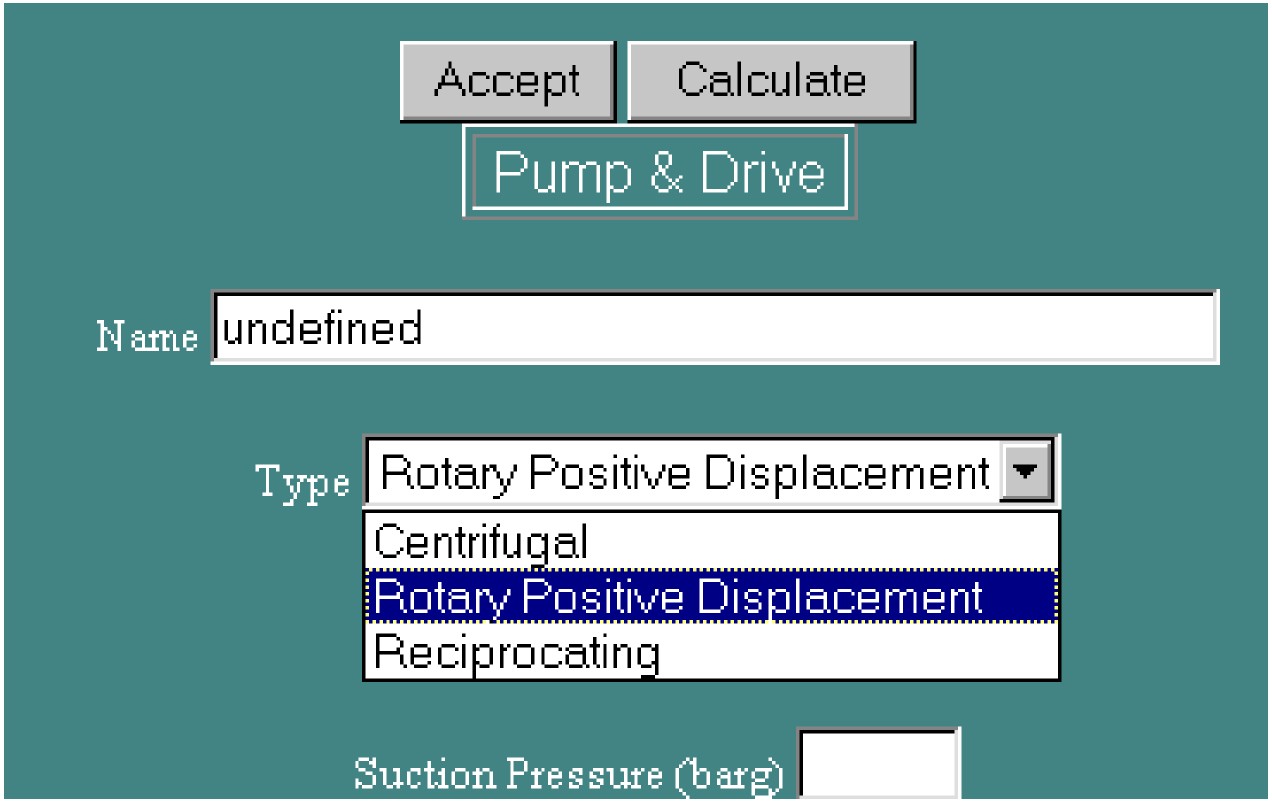
Rotating Equipment

- Agitators



Pump Sizing For CHEE 470

Pump Selection

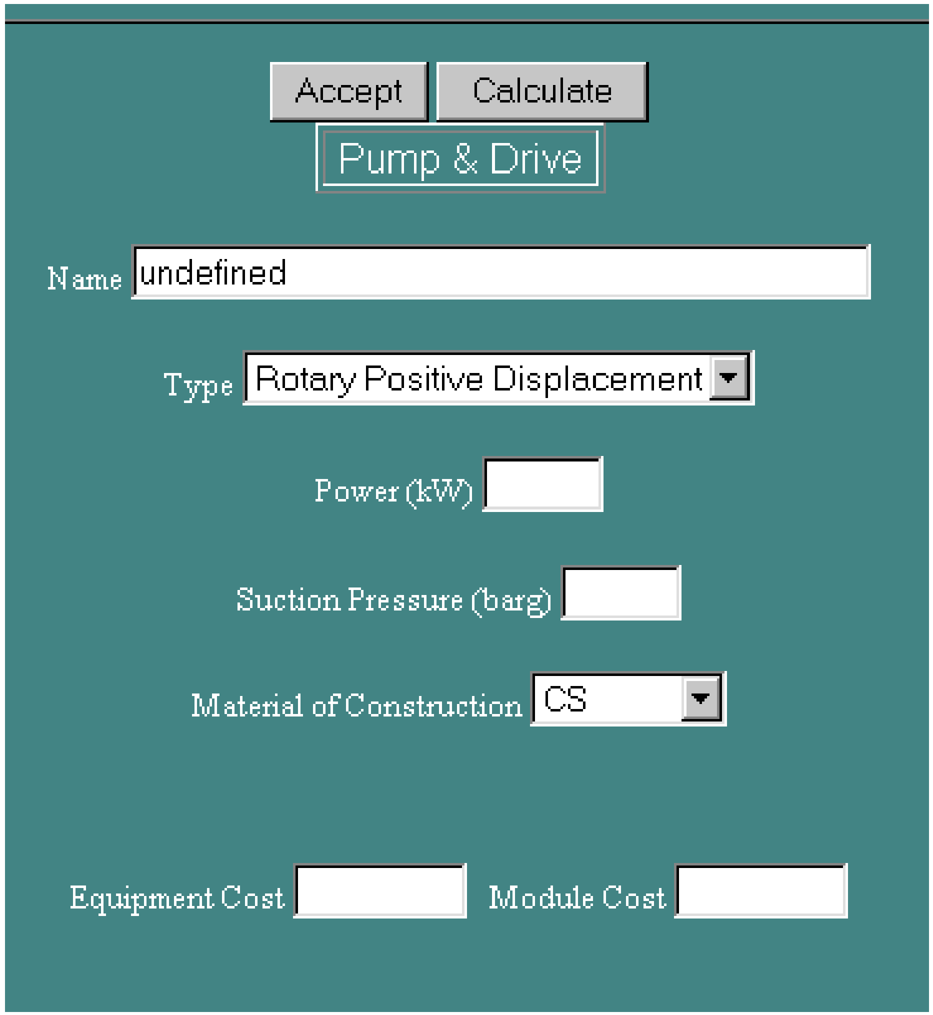


Pump Selection

- Single Stage Centrifugal Pumps for 0.057-18.9 m3/min, 152 m maximum head
- Rotary Pumps for 0.00378-18.9 m3/min, 15,200 m maximum head,
- Reciprocating Pumps for 0.0378-37.8 m3/min, 300 km maximum head,

$$1 \cdot \frac{m^3}{min} = 264.2 \frac{gal}{min}$$

Pump Sizing


Accept
Calculate
Pump & Drive
Name
undefined
Type
Rotary Positive Displacement
Power (kW)
Suction Pressure (barg)
Material of Construction
CS
Equipment Cost
Module Cost

Common Equations

$$Shaft\ Power = \frac{Hydraulic\,(\,fluid\,)\ Power}{Hydraulic\ Efficiency \times Motor\ Efficiency}$$

$$= \frac{Hydraulic\,(\,fluid\,)\ Power}{50\%}$$

$$\underset{\text{(HP)}}{Hydraulic\,(\,fluid\,)\ Power} = \frac{Volumetric\ \ Flow(USGPM\,) \times Differential\ \ pressure(\,psi\,)}{1714}$$

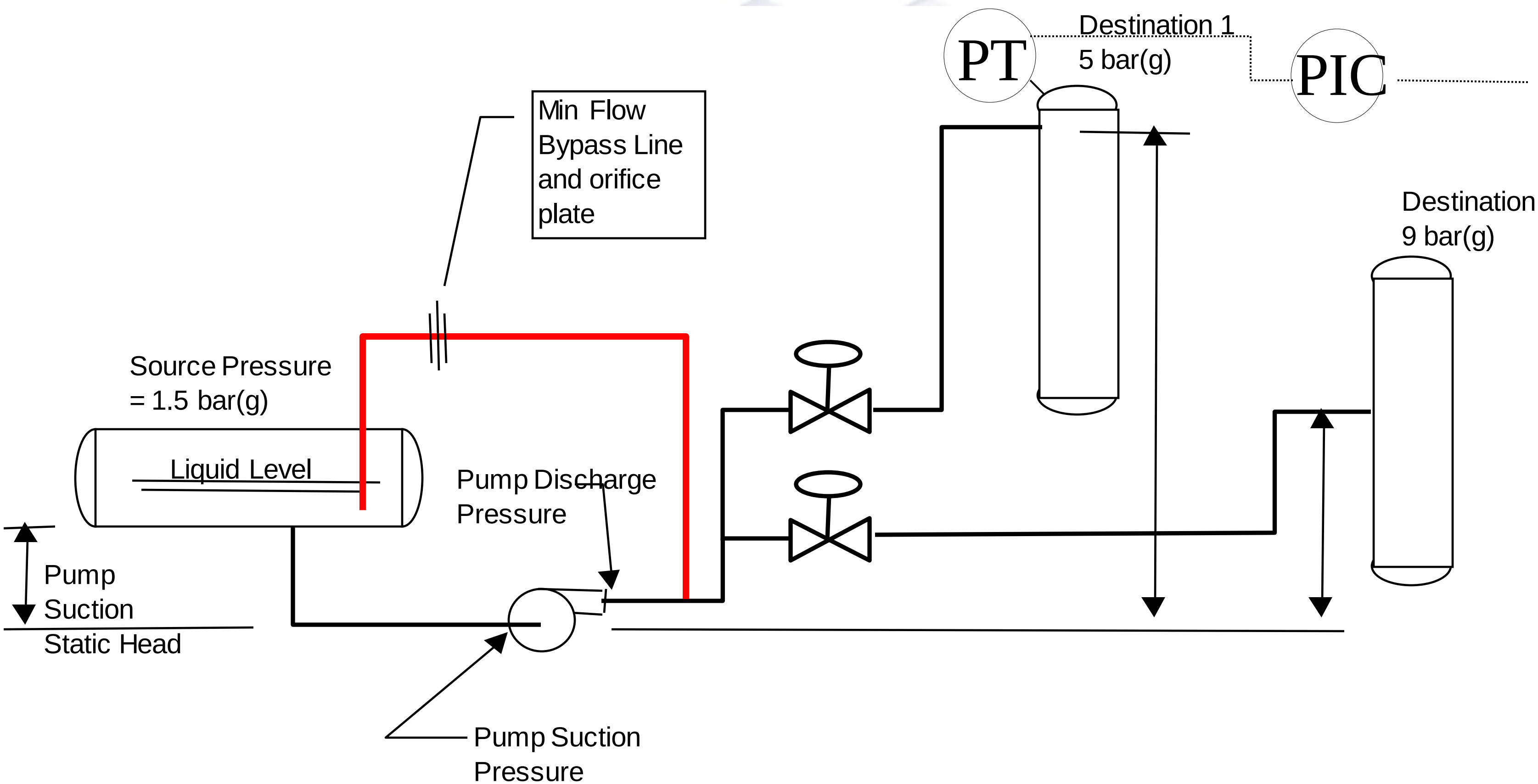
$$Differential\ \ pressure(\,psi\,) = Head(\,ft\,) \times 0.43352 \times Spec\ Grav$$

Pump Sizing

- 5 Easy Steps
  - Draw a Diagram
  - Determine the flow
  - Determine the inlet pressure
  - Determine the discharge pressure
  - Calculate shaft power

Pump Sizing - Step 1

- 1.Draw A Diagram ! - based on P&ID

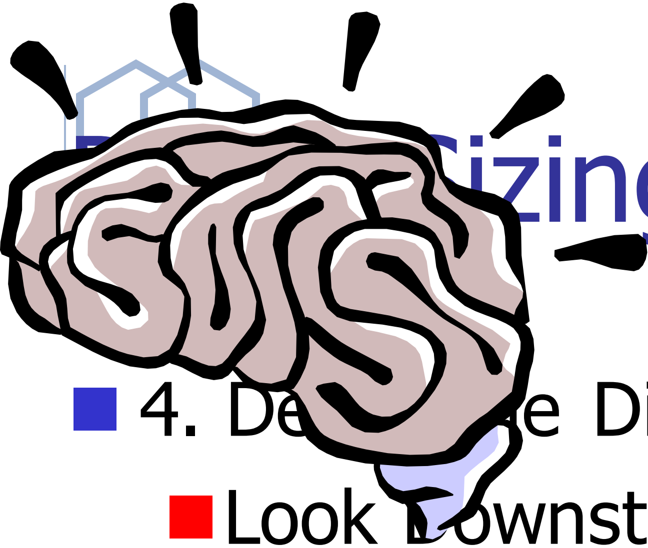


Pump Sizing - Step 2

- 2.Determine the Flow Rate
  - Take Simulation Flow add 20%
  - If there's a min flow bypass- it's flow is 15% of the rated flow
  - Simul = 100 gal/min
  - Rated flow = 100 gpm * 1.20
    - Rated flow = 120 gal/min
  - If Min Flow Bypass 100 * 1.20 / (1-0.15)
    - Rated flow = 141 gal/min

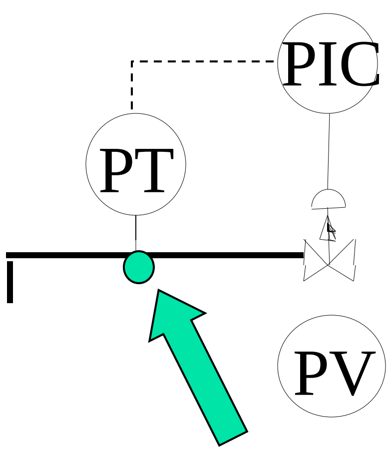
Pump Sizing - Step 3

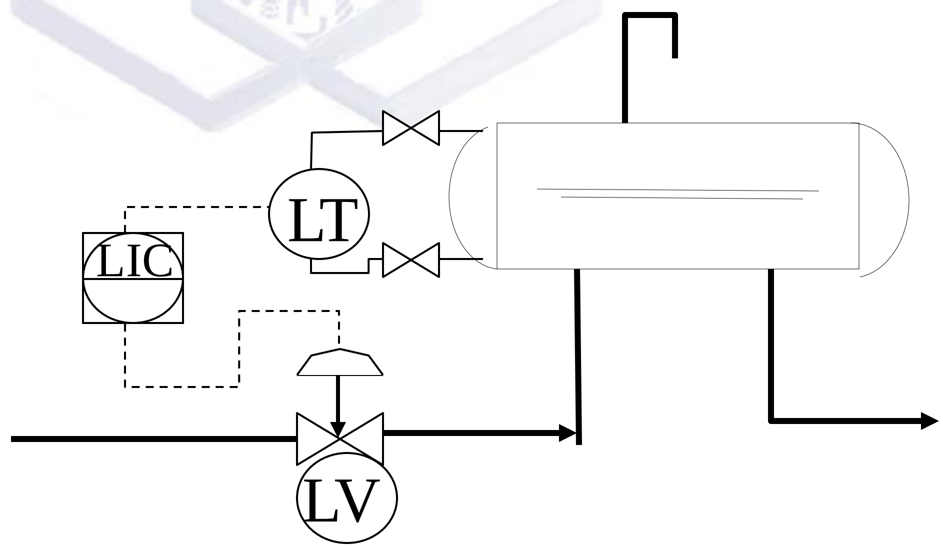
- 3. Determine Pump Inlet Pressure
  - Use Pressure from Simulation
  - Assume elevation changes offset piping pressure drops



Pump Sizing - Step 4

- 4. Determine Discharge Pressure
  - Look Downstream of the pump for a place in the process where the pressure is controlled (or P is atmospheric or P is set by vapour pressure of fluid in tank)



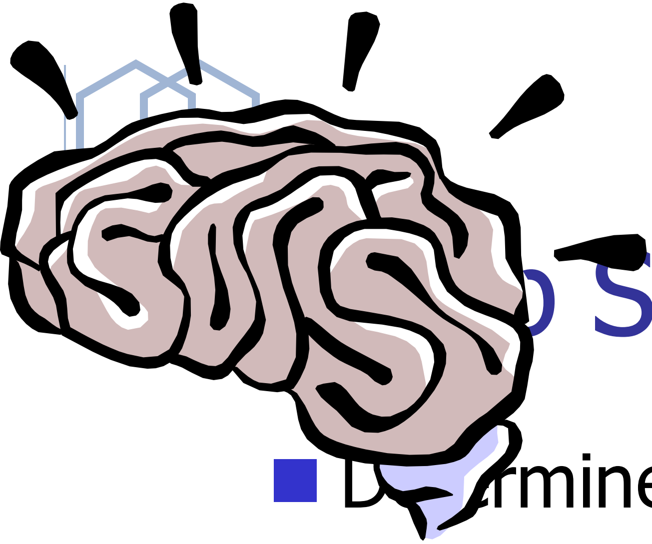


Pump Sizing - Step 4

- 4. Determine Discharge Pressure
  - Work Backwards from Downstream Pressure
  - Work your way back to pump adding/subtracting
    - add ΔP due to frictional loss (piping)
    - add OR subtract ΔP due elevation changes
    - add ΔP due to control valves
    - add ΔP due to equipment (exch, packed bed reactors, etc.)

Pump Sizing - Step 4

- Assume (first pass) that Control Valves have 10 psi differential.
- If there's more than one control valve **in parallel** go back later and determine which one has the 10 psi and which one(s) has more.
- Do ΔP of min flow bypass orifice last.



p Sizing - Step 4

- Determine the Control Valve DP

1 bar

0.5 bar

Pump Sizing - Step 4

- Determine the Control Valve DP
- Control Valve Sizing
  - CV vs % Opening Characteristic

Pump Sizing - Step 4

- CV vs % Opening Characteristic

Product Flier PF51.1:E

Design ED, ES, and ET Flow Coefficients

FLOW CHARAC-TERISTIC	VALVE SIZE		MAXI-MUM TRAVEL	PORT DIA.	DESIGNS ED AND ET (FLOW DOWN)					DESIGN ES (FLOW UP)				
					Valve Opening, Percent of Total Travel									
					10	30	70	100	100	10	30	70	100	100
	DIN	Inches	mm	mm	C_V				F_L	C_V				F_L
	- - -	1/2	19	33.3	- - -	- - -	- - -	- - -	- - -	4.00	6.22	6.52	6.53	.88
	- - -	3/4	19	33.3	- - -	- - -	- - -	- - -	- - -	4.94	11.8	14.2	14.2	.83
	DN 25	1, 1-1/4	19	33.3	4.86	13.4	21.1	22.1	.81	5.24	15.0	21.1	21.4	.89
	DN 40	1-1/2 2	19	47.6	7.79	20.5	39.4	44.0	.79	7.60	22.3	38.0	38.0	.94
	DN 50		29	58.7	13.4	39.9	73.7	77.6	.77	14.3	48.6	67.2	67.2	.93
	DN 65	2-1/2	38	73.0	20.9	58.8	103	109	.81	21.8	66.6	93.1	93.1	.91
	DN 80	3	38	87.3	27.2	77.9	149	161	.77	23.3	78.3	136	150	.87
	DN 100	4	51	111.1	37.7	125	238	251	.79	39.0	132	225	235	.89
	DN 150	6	51	177.8	73.6	232	416	460	.82	[illegible]	[illegible]	[illegible]	[illegible]	.82
	DN 200	8	76	203.2	135	434	759	863	.85	156	490	796	875	.85
Quick Opening					X_T				- - -	X_T				- - -

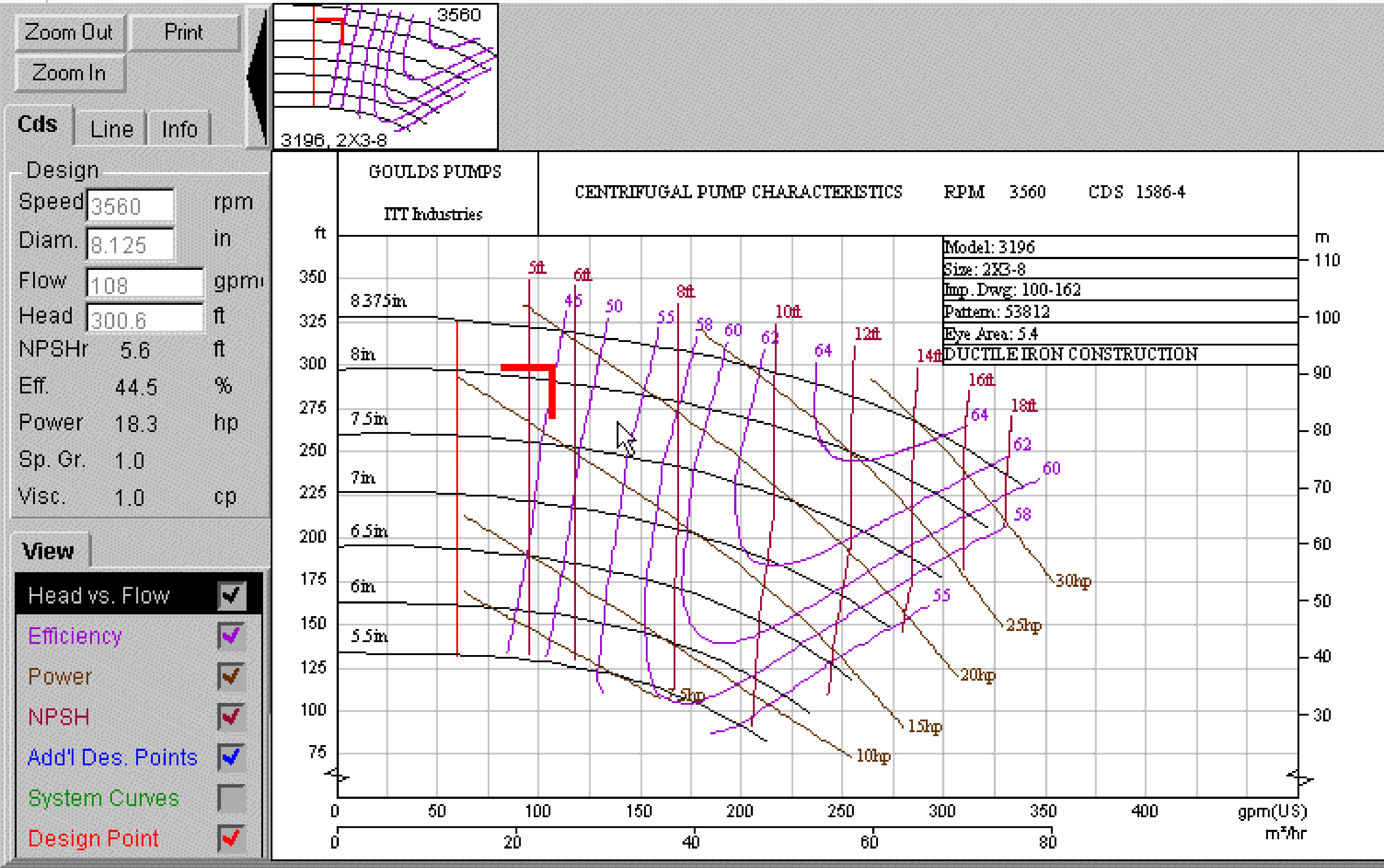
Pump Sizing - Step 4

- Piping DP = 15 psi at rated flow
- Flow Elements (FE's) = 3 psi
- Heat Exchangers = 10 psi
- Filters - there are none
- Packed Beds - hmmm 25 psi in liq service
  - could use Ergun Equation (See Perry's) to calc

Pump Sizing - Step 5

- Determine Pump Differential Pressure
  - Subtract Inlet Press from Discharge Press
    - (note error in equipment list spreadsheet)
- Assume efficiency
- Calc Pump Shaft Power

http://www.gouldspumps.com/gp_hss.ihtml



Goulds Pump Sizing

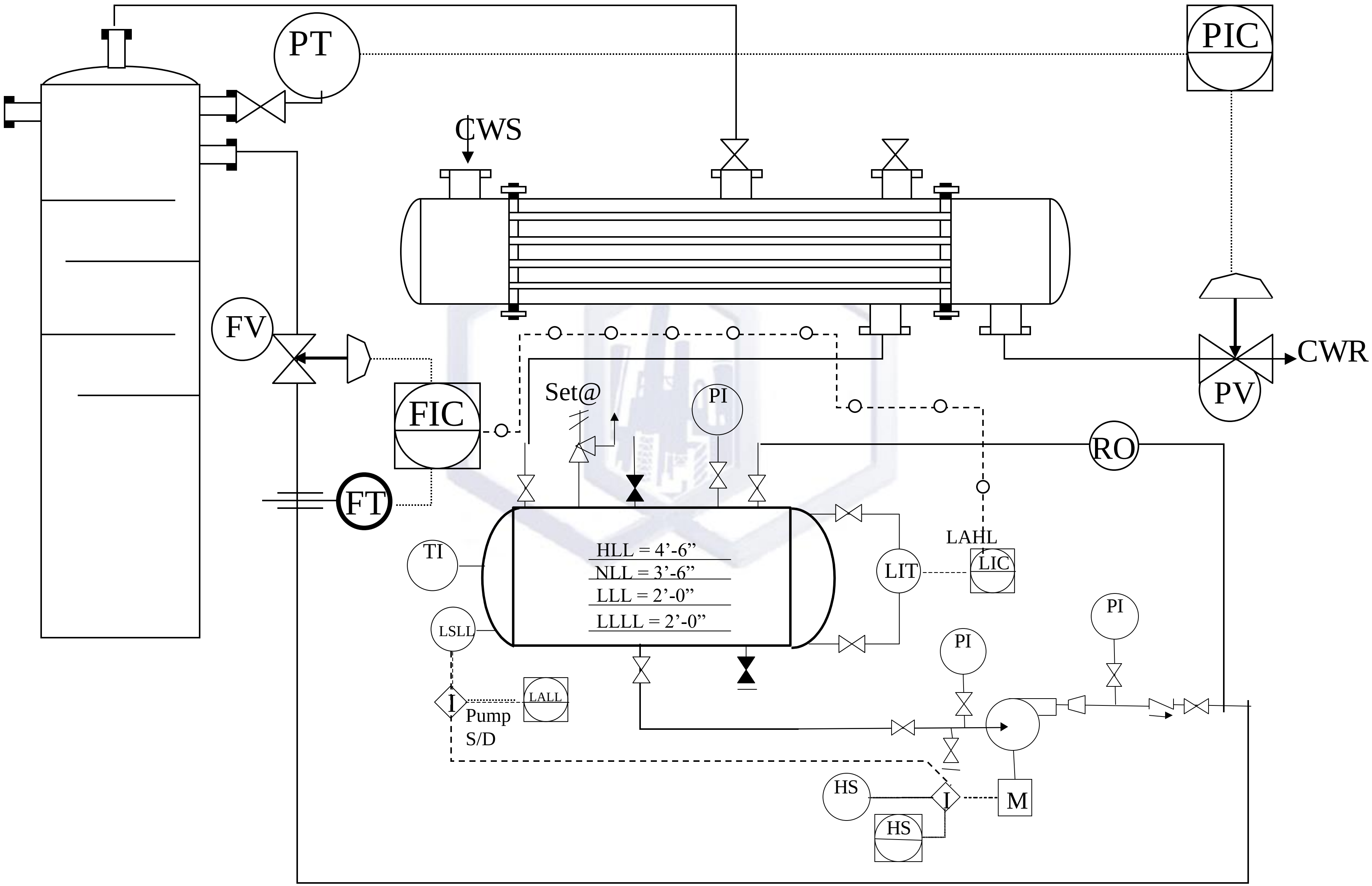
- 3600 or 1800 RPM
- Start with Model 3196 (Standard Chemical Service)

- Look for the pump with the highest efficiency

http://www.gouldspumps.com/gp_hss.ihtml

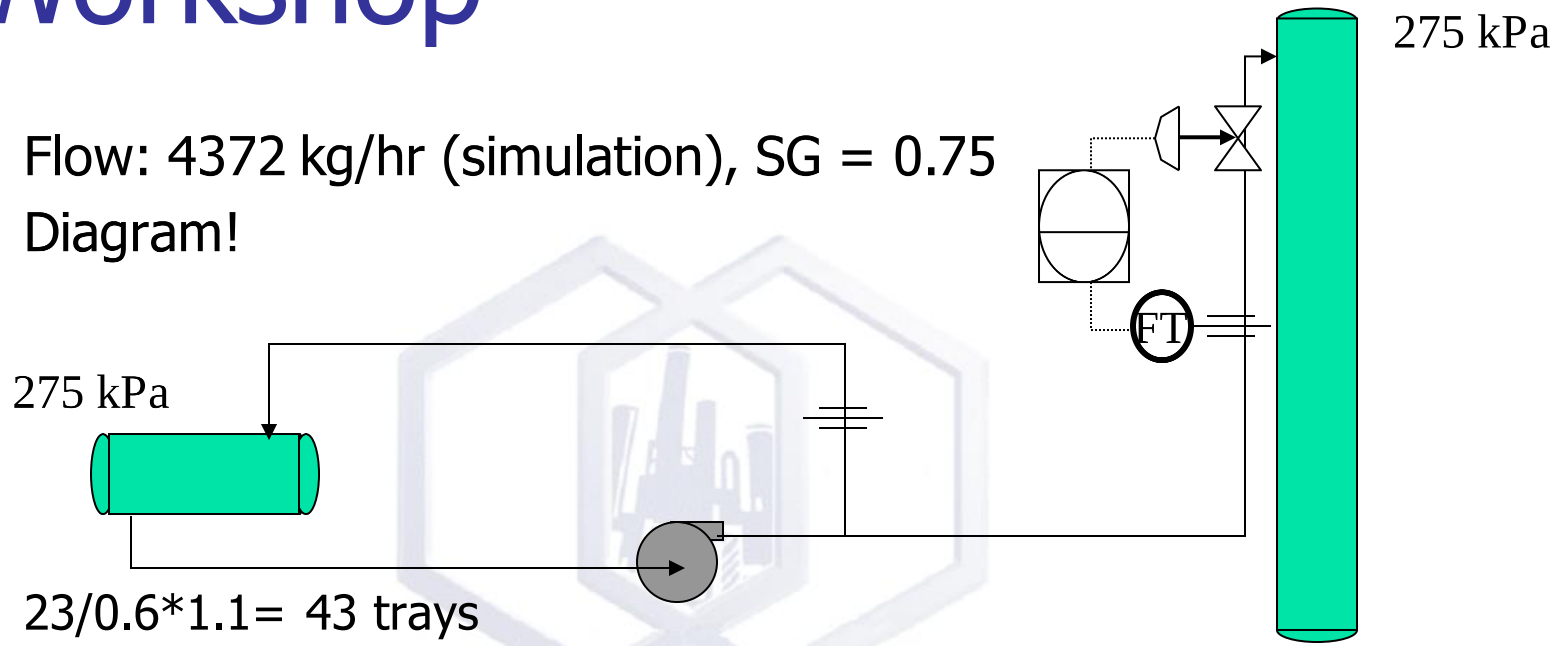
Workshop

- reflux pump on the acetone column (easy one)


PT
PIC
CWS
FV
FIC
FT
Set@
PI
RO
CWR
PV
TI
HLL = 4'-6"
NLL = 3'-6"
LLL = 2'-0"
LLLL = 2'-0"
LIT
LAHL
LIC
LSLL
I
LALL
Pump
S/D
PI
PI
HS
I
M
HS

Workshop

- Flow: 4372 kg/hr (simulation), SG = 0.75
- Diagram!



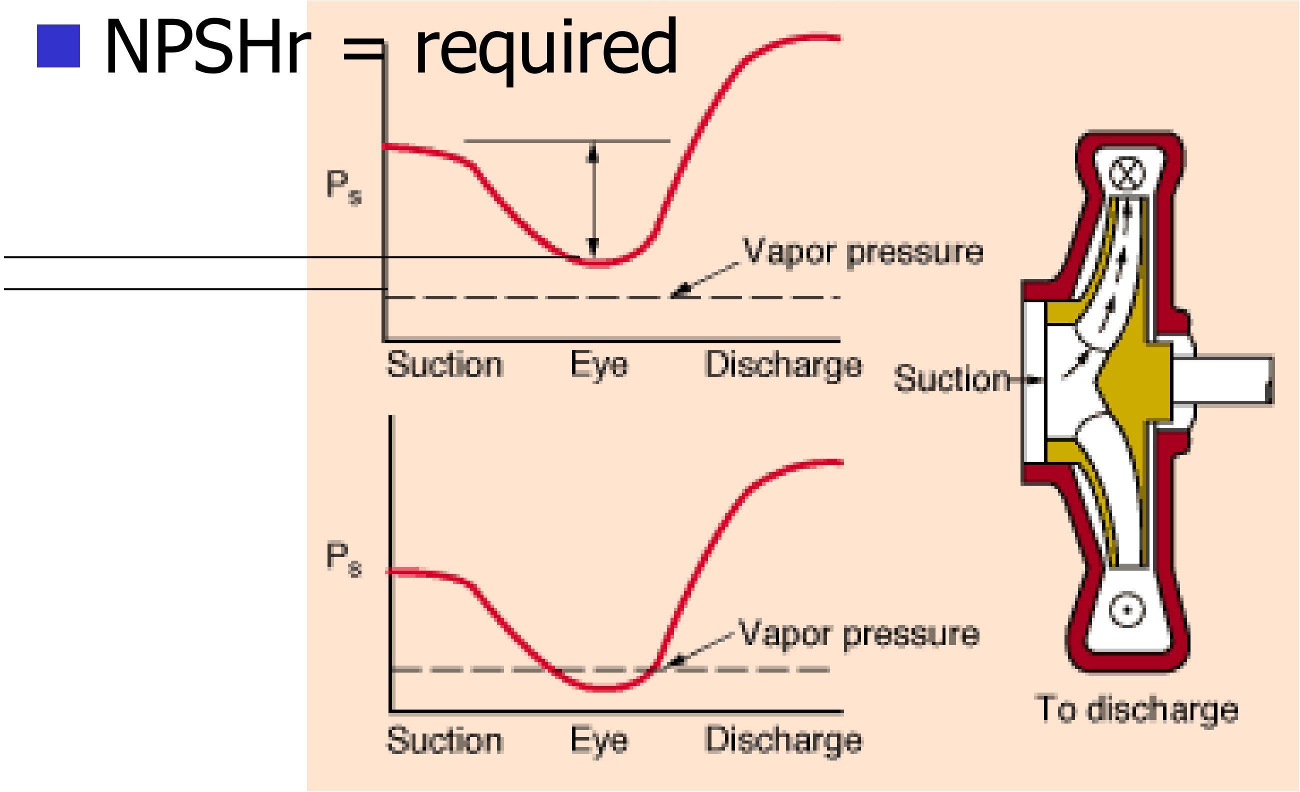
- 23/0.6*1.1= 43 trays
- height to reflux nozzle= 43*2ft+6 ft = 90 ft
- Find the pump type, hydraulic horsepower, and the Brake HP

Questions

- NPSH
- compression ratio
- driver types

NPSHa vs NPSHr

- NPSHa = available
- NPSHr = required



- Rated Flow: 4372 * 1.2 / (1-0.15) = 6172 kg/hr = 35.3 usgpm
- Suction Pressure = 275 kPa(g)
- Liq head to pressure = 90ft * 0.4432 psi/ft * 0.75(sg) = 29.3psi
- Discharge Pressure = 275 kPa(g) + 15 psi (pipe) + 10 psi (valve) + 3 psi (FE) + 29.3 psi (liq height) = 670 kPa
- Differential Pressure = 394 = 57 psi
- HHP = 57 * 35.3 / 1715 50% = 2.3 hp