ALL-PUMPS
SALES & SERVICE

Classification Of Pumps

Turnkey Pump Solutions

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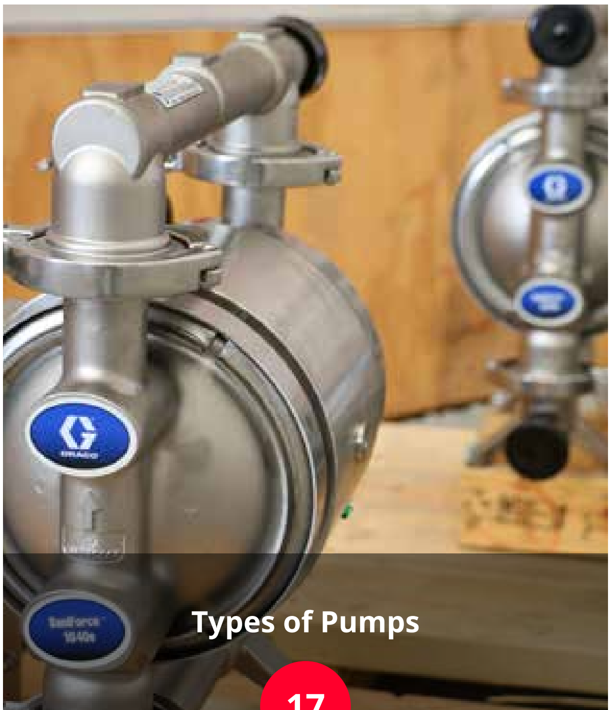
Contents



Introduction

Every industry today requires a pump somewhere in its operation. From food processing to oil wells, pumps play a critical role in the production and maintaining our standard of living. Pipes carry the fluid, but pumps supply the energy to move it. Because the piping and pumps work together, they must be thought of and designed as an integrated system. Change one part, and the system can become less efficient.

In this Beginner's Guide to Pumps, we attempt to keep the information basic and non-technical as possible. Bear in mind that pumping systems are highly technical in nature. Every length of pipe, elbow, valve, the height of the pump above or below the reservoir, fluid viscosity and inside diameters of all equipment effect the optimal discharge flow for the system.

This guide covers the short history of pumps to see how they evolved over time. We then cover the basic parts, Types of Pumps and the industries that use them. Lastly, we include some basic troubleshooting topics.

We hope that you find this guide useful. When it comes time to plan for a new pumping system or repair an existing one, you can rely on the experts at All Pumps to get the job done right the first time... every time.

Common Pump Terminology

Absolute Pressure

A pressure measurement that is the sum of the gauge pressure plus atmospheric pressure.

Belt Drive

When the pump drive is a belt and pulley instead of attached directly to a motor

Cavitation

Rapid formation and the collapse of vapour bubbles in a moving fluid in regions of low pressure.

Characteristic Curve

A graph showing the pump performance under various conditions of flow, head, power, speed and efficiency.

cPs

stands for Centipoise, a viscosity unit of measurement.

Cutwater

Located near the discharge nozzle of the centrifugal pump, this part of the casing helps to direct fluid out of the pump.

Diffuser Vane

Fixed curved vanes inside of some centrifugal pumps to convert velocity head into pressure head.

Direct Coupling

When the pump connects in line directly to the motor or driver using a coupling.

Displacement

The volume of liquid moved or displaced by a single stroke of a piston or plunger.

Driven Unit

Another name for a pump. It can move fluids by rotary or reciprocating motion.

Driving Unit

The power source that drives a pump. Typically, an internal combustion engine or electric motor. Also, known as the prime mover.

Efficiency

(pumps) Expressed as a ratio between the water horsepower output and the mechanical power input.

Entry Head

Head required to overcome frictional resistance leading into a pipe entrance.

Equivalent Length

A pressure loss due to flow through fittings and valves expressed as an equivalent straight length of the same diameter pipe.

Flooded Suction

Referred to as Positive Suction, when the reservoir is above the centreline of the pump.

Foot Valve

A non-return valve fitted at the bottom of the pump suction pipe to keep the water in the pipe when the pump is not working.

Forced Circulation

The imparting of flow motion by mechanical means (pump) to a fluid in any system circuit.

Friction Head

Entrance and exit head losses due to the friction of fluid in a pipe system including pipe skin, valves and fittings.

Gauge Pressure

The pressure above atmospheric.

Head

The vertical height measured from a datum point (centreline of the pump) to the free surface of the fluid in a system.

Pump Rating

The size of a pump based on the required flow and total head.

Pressure Gauge

An instrument used for measuring fluid pressure.

R.P.M. Curve

A curve on a graph which shows the speed of a prime mover (motor) driving the pump.

Priming

The expulsion of air by completely filling the suction pipe and pump casing with fluid.

Rate of Flow

Also called "Capacity" or "Quantity." Stated in units of volume per unit of time such as gallons per minute or GPM.

Pump Datum

The term used relating to the position of the suction and discharge, normally the centreline of the pump or "pump suction eye."

Shaft

The shaft is the part of the pump that carries energy from the motor to the impeller inside the pump casing.

Shut Off Head

Refers to a head condition at no flow.

Split Casing

A term applied to a centrifugal pump design where the pump casing is composed of two sections which are bolted together.

Static Suction Head

The vertical distance between the centreline of a pump and the pumped liquid level.

Stuffing Box

The stuffing box houses a seal or packing to help prevent leakage from where the shaft enters the pump casing.

Suction Lift

A condition where the reservoir is below the centreline of the pump.

Throttle

When the flow of fluid is reduced or controlled by a regulating device such as a globe valve.

Total Equivalent Length

The length of the longest circuit of pipe through which a fluid is pumped plus the length equivalent to the resistance offered by the fittings and valves.

Total Delivery Head

The sum of the static delivery head and friction head in the discharge pipe and fittings.

Total Suction Lift

The sum of static suction lift and friction head in the suction pipe and fittings.

Total Head

The sum of the total suction head and total delivery head in a pumping circuit, otherwise known as Total Dynamic Head.

Vane

Refers to impeller vanes that accelerate the fluid outward from the suction eye, and up to the discharge nozzle of the pump.

Velocity Head

Kinetic energy due to directional travel due to the height through which a fluid must fall to obtain a given velocity.

Veloute Casing

A whirling fluid formed in an area of low pressure or cavity at the centre of a rapidly spinning fluid resembling a whirlpool.

Water Hammer

A pressure that results from a sudden arresting of the velocity of a flow of fluid in a closed circuit.

Breif History Of Pumps

The World's first "Pump" is the Shadoof

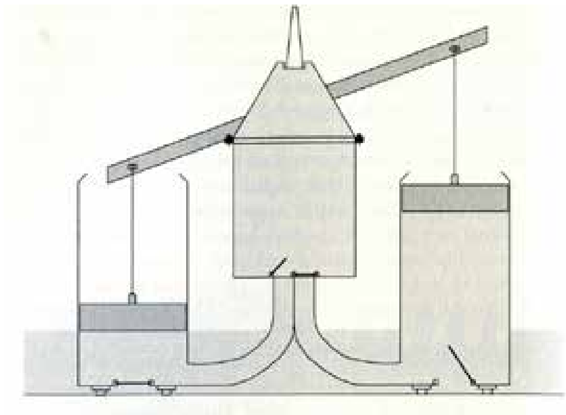
2000 B.C. – The shadoof or shaduf is the first manual water pump invented by the Egyptians, consisting of a bucket suspended by a rope at one end of a long pole.

The Waterwheel Lifts Water at a Constant Rate

Circa 600 – 700 B.C. – The Romans invented the Egyptian waterwheel or Noria. It was the first vertical (Horizontal axis) waterwheel and consists of a wooden wheel fitted with buckets.

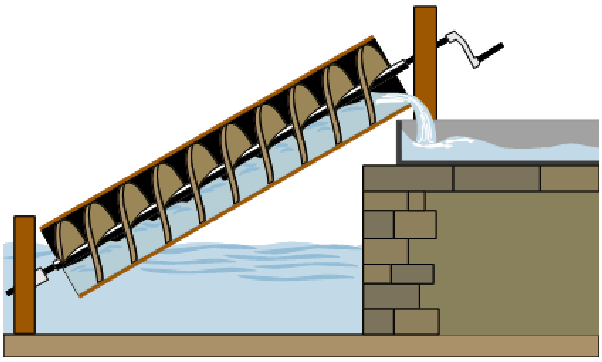
The first Piston Pump

222 B.C. – A Greek inventor. Ctesibius or Ktesibios creates the piston water pump.



The Archimedean Screw is the First Screw Pump

Around 230 B.C. – Archimdes of Syracuse, Greece invents the Archimedean Screw Pump.



Pump Technology from the 1400's to 1700

1475 – Believed to be the first mention of a centrifugal pump.
1588 – Italian Agostino Ramelli describes what is thought to be the first sliding vane pump.
1593 – Frenchman Nicolas Grollier de Seviere creates the first gear pump.
1636 – German, Pappenheim invents the double deep-toothed rotary gear pump.
1654 – The first vacuum piston pump was invented by a German physicist.
1675 – Englishman Sir Samuel Moreland, patents the packed plunger pump, or positive displacement pump.
1687 – French-born inventor Denis Papin is credited with developing the first true centrifugal pump, one with straight vanes used for draining a local canal.

Pump Technology improves during the 1700's through the 1900's

1738 – Daniel Bernoulii creates a principle of fluid dynamics, known as "Bernoulli's Principle"
1782 – James Watt, invents of the connecting rod-crank mechanism on steam piston pumps.
1818 – First practical centrifugal pump called the Massachusetts pump, built in the U.S.
1849 – Centrifugal pump improved by the addition of curved vanes.
1859 – American, Henry Rossiter Worthington patented the duplex steam pump.
1868 – Stork Pompen of Hengelo, Netherlands creates the first concrete volute pump.
1885 – First fuel pump went into service in Fort Wayne, Indiana, USA.
1930 – Rene Mnieneau's thesis leads to the invention of the first progressing cavity pump.
1947 – First submersible pump is developed by Sixten Englesson in Sweden.
1955 – Franz Klaus introduces the first magnetic drive pump.

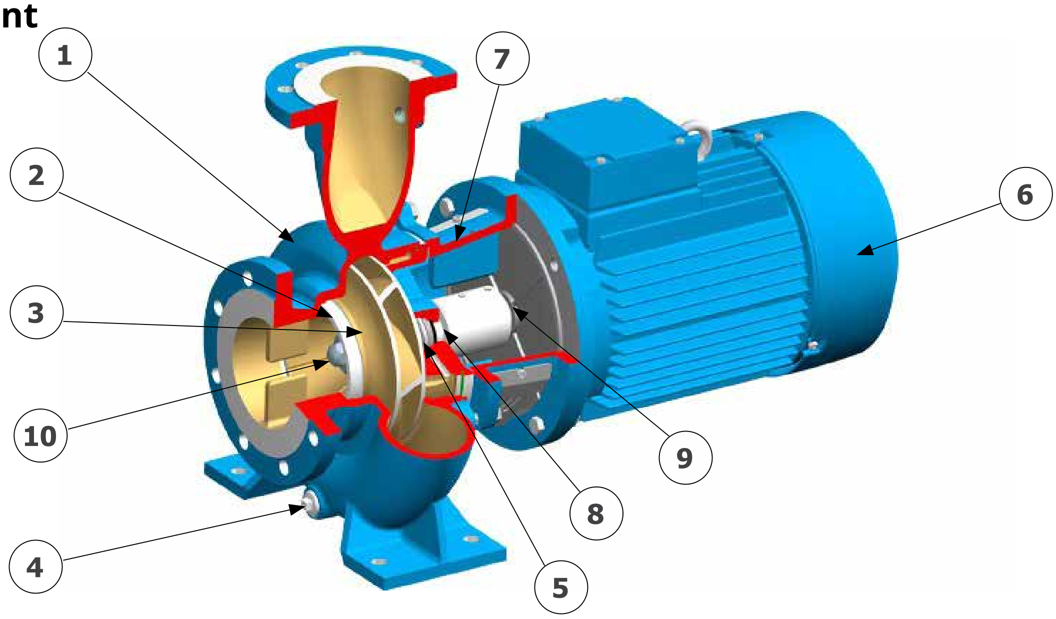
How Pumps Work

Pumps work by creating a vacuum in which ambient air pressure forces the liquid. All pumps work by creating areas of low pressure. In a centrifugal pump, centrifugal force accelerates the water to the outside of the impeller creating a low pressure at the eye or centre of the impeller.

With reciprocating pumps, the upstroke of the plunger or piston creates a vacuum. In gear pumps or lobe pumps, as the teeth or lobes mesh then come apart, a vacuum is created. The difference in pressure creates suction. A liquid under higher pressure will move to an area of lower pressure.

General Arrangement

Parts	
#	Description
1	Volute Casing
2	Wear Ring
3	Impeller
4	Screw Plug
5	Mechanical Seal
6	IEC Standard Motor
7	Adapter
8	Slinger
9	Shaft
10	Impeller Nut



Pressure Terminology for Pumps

Atmospheric Pressure

At sea level, air pressure exerts a pressure of 14.7 psi all around us. By placing one end of a tube in water and applying a perfect vacuum to the other end, that 14.7 psi could hold a column of water 33.9 feet high. However, this is only attainable at sea level and with a perfect vacuum.

Centrifugal pumps can lift water no more than 26 feet at sea level because the pressure drops off approximately 2 feet for each 1000 feet of altitude above sea level.

Head – Head refers to the height at which a pump can raise a fluid and can be calculated from H (metres)= pressure in kPa/ (9.8 x specific gravity).

Static Suction Head – The vertical distance between the centre line of a pump and the level to which the liquid is pumped.

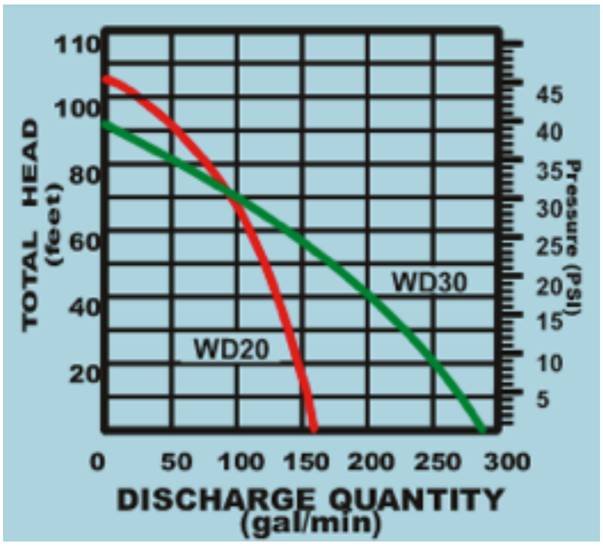
Suction Lift – The distance between the level of the where the liquid enters the suction line to the height of the centre line of the pump when the pump is higher than the reservoir.

Vacuum – Defined as any pressure lower than atmospheric. Each pump creates a vacuum into which fluids flow under atmospheric pressure.

Pumps create low pressure or suction in a variety of ways and define the type of pump. Pumps that rotate use centrifugal force to accelerate the fluid, creating low pressure in the centre of the impeller. Positive displacement pumps use plungers, pistons or diaphragms to displace water and create a vacuum using a linear reciprocating motion of a piston moving in and out of a cylinder.

Pump Performance

Pumps have strict tolerances and precise conditions under which they must operate to generate the Best Efficiency Point or BEP. Every pump has a chart showing the performance curves and how to attain the BEP. Pump manufacturers calculate performance curves with a pressure gauge and a flow meter connected to the discharge port to find the optimal configurations of piping, type of fluid and head. The discharge capacity can be calculated for any head.



Considerations for BEP

Pump performance factors include:

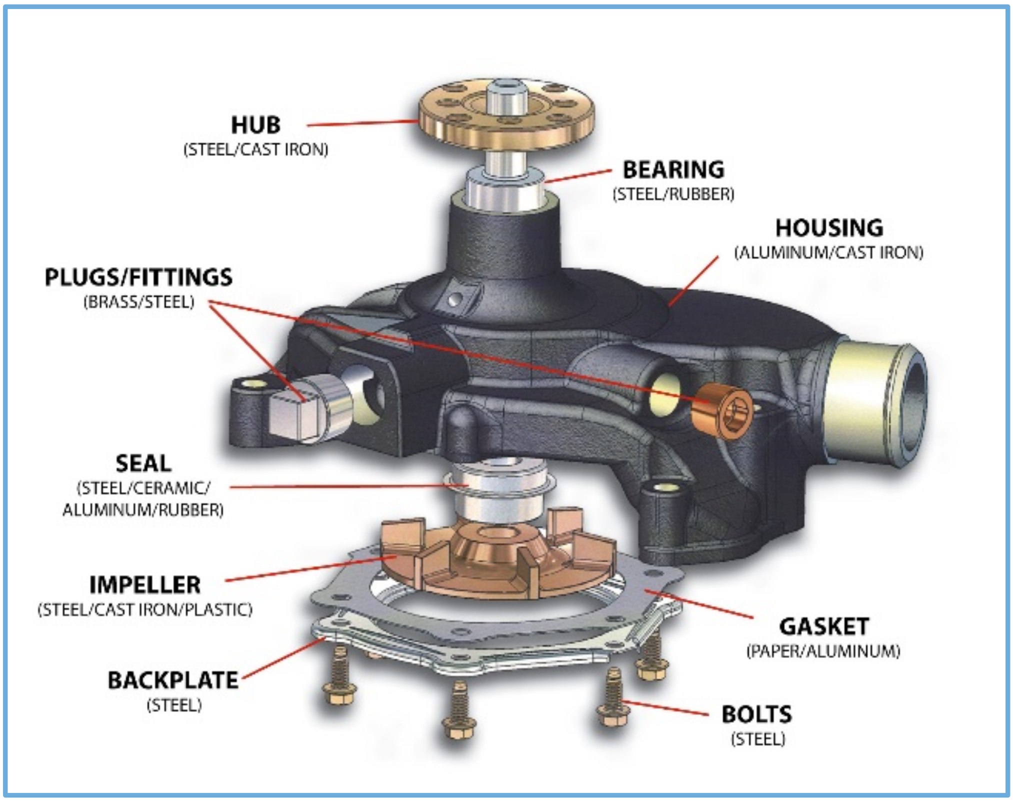
- How high the pump will sit above the water source (static suction head).
- How high the discharge end is above the pump (static discharge head)
- Determine what the discharge capacity at gallons per minute (GPM).
- Friction losses to fluid viscosity, type and length of hose or pipe.
- Altitude above sea level where the pump will operate.
- Discharge Head or height of the discharge above the pump.
- Restrictions, couplers, elbows and valves.

As you can see, there are several forces acting upon a pump that directly affects its performance. Each force has a mathematical calculation that helps define the BEP for each pump. Consider a manufacturer's performance curves to be your mathematical cheat sheet for helping you select and properly install the right pump for your application.

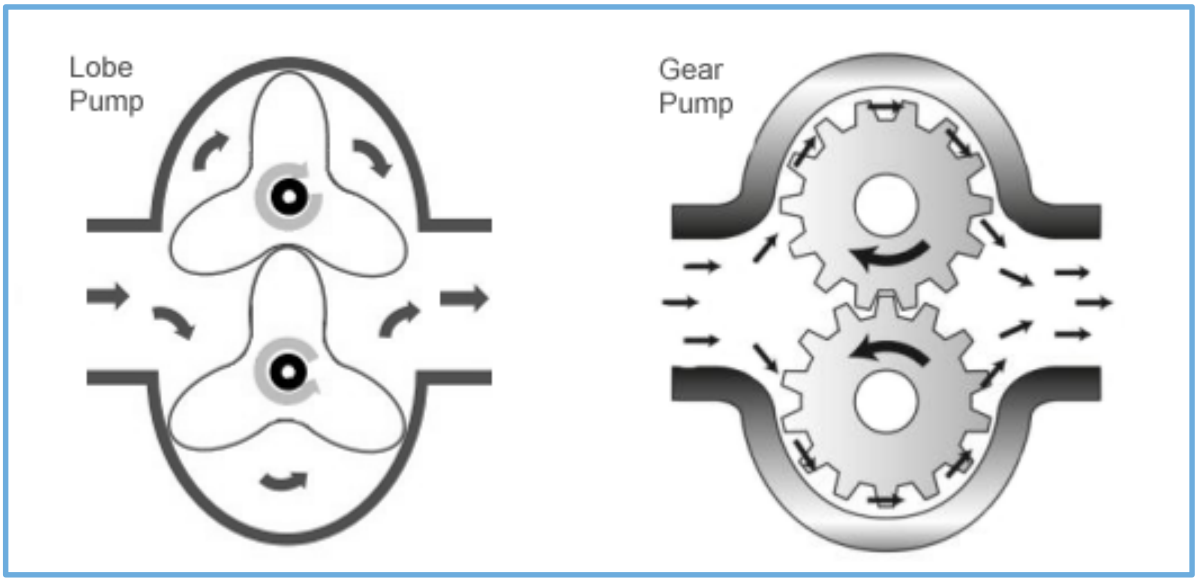
Basic Parts of Pumps

Although pumps come in all shapes, sizes and configurations, most pumps contain five basic components:

- **The Casing** – this is the outer shell or housing that encases the pump.
- **Fluid Displacement Device** – The two main ways of moving fluid are centrifugal and positive displacement. In centrifugal pumps, impellers are the rotating discs with fins or vanes attached. They spin rapidly accelerating the fluid outwards to the discharge port. Positive displacement pumps use different types of pistons, gears, lobes or screws to pump fluids.
- **Bearings** – a mechanical support that allows continuous rotation of the impeller, reduce the rotational friction and support the loads in other pump assemblies.
- **The Hub** – the central part of a wheel attached to the bearing assembly. It is the source of power for impeller rotation in centrifugal pumps.
- **The Seal** – protects the bearing assembly from excess grease loss and contamination. Seals also keep fluids inside the pump from leaking while allowing the shaft to spin or reciprocate depending upon the pump.



Centrifugal
Water Pump
Components



Positive Displacement
Water Pump
Components

Industries and Applications for Pumps

We find pumps in every area of our modern lives. They are essential equipment for manufacturing the goods we take for granted. From running water to the box of cereal on the table, they all require pumps as part of the process.

Four general industries that rely on pumps are:

- Industrial
- Mining, Oil & Gas
- Building and Construction
- Food Manufacturing

Within each industry, there are many variations of pumps depending upon the amount and type of fluid they move. Let's look at some examples for each industry.

Industrial

Industrial pumps are typically part of an assembly process. These pumps move liquids from a storage tank to be mixed with other components like a chemical process or directly applied to a part such as paint.

Industrial pumps must be built to withstand highly corrosive or volatile chemicals, extremely high or low temperatures, high pressure and constant use. Pump materials and construction vary depending upon the liquids they handle and their environment.

Pumps used for industrial purposes include both centrifugal pumps and positive displacement pumps.

Mining, Oil & Gas

Most mining operations are always battling rising water from underground sources. Mining pumps must be durable enough to pump not only water but mud and rocks that get sucked into the intake. These pumps are "Trash" or "Slurry" pumps built to let small stones pass through the pump without damaging the impeller.

The oil and gas industry uses a variety of pumps due to the different densities of fluids such as crude oil, distillates, gas and slurries. In drilling operations, cement or mud is pumped around the well casing to hold the pipe in place and seal the well. Crude oil is typically high viscosity and very hot when pumped to the surface. Along with the oil is a variety of corrosive and toxic gasses such as H2S or Hydrogen Sulphide. The gas must be separated and pumped to a holding tank or pumped to a flare boom where it is released and burned. H2S will corrode iron aggressively, so these pumps are made of other materials.

Slurry Pump

Building and Construction

If you live or work in a building higher than two storeys, you can thank a pump for the water pressure. Every tall building uses pumps to push water to the top and to pressurize fire water systems. Pumps also move sewage water to the central sewer lines.

Food Manufacturing

Every bottle of sauce or oil found in a grocery store requires a food-grade pump for production and packaging. Food manufacturing facilities require pumps for most processes. For example, in fresh vegetable production, the cut vegetables undergo sanitisation by pumping through a chlorinated closed flume system.

The canning industry requires pumps that handle live steam and boiling liquids such as soup and stews. For buildings handling frozen food, cryogenic pumps handle liquid nitrogen or other pressurized gas at below freezing temperatures.

Pumps in the food industry are not limited to liquids. They must move powders, granulated solids, whole grains and finished cereals all without damaging the products.

Examples of Food Grade Pumps

Types of Pumps

Basic Pump Configurations

Pumps are categorized by the way they move the fluid, and the two main categories are Rotodynamic and Positive Displacement.

Rotodynamic pumps use centrifugal force to move liquids and are commonly called Centrifugal pumps. Positive Displacement pumps displace a known quantity of liquid with each revolution of the pumping elements and have two major sub-categories, Reciprocating and Rotary. These categories are further classified based on the way they move the fluid. The outline below shows the basic breakdown of pump classifications by design.

Positive Displacement pumps work best with a high viscosity application as a centrifugal pump becomes very inefficient at even modest viscosity. The acceptable viscosity ranges for centrifugal pumps depends on pump size.

- **Rotodynamic**

— **Centrifugal**

- Horizontal Split Case
- Magnetic Drive
- Self-Priming
- Single Stage, End Suction
- Slurry Pumps
- Submersible Pumps
- Dry Pit Submergible Pumps
- Vertical Multi-Stage
- Vertical Turbine

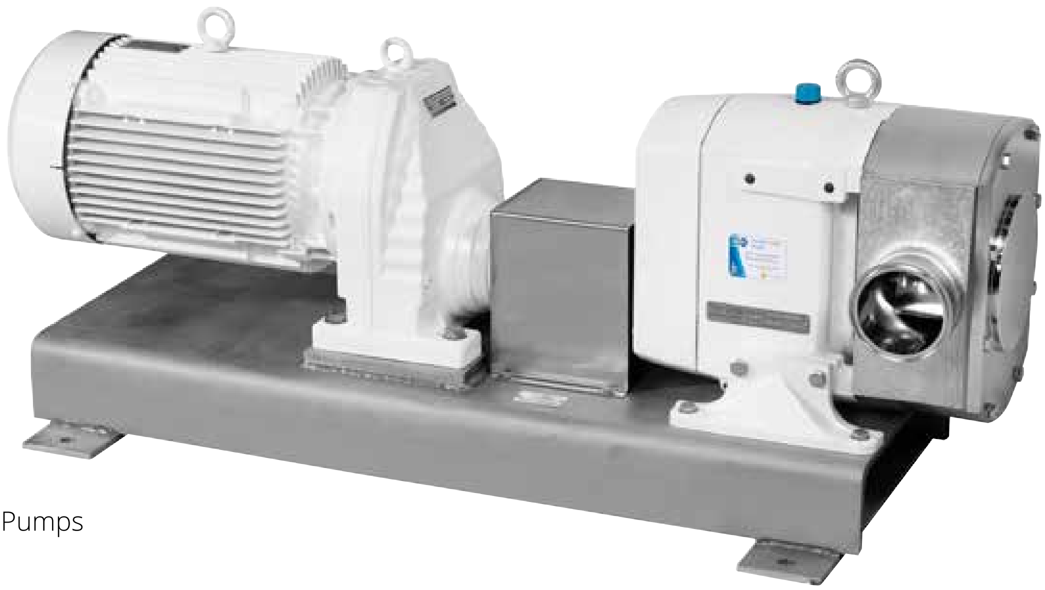
- **Positive Displacement**

— **Reciprocating**

- Diaphragm
- Duplex
- Multiplex
- Piston or Plunger

— **Rotary**

- Gear
- Lobe
- Peristaltic Pumps
- Progressive Cavity Pumps
- Screw Vane



Another difference between Centrifugal and Positive Displacement pumps is how they discharge their contents. Displacement pumps typically have a pulsating flow or periods when there is no flow whereas rotodynamic pumps have a continuous flow.

Other factors in pump classification include:

- Whether the fluid delivery is constant or variable at a given speed
- Type of application
- Materials from which they are constructed
- Type of fluids or materials they move
- Structural features

Although the pipes that go from the source to the pump are called "suction lines," pumps do not "suck" liquid; they push it. The pump creates a vacuum into which the fluid flows forced by atmospheric pressure, the same pressure when using a drinking straw or vacuum cleaner.

For example, centrifugal pumps create a low pressure in the eye of the impeller and air pressure pushes the fluid into the pump via the suction line.

Now let's look at each pump type in more detail.

Centrifugal Pumps

Horizontal Split Case pumps have a design feature that allows for the upper casing to be unbolted and removed for easier inspection, maintenance, or replacement of the impeller, without disconnecting the piping or altering the alignment. This access is especially important for heavy industrial pumps and tight fitting areas.

Split case pumps can contain multiple impellers, or stages, to generate higher head. Bearings on both ends of the shaft support and provide balance for the impellers. Double suction pumps use closed impellers with two opposing eyes, each receiving half the flow further balancing axial thrust.

The horizontal split case pumps are best suited for applications that require high capacities and high head where the fluid contains no solids such as boilers and cooling towers.


Split case with double closed impeller

Magnetic Drive pumps coupled to the motor magnetically, rather than by a direct mechanical shaft. These pumps are critical in manufacturing processes to transfer highly corrosive liquids. Facilities requiring a continuous process benefit by using magnetic because there are no seals to replace or leak


Magnetic drive pumps

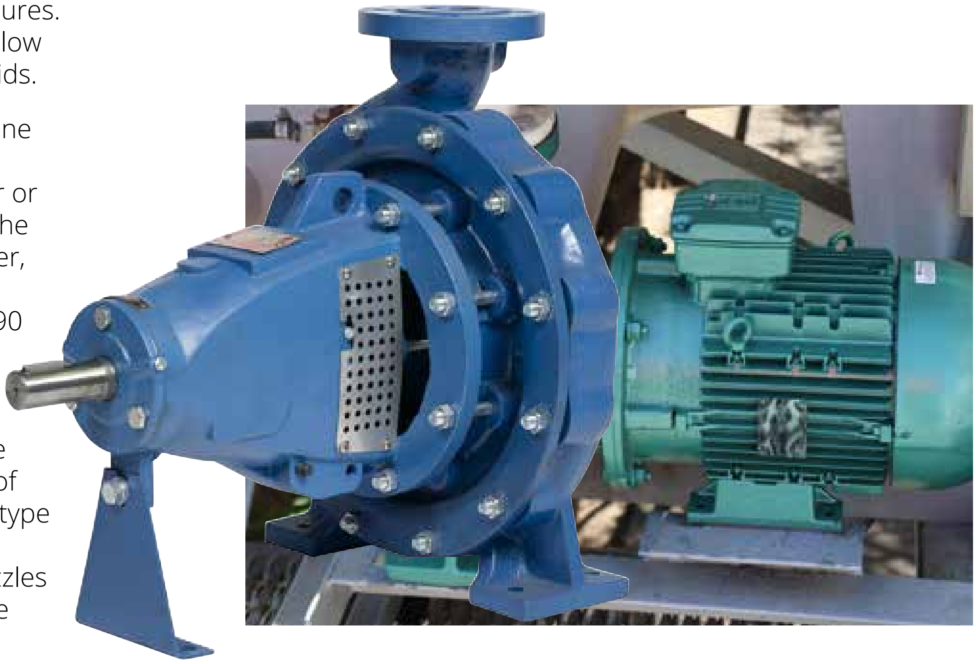
However, Mag drive pumps only work with liquids that have no suspended solids. Although they are more expensive than pumps with mechanical seals, over the life of the pump, there will be considerable savings from reduced maintenance and production downtime.

Self-Priming Pumps are a design of centrifugal pumps that use an air-water mixture to reach a fully-primed pumping condition. By using fluid left in a reservoir, the impeller forces out the air from the casing, creating a vacuum and suction that primes the pump. The advantage is the pump stays in areas that are dry and easy to access for maintenance.

Self-priming pump applications including sewage, construction dewatering, slurries and flood control. Some pumps can handle solids up to three inches.

Single Stage, End Suction Pumps are the most common centrifugal pump. The are available in all sizes, impeller types and discharge pressures. They are best at pumping low viscosity fluids without solids.

Fluid enters the pump in line with the drive shaft at the opposite end of the motor or driver. The fluid contacts the eye of the spinning impeller, and the vanes accelerate the fluid radially outward 90 degrees to the discharge outlet. The pressure of the fluid increases due to the centrifugal force of the impeller, but the amount of pressure depends on the type of impeller, the size of the suction and discharge nozzles and the rpm (speed) of the shaft.



Slurry Pumps are the workhorses of the mining industry. They are robust pumps usually constructed from thick cast iron to withstand abrasive fluids mixed with solids like concrete, mud and other viscous, abrasive materials. The casing has a replaceable rubber coating or lining to protect the metal from damage. The impeller vanes are shorter to allow passage of stones and solids without damaging the system.

Submersible Pumps stay below the surface of the fluids they pump, typically inside tanks or wells. The pump motor is hermetically sealed and close-coupled to the pump end. They have the advantage of being self-priming but can be more problematic to maintain.

Submersible pumps are also called stormwater pumps, sewage pumps and septic pumps and effectively used in building services, commercial, domestic, municipal, rural, industrial, and rainwater re-use for subsoil water, stormwater, sewage, grey water, black water, trade waste, rainwater, bore water, chemicals and food waste. They come in a variety of sizes and impeller types depending on the fluid viscosity, type of solids to be processed and pumped.

The Dry pit submersible pump differs from a typical submersible in that it can run both above and below the level of the fluid. They are designed to de-water areas that only flood occasionally. A conventional submersible would overheat, but dry pit pumps ha the motor housing filled with a cooling oil.

Vertical Multi-Stage Pumps are centrifugal pumps with multiple impellers placed in series on the same shaft in a single casing. The fluid increases in pressure as it leaves each impeller chamber or stage. The more stages the pump has, the higher the discharge pressure.

Vertical Multi-stage pumps require less space for installation. The pump uses only one motor to power multiple stages and is best suited for boosting pressure to any clear liquid. Practical applications include increasing water pressure in buildings, light industrial water supply, washing and cleaning systems, such as car washes, irrigation systems and providing cooling lubricants to machine tooling processes.

Vertical Turbine Pumps primarily to pump water from deep wells in mining and for agriculture irrigation where the high head and pressure is required. The unit consists of a motor on top, the discharge head below that and one or more flanged columns that house the drive shaft and one or more impeller bowls or stages. There is usually a type of strainer at the suction end to filter out stones and debris.

Vertical turbine pumps are used for small, single pump commercial applications as well as large, multi-pump municipal water supply systems. One disadvantage is the high headroom required for installation and maintenance. The advantage of these pumps is that they have a small footprint, are easily customised and very efficient for high head, low flow applications.

Positive Displacement Pumps

A positive displacement pump operates by drawing in a fluid, filling a cavity and then displacing the same volume of fluid, delivering a constant amount of liquid for each cycle that the pump makes regardless of the discharge pressure or head.

Positive displacement pumps differ from centrifugal pumps in that the volume of the chamber changes, driving the fluid. When the plunger draws back the volume increases, creating a vacuum and the cylinder fills. Pushing on the plunger has the opposite effect and forces the fluid out. The mechanical devices that move the fluid in a positive displacement pump can be a plunger, piston, diaphragm, gears or intermeshing lobes.

PD Pumps are the designed for use where there are solids or abrasive material suspended in the fluid. High velocities within a centrifugal pump will wear out the impeller and casing rapidly if they pump anything but low viscosity clear fluids.

Positive displacement pumps run at lower internal speeds and should be a more economical option for viscous or abrasive liquids.

PD Pumps are the best choice if:

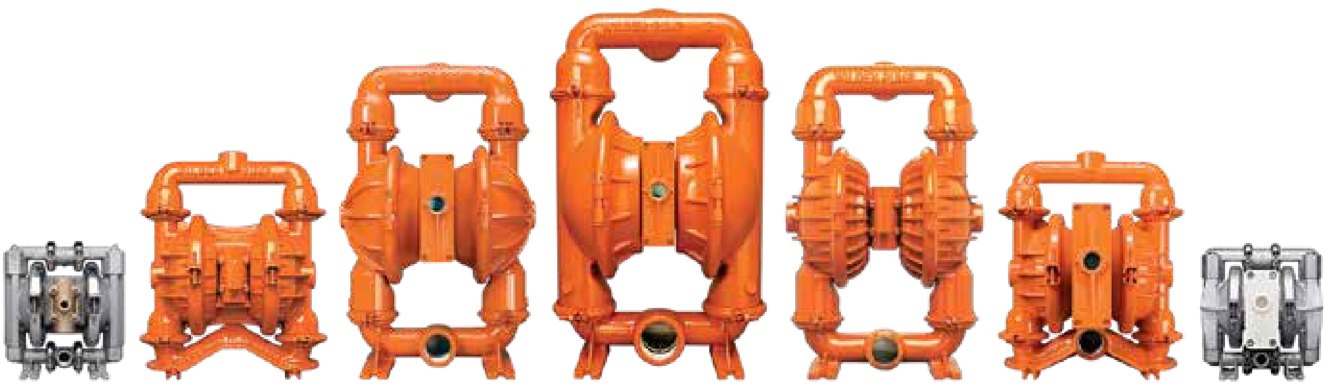
- The smallest available centrifugal pump needs to operate at a flow less than 50% of best efficiency flow.
- The fluid is high viscosity.
- You need to produce higher heads or pressures at a more economical price.
- You require a near constant flow that makes it possible to match the flow to the process requirements.
- For metering applications.

Reciprocating pumps use a crankshaft-connecting rod mechanism the same way it works on the engine in a car. It converts the crankshaft's rotary movement into straight or linear movement of the piston.

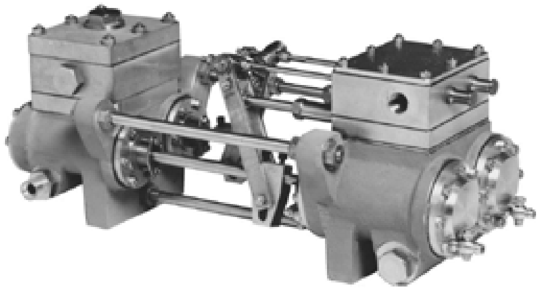
There are three moving parts including the inlet valve, the plunger or piston and the outlet or discharge valve.

As the piston retracts, ambient air pressure forces the fluid in through an inlet check valve to fill the vacuum left by the piston. As the piston reverses the cycle, pressure closes the inlet check valve, and the outlet check valve opens discharging the fluid. The volume of fluid remains constant with each revolution of the crank, but pump configuration determines pressure and system flow. Pump shaft speeds are relatively low, requiring speed reduction from the motor or driver to the pump shaft.

Diaphragm Pumps also, called Membrane Pumps, Diaphragm Pumps use a flexible membrane to create low and high pressure by flexing in and out of a chamber. Check valves direct the flow of liquid in and out of the chamber with each reciprocating cycle of the diaphragm. These pumps work well pumping high viscosity fluids such as sludges and slurries containing solid materials. They can reach discharge pressures up to 1,200 bars.



Air-operated double diaphragm (AODD)



Duplex Pumps the official name of the Duplex Pump is Direct Acting Reciprocating Steam Pump. Invented by Henry R. Worthington in 1840 they are still used today. However, the steam has been replaced with compressed air.

Duplex pumps have two steam and two water cylinders that work in tandem.

Compressed air enters the top of the cylinder on one side or the other depending on the motion of the rocker arm over the intake ports creating constant lateral motion of the pump plunger. This is an efficient arrangement as there are no "dead spots." With the two cylinders about 1/4 cycle out of synchronization, there is always a piston under pressure during the entire cycle.

The duplex pump is used where a high volume of water is required without the threat of backwash.

Backwash could contaminate large freshwater storage tanks and render the system unfit for use. They are commonly used in oil drilling to cool drilling heads as well as to flush out the boring holes. Duplex Pumps also work well for transferring low viscosity fuels like heating oil.

Multiplex Pumps Simply put, Multiplex pumps are a series of plunger pumps with a common power end and fluid end. The power end contains a crankshaft in a crankcase with connecting rods connected to crossheads instead of pistons to alleviate sideways forces to the piston. The fluid end includes individual plungers, each having different spring loaded intake and discharge check valves.

Multiplex pumps provide higher flow rates at lower pressures due to the load limits on the crankshaft and primarily used in oil field applications.

Regardless of the well pressure, multiplex pumps can move significant amounts of fluid.

Piston and Plunger Pumps Both Piston and Plunger Pumps work with the linear motion displacing fluid inside of a cylinder. The difference is that the seal on the piston moves with the piston contacting the cylinder wall to create a seal. The plunger on a Plunger pump passes through a stationary seal and will generate higher pressure than piston pumps.

There are two types of piston pumps, Lift and Force.

In a lift pump, it takes three strokes to complete the cycle. The first stroke or upstroke of the piston draws water, through a valve, into the lower part of the cylinder. With the second or downstroke, water passes through valves in the piston, filling the upper portion of the cylinder. On the third or upstroke, water discharges from the top part of the cylinder via a spout.

Force pumps need only an upstroke to fill the cylinder and a down stroke to force the fluid out.

Rotary Pumps

Because of their design, Rotary pumps can produce more fluid than reciprocating pumps of the same weight, and they are self-priming. The pump classifications under Rotary pumps are **Gear, Lobe, Peristaltic and Screw or Moving Vane.**

Rotary pumps are capable of pumping more fluid than reciprocating pumps of the same weight. Unlike the centrifugal pump, the rotary pump is a positive-displacement pump meaning that for each revolution of the pump, a fixed volume of fluid is moved regardless of the resistance against which the pump is pushing.

Gear Pumps Rotary Gear Pumps consist of at least one or two sets of rotating gears with intermeshing teeth. As the teeth separate, they create a partial vacuum which is filled by the fluid. When the gears continue to rotate, the fluid becomes trapped and carried around the casing to the discharge port of the pump. Gear pumps can be external or internal.

Internal gear pump

Internal Gear Pumps handle low and high viscosity liquids from solvents and fuel oil to asphalt and adhesives. The viscosity range is 1cPs to over 1 million cPs. Moreover, they perform well pumping high-temperature liquids up to 400ºC because the clearance is adjustable to account for the temperature expansion. The internal gear pump has self-priming capabilities and can even run dry for short periods. These pumps are bi-rotational and are used to load and unload the same tanks. With only two moving parts they are reliable and easy to maintain.

External Gear Pumps although external gear pumps are like internal gear pumps in that two gears come into and out of mesh to move fluid, the external gear pump uses two identical gears rotating against each other. One gear is connected to the motor and drives the other gear. They are very strong and quiet-running due to bearings supporting each side of the gear shaft. They are ideal for high-pressure hydraulic applications. Large pumps can run at 640 rpm while smaller pumps can run as high as 3,000 rpm. Common uses include:

- Chemical additive and polymer metering
- Chemical mixing and blending
- Industrial hydraulic applications (log splitters, lifts, etc.)
- Acids and caustic fluids
- Fuel oil and lubricants

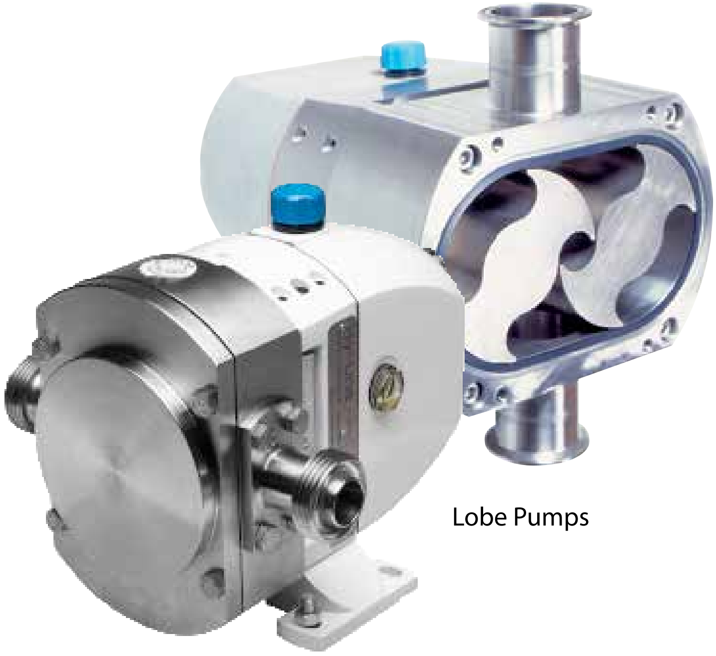
External gear pumps & gears

Lobe pumps are like external gear pumps in that fluid flows around the interior of the casing. However, the lobes do not contact each other like gear teeth. External timing gears located in the gearbox prevent lobe contact.

Because the lobes do not contact, they can pass medium solids. They are used for pumping fluids such as polymers, soaps, coatings, adhesives and food products.

Lobe pumps can handle different products because they are CIP (Clean In Place) and SIP (Sanitisation In Place) capable. They are cleaned or sanitized by circulating a fluid through them when products of different colors or properties are batched.

The disadvantages are that they require two seals and two timing gears making them more complex to maintain. They lose efficiency pumping low viscosity liquids.

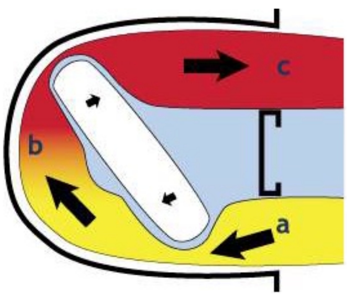


Lobe Pumps

Peristaltic Pump differs from every other pump in that the pump does not contact the fluid. Instead, the fluid flows inside of a flexible tubing which fits into a circular casing. Rollers fitted onto a rotor squeeze the fluid out as they rotate inside the casing, just like squeezing a tube of toothpaste.

Peristaltic pumps are essential for medical applications for a sterile environment and for dispensing corrosive chemicals such as pumping detergents into commercial dish or laundry machines.

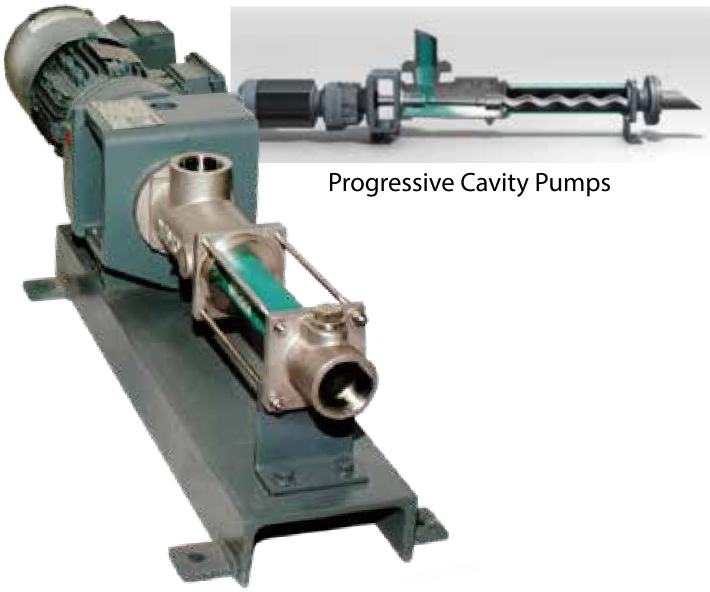
The advantages of Peristaltic pumps are that it has no pump moving parts, easy to maintain, handles abrasive or corrosive fluids and is self-priming. The downside is that it requires moderate speeds, gives a pulsing flow, low hose life and limits of reactivity of the fluid depends on the type of tubing used.



Progressive Cavity Pumps have smooth output flow and good self-priming ability. Capable of pumping both thick liquids with high solids and abrasives content and shear sensitive fluids, such as sauces, cream products for the food industry.

Progressive cavity pumps are commonly known as Single-screw pumps or Helical Rotor Pumps. Multiple screw pumps can handle high pressure, temperature, speed and power combined. However, they have some limitations and require some care in application. All PC pumps have three basic sections, the pumping element, suction housing and drive train. The pumping element consists of the rotor and stator elements. The rotor is made of metal and has the shape of a single helix while the stator is typically made from an elastomer and has the shape of a double helix (the internal shape). The rotor is slightly larger than the stator, so that creates friction and moves the fluid forward as it rotates against the stator.

They handle a wide range of fluid viscosities, low shear, non-pulsing flow, require only one seal and are self-priming. The downside is the can be damaged quickly if run dry, have temperature limitations and require long floor space.



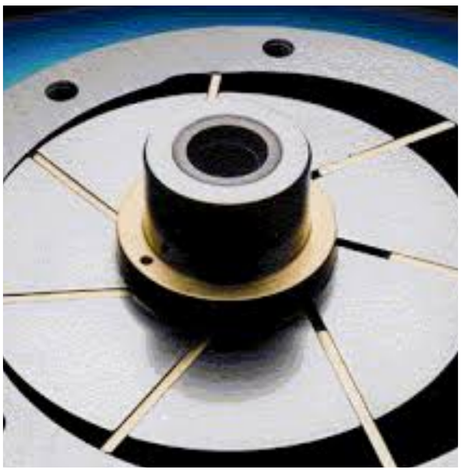
Progressive Cavity Pumps

Vane Pumps slotted rotor is positioned slightly off-center, creating a crescent shaped cavity in the body of the pump. Vanes or blades fit within the slots of the impeller and move in and out with centrifugal force creating a seal with the pump casing. Fluid fills the pockets formed by the vanes, rotor, cam, and side plate as the impeller turns.

The vanes sweep the fluid to the opposite side of the crescent where it then exits the discharge port.

Vane pumps excel at pumping low viscosity liquids such as LP gas (propane), ammonia, solvents, alcohol, fuel oils, gasoline, and refrigerants. Vane pumps have no internal metal-to-metal contact and can handle volatile fluids from -32ºC / -25ºF to 260ºC / 500ºF.

The disadvantages of vane pumps are they are complex with many parts, are not suitable for high pressures or high viscosity and are not good with abrasives.



Vane Pump

Troubleshooting Pumps

Studies show that 80% of pump failures tend to centre around the bearings and seals. Like a circuit breaker in an electrical system, these parts are a warning sign that something more serious is occurring within the pumping system. The key to correcting the problem instead of fixing the symptom is to do a proper root cause analysis. Replacing the seal or bearing without understanding the exact reason for the failure can create bigger problems in the future.

There are as many reasons why pumps break down as there are pumps and parts. In this basic guide, we will cover only the main categories. To troubleshoot a particular pump in a specific location, contact the manufacturer or supplier and refer to the owner's manual for the pump.

An in-depth root cause analysis requires an inspection of each component of the system and a review of the troubleshooting guide for the pump in question. Contact your manufacturer or supplier early in the investigation as they are an excellent resource to help with troubleshooting. They have the experience and training to help you find the underlying cause.

Three Main Areas of Pump Troubleshooting

The three general categories why pumps fail are the intake or suction side, the pump itself and the discharge line. If there is any blockage or leakage in any of these areas the pump will not run at the Best Efficiency Point (BEP).

Unless otherwise specified, for this general troubleshooting discussion, both centrifugal and positive displacement pumps are treated the same.

Suction Line Troubleshooting

The symptom for suction line problems is called Low Volumetric Efficiency or failure to deliver rated capacity and pressure.

- **Air Entrainment –** When air, gas or vapor enters the pump mixed with fluid it is called air entrainment. It is caused by a leak in the suction line or trapped bubbles in the liquid such as fermenting liquids, foaming agents or condensate that is close to its boiling point. The result in centrifugal pumps is cavitation. A vortex in the supply tank can also cause air in the suction line.

- **Cavitation –** In centrifugal pumps, air entrainment causes cavitation creating an unbalance in the impeller due to the difference in densities between the fluid and gas. Although the problem occurs in the pump, the reason comes from air or turbulence in the suction line. Cavitation can result in rapid damage to the impeller, bearings and shorten the lifespan of the pump.

- **Restrictions –** Some ways that suction lines can restrict the proper flow of liquid include a gasket with too small an inside diameter or improperly installed so that it protrudes into the flow. Should the wrong type of valve be installed, for example, substituting a globe valve for a gate valve, it will reduce the head pressure significantly.

Blockage from foreign materials is common, especially with new piping installations or the pipe could be damaged. There can be build up inside pipes from minerals or marine crustaceans restricting the flow. Foot valves and check valves from the tank to the pump can be stuck.

Remedies for Suction Line Problems

- Baffles in the supply tank to prevent vortices.
- Install a straight run of pipe at least to five to ten times the diameter of that pipe, between the suction reducer and the first obstruction in the line. This creates a smooth, uniform flow of liquid to the eye of the impeller, avoiding any turbulence and air entrainment.
- Avoid low flow rates.
- Thoroughly flush all lines before installing the pump. Use a filtering system in open systems where contamination is possible.
- Ensure replacement parts designed for the system are the only ones used.

Pump Troubleshooting

Seals – Broken, worn or the wrong seal can allow air to enter the pump and cause leakage. These are the main factors contributing to seal failure.

- Allowing your pump to run dry can destroy a mechanical seal with thermal shock and shatter within 30 seconds or less.
- Using a Hammer to install a seal will damage it.
- Vibration caused by imbalance, misalignment or operating the pump outside of the BEP (Best Efficiency Point), damages the seals and shortened their life.
- Operator error such as not following proper start-up procedures or incorrect installation.
- Not flushing seals can result in contaminating backup and result in failure.
- Using the wrong seal.

Shafts – A bent or displaced shaft will wear out bearings and seals rapidly. The reasons that a shaft displaces are:

- Misalignment between the pump and driver at installation.
- A shaft is hit with an object or becomes overheated.
- The rotating assembly is not dynamically balanced.
- Cavitation and other types of vibration.
- Water hammer.
- Operating the pump outside of the BEP.
- Pulley driven pumps with too much lateral force.

Drive – The two main issues with the drive motors are the correct voltage/amperage and incorrectly wiring to the correct phase. The wrong phase causes the motor to run backward. If it is a variable frequency motor, check to see if it is running at the correct speed.

- If the pump is pulley driven, ensure that the pulley is the right size.

Gear Teeth – Gear pumps were designed to transfer or spray clean liquids. The close tolerances between both gears and the pump body are the key to its ability to deliver a strong suction and high discharge pressure. However, sand or debris will wear all contacting surfaces or even lock up the pump potentially causing motor or shaft damage.

Bearings – Bearings are critical for smooth operation and long pump life. The reasons that bearings wear out too quickly or fail completely are symptoms of other problems such as:

- Obstruction in pump casing or the impeller.
- The impeller is out of balance.
- Shaft bent, running off centre (due to worn bearings) or misaligned.
- Excessive thrust caused by internal mechanical failure of pump
- Lack of bearing lubrication or correct lubrication.
- Incorrect assembly of stacked bearings. For example, when angular contact ball bearings are installed front-to-front instead of back-to-back.
- Contaminants such as dirt or rust enter bearings.

Impellers (Centrifugal pumps) – Because of the high RPMs at which impellers run, any imbalance or frequent change in head can cause malfunctions and damage. Here is a short list of problems that cause impeller damage.

- The impeller diameter is too small.
- It is too narrow.
- Speed is too slow. (Check the voltage and frequency)
- It is damaged or clogged.
- Open impeller clearance is too large.
- The impeller to cutwater clearance is too large.
- Impeller installed backward.

Refer to original specifications when repairing or replacing anything to do with the impeller.

Pipe Strain – Pipe strain relates to a condition where a pipe pulls on a pump caused by improperly supported pipes or misalignment between the pipe and the pump. The condition can cause the casing and shafts to become misaligned affecting the internal parts of the pump.

Discharge Line Troubleshooting

Piping – Problems with the discharge side occur if the length of the piping changes and the resistance increases or decreases. A siphon effect can happen if the discharge piping enters the top of the tank and discharging at a lower level. The pump must build enough head initially to take advantage of the siphoning action.

- Another issue is if the discharge valve (manual or automatic) opens too much.

Conclusion

The aforementioned problems listed are the most frequent issues found in pump systems. However, each pump has its individual set of circumstances. Whenever there is a change to the original system design, a new installation or any repairs, the specific conditions change and affect the operation of the pump.

Only detailed and methodical inspection will provide the correct repair solutions. As previously mentioned, your supplier and manufacturer are the best sources to guide you to the right conclusions.

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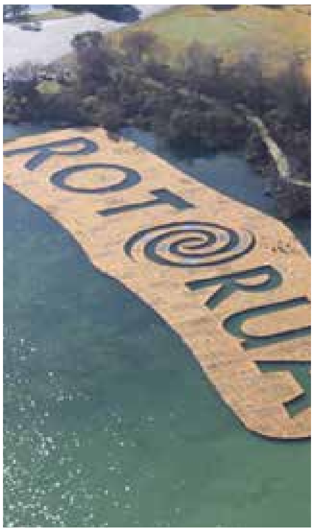

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