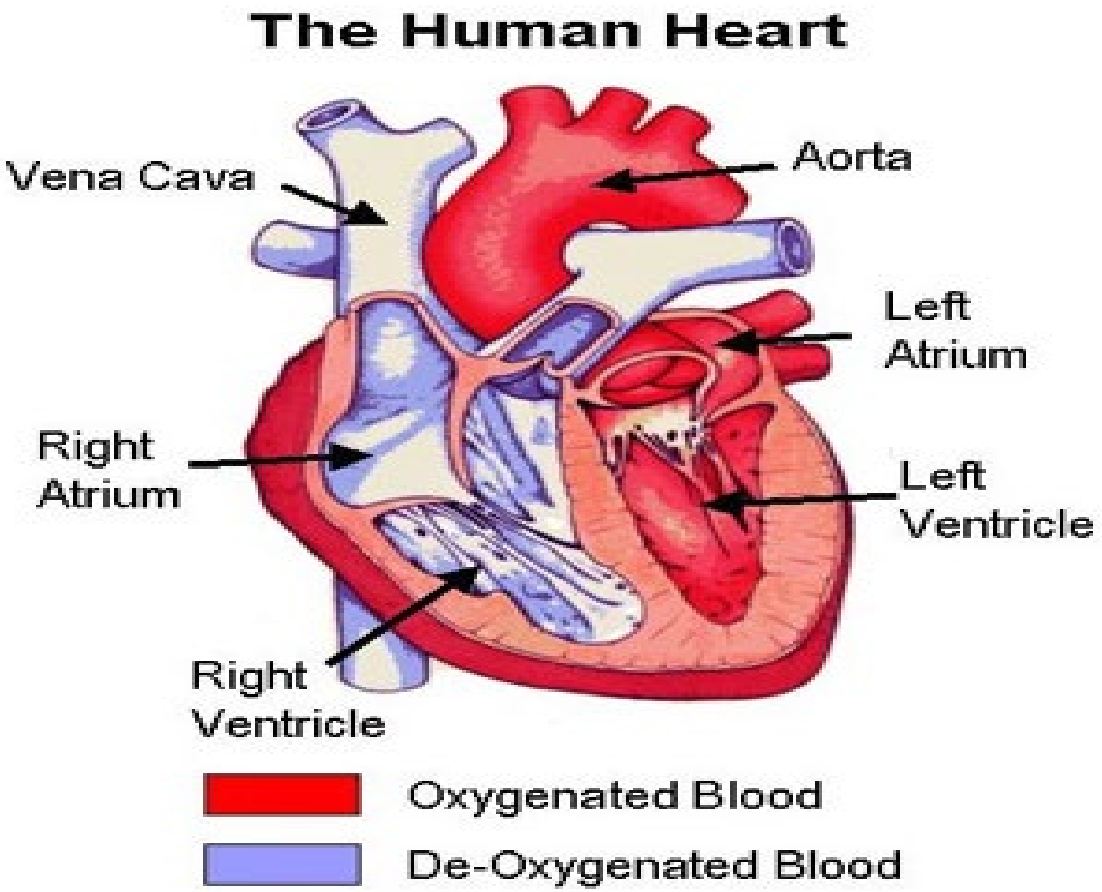
Pumps & Motors

Pre-certification

Archimedes Pump

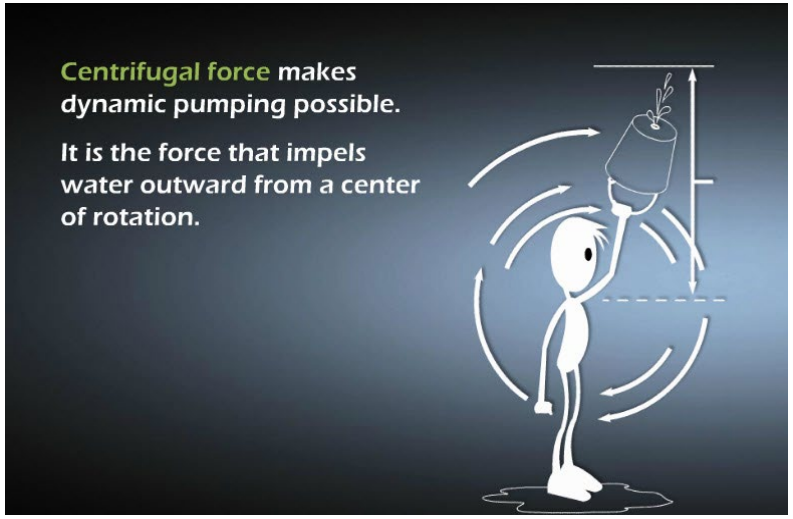
- First invented by Archimedes of Syracuse (287 BC – 212 BC)
- Called the Egyptian Screw
- Used to pull water from the Nile River to irrigate the Nile Delta.

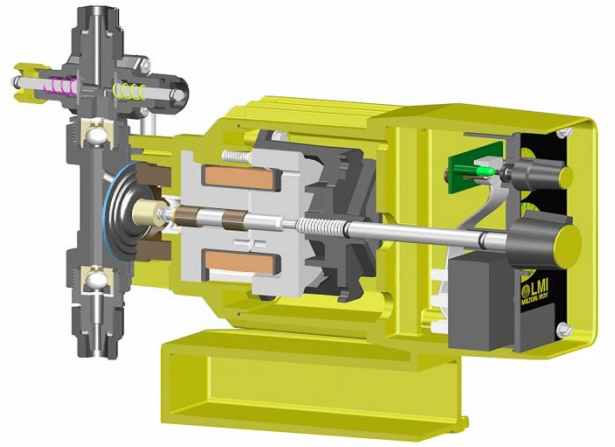
Human Heart


The Human Heart
Vena Cava
Aorta
Left Atrium
Right Atrium
Left Ventricle
Right Ventricle
Oxygenated Blood
De-Oxygenated Blood

Pump Classes

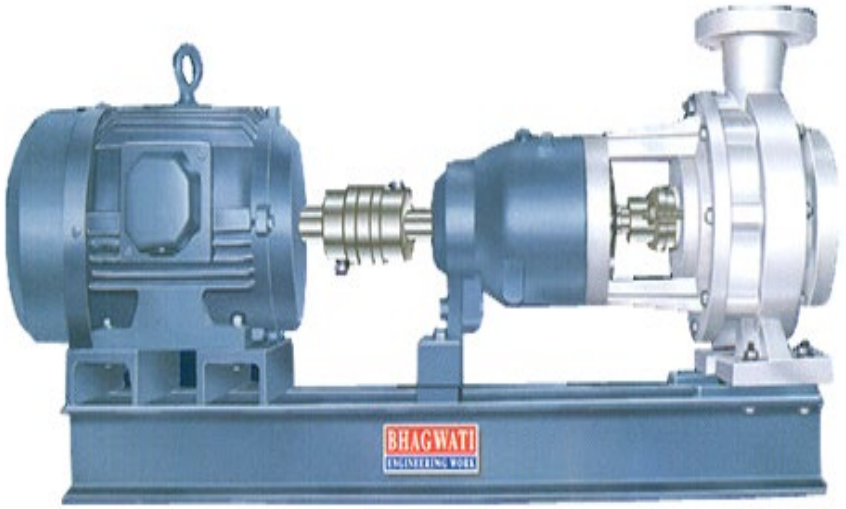
- Centrifugal is most commonly used & is a velocity type pump
- Positive displacement





Frame Mounted Pumps

- Are a horizontal pump
- Pump and Motor bearings are independent of each other
- Motor can be replaced without removing pump piping



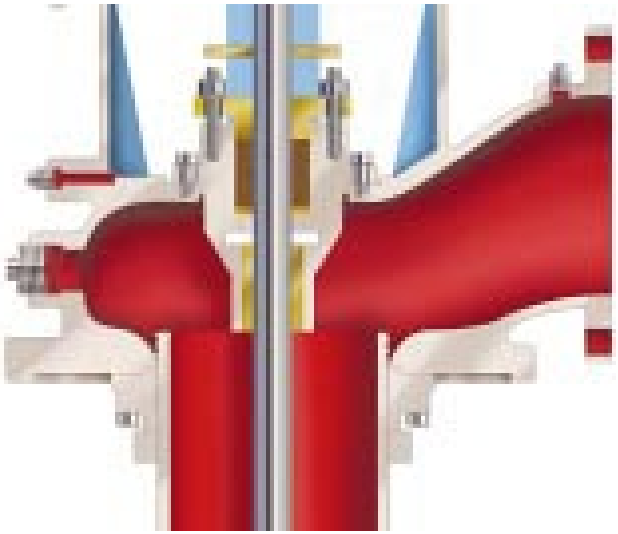
Close Coupled Pumps

- Are a horizontal pump
- Impellers are supported by the motor bearings
- Piping in most cases needs to be removed to access impeller

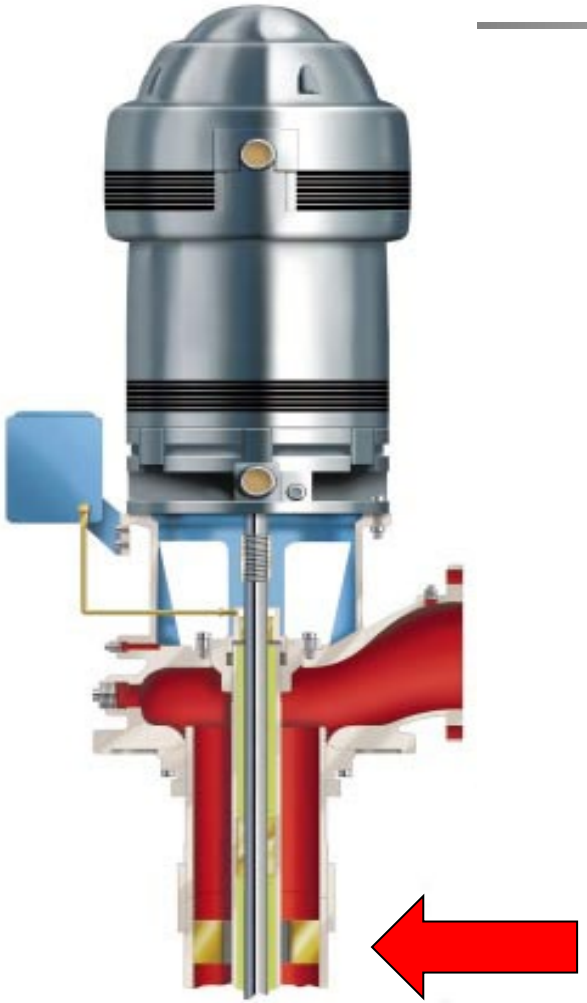
Vertical Lineshaft Pumps

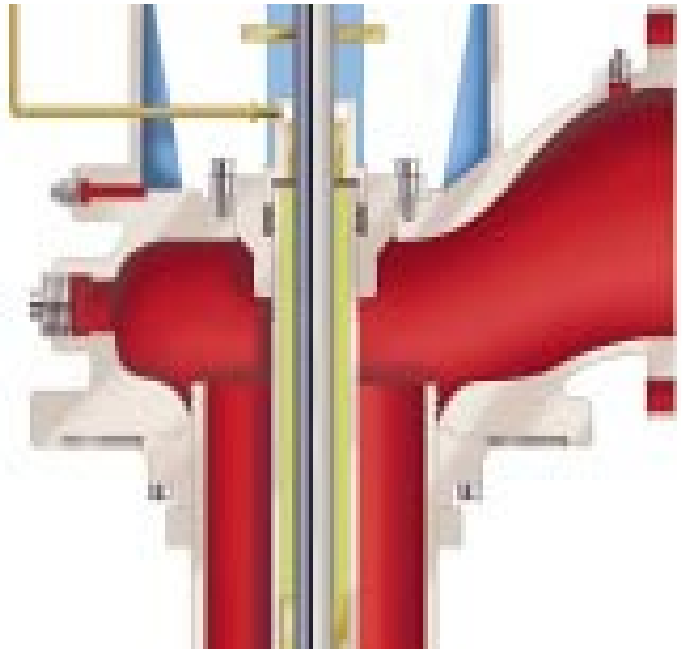
- Lineshaft Turbine
- Can Turbine
- Submersible
- Axial Flow

Lineshaft Turbine- Water Lube



Lineshaft Turbine- Oil Lube

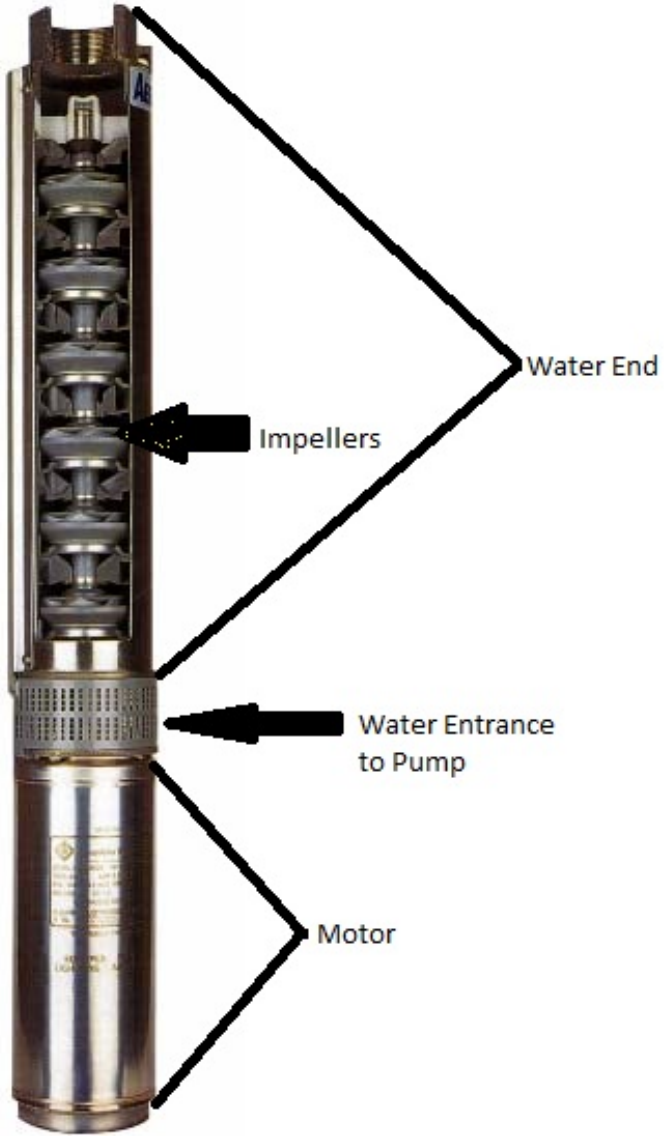




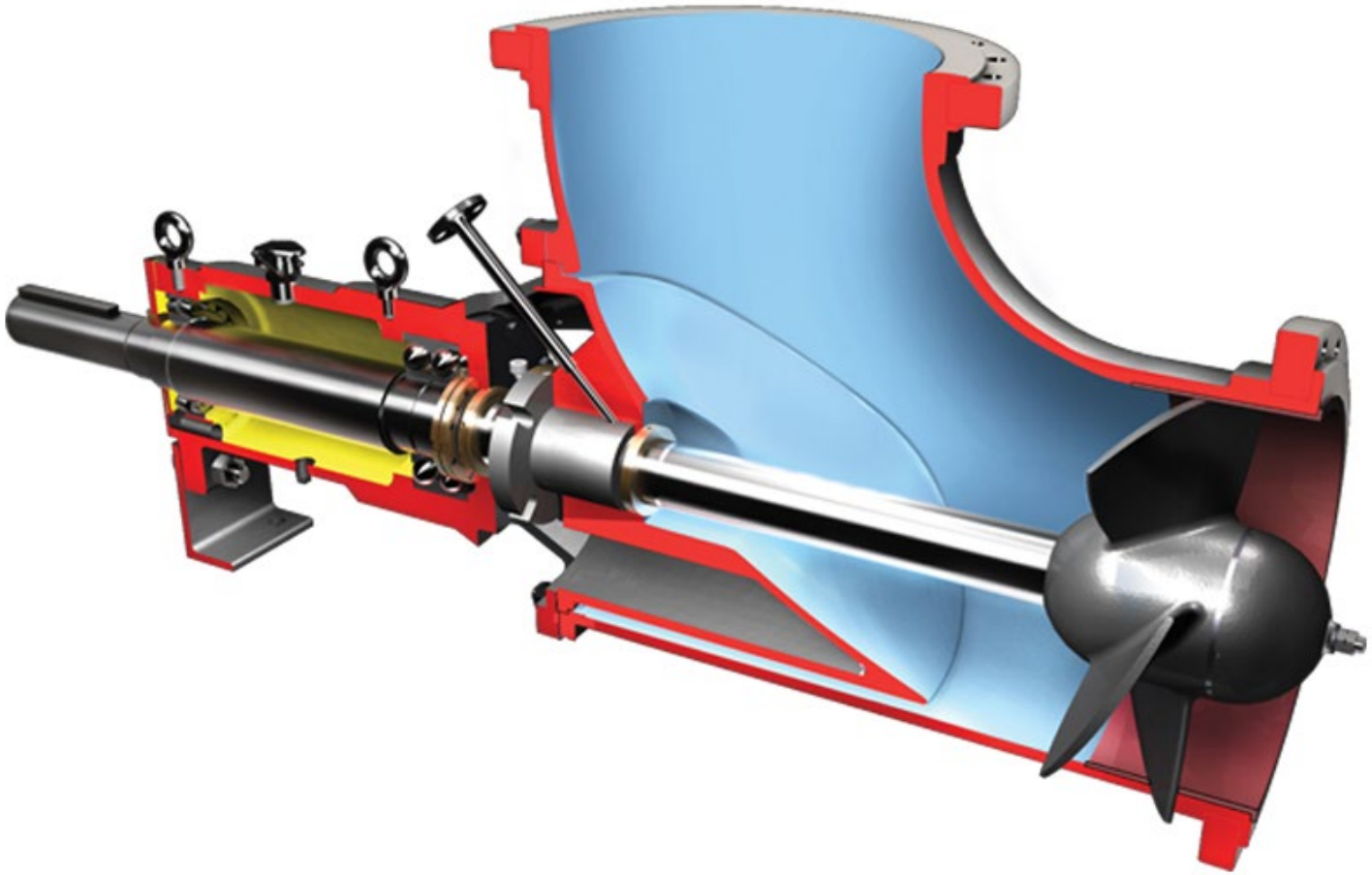
Can Turbine

- Operates in flooded suction or pressure condition

Submersible

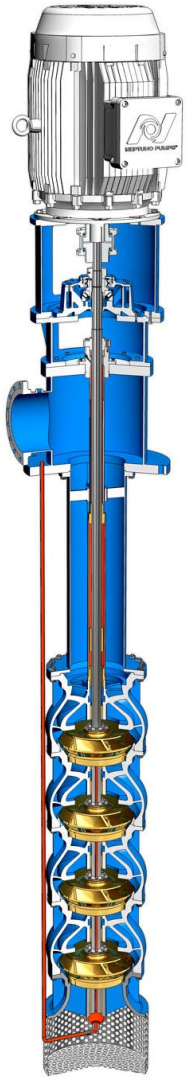


Axial Pumps



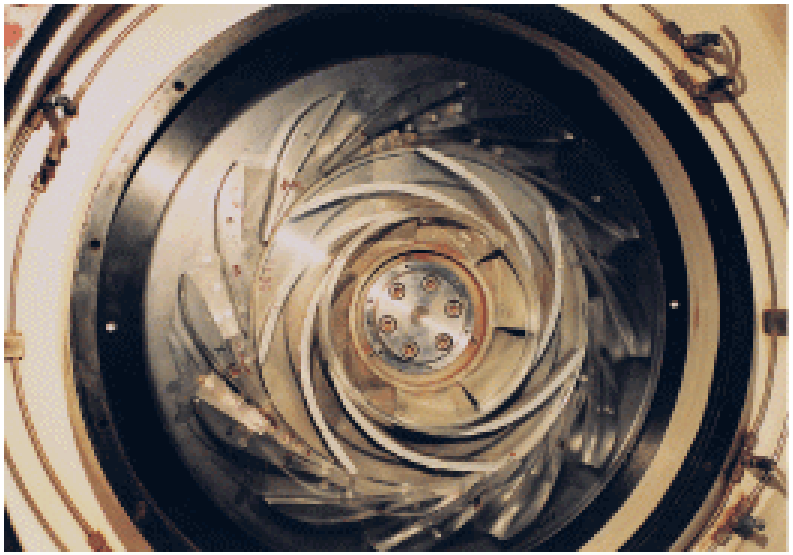
Bowls

- Impellers Located in Bowls
- Multi-stage – bowls add pressure not volume
- Flow is restricted to the size of the bowl



Diffuser Vanes

- Diffuser vanes convert velocity to pressure



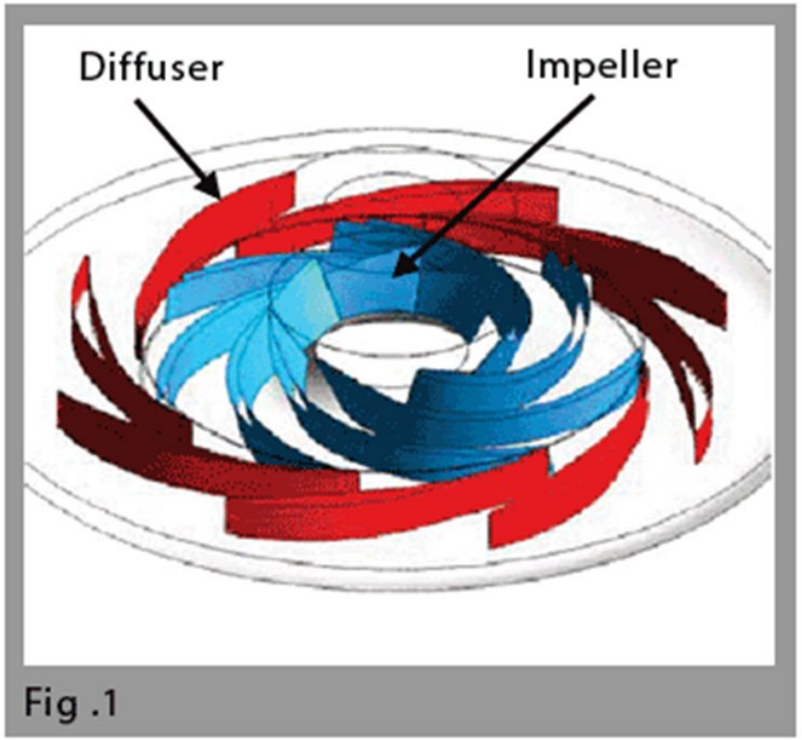
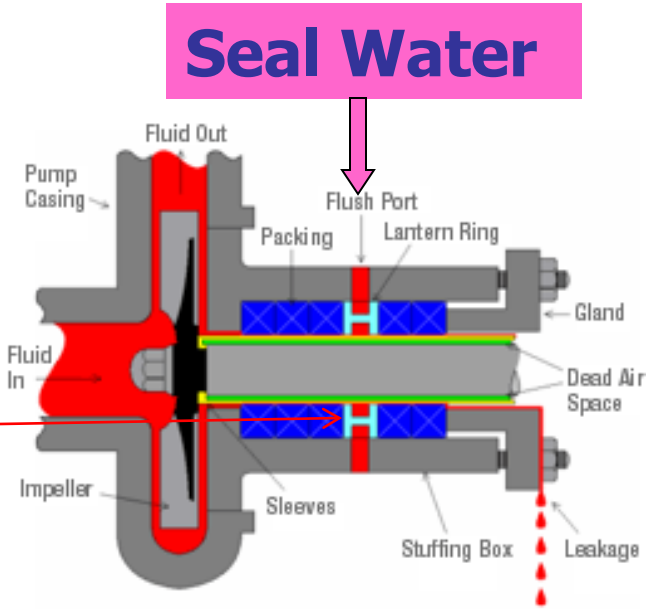


Fig .1

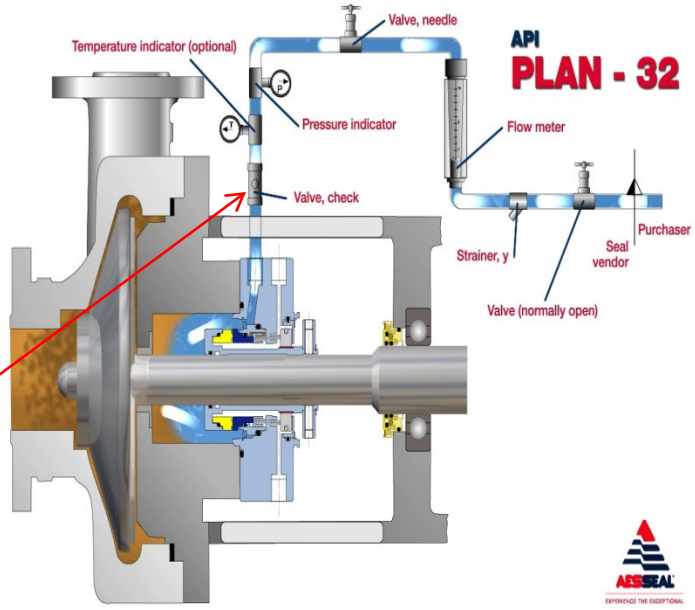
STUFFING BOX

- Packing or mechanical seal
- Packing glands
- Seal water - 5 psi higher than maximum suction pressure
- Lantern ring



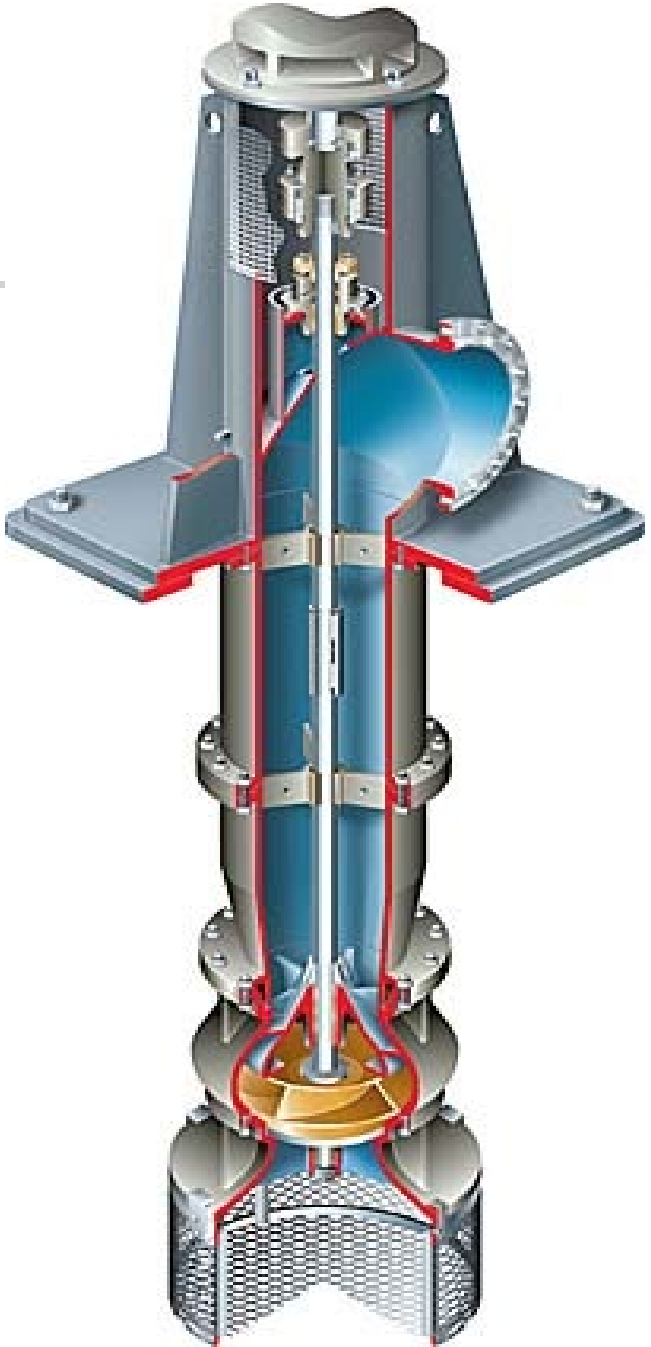
External Seal Water

- Clean water source
- Used when pumped water has grit in it
- Needs to be turned on several minutes before starting pump
- Should have backflow preventer on clean water source.



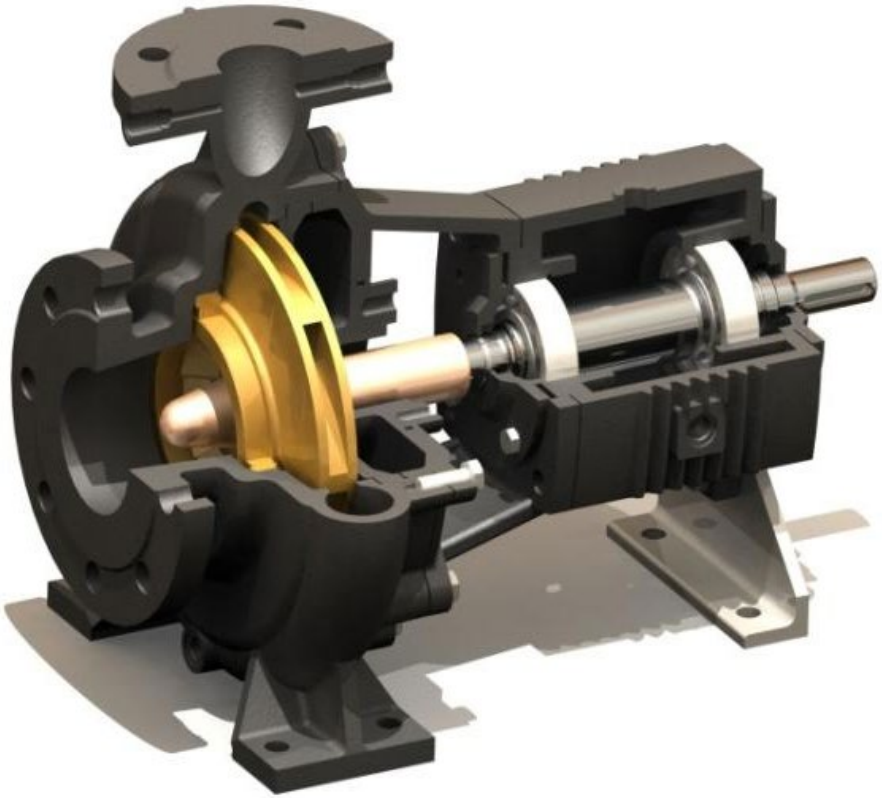
Impellers

- Vertical Pump Location



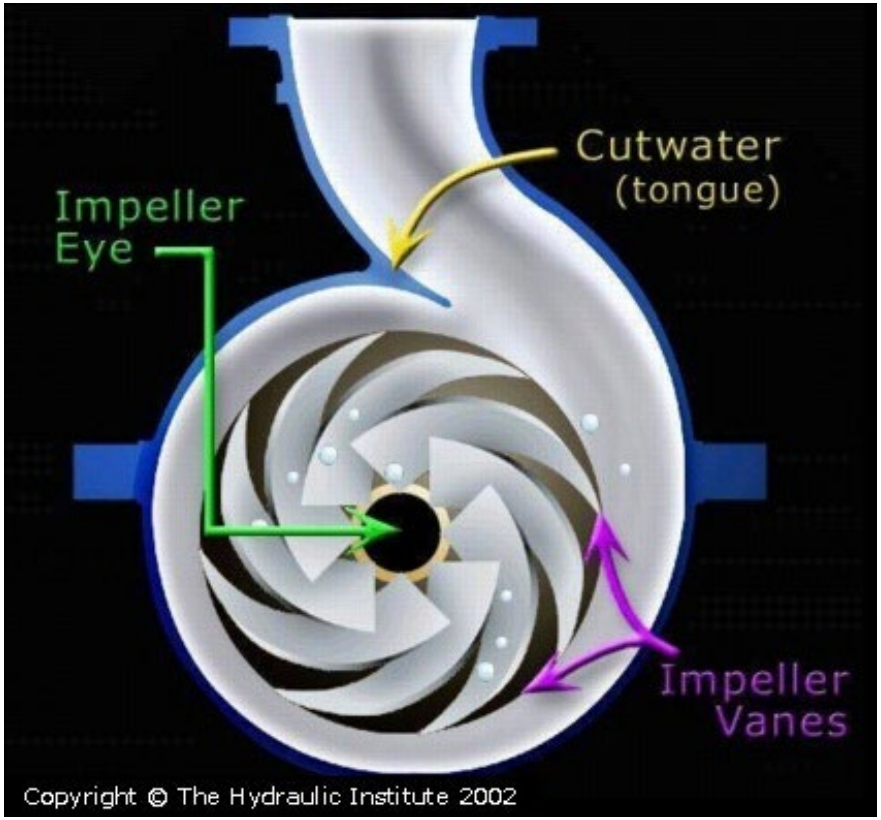
Impellers

- Horizontal Position

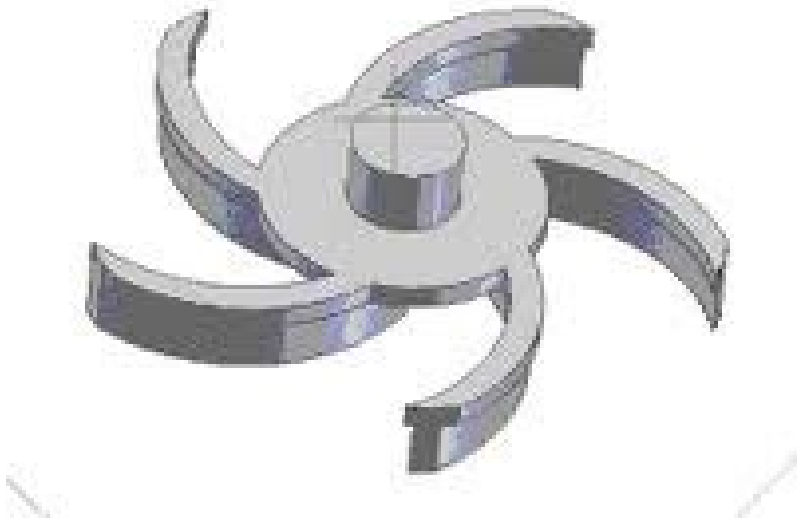


Impellers

- 3 types - open, semi-open, & closed
- Heart of the pump
- Made from metal, plastic, rubber
- Impeller eye - low pressure zone
- Suction of water is created at the center of the impeller, then it is pushed away from impeller by centrifugal force



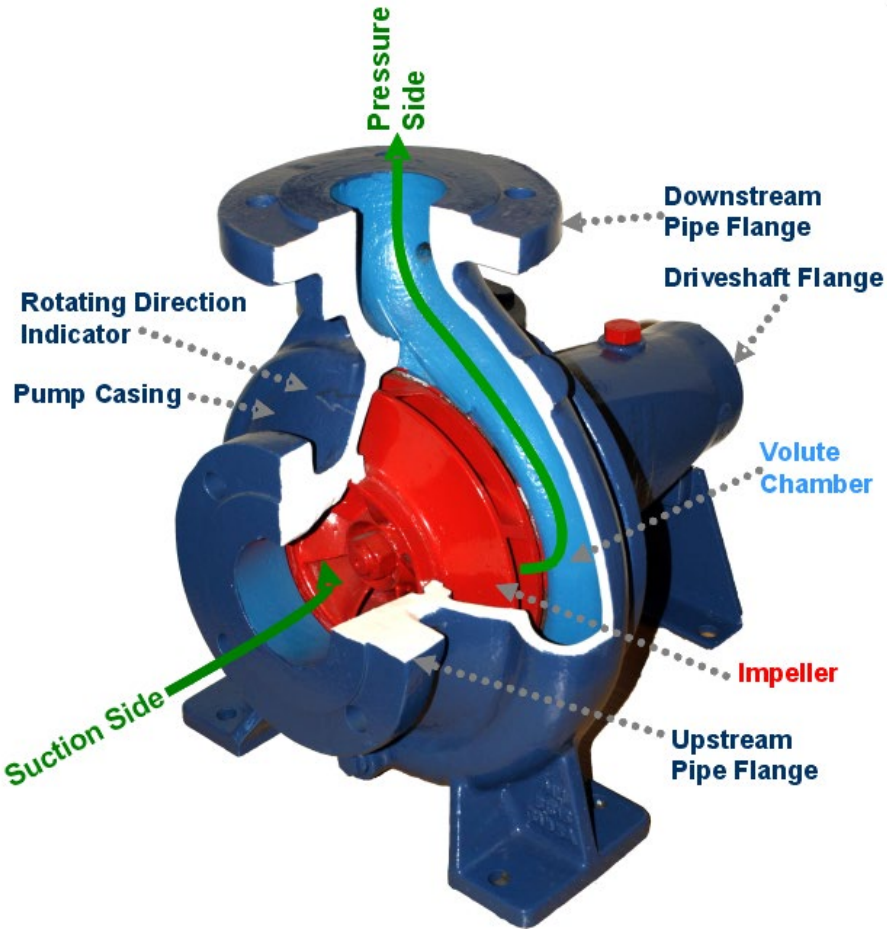
Open Impellers

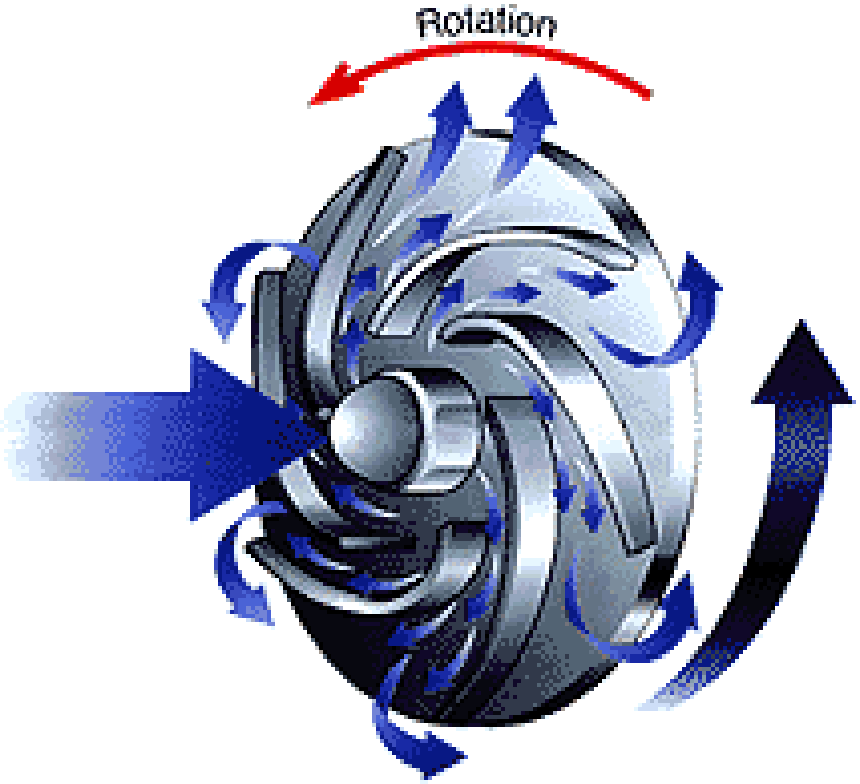


Semi-Open Impeller

Closed Impeller

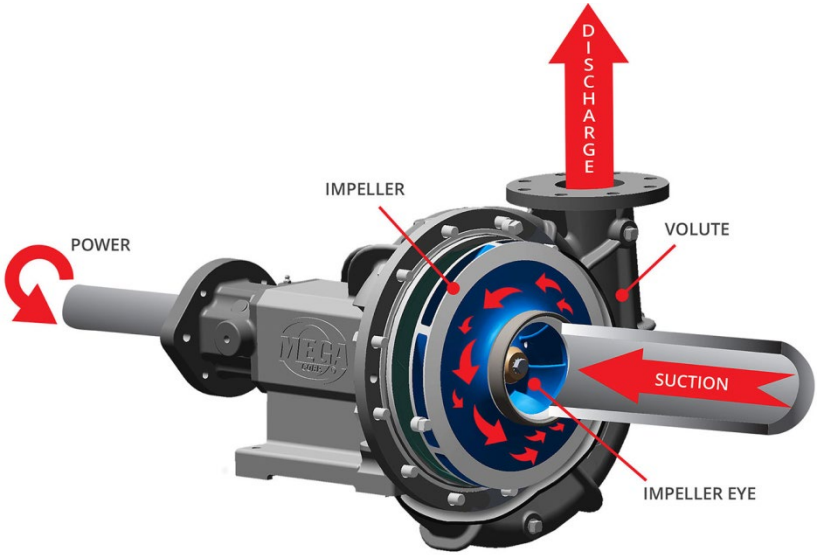
Pump Rotation

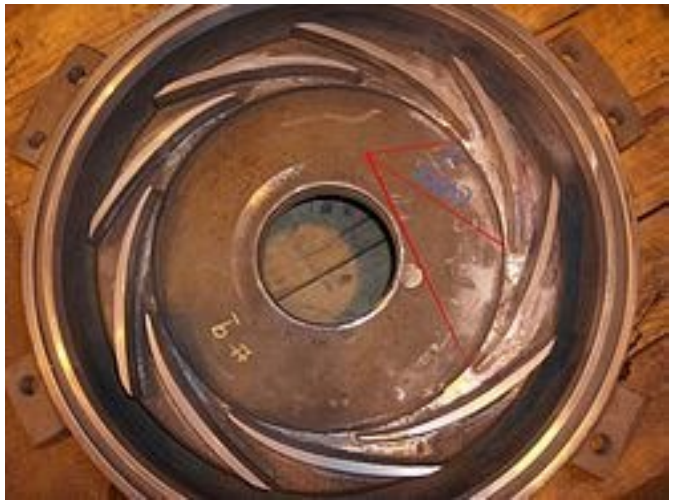




Volute Case

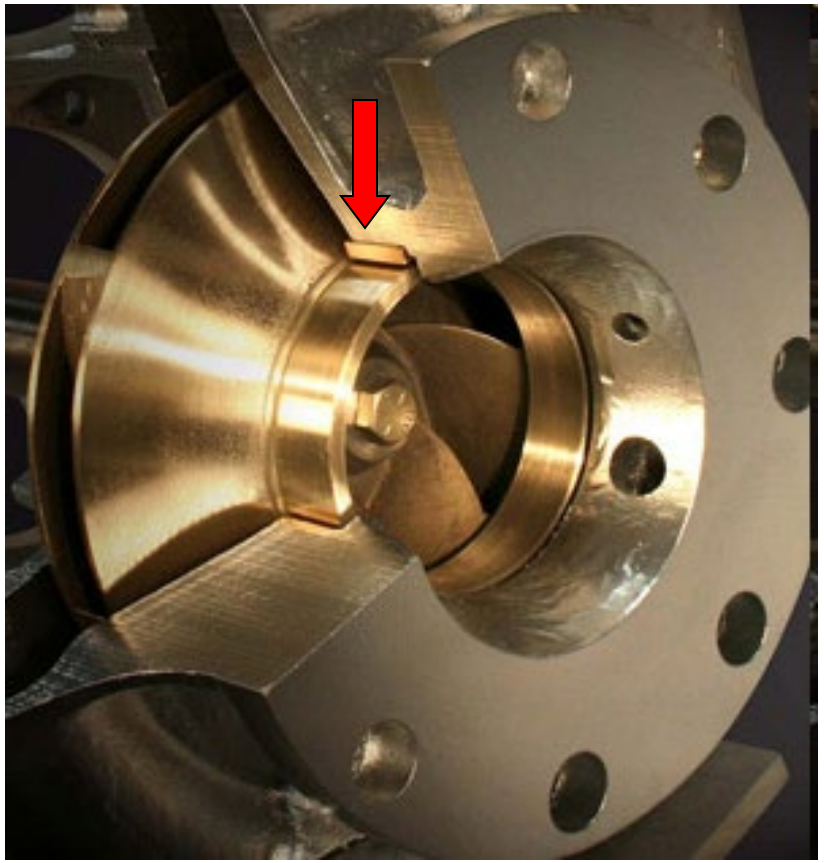
- Houses the impeller
- Curved vanes inside volute case are called volutes & convert velocity energy to pressure energy.
- Should be primed full of water on start up





Wear Rings

- Keep water from recirculating from the high pressure zone to the low pressure zone
- Used to protect the volute case and impeller from wear
- Worn rings cause recirculation of water costing more to operate

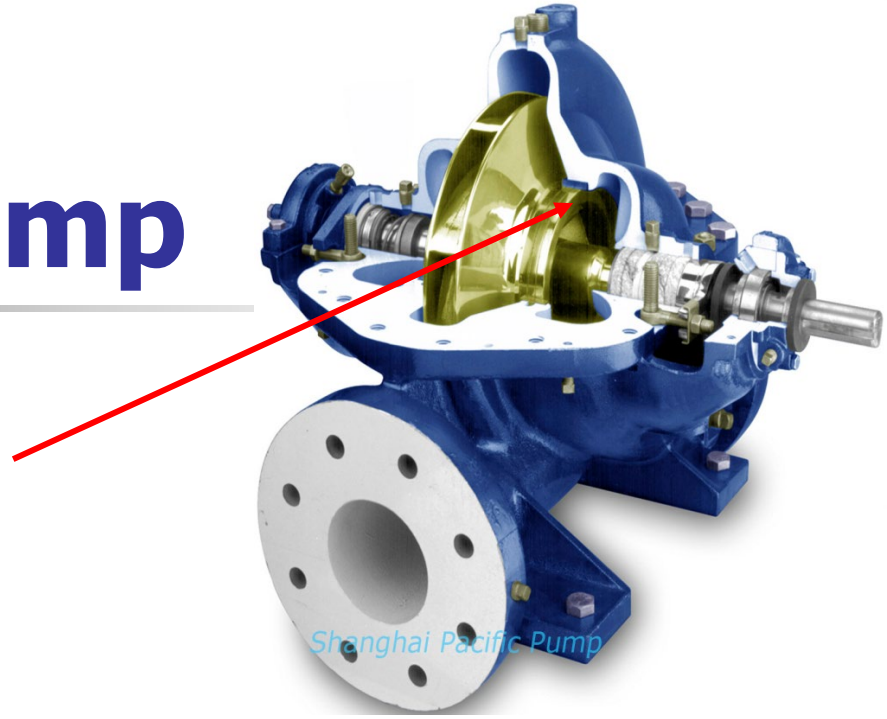


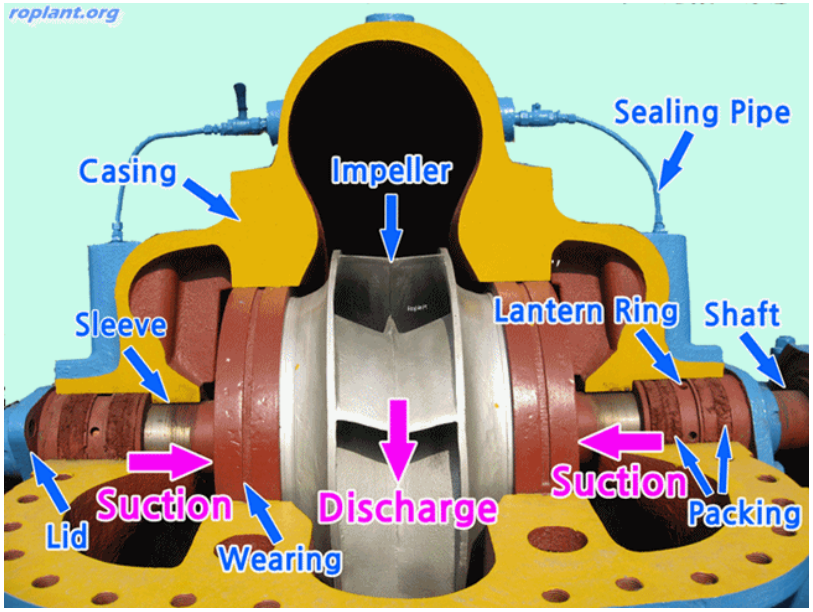
Wear Ring

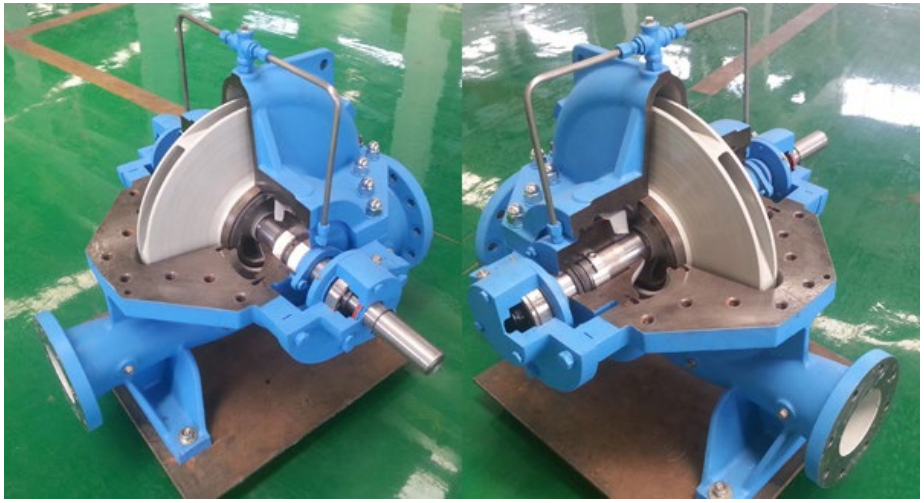
- Worn out wear ring

Split Case Pump

- Wear Rings act as a restriction between the impeller discharge and suction areas.

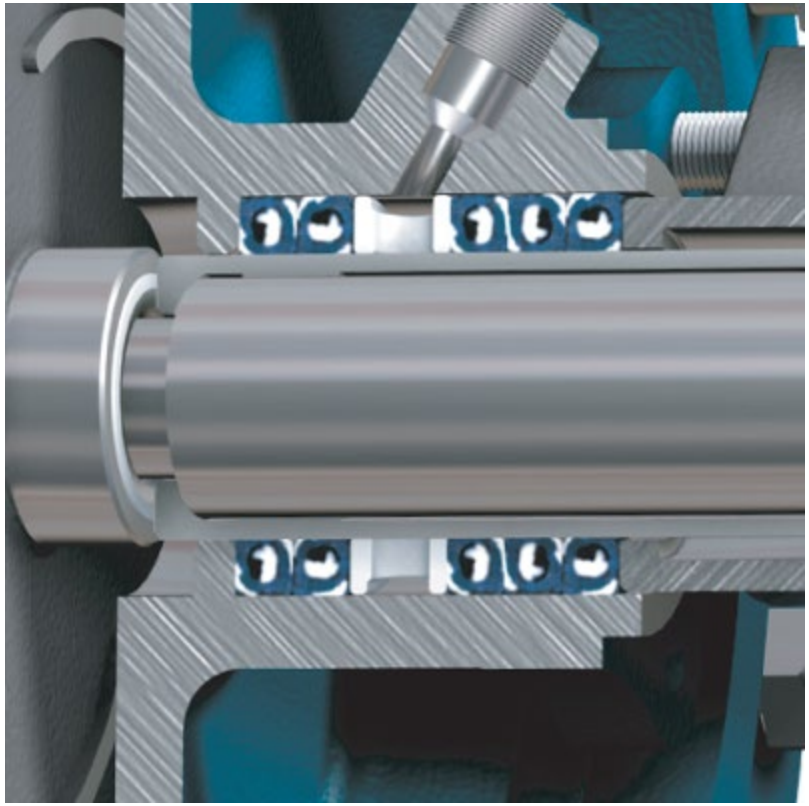






LANTERN RING

- H - shaped cross section
- Made of metal or plastic
- Located inside the stuffing box where seal water enters
- Not used with a mechanical seal
- Allows water to flow evenly through the packing

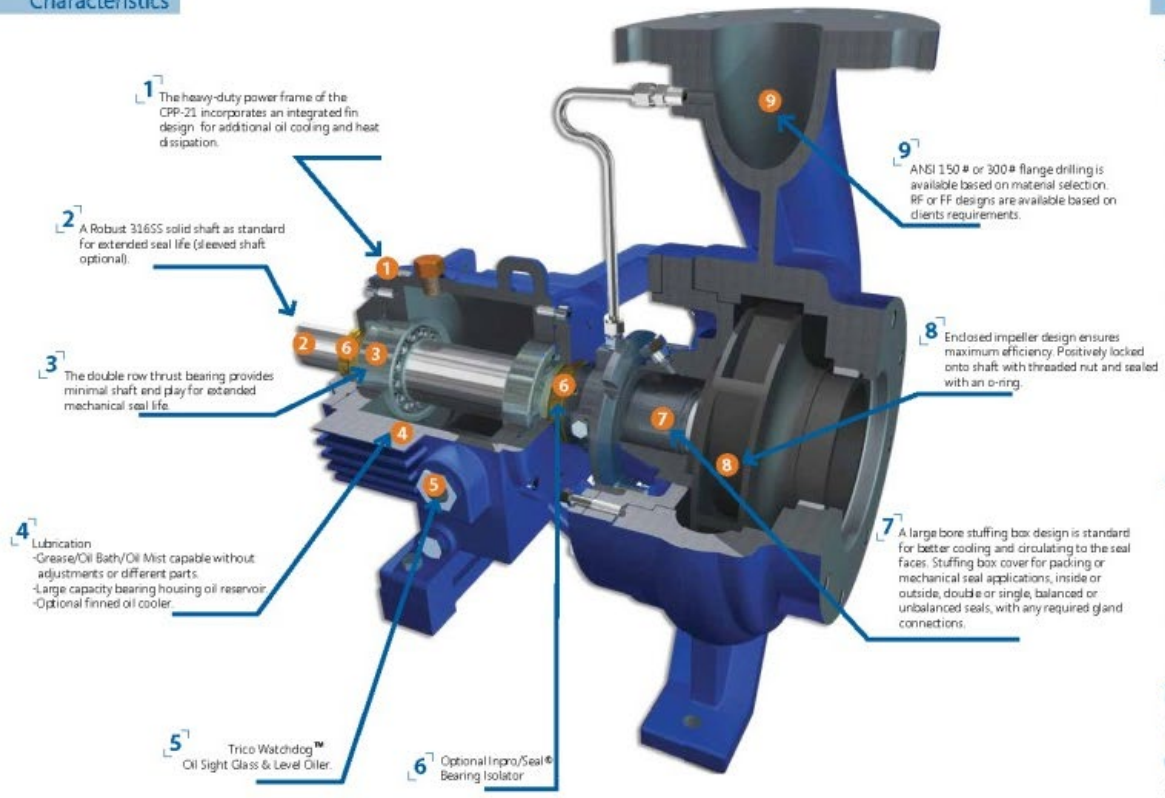


Seal Water

CPP-21

Heavy Duty, Single Stage, ANSI Chemical Process Pump

Characteristics



Description

PRODUCT DESCRIPTION

- Single stage horizontal centrifugal pump.
- Radially split casing with flanged connections.
- Horizontal end suction and vertical discharge on the centerline. Enclosed impeller, clockwise rotation (viewed from coupling end).
- Outstanding L^3 / D^4 deflection index.
- Foot mounted.
- Oil lubricated.
- ANSI std. B-73-1.
- "Back pull-out" design allows pump disassembly without disturbing pipe connections.
- Standard or large bore stuffing boxes are available for packing, single, or double seals. All ANSI flush plans are offered, as needed, in a variety of configurations.

BROAD APPLICATION RANGE

The Ruhrpumpen CPP-21 is designed for a wide range of industrial, chemical process and municipal applications such as:

- Petrochemical
- Oil & gas
- Steel industry
- Automotive
- Agriculture
- Tank farm
- Food processing
- Power generation
- Pharmaceuticals
- Water treatment
- Paper stock
- Pipeline
- General industries

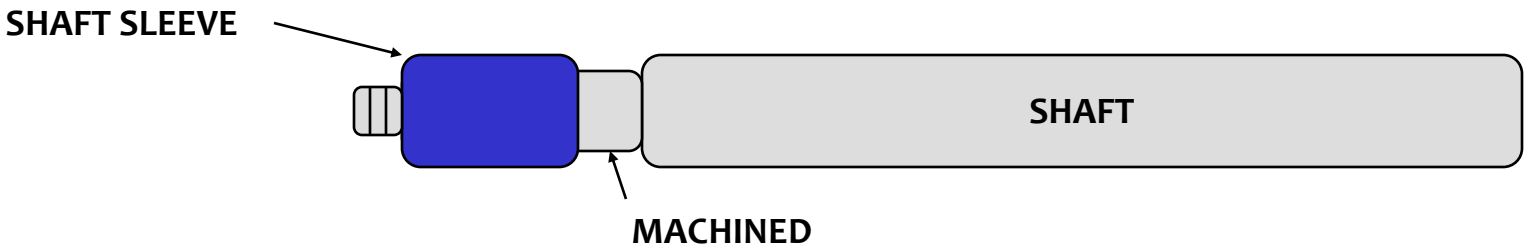
PERFORMANCE DATA

Capacity	to 5,000 U.S. gpm	
Head	to 770 Feet	
Flange size	1" to 8"	Discharge
Pressure	to 375 psig	(4,600 KPa)
Temperature	-50 °F to 600 °F (-45 °C to 315 °C)	

*The performance is not limited. For pump operation outside this range, please contact us for more information.

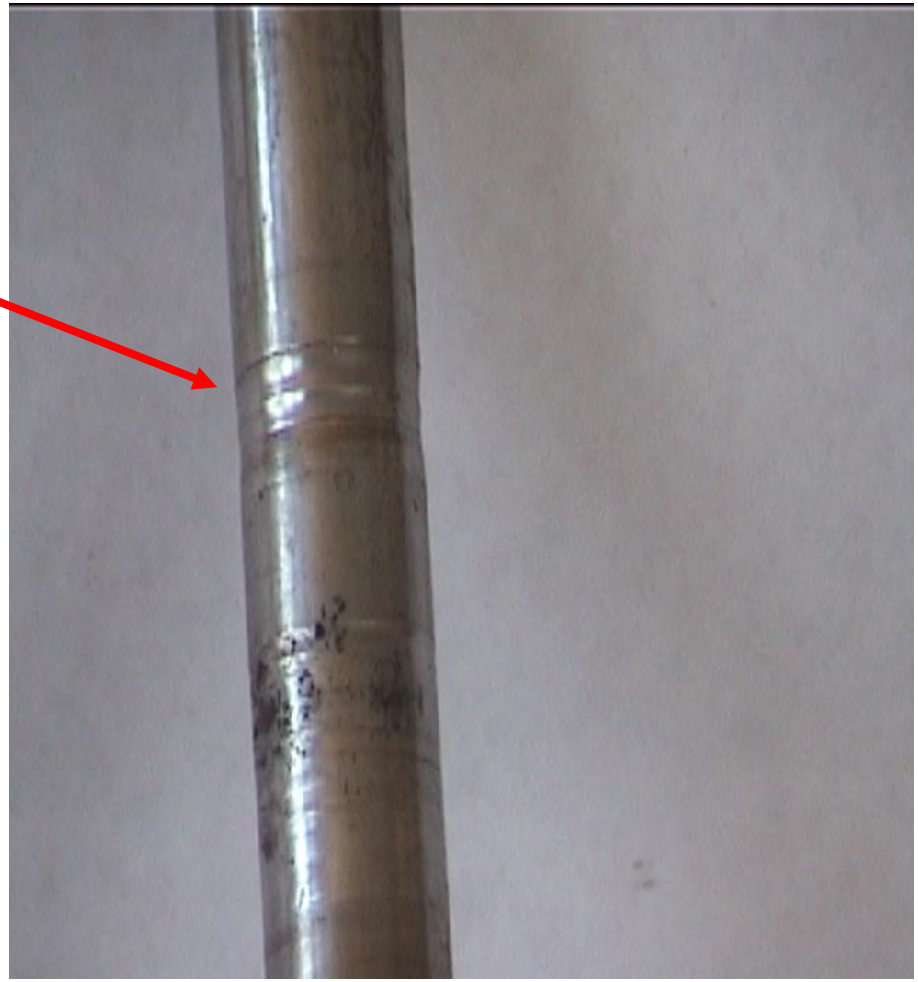
SHAFT

- Driven by motor to turn & support the impeller
- Shaft sleeve - pressed on the shaft, located inside stuffing box
- Shaft sleeve is an expendable part used for wear



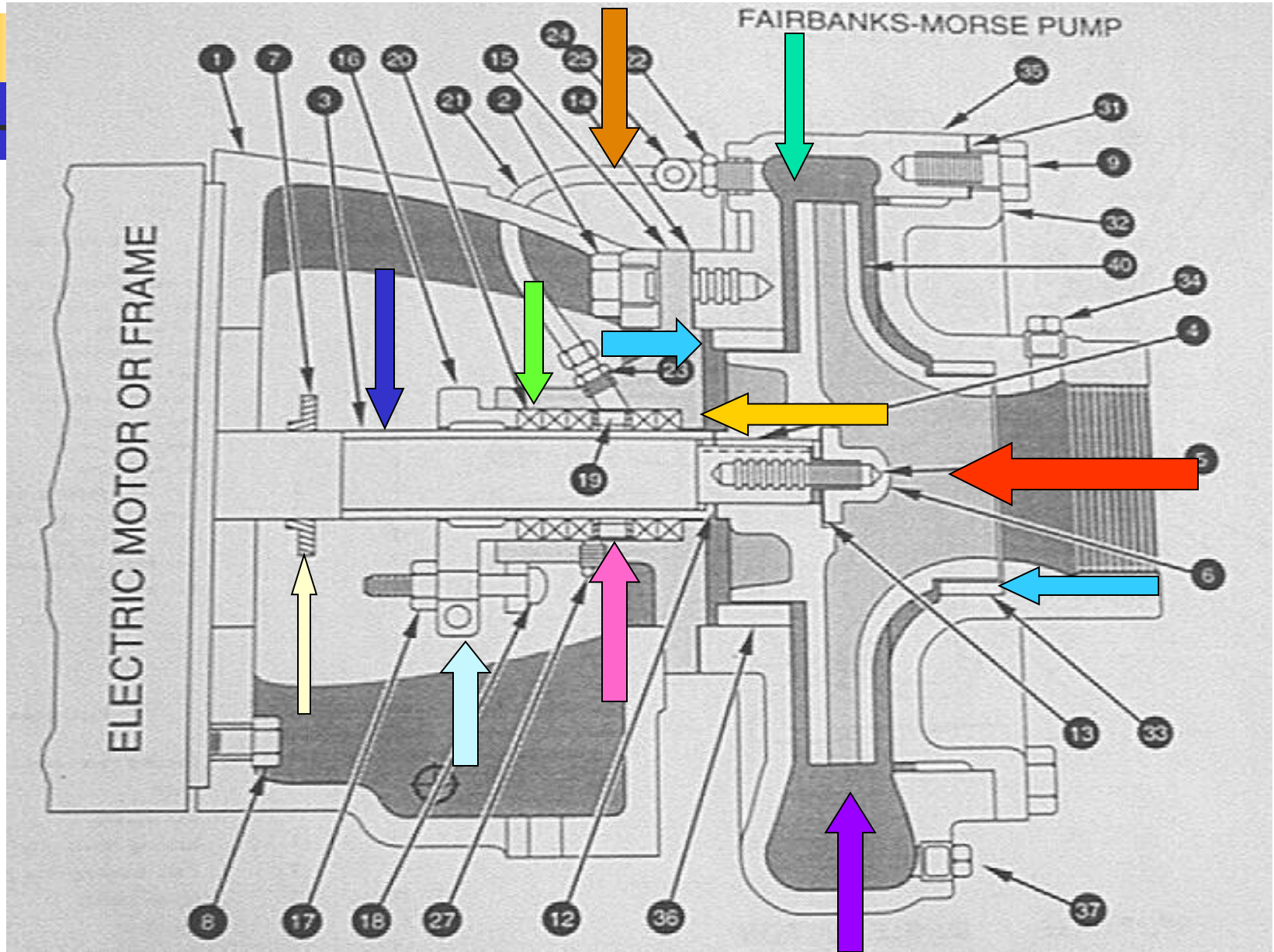
No Shaft Sleeve

- Worn shaft that had no sleeve



Worn Shaft Sleeves

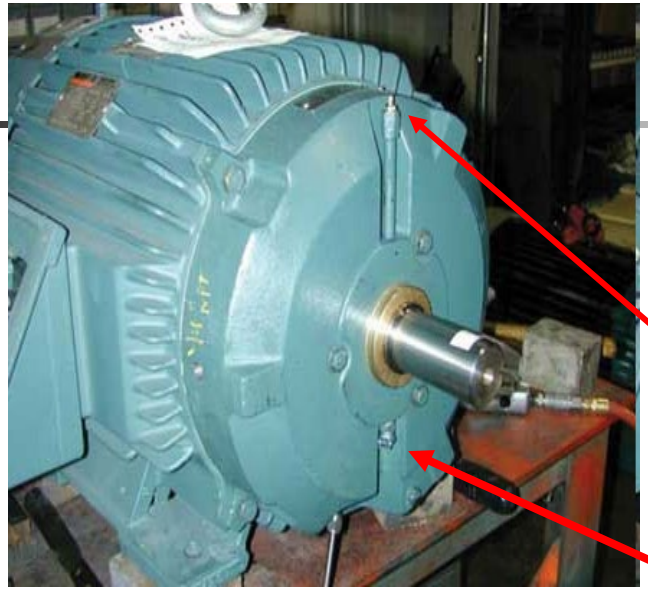
CENTRIFUGAL PUMP COMPONENTS

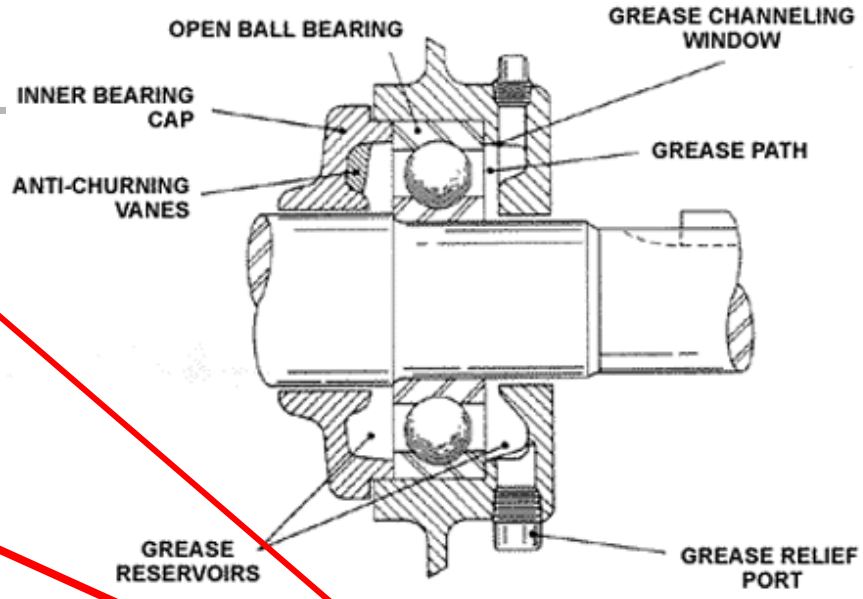


BEARINGS

- Anti-friction bearings
  * Roller bearings
  * Ball bearings
- Manufacturer determines type & frequency of lubrication
- Sleeve bearings

Proper Bearing Lubrication

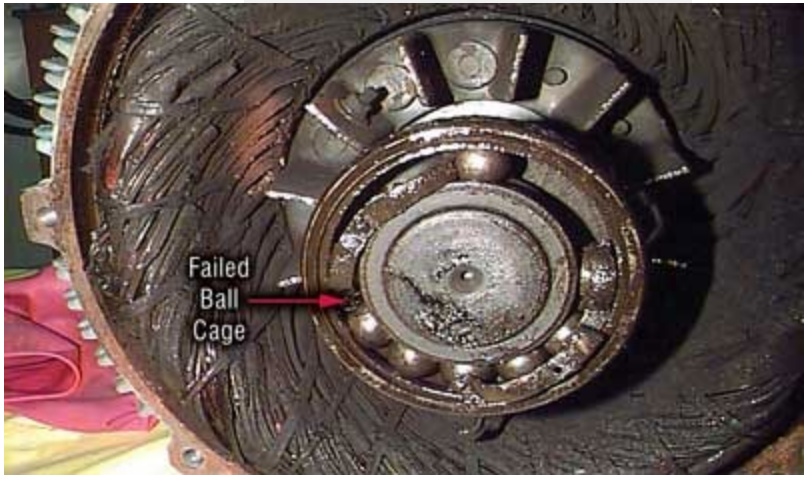




- Remove plug in grease relief port
- Press new grease into grease fitting displacing old grease
- Allow motor to run and let excess grease exit
- Replace plug in grease relief port

BALL BEARINGS

- Outer Ring
- Inner Ring
- Cage
- Rolling Element



ROLLER BEARINGS

- Supports radial loads and/or thrust loads depending on the design and where the rolling elements are placed

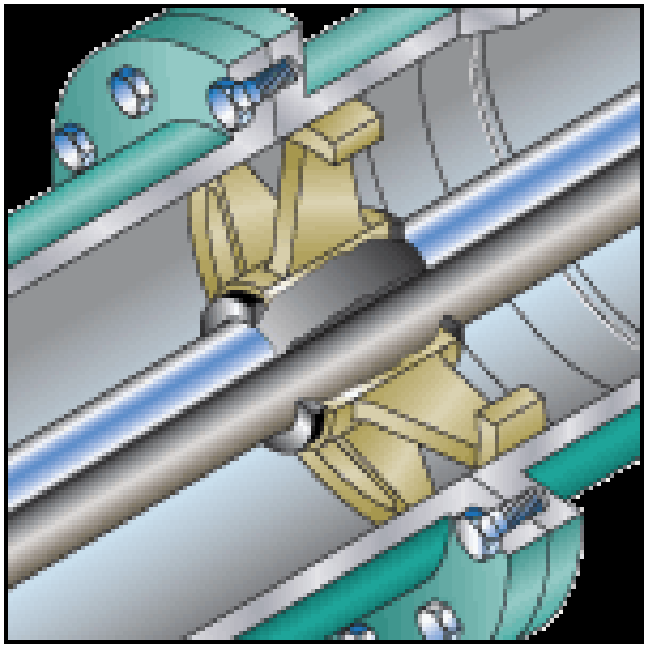
ROLLER TYPE BEARINGS

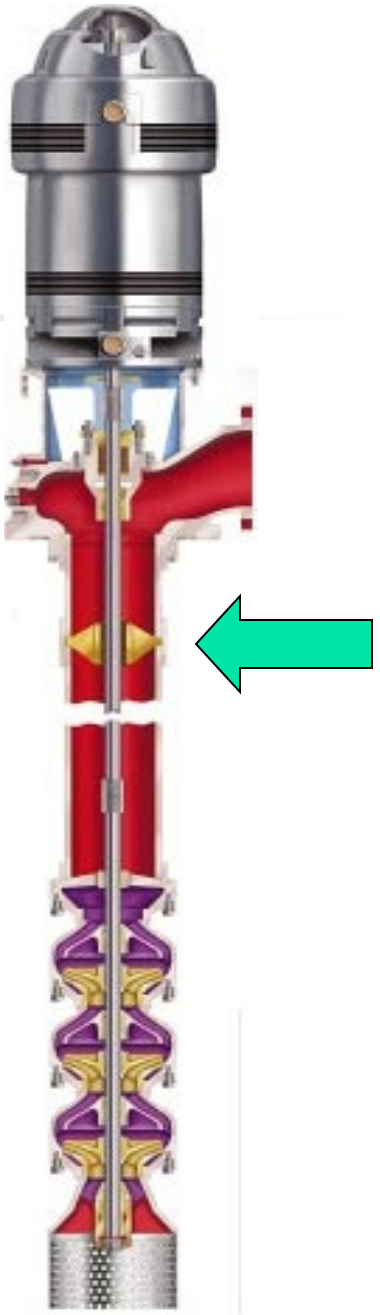
Roller Bearings

Needle Bearings

Sleeve Bearings

- Located in Spider



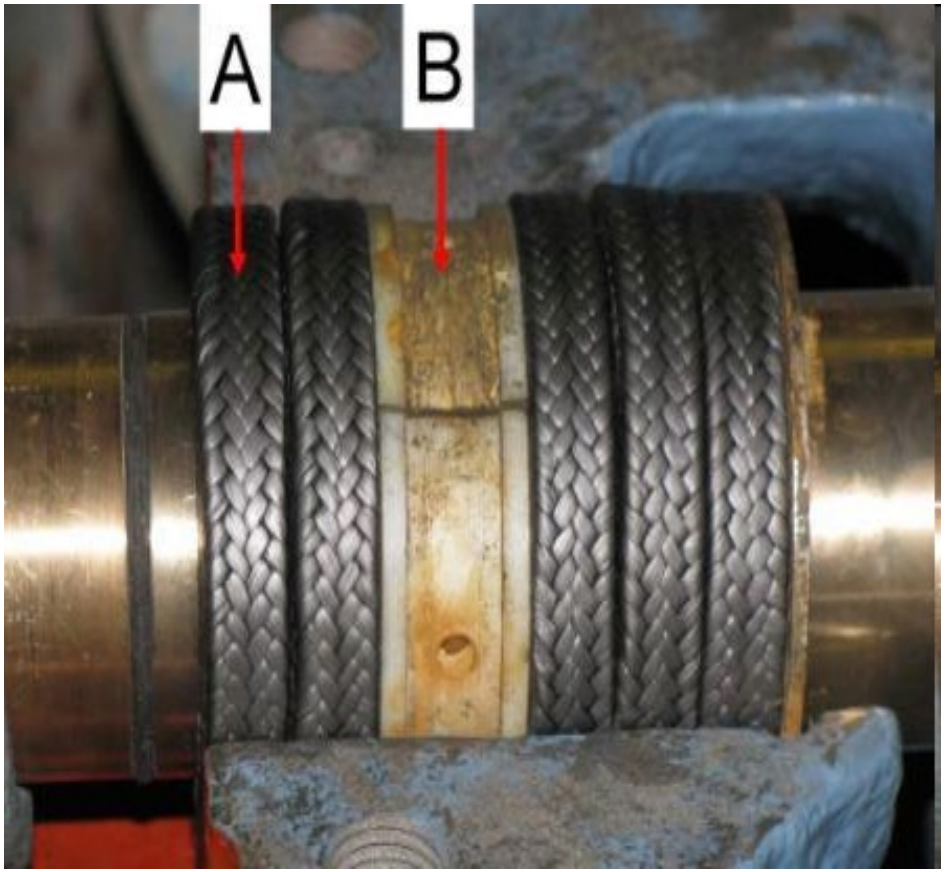


SHAFT SEALS

- Packing
- Mechanical seals
- Separate the wet from dry end of the pump
- Mechanical seals are for high suction head, metal packing can also be used

PACKING

- Should be adjusted to allow a steady drip of water from the packing gland
- Made out of braided animal, flax, plant, mineral or synthetic material
- Impregnated with some type of lubricant
- Comes in contact with shaft sleeve

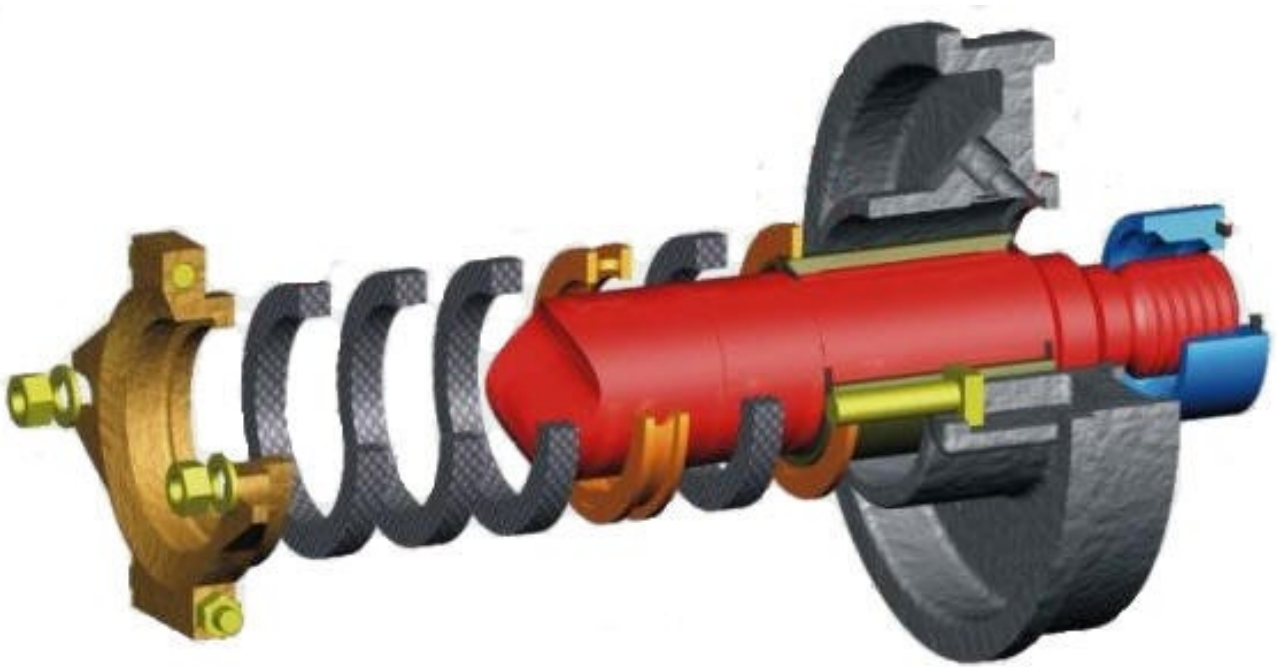


PACKING CONDITIONS

CONDITIONS	*PACKING*
Less than 100 psi or 1000 FPM	Plant fibers lubed with Teflon, silicon, TFE, or PTFE
100 to 150 psi or 1000 to 2000 FPM	Graphite, acrylics, TFE, kevlar, PTFE, & carbons
Above 150 psi or 2000 FPM	Metal, packing with metal cores or combination of synthetics & metals. Asbestos no long used

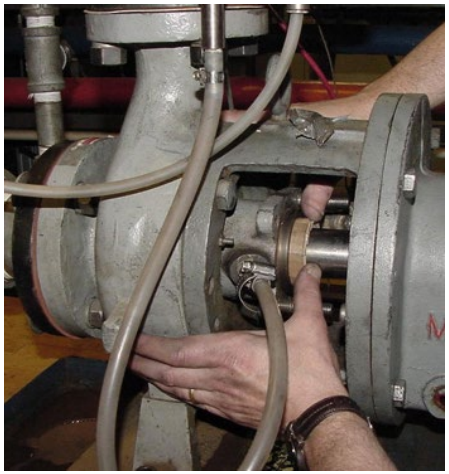
Stuffing Box

- Packing Location



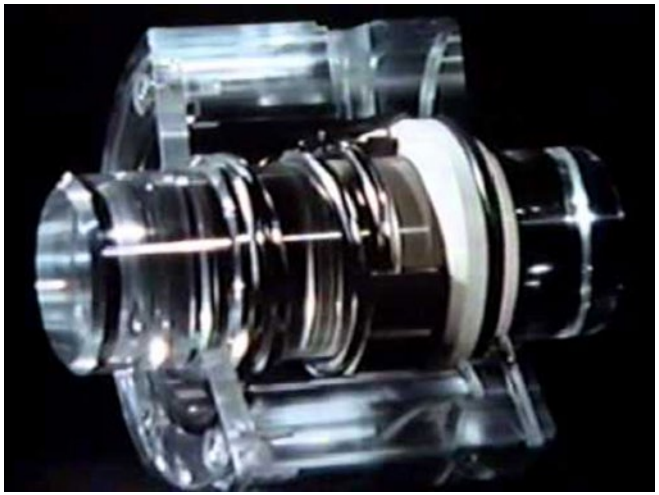
PACKING PROCEDURE

- Remove old packing, never stack new on top of old
- Cut in scarf or butt cuts
- Cut 1/16 - 1/8 shorter than shaft circumference
- Lubricate 1st ring & seat at the bottom of the stuffing box
- Stagger rings 90 degrees
- Line lantern ring with seal water
- Finger tight adjustment nuts



MECHANICAL SEALS

- Located inside stuffing box
- Two surfaces: one is stationary and the other is rotating
- Stationary surface is made of a harder material than the rotating surface
- Spring keeps tension on the surfaces
- Seal components must match properly



START-UP

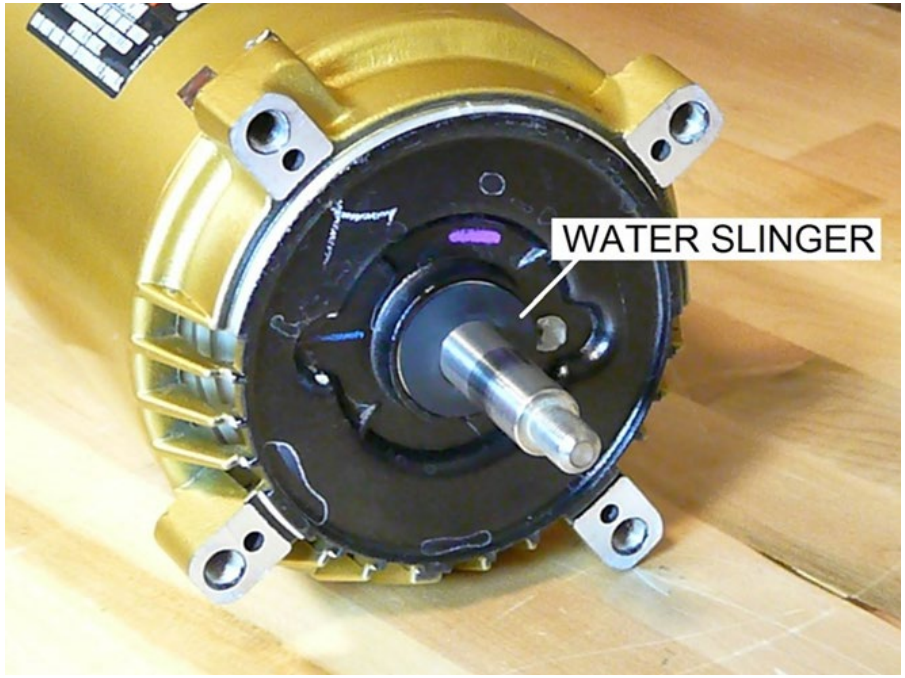
- Rotate shaft by hand
- Run seal water 15 min. prior to start up
- Finger tight adjusting nuts
- Start pump, run 15 min., don’t adjust
- Adjust nuts equally, 1/6 turn every 15 min., until desired leakage is reached
- Stuffing box should be cool

START-UP

- Check valve positions
- If pump has set for an extended period of time, the shaft should be turned to oil the bearings
- Check oil levels, amp readings, volt readings, flows, well info., Comments

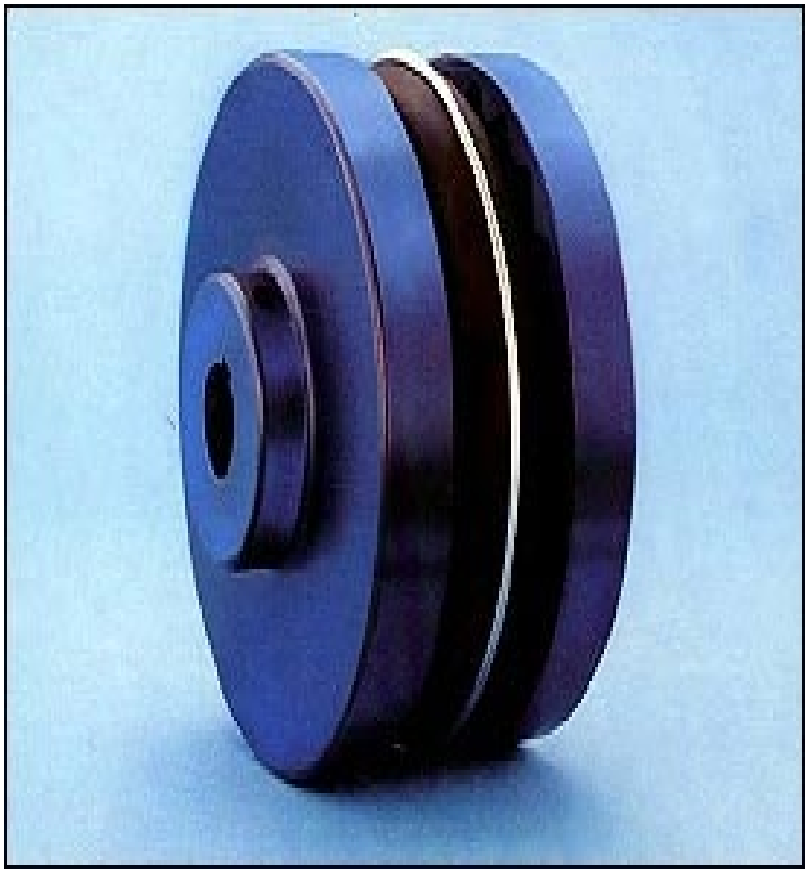
SLINGER RING

- Made of either leather or rubber
- Fits on shaft near the motor
- Prevents water from entering the motor bearings



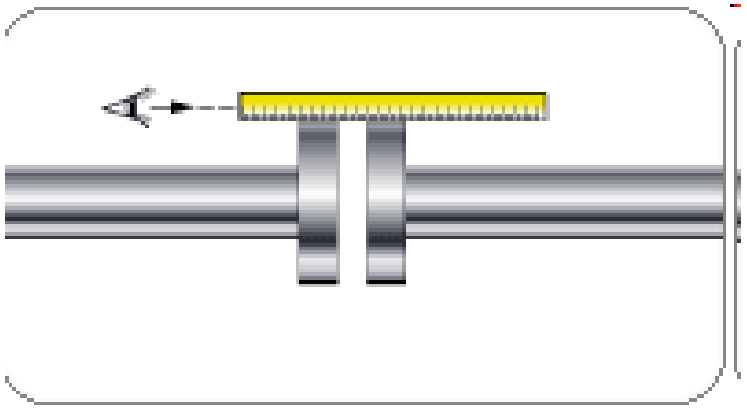
COUPLINGS

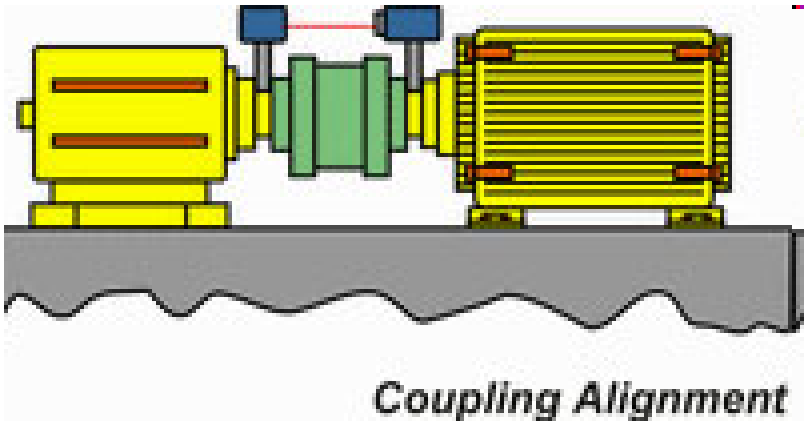
- Connect shafts of different diameters
- Transfer energy
- Most allow for slight misalignment
- Absorb starting torque
- Dampen vibrations
- Insulate units from electrical current
- Allow for end movement of shafts



ALIGNMENT TECHNIQUES

- Straight edge and feeler gauge
- Dial indicator
- Severe vibration upon pump start up would indicate misalignment between motor and pump shafts





Coupling Alignment

PUMP MAINTENANCE

- Oil Drip rate = 5 drops per minute
- Use approved food grade mineral oil
- If a pump has been pulled for repair, you must have satisfactory bac-t results before putting back in service

Pump Station Flow

- Each pump must be able to deliver the maximum flow of the station
- Make sure the shaft bearings are wet before starting the pump
- Flow increases with decreased pressure head
- Alternating pump operation will help keep windings dry & serviceable
- Booster pumps fill tanks & supply pressure to mains

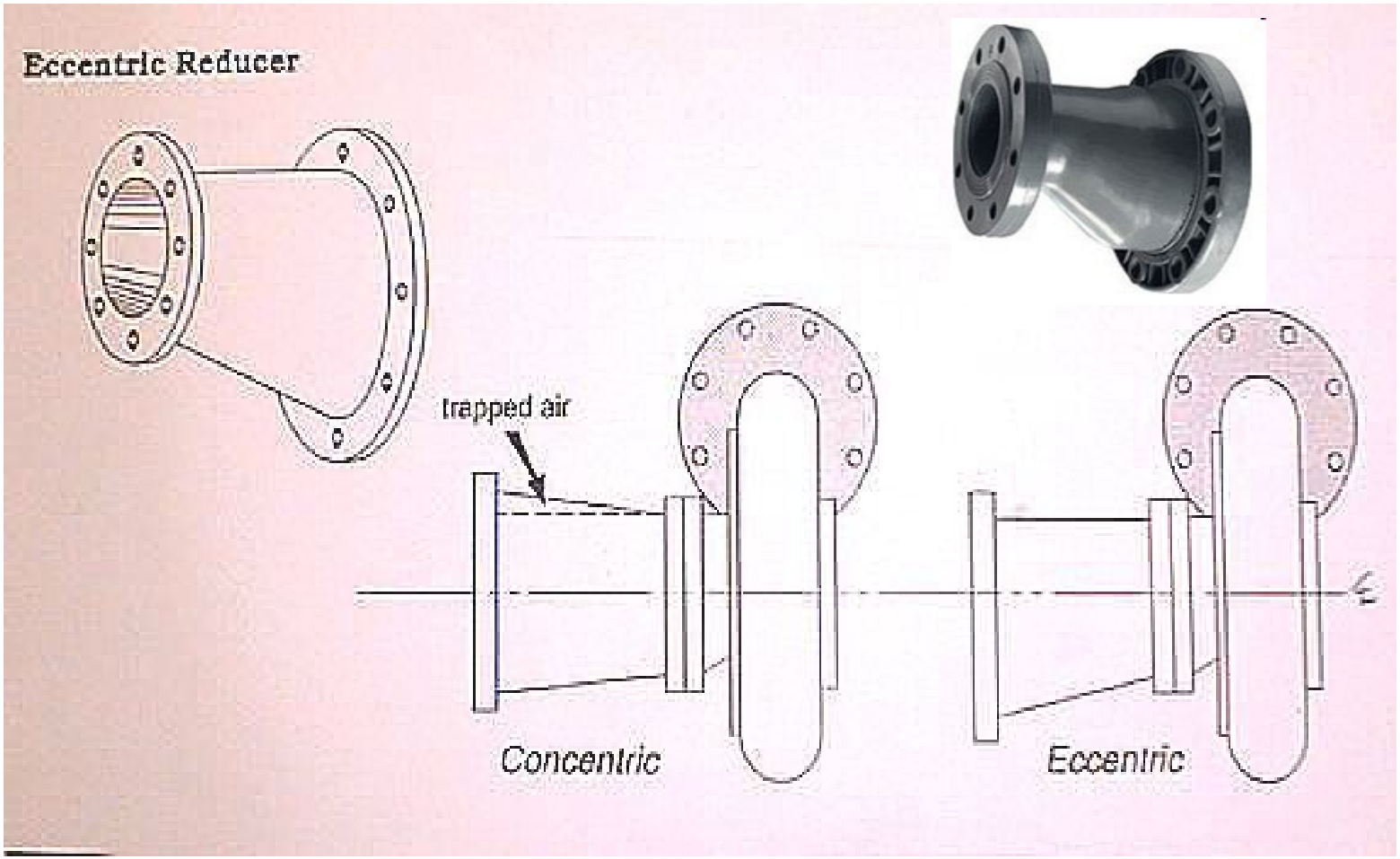
PUMP WEAR AND TEAR

- Pumps condition can be checked by comparing performance when new
- Wear is the main cause of loss in pumping efficiency
- Pump will run longer because of wear, increasing power costs
- Particles from wear can be seen in cooling water from stuffing box

PIPING

- Eccentric reducer - suction side
- Concentric increaser - discharge side
- Eccentric installed with the flat side up, reduces air entering casing & one size larger than suction inlet
- Concentric increases pipe one size, reducing velocity and head loss, for higher pump efficiency
- Should be drained in freezing conditions & when the pump is shut down for long periods of time

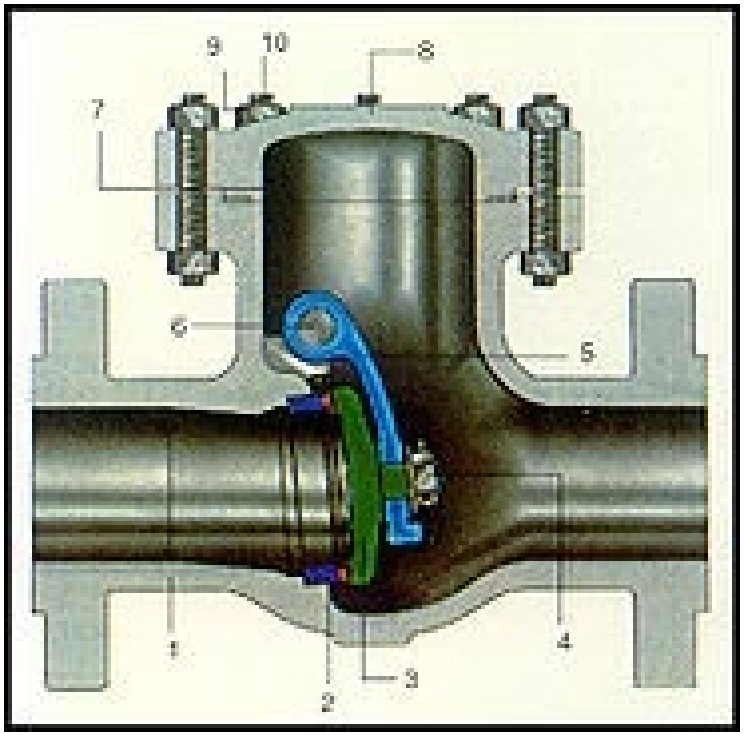
REDUCERS & INCREASERS



VALVING

- A check valve prevents the shaft from spinning backwards and causing damage to the pump
- If no check valve, you can start and stop a pump with the discharge valve closed to prevent water hammer by opening it slowly

CHECK VALVES



Swing Check Valve

Silent Check Valve

Keep pump from spinning backwards

Pump Control Valves

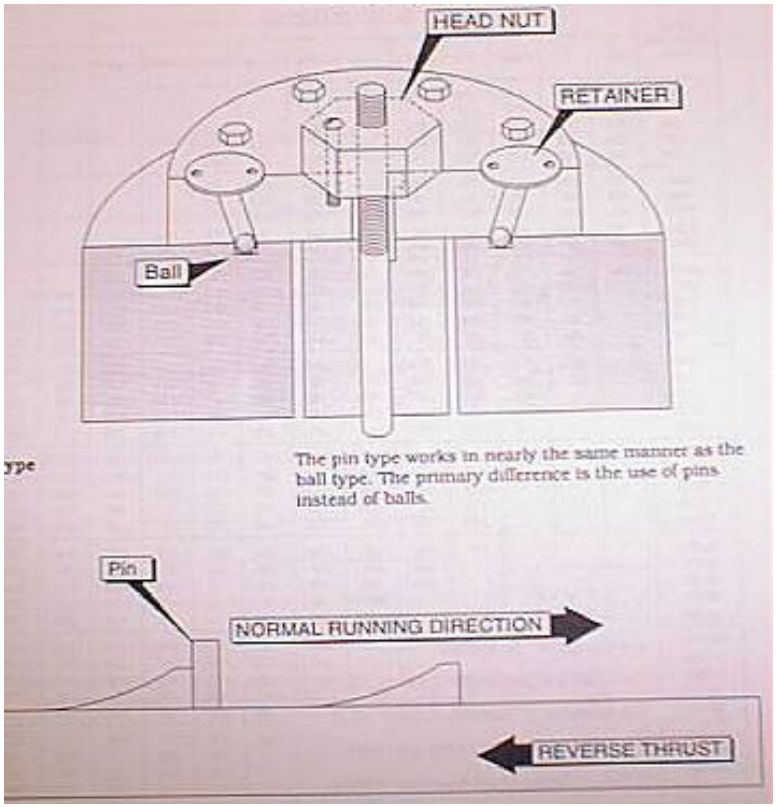
Foot Valves

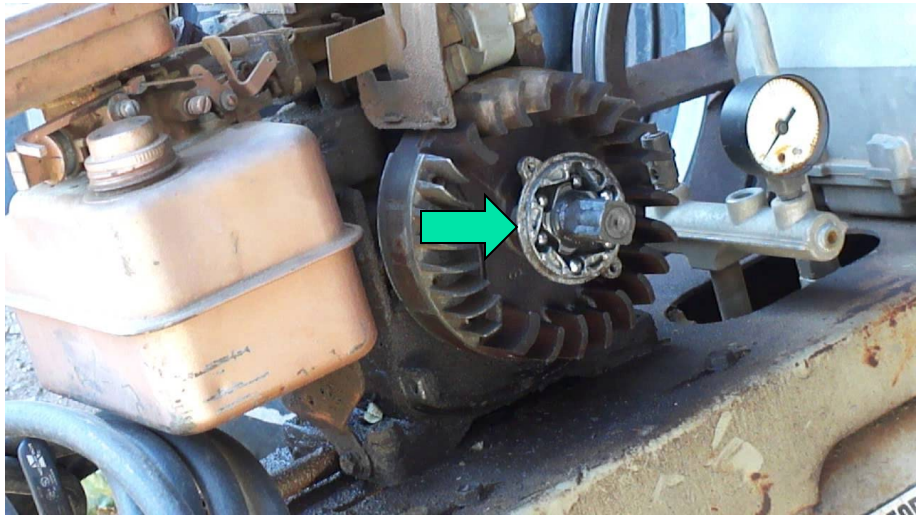
- Located at the bottom of suction pipe to hold prime

Air Vacuum Release Valves

- Air vacuum release valves - prevent vacuum conditions during shut down, they also release air pockets during start-up.
- Placed at high points of the system

RATCHETING DEVICES





Motor Maintenance

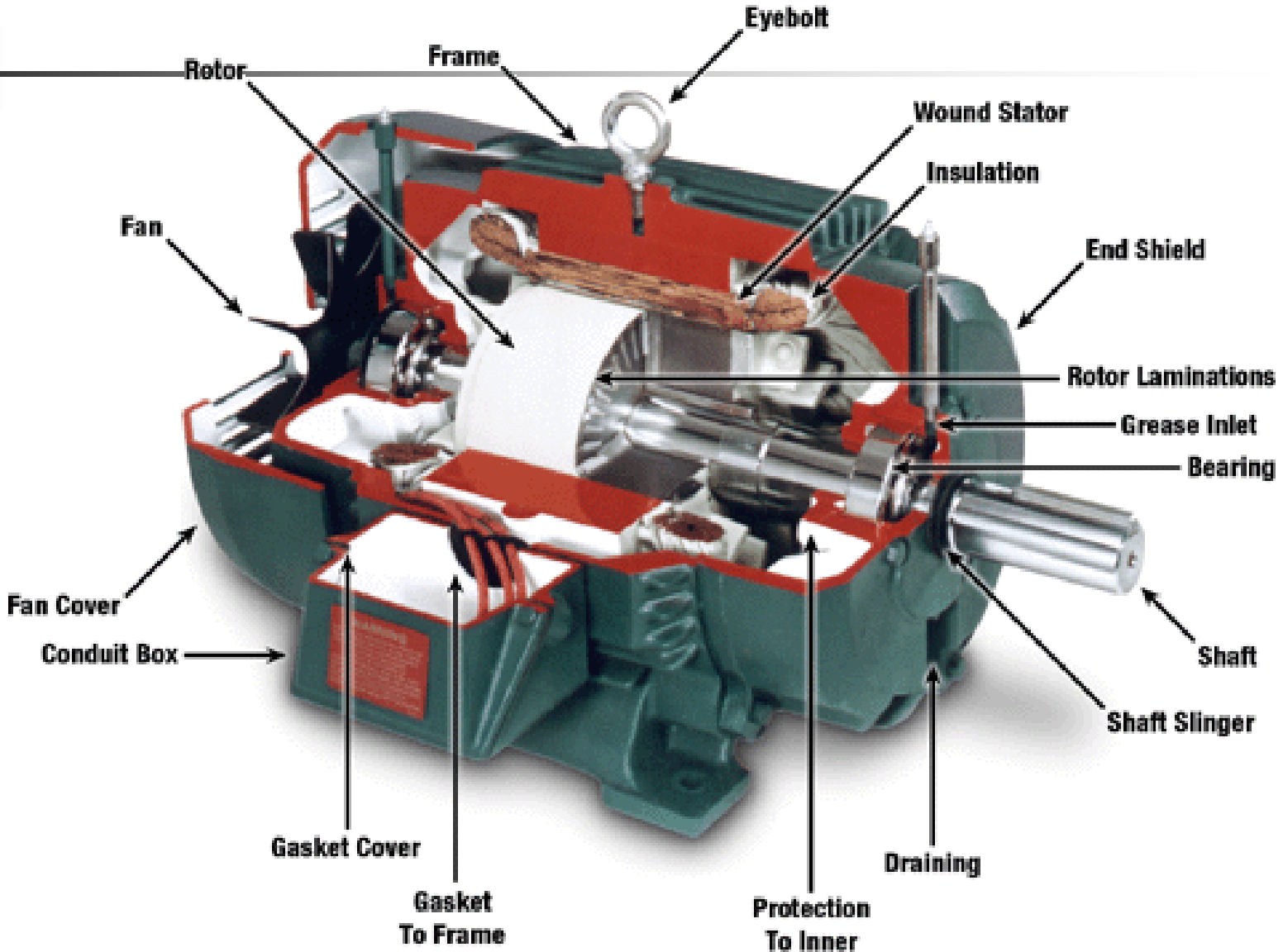
- Follow manufacturer's recommendations
- Over greasing - grease acts like an insulator, holding in heat, causing premature bearing failure
- Two most common speeds are 1800 and 3600 rpm
- Oil seals hold in the lubricant

Pump Motor Operation

- Motor could overheat with low head pressure
- In a low pressure head situation, throttling the discharge valve would cool the motor cool down due to the increase of pressure head
- Losing a phase on a 3-phase motor would cause the motor to single phase and heat up.
- Voltage imbalance can cause the motor to overheat & burn out windings
- Blow dust off to clean motor housing
- Brake HP is HP supplied by the motor

Vertical Motors Cutaway

Motor Cutaway



Motor Types

Hollow Shaft Motor

Motor With Shaft

TROUBLESHOOTING

- Losing a phase on a 3-phase pump:

*motor would continue to run

*motor would overheat

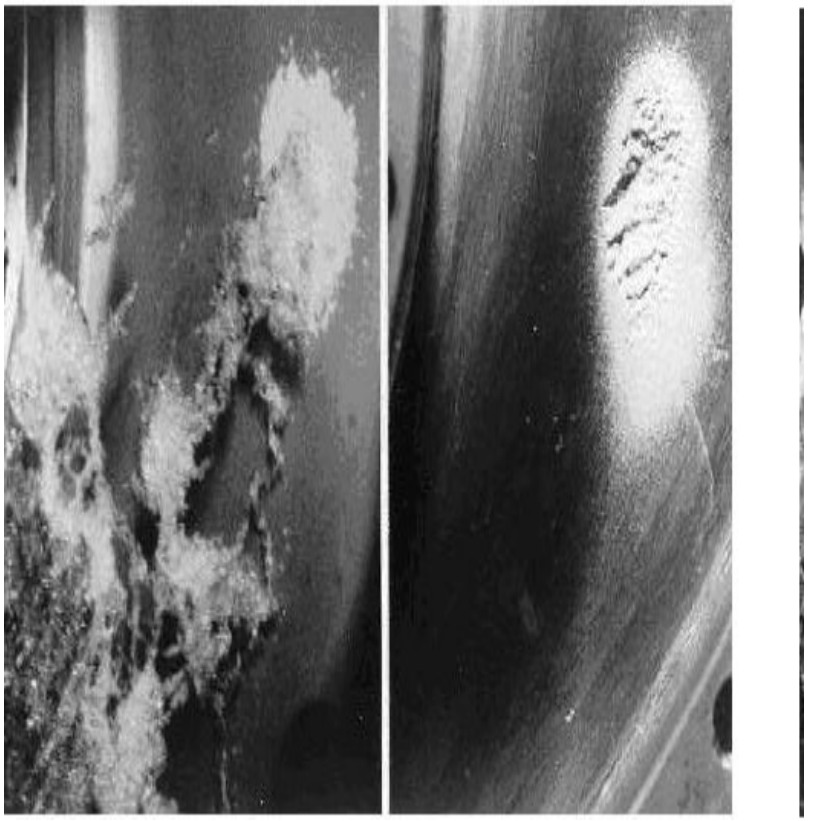
*damage could occur

Cavitation

- Main cause of losing pump suction
- Sounds like pumping rocks or pinging
- Vibration & popping noises caused by low pressure in volute
- Generally caused by vapor bubbles
- Vapor bubbles implode causing damage to pump
- Volute case needs to be full of water
- Prevented by having adequate suction pressure and proper bowl depths

Types of Cavitation

- Vaporization of the liquid in volute
- The "vane passing syndrome" from too small an impeller
- Too high suction speed
- Air ingestion on the suction side of the pump
- Turbulence of the fluid



Priming a Pump

- Priming displaces the air in the volute case
- Helps the pump create suction so the pump will pump
- It also helps reduce cavitation

TROUBLESHOOTING

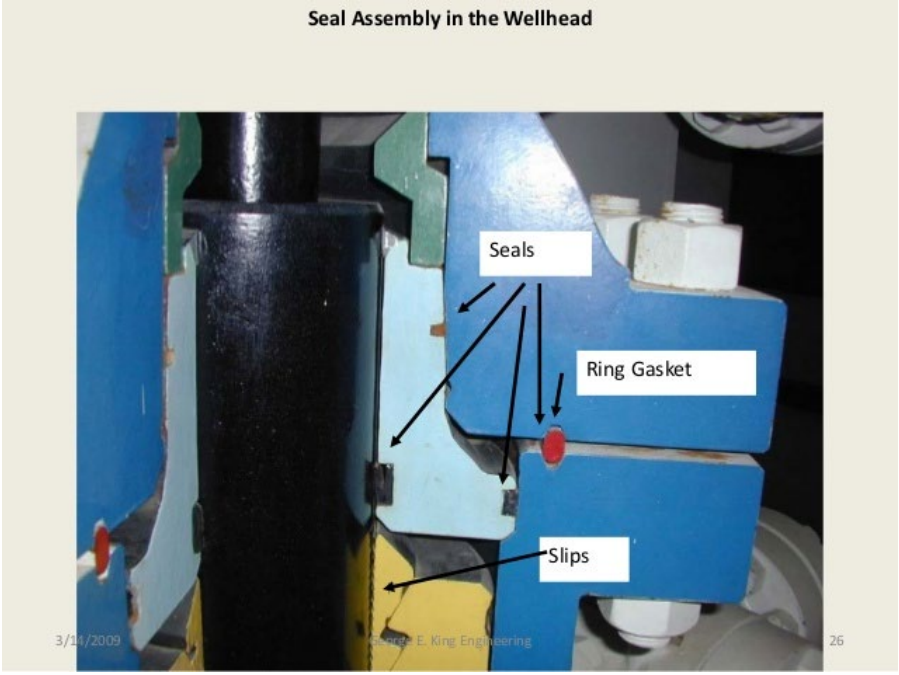
- Bearing failure is first detected by a change in operating sound of the pump and vibration

Accurate Record Keeping

- Shows loss of pumping efficiency along with record of flows & pressures
- Shows drawdown levels to evaluate condition of the well
- Drawdown level is elevation difference between static & pumping levels
- Helps determine proper depths for bowls.
- Shows when preventive maintenance or repairs were last performed

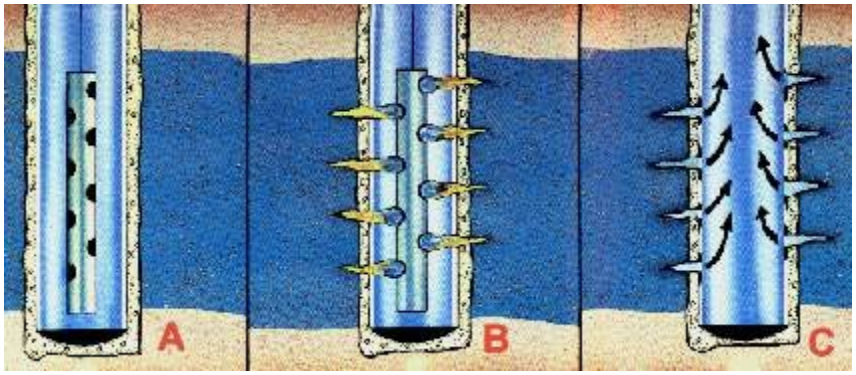
Well Seals

- Well casing maintains an open hole for the well
- Sanitary seal - all openings around well head are sealed off to prevent contamination.



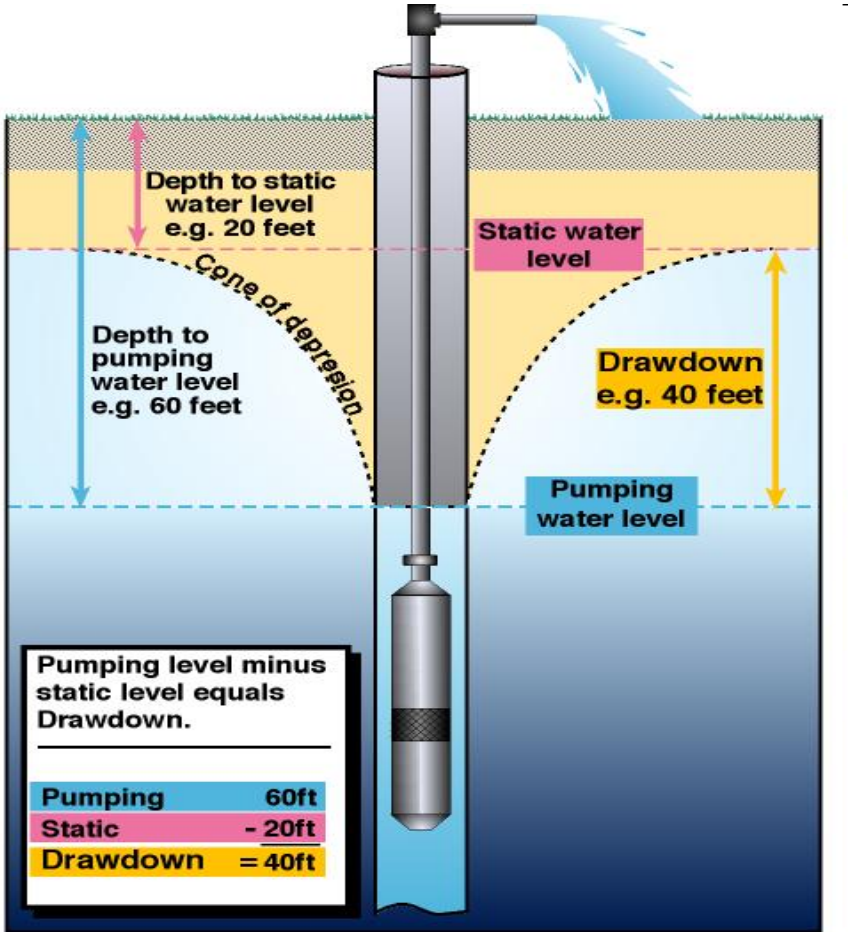
Well Casing

- Well casing perforations provide a way for water to enter pump
- Well casing helps protect the quality of the water.
- Surging a well form of plunging or cleaning the gravel pack around the screen



WELLS

- Well casing size is determined by the amount of water that is safe to yield
- Acidizing a well is a process used to rehabilitate a well for higher flows
- When a well pump is not running, the level of the water is the static level
- After a well pump runs for a period of time, the level is known as the pumping level



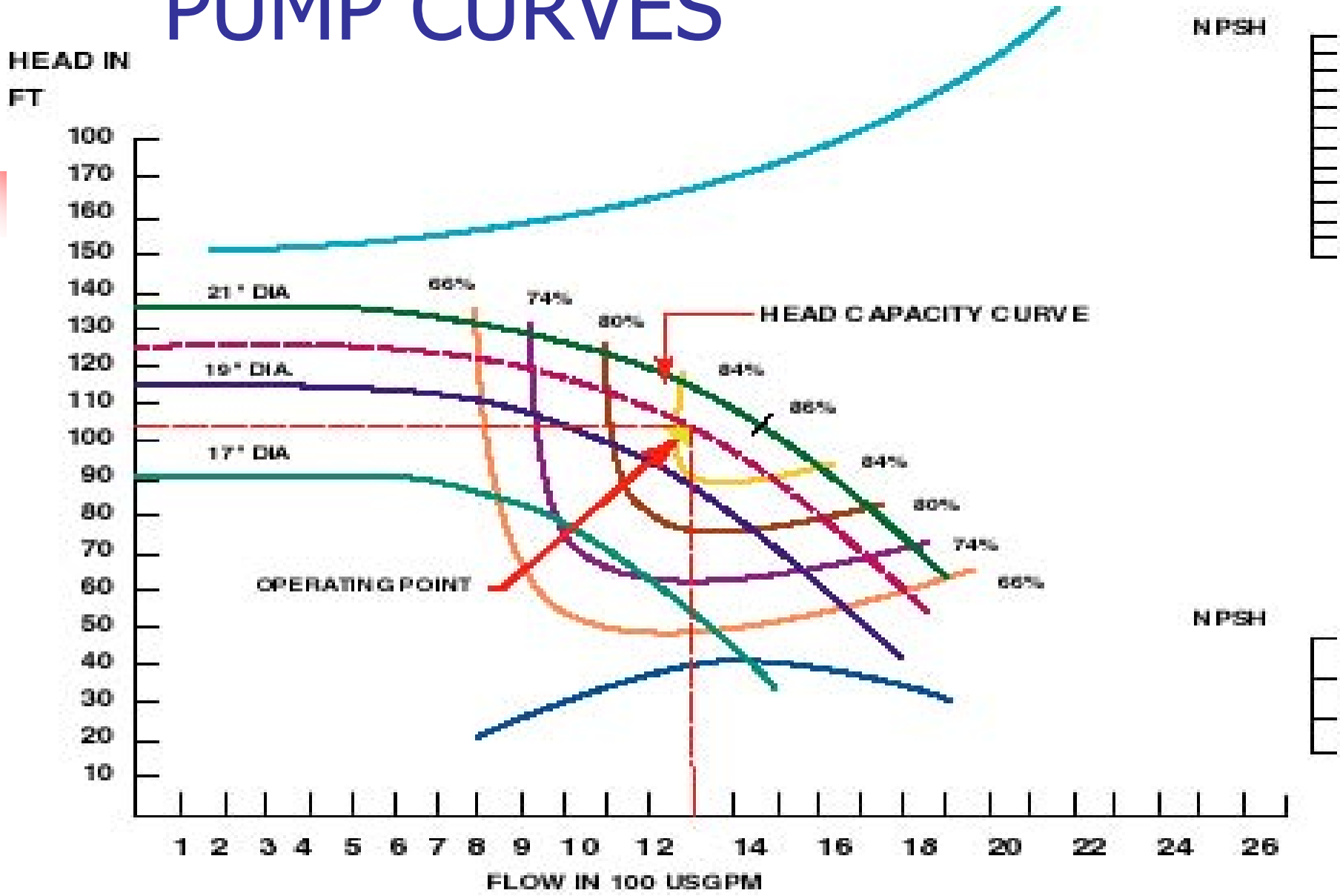
Pressure Head

- Pressure at which a pump operates against expressed as feet of head or head feet
- Total static= static discharge head - the static suction head
- Static suction head is the height of the water above the suction inlet & is the pressure created by elevation or depth
- When calculating total dynamic head, static discharge head is part of the equation.
- The total operating head is the vertical distance of pumped water along with all other head losses

Pump Curves

- Generally show capacity (flow rate), total head, power (brake horsepower), and efficiency
- The pressure at which a pump operates against is head pressure

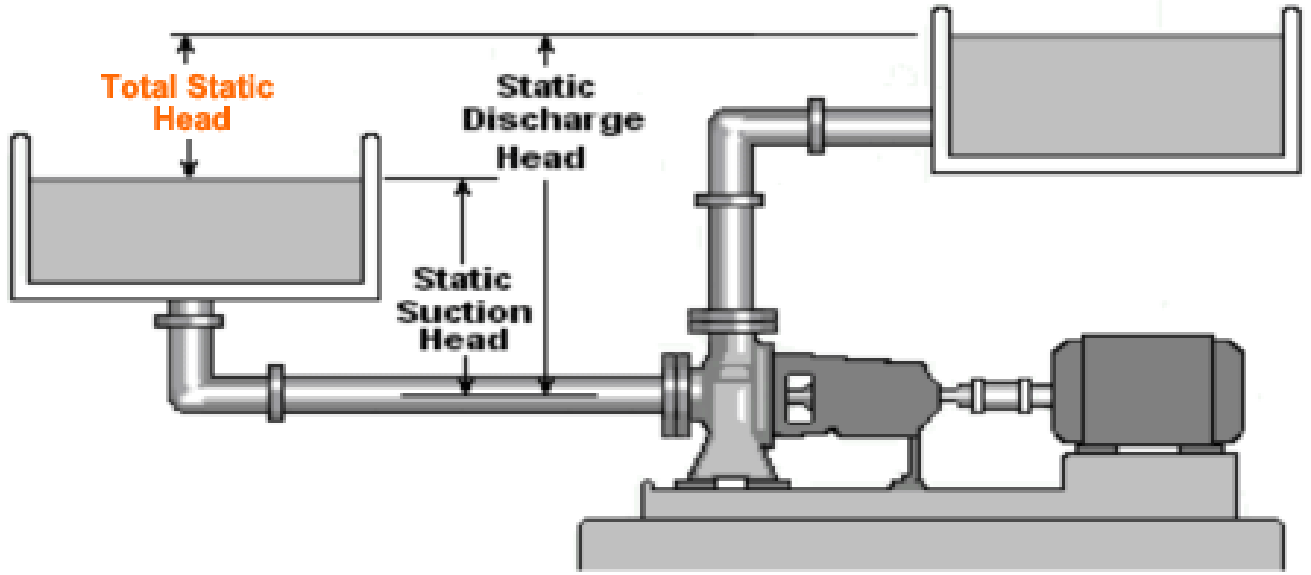
PUMP CURVES

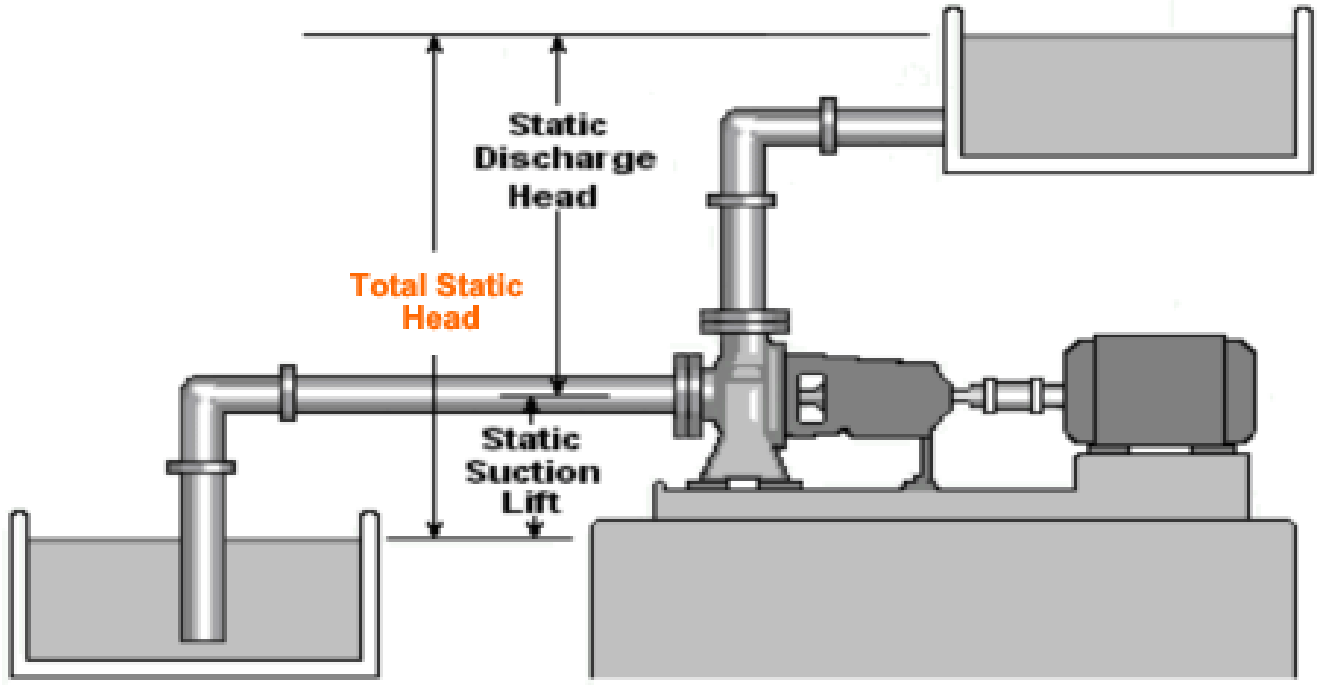


The pressure at which a pump operates against is head pressure

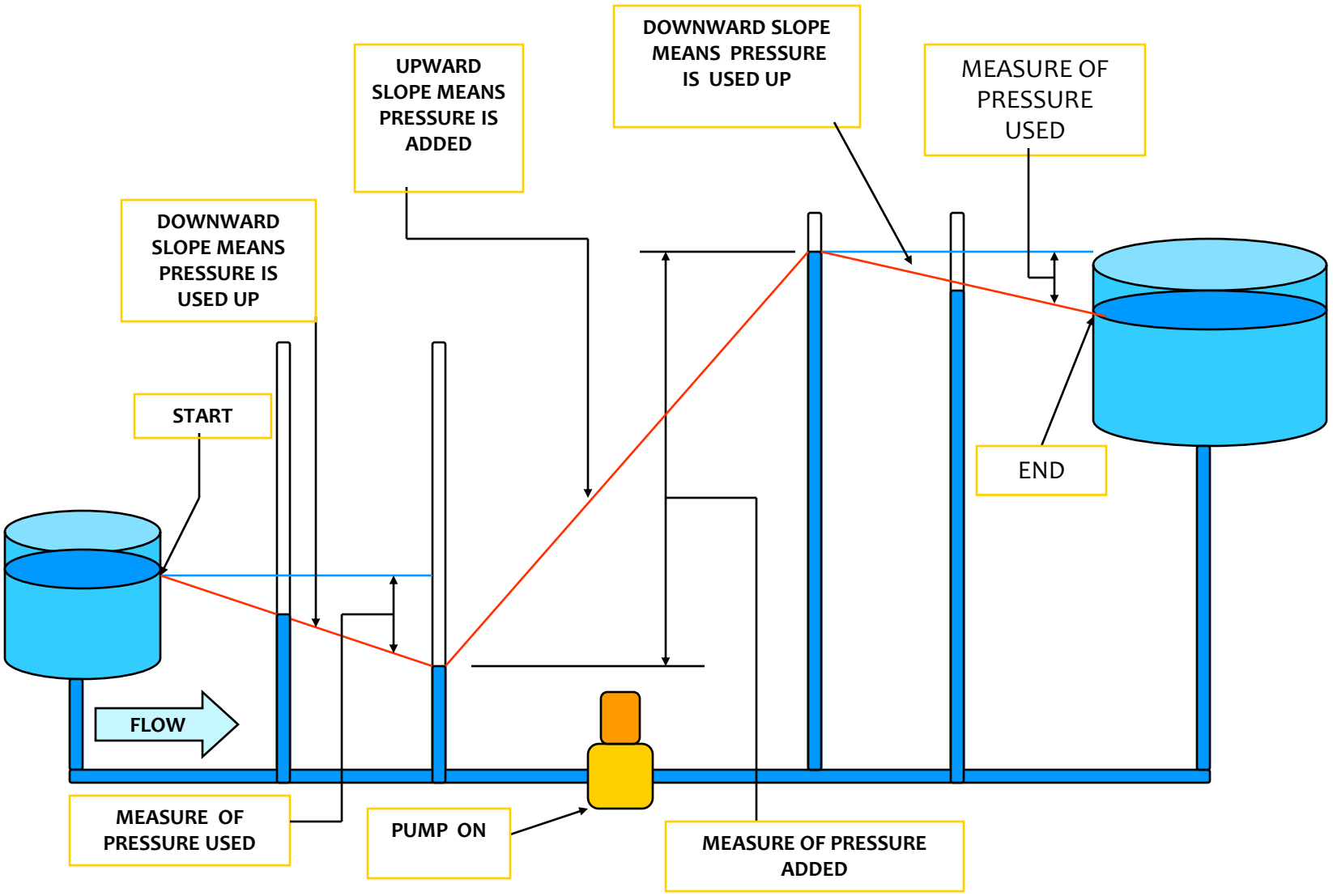
Flooded & Lift

- Suction lift is the water level on the inlet side of the pump that is lower than the pump
- Suction lift should be limited to 15 feet
- Flooded means the pump has either an elevation of head feet or water system pressure to operate with

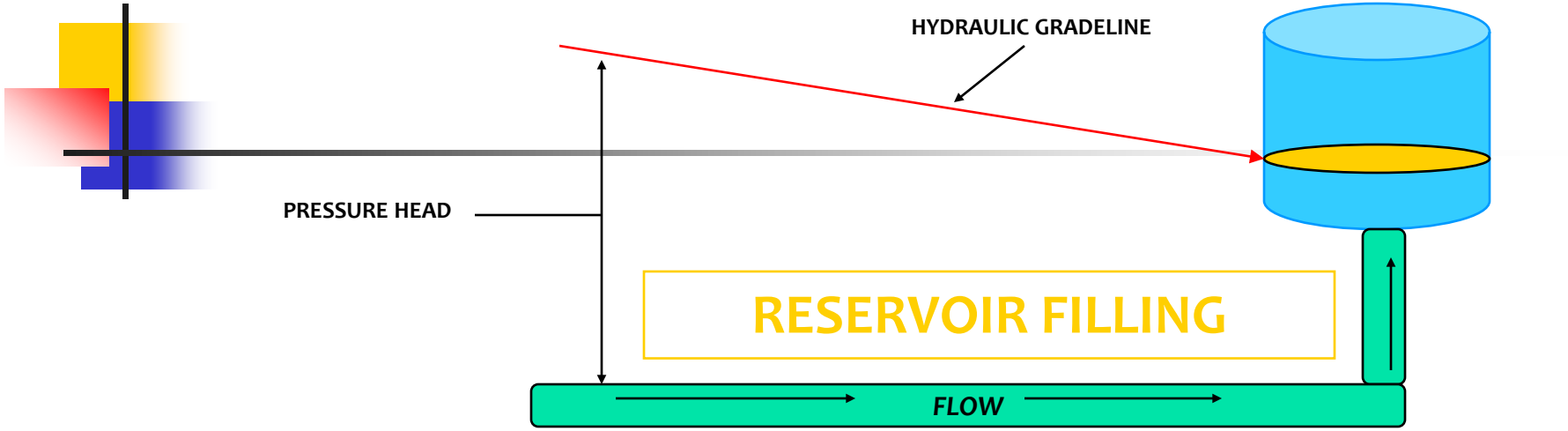

Total Static Head
Static Discharge Head
Static Suction Head

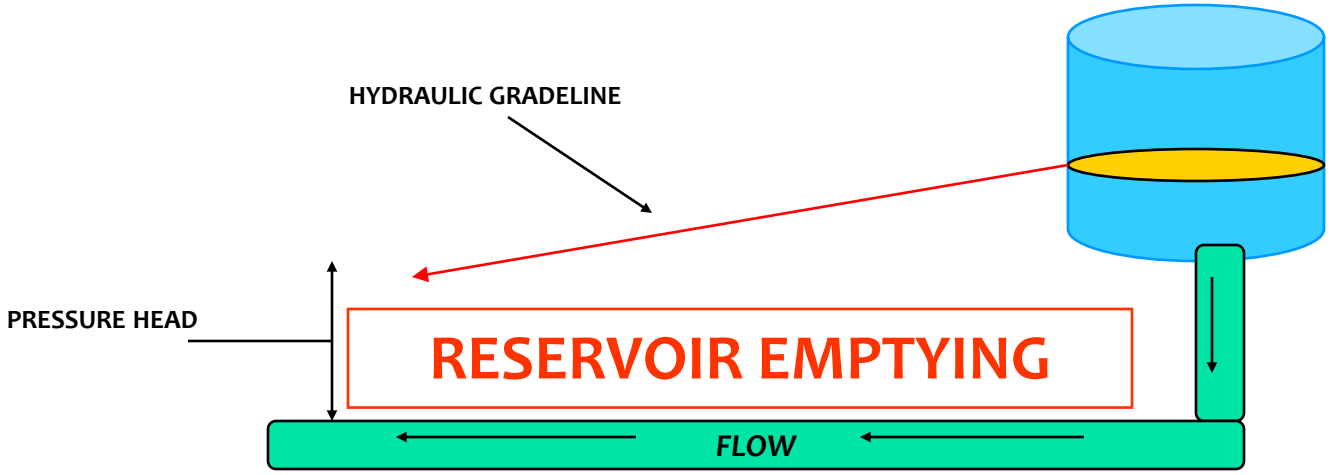

Static Discharge Head
Total Static Head
Static Suction Lift

Hydraulic Gradient



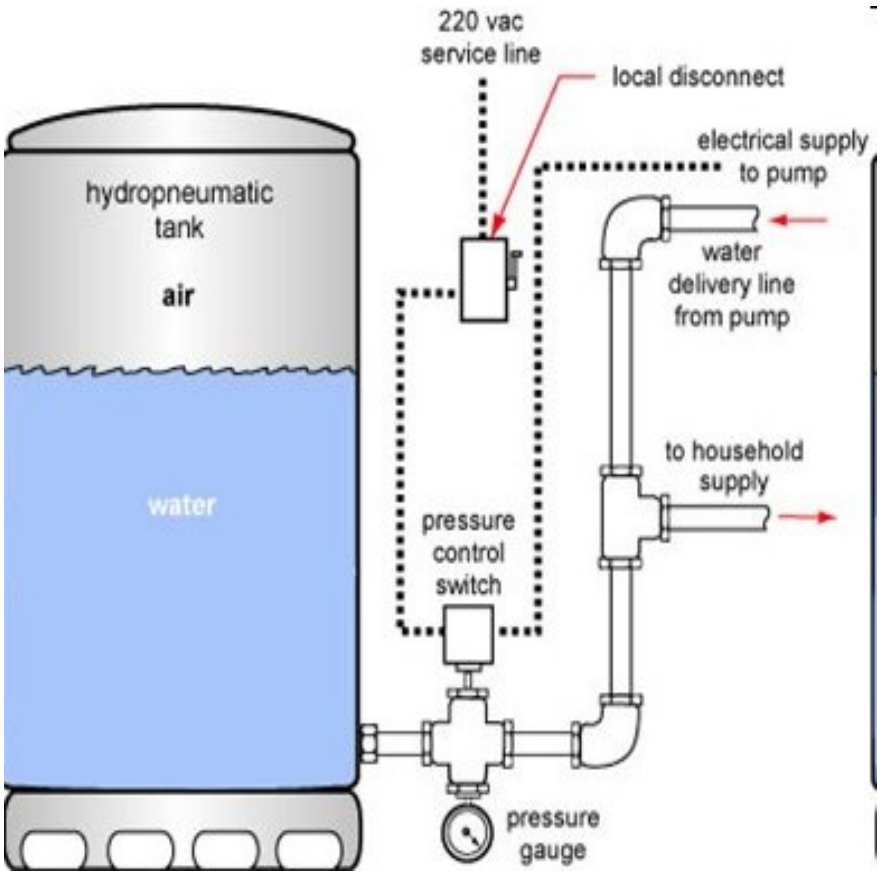
TANK GRADELINES





HYDROPNEUMATIC TANKS

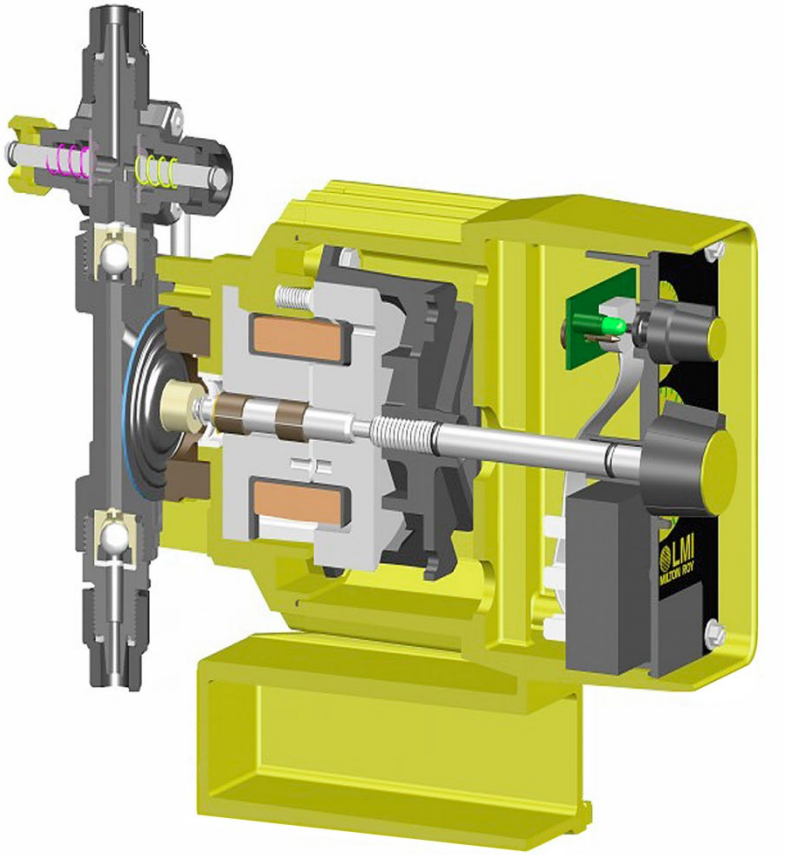
- Operate by applying air pressure to tank
- Tank levels controlled by pressure switches to pumps
- Air leaks can cause pumps to cycle on and off
- 1/3 to 2/3 air to water ratio limiting storage capacity



Positive Displacement Pumps

Positive Displacement

- Suction and discharge valves must be open all the way
- Used mainly for chemical dosing
- Not velocity-type pumps



Peristaltic Pumps

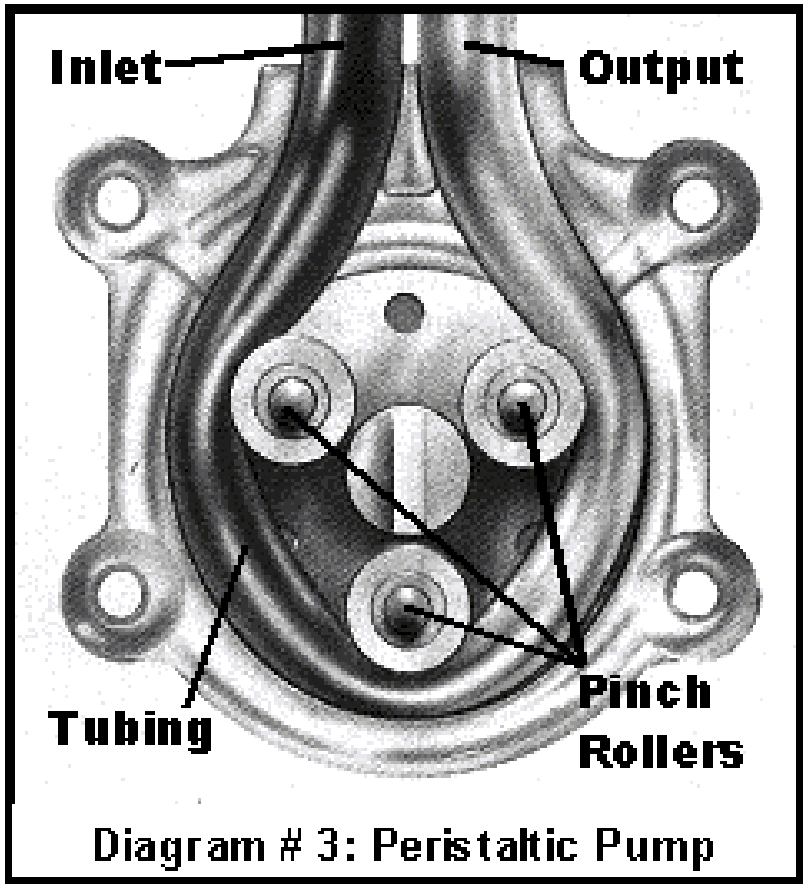
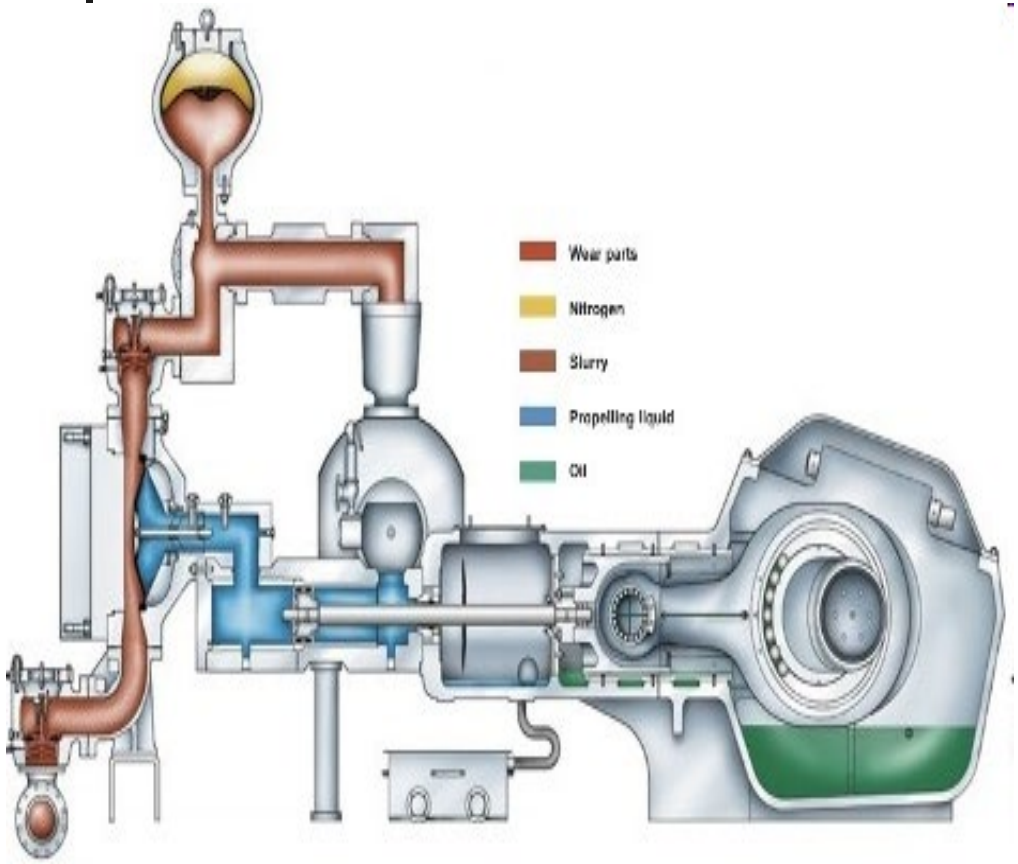
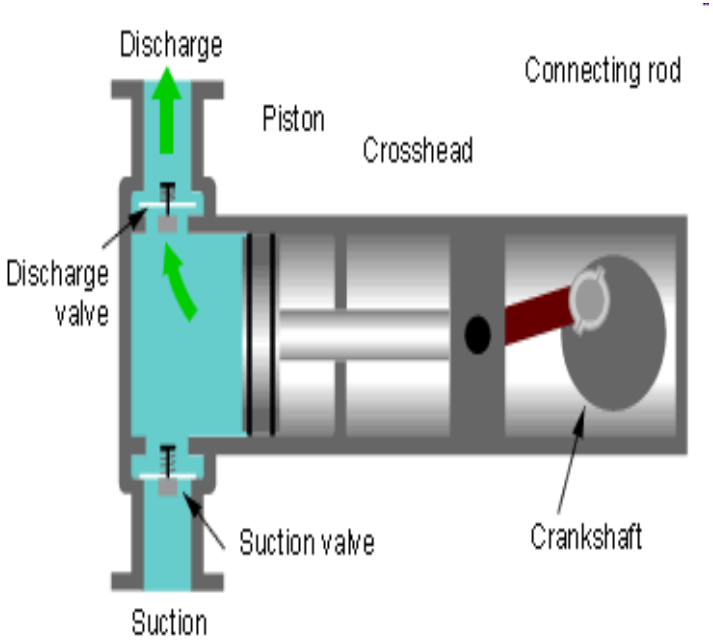


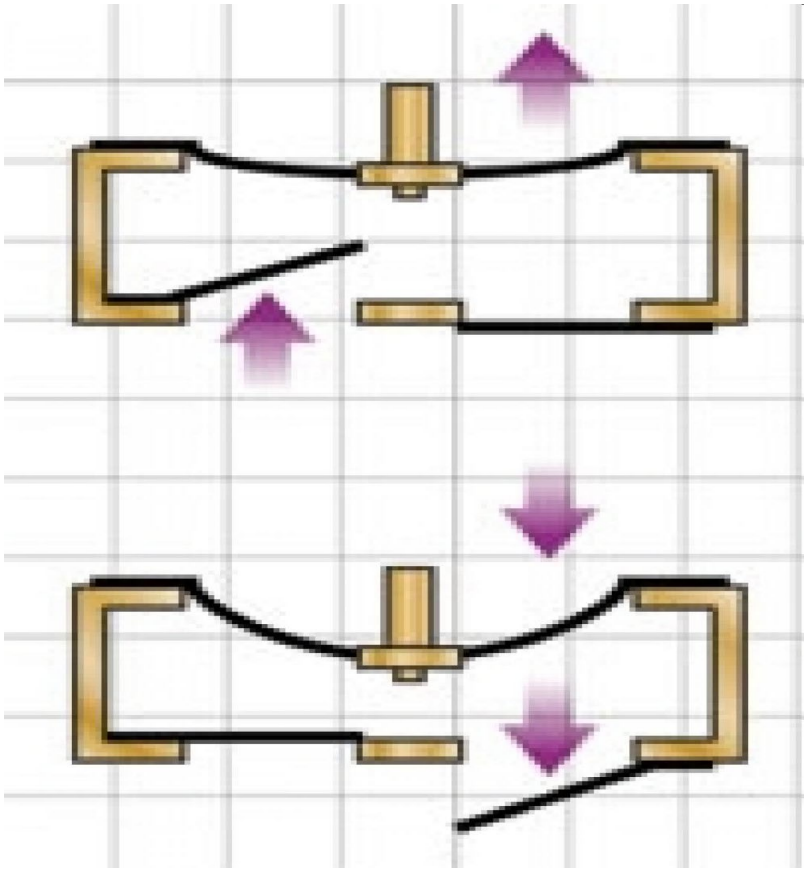
Diagram # 3: Peristaltic Pump

PISTON PUMP


Wear parts
Nitrogen
Slurry
Propelling liquid
Oil


Discharge
Connecting rod
Piston
Crosshead
Discharge valve
Suction valve
Crankshaft
Suction

Bilge Pump



Diaphragm Pump

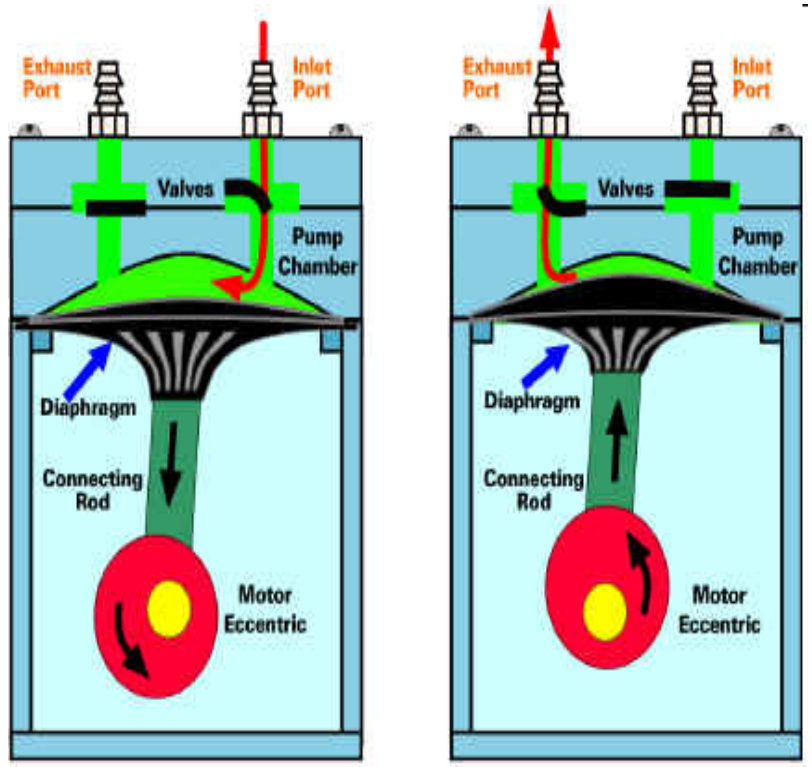
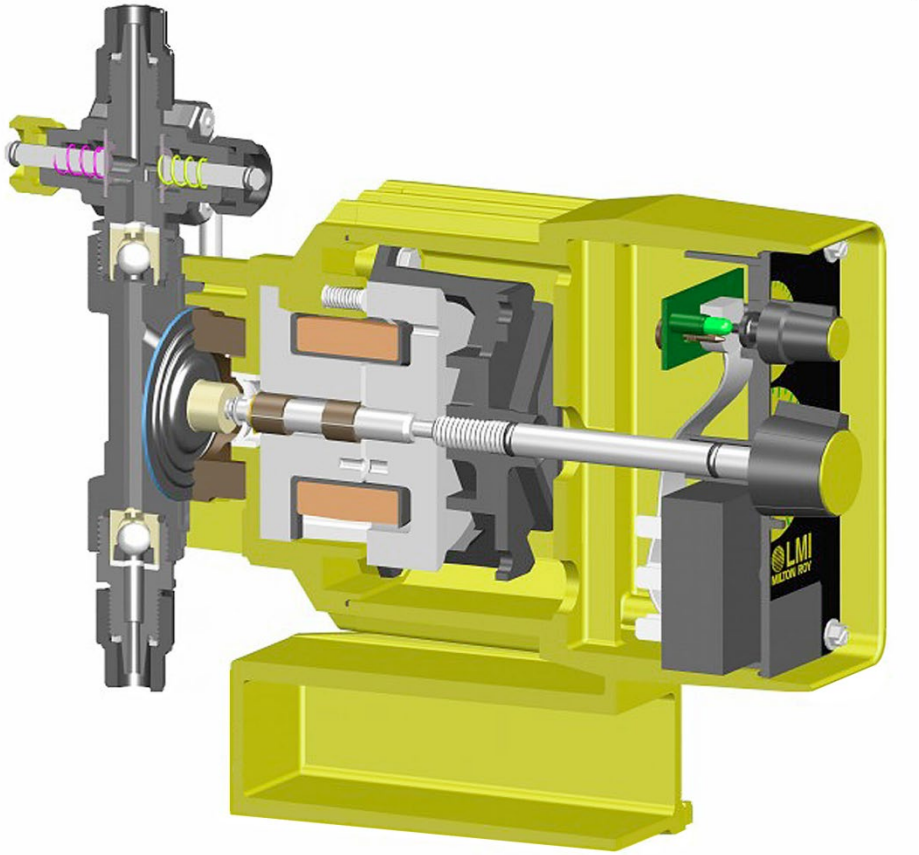
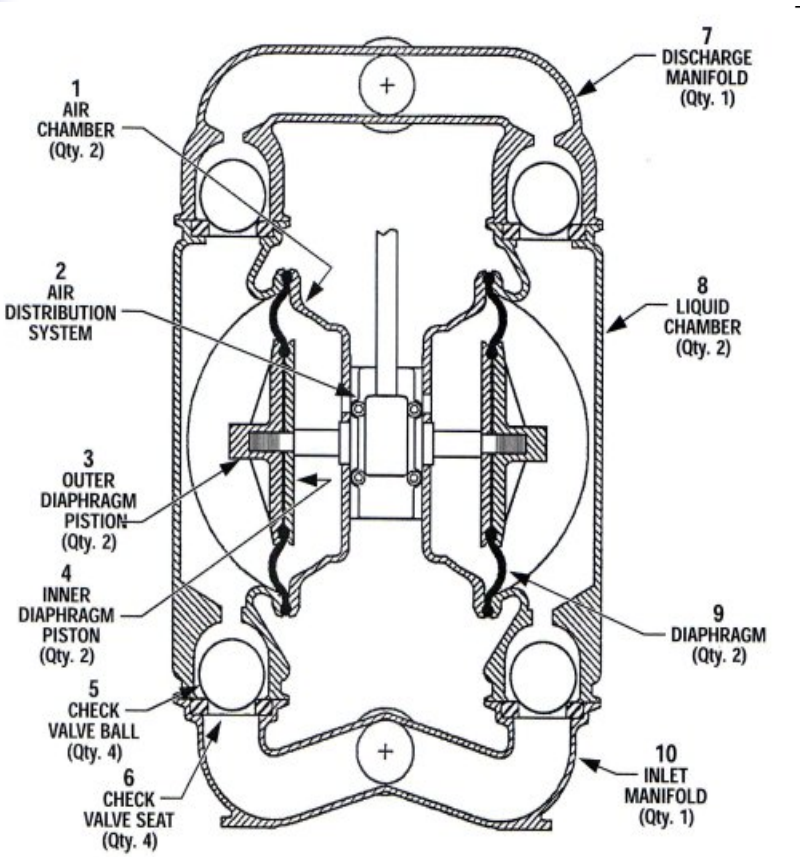


Figure 1 Operation of a liquid diaphragm pump.

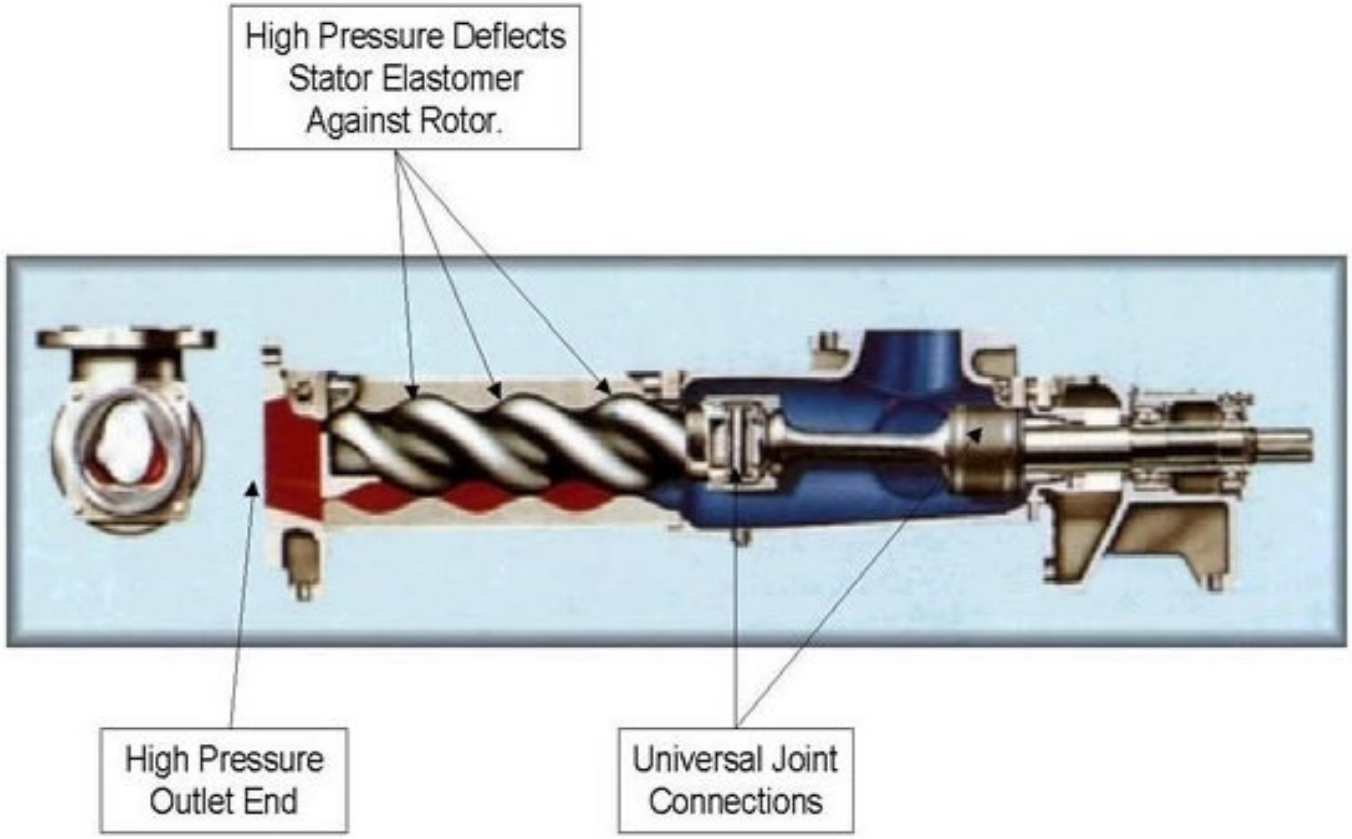


Double Diaphragm Pump



Screw Pump

Progressive Cavity



Rotary Lobe Pump