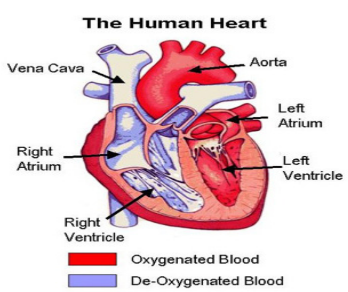
Pumps & Motors

Pre-certification

Archimedes Pump

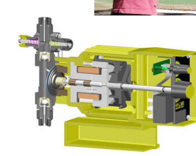
- **First invented by Archimedes of Syracuse (287 BC – 212 BC)**
- **Called the Egyptian Screw**
- **Used to pull water from the Nile River to irrigate the Nile Delta.**

Human Heart



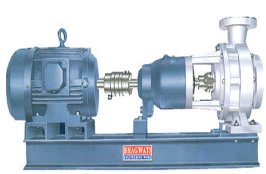
Pump Classes

- 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



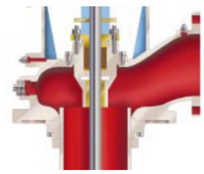
Close Coupled Pumps

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

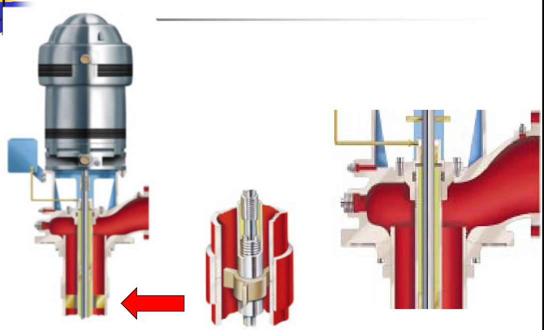
Vertical Lineshaft Pumps

- Lineshaft Turbine
- Can Turbine
- Submersible
- Axial Flow

Lineshaft Turbine- Water Lube

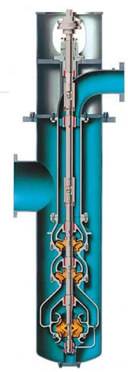


Lineshaft Turbine- Oil Lube

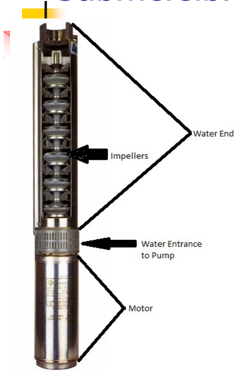


Can Turbine

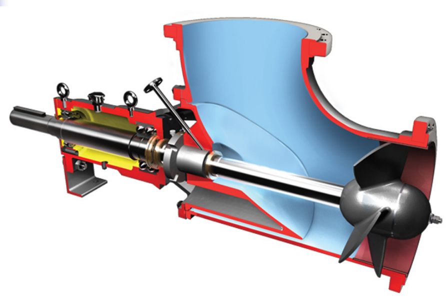
- Operates in flooded suction or pressure condition



Submersible

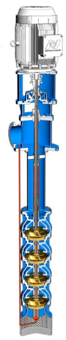


Axial Pumps



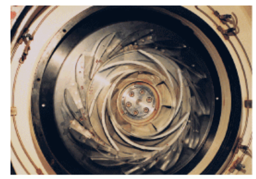
Bowls

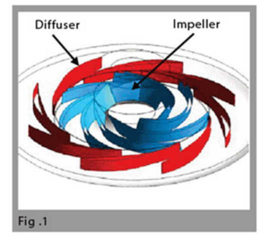
- Impellers Located in Bowls
- Multi-stage – bowls add pressure not volume
- Flow is restricted to the size of the bowl



Diffuser Vanes

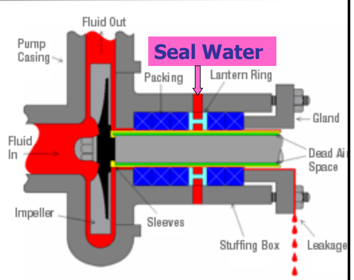
- Diffuser vanes convert velocity to pressure





STUFFING BOX

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



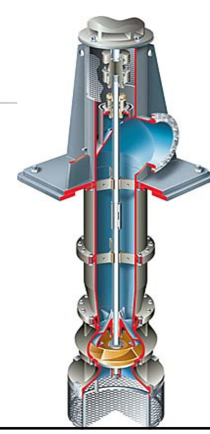
External Seal Water

- 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.

Positive Displacement Pumps

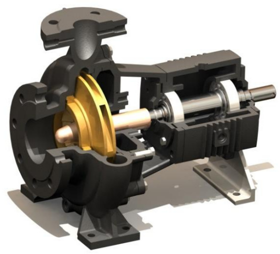
Impellers

- Vertical Pump Location



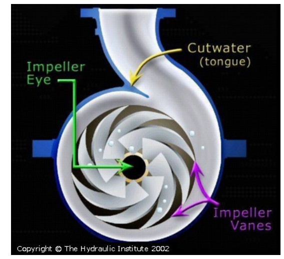
Impellers

- Horizontal Position



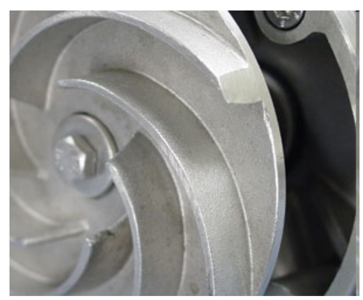
Impellers

- 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



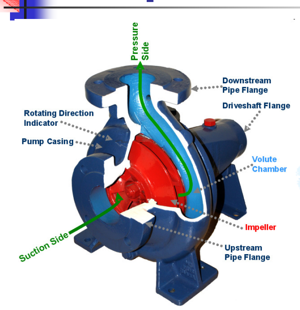
Open Impellers

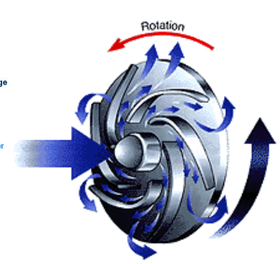
Semi-Open Impeller



Closed Impeller

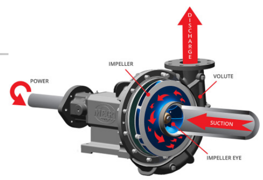
Pump Rotation

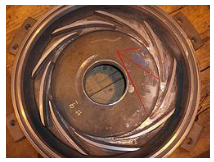




Volute Case

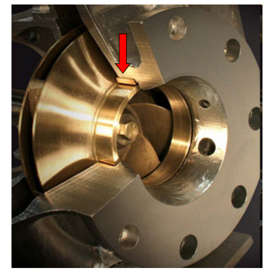
- **Houses the impeller**
- **Curved vanes inside volute case are called volutes & convert velocity energy to pressure energy.**
- **Should be primed full of water on start up**





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

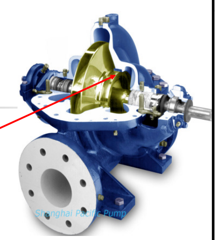


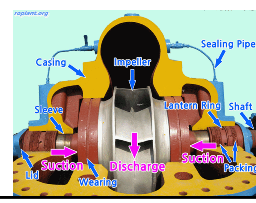
Wear Ring

- Worn out wear ring

Split Case Pump

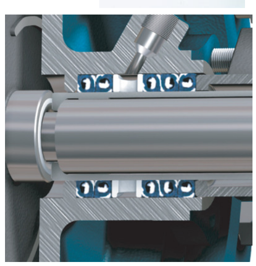
- **Wear Rings act as a restriction between the impeller discharge and suction areas.**





LANTERN RING

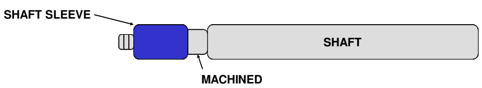
- H - shaped cross section
- Made of metal or plastic
- **Located inside the stuffing box where seal water enters**
- Not used with a mechanical seal
- Allows water to flow evenly through the packing



Seal Water

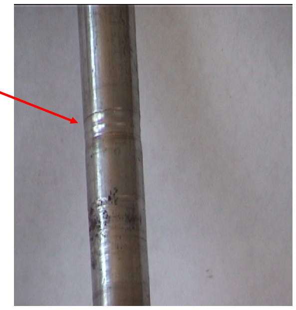
SHAFT

- 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



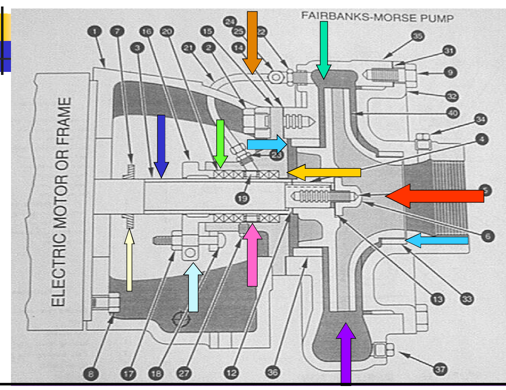
No Shaft Sleeve

- **Worn shaft that had no sleeve**



Worn Shaft Sleeves

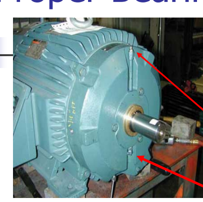
CENTRIFUGAL PUMP COMPONENTS

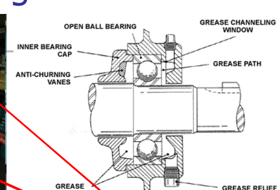


BEARINGS

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

Proper Bearing Lubrication





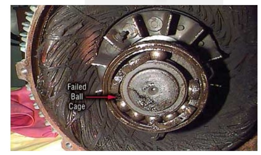
- Remove plug in grease relief port
- Press new grease into grease fitting displacing old grease
- Allow motor to run and let excess grease exit
- Replace plug in grease relief port

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.

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

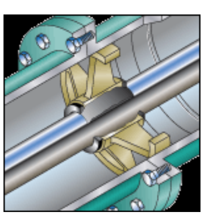
ROLLER TYPE BEARINGS

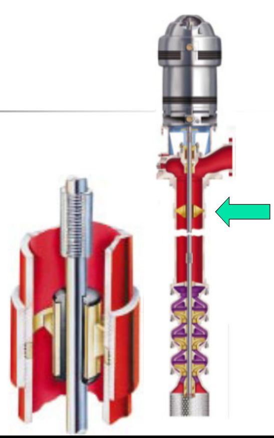
Roller Bearings

Needle Bearings

Sleeve Bearings

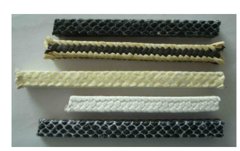
- Located in Spider

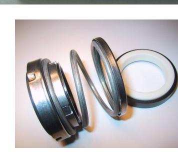




SHAFT SEALS

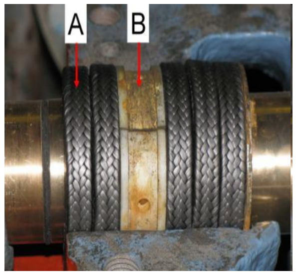
- Packing
- Mechanical seals
- Separate the wet from dry end of the pump
- Mechanical seals are for high suction head, metal packing can also be used





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

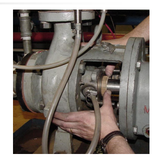
CONDITIONS	*PACKING*
Less than 100 psi or 1000 FPM	**Plant fibers lubed with Teflon, silicon, TFE, or PTFE**
100 to 150 psi or 1000 to 2000 FPM	**Graphite, acrylics, TFE, kevlar, PTFE, & carbons**
Above 150 psi or 2000 FPM	**Metal, packing with metal cores or combination of synthetics & metals.**
	Asbestos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

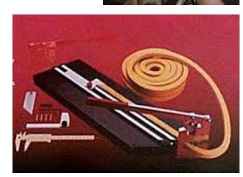
Stuffing Box

- 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

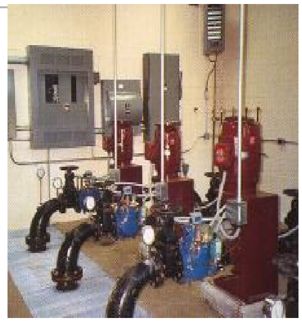
- **Located inside stuffing box**
- **Two surfaces: one is stationary and the other is rotating**
- **Stationary surface is made of a harder material than the rotating surface**
- **Spring keeps tension on the surfaces**
- **Seal components must match properly**

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

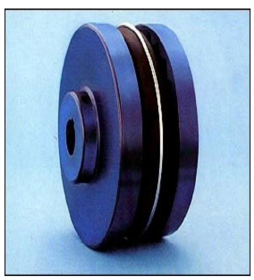


SLINGER RING

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

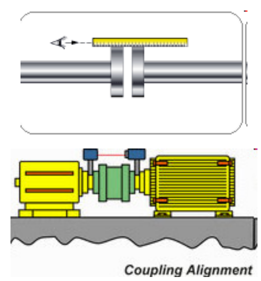
COUPLINGS

- 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



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

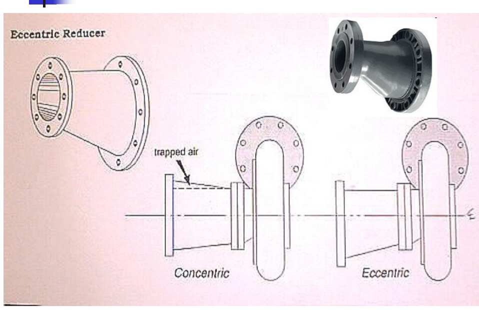
PUMP WEAR AND TEAR

- 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

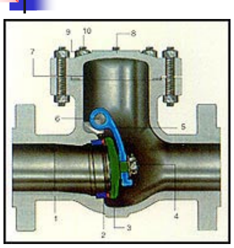
REDUCERS & INCREASERS



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

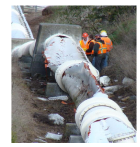
Pump Control Valves

Foot Valves

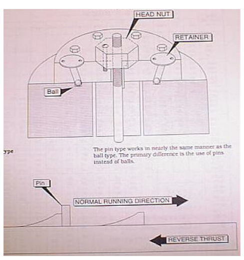
- Located at the bottom of suction pipe to hold prime

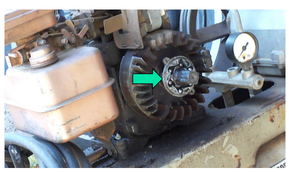
Air Vacuum Release Valves

- 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





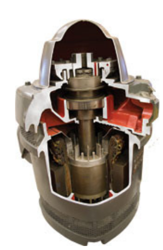
Motor Maintenance

- **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**

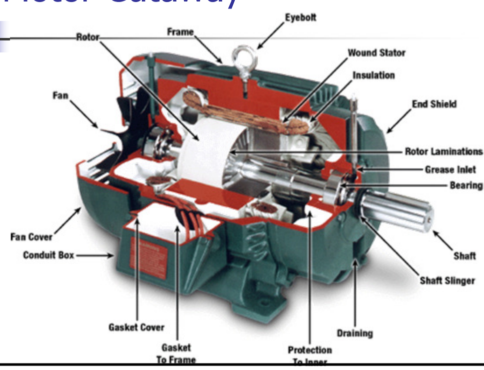
Pump Motor Operation

- 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**

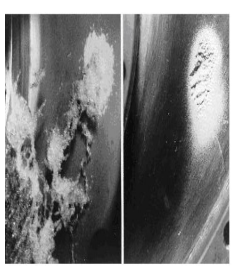
***damage could occur**

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

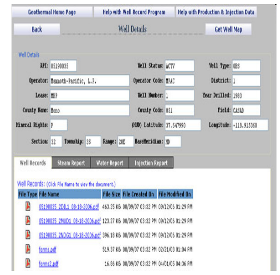
- Priming displaces the air in the volute case
- Helps the pump create suction so the pump will pump
- It also helps reduce cavitation

TROUBLESHOOTING

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

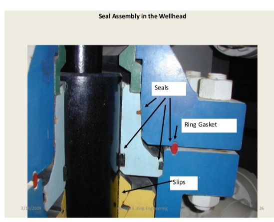
Accurate Record Keeping

- 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



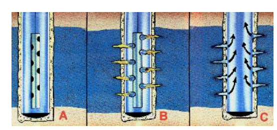
Well Seals

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



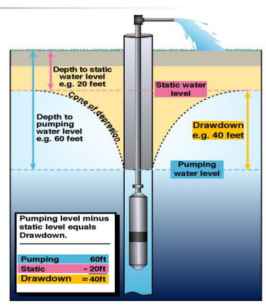
Well Casing

- 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**



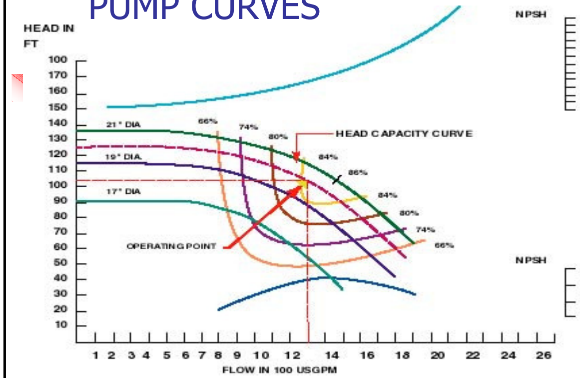
Pressure Head

- 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**

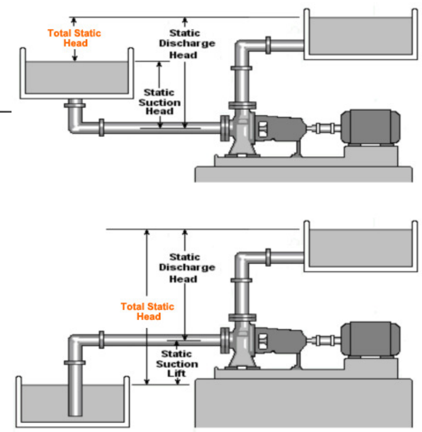
PUMP CURVES



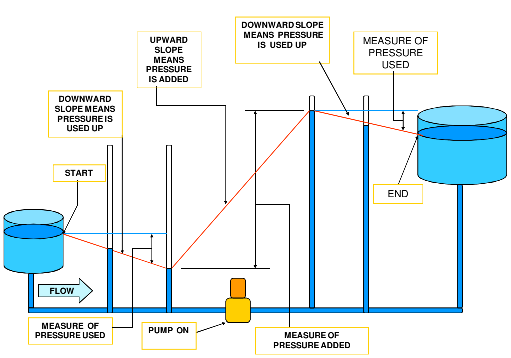
The pressure at which a pump operates against is head pressure

Flooded & Lift

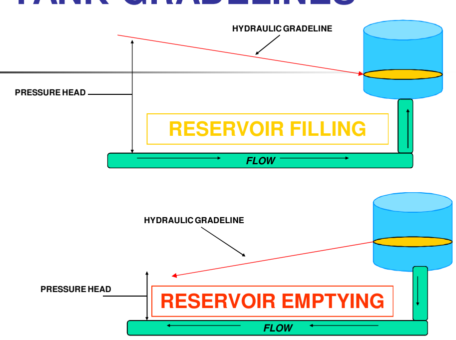
- Suction lift is the water level on the inlet side of the pump that is lower than the pump
- Suction lift should be limited to 15 feet
- Flooded means the pump has either an elevation of head feet or water system pressure to operate with



Hydraulic Gradient

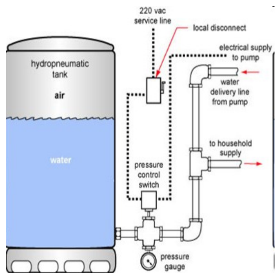


TANK GRADELINES



HYDROPNEUMATIC TANKS

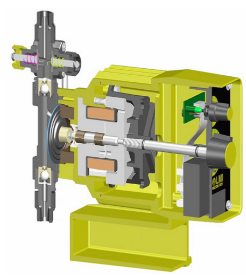
- Operate by applying air pressure to tank
- Tank levels controlled by pressure switches to pumps
- Air leaks can cause pumps to cycle on and off
- 1/3 to 2/3 air to water ratio limiting storage capacity



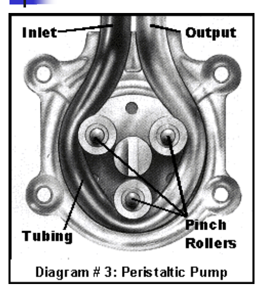
Positive Displacement Pumps

Positive Displacement

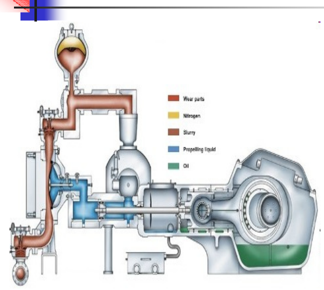
- Suction and discharge valves must be open all the way
- Used mainly for chemical dosing
- Not velocity-type pumps

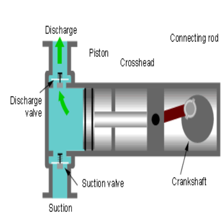


Peristaltic Pumps

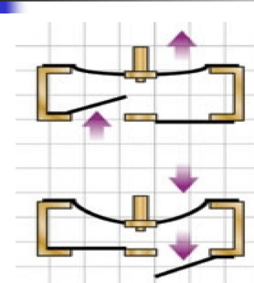


PISTON PUMP





Bilge Pump



Diaphragm Pump

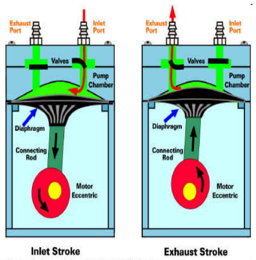
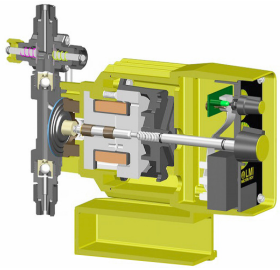
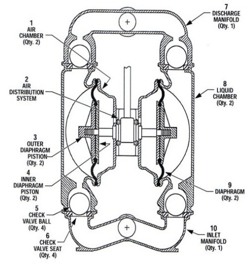


Figure 1 Operation of a liquid diaphragm pump.

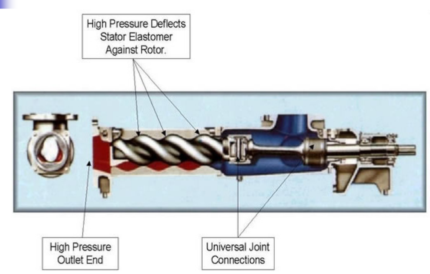


Double Diaphragm Pump



Screw Pump

Progressive Cavity



Rotary Lobe Pump