PUMPS: SELECTION & TROUBLE SHOOTING

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Abstract: This articles deals with a brief overview of Pumps. Different types of pumps and the problems associated with them are discussed. A detailed account of selection of pumps is given including the method of selection and the design pointers. Trouble shooting in different types of pumps such as centrifugal, reciprocating (steam driven, power driven, and metering), and rotary is addressed in detail.

1. Introduction

Pumps are the fluid moving machineries which increase the mechanical energy of the fluids to be displaced. The energy increase may be used to increase the velocity, the pressure or the elevation of the fluids. A large number of pumps, differing widely in principle and mechanical construction, have been developed to meet a wide variety of operating conditions. For selection of pumps for a specific application requires the knowledge of operating conditions of the system and applicability of different available pumps.

By far the most common method of adding energy is by Positive displacement or Centrifugal action, which can be supplied by the outside forces. These methods lead to the two major classes of fluid moving machinery: 1. Applying direct pressure to the fluids e.g. Positive Displacement Pumps 2. Using torque to generate rotation e.g. Centrifugal Pumps

1.1 POSITIVE DISPLACEMENT PUMPS

Depending upon the way of force generation, these can be classified as Reciprocating (force applied to the fluid by a piston acting in a cylinder) and Rotary (by rotating pressure members) pumps.

1.1.1 Reciprocating Pumps

A definite volume of liquid is trapped in a chamber, which is alternately filled from the inlet and emptied at a higher pressure through the discharge. The chamber is a stationary cylinder that contains a piston or plunger. According to the required operating pressure Piston (upto 50 atm), Plunger (1500 or more atm.) or Diaphragm (> 100 atm.) is used to apply force to the fluid.

Liquid is drawn through an inlet check valve into the cylinder by the withdrawal of a piston and then forced out through a discharge check valve on the return stroke. Most piston pumps are double acting with liquid admitted alternately on each side of the piston so that one part of the cylinder is being filled while the other is being emptied. Often two or more cylinders are used in parallel with common suction and discharge headers, and the configuration of the pistons is adjusted to minimize fluctuations in the discharge rate. The piston may be motor driven through reducing gears or a steam cylinder may be used to drive the piston rod directly. The maximum discharge pressure for commercial piston pumps is about 50 atm. For higher pressure services plunger pumps can be utilized. A heavy-walled cylinder of small diameter contains a close-fitting reciprocating plunger, which is merely an extension of the piston rod. At the limit of its stroke, the plunger fills nearly all the space in the cylinder. Plunger pumps are single acting and usually are motor driven. They can discharge against a pressure of 1500 atm. or more. Diaphragm pumps can be used to handle toxic or corrosive liquids. The reciprocating member is a flexible diaphragm of metal, plastic or rubber. This eliminates the need for packing or seals exposed to the liquid being pumped. They handle small to moderate amounts of liquid, upto about 100 gal/min, and can develop pressures in excess of 100 atm.

Positive displacement machines handle smaller quantities of fluids at higher discharge pressure than centrifugal machine, not subject to air binding, and usually self-priming. The discharge rate is independent of discharge pressure, so that these are extensively used for controlling and metering flow. They require considerable maintenance but can produce the highest pressures and deliver pulsating streams.

1.1.2 Rotary Pumps

Unlike reciprocating pumps, rotary pumps contain no check valves. They operate best on clean, moderately viscous fluids, such as light lubricating oil. Discharge pressures upto 200 atm. or more can be obtained. Depending upon the rotating mechanism rotary pumps can be classified as Gear pump, Lobe (a broad rounded segmental division) pump, Screw pump, Cam (eccentric projection on a revolving shaft, shaped so as to give some desired linear motion) pump, and Vane (blade of a wind mill, propeller, revolving fan) pump.

Intermeshing gears rotate with close clearance inside the casing in a spur gear pump. Liquid entering the suction line at the bottom of the casing is caught in the spaces between the teeth and the casing and is carried around the top of the casing and forced out the discharge. Liquid cannot short-circuit back to the suction because of the close mesh of the gears in the center of the pump.

In an internal gear pump a spur gear, or pinion, meshes with a ring gear with internal teeth would be there. Both gears are inside the casing. The ring gear is co-axial with the inside of the casing. But the pinion, which is externally driven, is mounted eccentrically with respect to the center of the casing. A stationary metal crescent fills the space between the two gears. Liquid is carried from inlet to discharge by both the gears, in the spaces between the gear teeth and the crescent.

Rotary pumps work best on fairly viscous lubricating fluids and discharge a steady stream at moderate to high pressures. They cannot be used with slurries.

1.2 CENTRIFUGAL PUMPS

The mechanical energy of the liquid is increased by centrifugal action. Centrifugal pumps are classified as single suction and double suction pumps depending upon the suction from either one side or from both sides respectively.

In a single suction centrifugal pump the liquid enters through a suction connection concentric with the axis of a high-speed rotary element called the impeller, which carries radial vanes integrally cast in it. Liquid flows outward in the spaces between the vanes and leaves the impeller at a considerably greater velocity with respect to the ground than at the entrance to the impeller. In a properly functioning pump the space between the vanes is completely filled with liquid flowing without cavitation. The liquid leaving the outer periphery of the impeller is collected in a spiral casing called the volute and leaves the pump through a tangential discharge connection. In the volute, the velocity head of the liquid from the impeller is converted into pressure head. The power is supplied to the fluid by the impeller and is transmitted to the impeller by the torque of the drive shaft, which usually is driven by a direct-connected motor at constant speed, commonly at 1750 rpm. Another common type uses a double-suction impeller, which accepts liquid from both sides. Also, the impeller itself may be a simple open spider, or it may be enclosed or shrouded.

The maximum head that is practicable to generate in a single impeller is limited by the peripheral speed reasonably attainable. A so-called high-energy centrifugal pump can develop a head of more than 200 m in a single stage. But generally when a head greater than about 30 m is needed, 2 or more impellers can be mounted in series on a single shaft and a multi-stage pump so obtained. The discharge from the second provides suction for the third, and so forth. The developed heads of all stages add to give a total head several times that of a single stage.

Because of environmental considerations, leak proof centrifugal pumps are increasingly used for handling dangerous liquids. There are 2 main types, both of which contain no seals or stuffing boxes. In canned rotor pumps a stainless steel can like enclosure surrounds the motor rotor to keep the pumped fluid away from the motor (no leakage). In magnetic drive pumps a magnetic-carrying disk drives the impeller, which carries magnets, on the other side of the casing wall (no direct contact and so no leakage). Both types are less efficient than conventional pumps, but a lower efficiency is often preferably to installing complicated mechanical seal and seal-flushing systems.

Centrifugal Machines deliver fluid at a uniform pressure without shocks and pulsations. They run at higher speeds than positive displacement devices. They are connected to the motor drive directly instead of through a gearbox. The discharge line can be completely closed without damage. Centrifugal pumps can handle a wide variety of corrosive liquids and slurries. Centrifugal blowers and compressors are much smaller for given capacity than reciprocating compressors and require less maintenance.

1.3 SUCTION LIFT & CAVITATION

From energy considerations it is immaterial whether the suction pressure is below atmospheric or well above it as long as the fluid remains liquid. However, if the suction pressure is only slightly greater than the vapor pressure, some liquid may flash to vapor inside the pump, a process called cavitation, which greatly reduces the pump capacity and causes severe erosion. If the suction pressure is less than the vapor pressure, there will be vaporization in the suction line, and no liquid can be drawn into the pump. To avoid cavitations, the pressure at the pump inlet must exceed the vapor pressure by a certain value, called the Net Positive Suction Head (NPSH). The required value of NPSH is about 2-3 m for small centrifugal pumps, but it increases with capacity, impeller speed and discharge pressure. Values upto 15 m are recommended for very large pumps

1.4 PUMP PRIMING

The theoretical head developed by a centrifugal pump is a function of impeller speed (N), radius of impeller (r), and the velocity of fluid leaving the impeller (V). If these factors (N,r,V) are constant, the developed head is the same for fluids of all densities and is the same for liquids and gases. Centrifugal pump is a constant head pump. However, the increase in pressure is the product of developed head and the fluid density. If a pump develops, say a head of 30 m and is full of water, the increase in pressure is around 3 atm. If the pump is full of air at ordinary density, the pressure increase is around 0.007 atm. A centrifugal pump trying to operate on air, then, can neither draw liquid upward from an initially empty suction line nor force liquid along a full discharge line. A pump with air in its casing is air bound and can accomplish nothing until air has been replaced by a liquid. Air can be displaced by priming the pump from an auxiliary priming tank connected to the suction line or by drawing liquid into the suction line by an independent source of vacuum. Also several types of self-riming pumps are available. Positive displacement pumps can compress a gas to a required discharge pressure and are not usually subject to air binding.

2. Selection of Pumps

A number of parameters must be considered in designing the pumping systems irrespective of the type of pump. These parameters include head, capacity, and nature of liquid handled, piping, drives and economics. So, in general, discussion on these parameters applies equally well to centrifugal, rotary, or reciprocating pumps. Sometimes, the important concept of design economies, which originate with the project and continue through its useful life, is neglected during system planning. For example, careful study of head conditions and pump location may produce worthwhile power savings over a long period without a major increase in the first cost of the project.

Wise choice of pipe sizes, based on predictable or estimated future loads, is another example of how careful design planning can be made to pay off in terms of operating economies. Piping for pumps can be conveniently classified into three broad categories-suction, discharge, and auxiliary lines. The head to be developed in many installations is principally a function of the piping resistance, and so an extreme care is to be taken in choosing pipe size and arrangement. The success or failure of any pumping system is usually a direct function of the degree of suitability of its piping.

Capacity also deserves equal importance in pump application. The liquid handled by a pump affects (1) the head and capacity at which the unit can operate, (2) the required power input to the pump, and (3) the materials of construction that must be used to ensure a satisfactory life for the pump (4) classes of liquids carrying solids in suspension. A careful study of the above is required as their handling may present difficult problems in pump selection, construction, and use.

For industrial pumps, every form of prime mover and power source with some kind of power-transmission device, if needed, has been used. Presently, electric motors drive most pumps-be they centrifugal, rotary, or reciprocating. But steam, gas, and hydraulic turbines and gasoline, diesel, and gas engines are also used. Other power sources having limited popularity are air motors, air-expansion turbines, windmills, etc., but their use is usually confined to certain specialized applications. Power-transmission devices for pump drive include flexible couplings, gears, flat or V belts, chains, and hydraulic and magnetic couplings or clutches.

The problem faced by an engineer in designing a pumping system is choice of the class, type, capacity, head and details of the pump or pumps to be used in the system. There are such a variety of pumps available as mentioned earlier, and so many applications are possible for each, that it is often difficult to narrow the choice to one specific unit. With the following discussion, the engineer can start with the hydraulic conditions to be met, and proceed, by means of a few simple steps, to the pump best suited for the liquid conditions, and using the economic analysis finally can arrive at the most economical unit for the plant.

2.1 METHODS OF SELECITON

Pumps are usually selected by any of the following three methods: (1) the prospective purchaser supplies one or more manufacturers with complete details of the pumping conditions and requests a recommendation and bid on the units which appear best suited for the conditions, (2) the purchaser makes a complete calculation of the pumping system and then chooses a suitable unit from current catalogs and rating charts, or (3) a combination of these two methods is used to arrive at the final selection. The essential data required by any pump manufacturer before a recommendation and bid can be prepared are:

1. Number of units required
2. Nature of the liquid to be pumped

   Is the liquid?
   a. Fresh or salt water, acid or alkali, oil, gasoline, slurry, or paper stock?
   b. Cold or hot and if hot, at what temperature? What is the vapor pressure of the liquid at the pumping temperature?
   c. What is its specific gravity?
   d. Is it viscous or non-viscous?
   e. Clear and free from suspended foreign matter or dirty and gritty? If the latter, what is the size and nature of the solids, and are they abrasive? If

the liquid is of a pulpy nature, what is the consistency expressed either in percentage or in 1b per cubic ft of liquid? What is the suspended material?
    f. What is the chemical analysis, pH value, etc.? What are the expected variations of this analysis? If corrosive, what has been the past experience, both with successful materials and with unsatisfactory materials?

3. Capacity
   What are the required capacity as well as the minimum and maximum amount of liquid, the pump will ever be called upon to deliver?
4. Suction Conditions
   Is there:
    a. A suction lift?
    b. Or a suction head?
    c. What are the length and diameter of the suction pipe?
5. Discharge conditions
    a. What is the static head? Is it constant or variable?
    b. What is the friction head?
    c. What is the maximum discharge pressure against which the pump must deliver the liquid?
6. Total Head
   Variations in items 4 and 5 will cause variations in the total head.
7. Is the service continuous or intermittent?
8. Is the pump to be installed in a horizontal or vertical position? If the latter,
    a. In a wet pit?
    b. In a dry pit?

9. What type of power is available to drive the pump and what are the characteristics of this power?
10. What space, weight, or transportation limitations are involved?
11. Location of installation
    a. Geographical location
    b. Elevation above sea level
    c. Indoor or outdoor installation
    d. Range of ambient temperatures
12. Are there any special requirements or marked preferences with respect to the design, construction, or performance of the pump?

In quick estimates, for convenience, below written 5 steps are related to size class, and best buy.

1. Sketching the pump and piping layout
2. Determining the capacity
3. Finding the total head
4. Studying the liquid conditions
5. Choosing the class and type

Studying the layout, capacity and head furnishes the first clue as to what class of pump is suitable. For example, where high-head small-capacity service is required, a reciprocating pump would probably suitable. Table-1 gives the characteristics of the pumps. Reviewing the liquid characteristics supplies another clue to class because exceptionally severe conditions may rule out one or another class right at the start. Sound economics dictate choosing the pump that provides the lowest cost per gallon pumped over the useful life of the unit. Operating factors are to be give due importance when deciding on the class of pump include type of service (continuous or intermittent), future load expected and its effect on pump head, possibility of parallel or series hookup, and many other conditions peculiar to a given job. Once class and type are known, a rating table can be checked to see if a suitable pump is available from the particular manufacturer whose unit is to be purchased. Where the required hydraulic conditions fall between two standard models, it is usual practice to choose the next larger size of pump, unless there is some reason why an exact capacity and head are required of the unit. One important fact to keep in mind is that some pumps are custom-built for a given job or plant. Under these conditions the pump manufacturer performs most of the steps listed above, basing his design on data supplied by the plant engineer.

2.2 DESIGN POINTERS

These are the miscellaneous pointers helpful in specifying and purchasing pumps of all types. Volatile liquids can be prevented from flushing in the pump suction line by introduction of cold liquid from an auxiliary source. Control of cold-liquid flow can be either manual or automatic.

When the packing gland is allowed to leak to provide shaft lubrication, check to see that the amount of liquid lost is not excessive. When liquid is to be injected to the packing, an outside-packed pump is often used, especially for oil. Care should be taken that this liquid does not contaminate the material being handled by the pump. A pressure regulator is to be fitted to the packing box sealing system set to relieve a few psi above the casing pressure. Double mechanical seals, used for problem liquids, also require a circulating-type sealing system fitted with a small pump. Consult seal manufacturer for hookup, cooling arrangement, and capacity needed. Wherever possible, it is advisable to use single seal instead of the double type.

Standby units must be carefully chosen if they are to handle more than one liquid. Choose head and capacity for the most severe requirements. Check the construction materials to see that they are suitable for all liquids to be handled.

Available NPSH should be as much as can be readily provided without adding too greatly to system cost.

Existing pumps can sometimes be used for new jobs in a plant.

Viscous liquids are handled more easily in heated pipes, pumps, strainers and other equipment. Steam, hot water, or electric tracing can be used for this purpose.

Friction losses recommended for discharge and suction lines vary. Here are some typical values: discharge lines, 1.5 to 6 psi per 100 ft for the flow of 0 to 150 gpm; 1 to 4 psi per 100 ft for 151 to 500 gpm, 0.5 to 2 psi per 100 ft for flows over 500 gpm; suction lines for 0.05 to 1 psi per 100 ft, depending on the available NPSH.

Pump center line is usually 1.5 to 3.0 ft above the floor level, depending on foundation height and pump size.

Pump bids should contain six copies of the pump-performance curves, six copies of a cross-section drawing of the pump, six copies of the pump-outline drawing, mechanical-seal data (if seals are used), and complete flange ratings.

Critical speed of pump shaft should be at least 30 per cent above, or 30 per cent below, the maximum operating speed of the pump.

Ball bearings used for pump shafts should have a minimum service life of at least 10,000 hr.

Auxiliary connections for centrifugal pumps should be ⅜ in or larger, except drains and vents, which can be ½ in.

Base plate should have a drain rim, drain holes, anchor-bolt holes, and grout holes.

Glands for pumps handling flammable liquids should be made of spark-proof material or lined on the interior with it.

Flushing-oil systems for mechanical seals should have a strainer, pressure gage, and thermometer.

Nameplate and rotation arrow should be furnished with pump. The metal nameplate should contain pump manufacturer's name, serial number of pump, size and type, design head, capacity, speed and temperature, and hydrostatic test pressure.

Pump piping is safest when designed to conform to the ASA code for Pressure Piping, ASA B31.1.

3. TROUBLE SHOOTING IN PUMPS

3.1 CENTRIFUGAL PUMPS

Failure of centrifugal pump in service may sudden, as when a shaft breaks, or gradual, as when brackish water causes blistering of the impeller or casing. But, neither condition is common in well-operated and maintained pumps. Hydraulic troubles, like failure to deliver any liquid, low discharge pressure, and others, are more common and more difficult to solve. It is estimated that, except for mechanical defects, about 85% of the troubles met with centrifugal pumps occur on the suction side of the unit. In the following paragraphs, each of the major troubles is listed separately; possible causes are given, followed by the recommended remedy or cure.

3.1.1 No Liquid Delivered

Lack of Prime: Fill the pump and its suction pipe completely with the liquid being handled. To rid the casing and piping of air, open all vent cocks while filling the pump and pipe. Leave the vents open until clear bubble-free liquid flows from them. Close the vents and start the pump.

Speed of Pump Driver Too Low: With a motor drive, check to see that it is connected directly across the line and receives full rated voltage. With alternating-current (a.c.) motors, check the frequency-it may be too low. Or the motor may have an open phase, causing it to run at a speed lower than its rated value.

Discharge Head Too High: Check all valves in the discharge line to see that they are wide open. Be sure that gage valves are not stuck closed by some obstruction in the pipe.

Suction Lift Too High: Check the pump inlet for clogging by mud or some other obstruction. If a foot valve is used, check it for broken disks or a clogged strainer. Check the vertical distance between the liquid surface and the pump inlet.

Impeller Plugged: Solids in the liquid may accumulate on the impeller, preventing it from discharging liquid. Open the casing and clean all parts of the impeller.

Wrong Direction of Rotation: See that the pump turns in the direction of the arrow on its casing.

Other, less common causes of no liquid being delivered are an air or vapor pocket in the pump suction line, suction pipe not sufficiently submerged, available NPSH not high enough, and the total head against which the pump works higher than that for which the pump is designed.

3.1.2 Not Enough Liquid Delivered

With this trouble the pump delivers some liquid but the amount is less than the rated capacity of the unit at the head at which it is operating. Possible causes include wrong direction of rotation, speed too low, discharge head too high, impeller clogged, suction pipe not sufficiently submerged, available NPSH insufficient, and clogged foot valve. Other causes are:

Air Leaks: These may occur in two places-the suction line or the pump stuffing boxes. Plug all leaks found in the suction piping.

Low NPSH: Connect a compound pressure gauge to the suction pipe. If the needle fluctuates rapidly, the liquid in the suction pipe is flashing into vapor.

Worn Wearing Rings: Inspect the rings visually. If they are badly worn, permitting leakage in the pump, replace all rings.

Damaged Impeller: Remove casing and inspect the impeller. Replace with a new one if vanes or other parts are damaged or worn.

Undersize Foot Valve: Area of foot-valve openings should be at least equal to that of the suction pipe, and preferably 1.5 to 2 times as large. The net clear area of the strainer should be 3 to 4 times that of the suction pipe.

Impeller Eye Too Small:

It is observed that larger the diameter of the impeller eye, greater the capacity of pump. Apart from this direction of rotation may be wrong, viscosity of the fluid may be very high, and gaskets might have worn.

3.1.3 Pump Discharge Pressure Low

Typical causes of this trouble include too low a speed, worn wearing rings, damaged impeller, worn packing, gas or vapor in the liquid, too viscous a liquid, wrong direction of rotation, impeller diameter too small, obstruction in water passages, and worn gaskets.

3.1.4 Pump Loses Prime After Starting

There are number of common causes of this trouble. These are incomplete priming, too high a suction lift, air leaks in the suction pipe or packing glands, gas or air in the liquid, suction line not filled with liquid, air or vapor pockets in the suction line, inlet not sufficiently submerged, low available NPSH, plugged seal-liquid piping, or a misplaced lantern ring in the stuffing box.

3.1.5 Pump Overloads Driver

The common causes of this trouble are low discharge head, too high speed, wrong direction of rotation, too tight packing, distorted casing, and shaft bent or misalignment

3.1.6 Stuffing Boxes Overheat

Common causes of this trouble include packing that is too tight, not enough packing lubricant, wrong grade of packing, not enough seal liquid flowing to the packing, and incorrect installation of the packing.

3.1.7 Excessive Vibration

Gas or air in the liquid leads to a starved suction, as do insufficient NPSH, not enough submergence of the end of the suction pipe, and gas or vapor pockets in the suction line. Other causes of vibration include pump misalignment, worn or loose bearings, rotor unbalanced because of a plugged or damaged impeller, bent shaft, improper positioning of a control valve in the discharge, and a non rigid foundation.

3.1.8 Bearings Overheat

The causes of this problem include too low an oil level, a poor or wrong grade of oil, dirt in the bearings or the oil, moisture in the oil, a clogged or scaled oil cooler, failure of the oiling system, not enough bearing cooling water, bearings too tight, misalignment, or oil seals fitted too closely on the shaft.

3.1.9 Bearings Wear Rapidly

Excessive wear of sleeve, ball, or roller bearings may be caused by misalignment, a bent shaft, vibration, excessive thrust from a mechanical failure inside the pump, lack of lubrication, wrong bearing-installation procedures, dirt in the bearings, moisture in the oil, and excessive cooling of the bearings.

3.2 RECIPROCATING PUMPS (STEAM DRIVEN)

Typical common troubles include failure to discharge, low discharge pressure, short stroking, speed too high, long-stroking, vibration, stalling, discharge-pressure fluctuation and excessive stuffing-box leaks.

3.2.1 Pump Doesn’t Discharge

Discharge trouble is due to too high suction lift, unprimed pump, air or vapor bound suction line or worn parts.

3.2.2 Pump Short Strokes

This may be due to too much steam cushion, wrong lubricant, steam valve leaks, too tight packing, gas or air in liquid, incorrectly set valves, or shoulders in steam cylinder.

3.2.3 Piston Hits Head

This trouble is due to excessive lost motion, misalignment of cushion valves, worn piston rings, or valve leaks.

3.2.4 Low Discharge Pressure

Low discharge pressure may because of low steam pressure, tight packing, high backpressure, worn valve rings.

3.2.5 Discharge Pressure Fluctuates

Higher speed than rated one, tight packing, un primed pump, misalignment in pump, too high suction lift or air bound in suction line lead to the fluctuation in discharge pressure.

3.2.6 Pump Stops

Valve Trouble: Incorrectly set or worn steam valves can cause a steam pump to stop.

3.2.7 Pump Runs too Fast

This may be due to suction line troubles or worn liquid piston packing.

3.2.8 Excessive Packing Wear

Defects in piston rod leads to excessive wear in packing.

3.3 RECIPROCATING PUMPS (POWER DRIVEN)

3.3.1 Power Input Excessive

Due to high discharge pressure, excessive power input required.

3.3.2 Pumps Doesn’t Discharge

Discharge trouble is due to too high suction lift, unprimed pump, air or vapor bound suction line or worn parts.

3.3.3 Piping Vibrates

Undersize discharge or suction pipe leads to vibration of piping.

3.3.4 Power End Is Noisy

Loose or worn Crosshead or guides or bearings, too high speed, loose crankpin or cross head creates power end noisy

3.3.5 Liquid End Is Noisy

Excessive suction lift, gas or air in liquid, valve troubles, too high pump speed leads to noisy liquid end.

3.4 RECIPROCATING PUMPS (METERING PUMPS)

Metering and proportioning pumps of the reciprocating-piston and plunger pumps often develop troubles resembling those given for steam and power pumps. But radial-piston and sucker-rod pumps develop troubles different from both the above. In axial and radial piston pumps the problem may be reduced capacity and noisy operation where as in sucker road pump, apart from this corrosion, erosion and scaling may also occur.

3.4.1 Reduced Capacity or Pressure

Clogged or leaking suction, too low liquid level, too thick oil, or improper functioning of relief valve reduces the capacity or pressure of the pump.

3.4.2 Noisy Operation

Gas, Liquid, or Impact Pounding: Gas entering the pump must be compressed to the same pressure as the liquid; else may lead to noise. Try to restore the original submergence of the pump. Using a higher compression ratio for the pump may also reduce gas pounding. Liquid pounding occurs in wells where the oil is so thick that the suction chamber does not fill during the suction stroke. Metallic pounding may be prevented by changing the location of the polished-rod clamp, using a barrel that is longer, or changing the length of the plunger stroke or the pump speed

3.4.3 Corrosion

Due to improper material of construction, which may get corroded with corrosive liquid.

3.4.4 Erosion

Solids in the liquid, crooked tubing, and not enough lubrication leads to erosion.

3.4.5 Paraffin and scale

Stuck Valves: If paraffin is the cause, dissolve the paraffin around the valves with hot water, steam, or naphtha. Scale, which also sticks valves, is best treated by suitable chemicals.

3.5 ROTARY PUMPS

The most common troubles in rotary pumps are failure to discharge, excessive noise, rapid wears, reduced capacity, excessive power consumption, and loss of suction. The causes and cures are discussed below:

3.5.1 Pumps Doesn't Discharge

Discharge trouble is due to too high suction lift, unprimed pump, air or vapor bound suction line or worn parts.

3.5.2 Excessive Noise

Liquid trouble, misalignment, discharge pressure too high leads to excessive noise.

3.5.3 Excessive Wear

Liquid trouble, casing distortion, too high discharge pressure, leads to excessive wear.

3.5.4 Reduced Capacity

Suction-line troubles, air in pump casing, driver troubles, excessive wear, discharge misdirected reduces the capacity of the pump.

3.5.5 Excessive Power Consumption

Excessive discharge pressure, shaft troubles, too thick liquid, too high pump speed, and internal wears consumes very high power.

3.5.6 Pump Loses its Suction

Due to suction line troubles pumps may loose its suction.

Table 1. Characteristics of Modern Pumps

	Centrifugal		Rotary	Reciprocating		
	Volute and diffuser	Axial flow	Screw and gear	Direct-acting steam	Double-acting power	Triplex
Discharge flow	Steady	Steady	Steady	Pulsating	Pulsating	Pulsating
Usual max. Suction lift, ft.	15	15	22	22	22	22
Liquids handled	Clean, clear, dirty, abrasive, liquids with high solids content		Viscous, nonabrasive	Clean and clear		
Discharge pressure range..	Low to high		Medium			
Usual capacity range	Small to largest available		Small to medium	Low to highest produced Relatively small		
How increased head affects:						
Capacity…	Decrease		None	Decrease	None	None
Power input…	Depends on specific speed		Increase	Increase	Increase	Increase
How decreased head affects:						
Capacity…	Increase		None	Small increase	None	None
Power input…	Depends on specific speed		Decrease	Decrease	Decrease	Dcrease

Reference: Lecture Notes for *3-Day Course on Chemical Engineering for Non-Chemical Engineers & Chemists*, jointly organized by Department of Chemical Engineering of DDIT Nadiad and Ankleshwar Industries Association, Ankleshwar, July 12-14, 1996.