Agricultural Machinery and Equipment operation

Level- II

Based on March 2022, Version- II Occupational Standard

Module Title: - Operating Irrigation Pumps and Equipment

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Introduction to the Module

Irrigation pumps are used to pump water from a lower to a higher level from which the water then flows through channels to the fields requiring irrigation (lift operation) or to raise it to the required pressure head so that it can be sprayed on the fields via piping systems (sprinkling).

LG #23	LO #1-Prepare for irrigation work

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Preparing Irrigation field
- Pumping system lines and outlets
- Crop water requirement and irrigation scheduling information
- Type of irrigation method
- Pipe, fitting valves and water metering
- Source and location of irrigable water
- Occupational Health and Safety (OHS) hazards

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Prepare Irrigation field
- Pump system lines and outlets
- Identify Crop water requirement and irrigation scheduling information
- Identify Type of irrigation method
- Identify Pipe, fitting valves and water metering
- Identify Source and location of irrigable water
- Apply Occupational Health and Safety (OHS) hazards

Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks 5. Perform Operation Sheets 6. Do the "LAP test"

Information Sheet: 1

1.1. Preparing Irrigation field

Land to be irrigated may have uniform slopes in one direction or it may be rolling, but if properly smoothed it can be uniformly wet by a proper location of the ditches carrying the water to all parts of the fields.

In order that the best crop may be grown by irrigation, a uniform wetting of the soil is necessary, and soil can be wet uniformly only when it is smooth. It is not meant by this that it must be level, but only that it must have a smooth surface, so that water can be made to run all over it, and that there shall be no low places in which the water can collect and stand An ideal field or farm for irrigation is one which has a smooth surface and a very gentle slope in one or two directions; but lands so nearly have and with such regular slopes are found only in river bottoms, and are not common. Even where lands are nearly level they almost perfectly smooth surface. It may, therefore, be said that practically no lands are ready for irrigation without some previous preparation other than plowing. The irrigated lands of the arid region and those that are irrigable are generally nearly level, with light sandy or ashy soils, and are commonly covered with a more or less dense growth of sagebrush. High winds are also characteristic of the region. The result is a drifting of the light soils, making hollows in unprotected places and small hills from a few inches to a few feet high, where the wind is broken by brush or any other obstruction.

1.2. Pumping system lines and outlets

A **pump** is a device that moves fluids (liquids or gases) by mechanical action, typically converted from electrical energy into hydraulic energy.

Figure 1.1 Irrigation pum

Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers and other components of heating, ventilation and air conditioning systems. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis.

When a pump contains two or more pump mechanisms with fluid being directed to flow through them in series, it is called a multi-stage pump. Terms such as two-stage or double-stage may be used to specifically describe the number of stages. A pump that does not fit this description is simply a single-stage pump in contrast.

Mechanical pumps may be submerged in the fluid they are pumping or be placed external to the fluid. Pumps can be classified by their method of displacement into positive-displacement pumps, impulse pumps, velocity pumps, gravity pumps, steam pumps and valve less pumps. There are three basic types of pumps: positive-displacement, centrifugal and axial-flow pumps.

In centrifugal pumps the direction of flow of the fluid changes by ninety degrees as it flows over an impeller, while in axial flow pumps the direction of flow is unchanged.

1.2.1. Positive-displacement pumps

A positive-displacement pump makes a fluid move by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe.

Some positive-displacement pumps use an expanding cavity on the suction side and a decreasing cavity on the discharge side. Liquid flows into the pump as the cavity on the suction side expands and the liquid flows out of the discharge as the cavity collapses. The volume is constant through each cycle of operation.

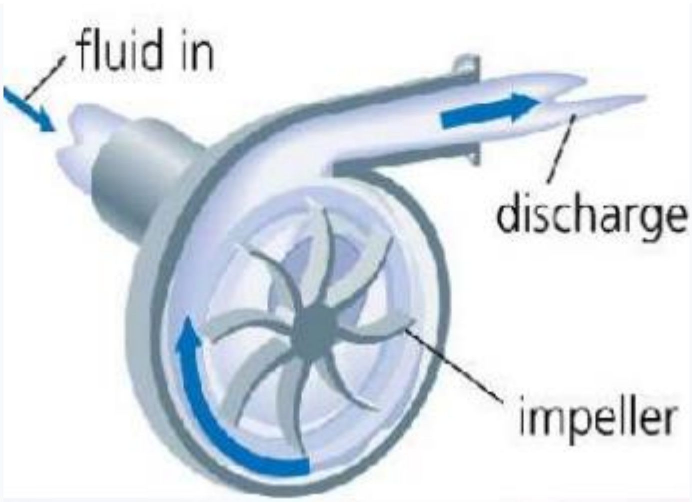


Figure 1.2 Lobe pump internals

1.2.2. Positive-displacement pump behavior and safety

Positive-displacement pumps, unlike centrifugal, can theoretically produce the same flow at a given speed (rpm) no matter what the discharge pressure. Thus, positive-displacement pumps are constant flow machines. However, a slight increase in internal leakage as the pressure increases prevents a truly constant flow rate.

A positive-displacement pump must not operate against a closed valve on the discharge side of the pump, because it has no shutoff head like centrifugal pumps. A positive-displacement pump operating against a closed discharge valve continues to produce flow and the pressure in the discharge line increases until the line bursts, the pump is severely damaged, or both.

A relief or safety valve on the discharge side of the positive-displacement pump is therefore necessary. The relief valve can be internal or external. The pump manufacturer normally has the option to supply internal relief or safety valves. The internal valve is usually used only as a safety precaution. An external relief valve in the discharge line, with a return line back to the suction line or supply tank provides increased safety.

1.2.3. Positive-displacement types

A positive-displacement pump can be further classified according to the mechanism used to move the fluid:

Rotary-type positive displacement: internal or external gear pump, screw pump, lobe pump, shuttle block, flexible vane or sliding vane, circumferential piston, flexible impeller, helical twisted roots (e.g. the Wendelkolben pump) or liquid-ring pumps

Reciprocating-type positive displacement: piston pumps, plunger pumps or diaphragm pumps

Linear-type positive displacement: rope pumps and chain pumps

1.2.4. Rotary positive-displacement pumps

These pumps move fluid using a rotating mechanism that creates a vacuum that captures and draws in the liquid.

Advantages: Rotary pumps are very efficient because they can handle highly viscous fluids with higher flow rates as viscosity increases.

Drawbacks: The nature of the pump requires very close clearances between the rotating pump and the outer edge, making it rotate at a slow, steady speed. If rotary pumps are operated at high speeds, the fluids causes erosion, which eventually causes enlarged clearances that liquid can pass through, which reduces efficiency.

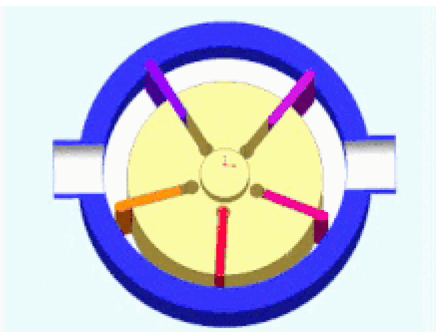


Figure 1.3 Rotary vane pump

- Rotary positive-displacement pumps fall into 5 main types:
  - ✓ Gear pumps – a simple type of rotary pump where the liquid is pushed around a pair of gears.
  - ✓ Screw pumps – the shape of the internals of this pump is usually two screws turning against each other to pump the liquid
  - ✓ Rotary vane pumps
  - ✓ Hollow disk pumps (also known as eccentric disc pumps or Hollow rotary disc pumps), similar to scroll compressors, these have a cylindrical rotor encased in a circular housing. As the rotor orbits and rotates to some degree, it traps fluid between the rotor and the casing, drawing the fluid through the pump. It is used for highly viscous fluids like petroleum-derived products, and it can also support high pressures of up to 290 psi

Vibratory pumps or vibration pumps are similar to linear compressors, having the same operating principle. They work by using a spring-loaded piston with an electromagnet connected to AC current through a diode. The spring-loaded piston is the only moving part, and it is placed in the center of the electromagnet. During the positive cycle of the AC current, the diode allows energy to pass through the electromagnet, generating a magnetic field that moves the piston backwards, compressing the spring, and generating suction. During the negative cycle of the AC current, the diode blocks current flow to the electromagnet, letting the spring uncompress, moving the piston forward, and pumping the fluid and generating pressure, like a reciprocating pump. Due to its low cost, it is widely used in inexpensive espresso machines. However, vibratory pumps cannot be operated for more than one minute, as they generate large amounts of heat. Linear compressors do not have this problem, as they can be cooled by the working fluid (which is often a refrigerant).

1.2.5. Reciprocating positive-displacement pumps

Reciprocating pumps move the fluid using one or more oscillating pistons, plungers, or membranes (diaphragms), while valves restrict fluid motion to the desired direction. In order for suction to take place, the pump must first pull the plunger in an outward motion to decrease pressure in the chamber. Once the plunger pushes back, it will increase the chamber pressure and the inward pressure of the plunger will then open the discharge valve and release the fluid into the delivery pipe at constant flow rate and increased pressure.
Pumps in this category range from simplex, with one cylinder, to in some cases quad (four) cylinders, or more. Many reciprocating-type pumps are duplex (two) or triplex (three) cylinder. They can be either single-acting with suction during one direction of piston motion and discharge on the other, or double-acting with suction and discharge in both directions. The pumps can be powered manually, by air or steam, or by a belt driven by an engine. This type of pump was used extensively in the 19th century in the early days of steam propulsion—as boiler feed water pumps. Now reciprocating pumps typically pump highly viscous fluids like concrete and heavy oils, and serve in special applications that demand low flow rates against high resistance. Reciprocating hand pumps were widely used to pump water from wells. Common bicycle pumps and foot pumps for inflation use reciprocating action.

These positive-displacement pumps have an expanding cavity on the suction side and a decreasing cavity on the discharge side. Liquid flows into the pumps as the cavity on the suction side expands and the liquid flows out of the discharge as the cavity collapses. The volume is constant given each cycle of operation and the pump's volumetric efficiency can be achieved through routine maintenance and inspection of its valves.

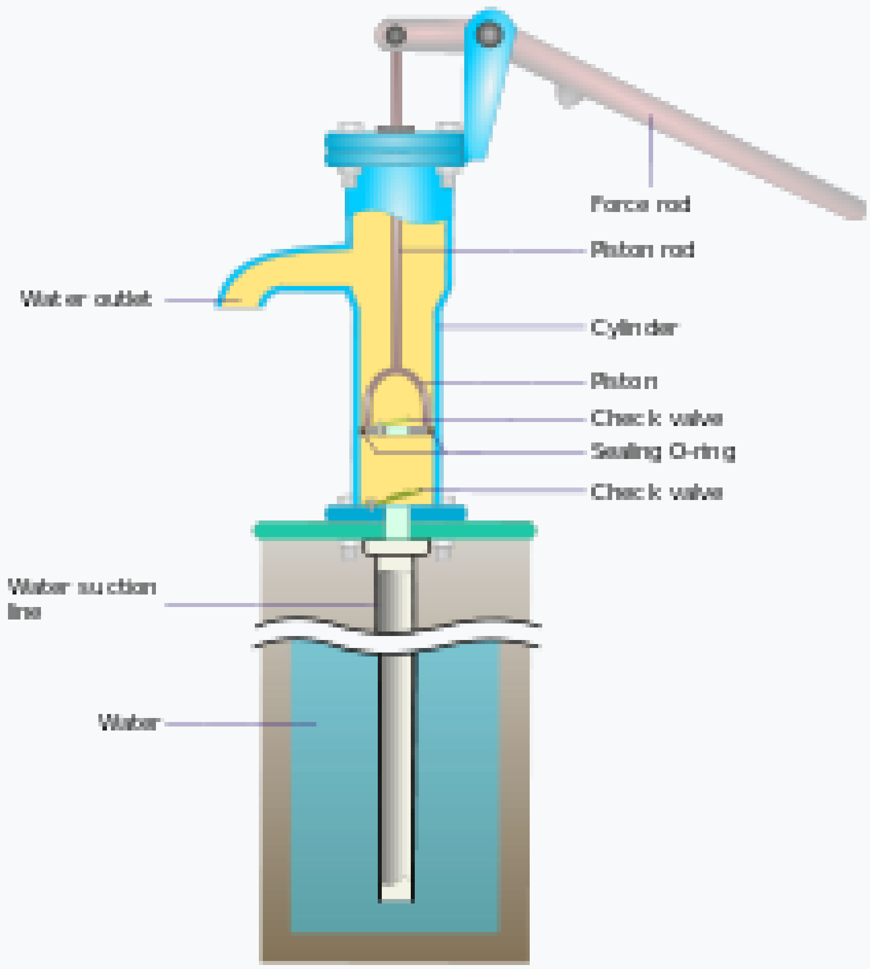


Figure 1.4 Simple hand pump

1.2.6. Typical reciprocating pumps

- Plunger pumps – a reciprocating plunger pushes the fluid through one or two open valves, closed by suction on the way back.
- Diaphragm pumps similar to plunger pumps, where the plunger pressurizes hydraulic oil which is used to flex a diaphragm in the pumping cylinder. Diaphragm valves are used to pump hazardous and toxic fluids.
- Piston pumps displacement pumps – usually simple devices for pumping small amounts of liquid or gel manually. The common hand soap dispenser is such a pump.
- Radial piston pumps - a form of hydraulic pump where pistons extend in a radial direction

1.3. Crop water requirement and irrigation scheduling information

Crop water requirements (CWR) are defined as the depth of water [mm] needed to meet the water consumed through evapo-transpiration by a disease-free crop, growing in large fields under non-restricting soil conditions including soil water and fertility,

1.3.1. The difference between crop water requirement and irrigation requirement

Crop water requirements depend on type of crop, stage of growth and development, and atmospheric conditions. Irrigation water requirement depends on crop water requirement and characteristics of the irrigation system such as uniformity of application and overall efficiency.

1.3.2. Irrigation scheduling

An irrigation scheduling is the decision of when and how much water to apply to a field. Amount of water needed to replenish the soil moisture to the desired level. Irrigation scheduling saves water and energy. All irrigation scheduling procedures consist of monitoring indicators that determine the need for irrigation and achieving full production potential.

1.3.3. The principles of irrigation scheduling

The goal in irrigation scheduling is to apply enough water to fully wet the plant's root zone while minimizing overwatering and then allows the soil to dry out in between watering, to allow air to enter the soil and encourage root development, but not so much that the plant is stressed beyond what is allowable.

1.4. Type of irrigation method

An adequate water supply is important for plant growth. When rainfall is not sufficient, the plants must receive additional water from irrigation. Various methods can be used to supply irrigation water to the plants. Each method has its advantages and disadvantages. These should be taken into account when choosing the method which is best suited to the local circumstances. A simple irrigation method is to bring water from the source of supply, e.g. a well, to each plant with a bucket or a watering can.

This can be a very time-consuming method and involves very heavy work. However, it can be used successfully to irrigate very small plots of land, such as vegetable gardens, that are close to the water source.

More sophisticated methods of water application are used when larger areas require irrigation. There are three commonly used methods irrigation

1.4.1. Surface Irrigation

Surface irrigation is the application of water by gravity flow to the surface of the field. Either the entire field is flooded (basin irrigation) or the water is fed into small channels (furrows) or strips of land (borders).

1.4.1.1. Basin irrigation

Basins are flat areas of land, surrounded by low bunds. The bunds prevent the water from flowing to the adjacent fields. Basin irrigation is commonly used for rice grown on flat lands or in terraces on hillsides. Trees can also be grown in basins, where one tree is usually located in the middle of a small basin. In general, the basin method is suitable for crops that are unaffected by standing in water for long periods

1.4.1.2. Furrow irrigation

Furrows are small channels, which carry water down the land slope between the crop rows. Water infiltrates into the soil as it moves along the slope. The crop is usually grown on the ridges between the furrows. This method is suitable for all row crops and for crops that cannot stand in water for long periods

Irrigation water flows from the field channel into the furrows by opening up the bank of the channel, or by means of siphons or spills.

1.4.1.3.Border irrigation

Borders are long, sloping strips of land separated by bunds. They are sometimes called border strips.

Irrigation water can be fed to the border in several ways: opening up the channel bank, using small outlets or gates or by means of siphons or spills. A sheet of water flows down the slope of the border, guided by the bunds on either side.

1.4.2. Sprinkler Irrigation

Sprinkler irrigation is similar to natural rainfall. Water is pumped through a pipe system and then sprayed onto the crops through rotating sprinkler heads

1.4.3. Drip irrigation

With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants. Only the immediate root zone of each plant is wetted. Therefore this can be a very efficient method of irrigation. Drip irrigation is sometimes called trickle irrigation

- **Function of irrigation systems**

Whatever irrigation method is being chosen, its purpose is always to attain a better crop and a higher yield. Therefore proper design, construction and irrigation practice are of utmost importance. If we fall to maintain the system, it results in lower irrigation efficiencyand thus less benefit from the irrigation system.

It is recommended to give canals, structures and methods a regular check-up and to repair damage immediately. Maintenance of canals and structures is dealt with in the Volumes concerning these subjects.

1.5. Pipe, fitting valves and water metering

1.5.1. Pipes

Irrigation pipes. A network of pipes supplying water to drip irrigation and sprinkler irrigation consists of the following elements: primary pipe, secondary pipe, and tertiary pipe.

Normally a single pipe leaves the pump and moves through the property to deliver water out of the reservoirs to the irrigation filed. A looped system has two pipes that are joined somewhere on the property to form a "loop". Looped systems are used to reduce the size of pipe required to deliver the necessary flow rate. Polyethylene and PVC are two types of pipe that are frequently used in sprinkler and irrigation systems

1.5.2. Fitting valve

Irrigation Valves are used to create various watering zones in an irrigation system. This separation allows for different watering devices to be encompassed in a single system
The 3 common types of valves are linear, rotary, and self-actuated. There are a variety of valve types within each of these categories each having its own benefits. This training course is focused on rotary and linear actuated valves.

1.5.2.1. Linear valves

Linear valves, also known as multi-turn valves, have a sliding-stem design that pushes a closure element into an open or closed position.

Figure 1.5 Leaner valve

1.5.2.2. Rotary valve

A rotary valve is a device commonly used to feed pneumatic conveying systems. They also can be used within various other applications and serve several other functions where a controlled feed of material is required. In its most simplistic form a rotary valve is made up of a rotor rotating within an external housing.

- **The purpose of rotary valve**

Rotary valves for industrial manufacturing are often used in bulk material handling, dust collection or pneumatic conveying systems, depending on the application. The valve is used to regulate the flow of a product or material by maintaining a consistent flow rate suited to the process.

Figure 1.6 Rotary valve

1.5.2.3.Self actuated valve

Self actuating mean spontaneous and natural true to oneself, rather than being how others want Self-actuated pressure control valves serve to maintain an adjustable set-point pressure within certain levels in pipelines or vessels (tanks). They are self-actuating i.e. do not feature additional auxiliary energy such as pneumatic air or electricity to operate.

Figure 1.7 Self actuated valve

1.5.3. Water metering

Water metering is a method, including its associated equipment that helps users to account for water consumption rates that are often coupled to pricing charges per unit consumed. Water metering is a component of public water resource management aimed at monitoring and eventually reducing water consumption.

Water meters measure the volume of water flow through a pipe. This could be the main water supply pipe for an entire facility, or a sub zone, like a refrigeration process. They may measure this volume in cubic feet or gallons.

Figure 1.8 Water metering

The water meter is installed after that valve. After the meter, another valve called the house-side valve is installed. The two valves are there to make it easier for the water department to change out the meter if needed.

One full rotation of the dial equals 1 cubic foot of water or 7.48 gallons. Water meters measure cubic feet of water used. To convert cubic feet to gallons, multiply the number of cubic feet by 7.48.

1.6. Source and location of irrigable water

The location of source of water refers to bodies of water (such as rivers, streams, lakes, reservoirs, springs, and ground water) that provide water to public drinking-water supplies and private wells. Water sources can include: Surface water (for example, a lake, river, or reservoir) Ground water (for example, an aquifer)

The main sources for irrigation water are groundwater from wells, surface water, drainage ponds, rain and municipal water. Drilled wells are a clean source of water for many greenhouse operations; however the water yield from drilled wells is usually limited.

Irrigation water can also come from groundwater, through springs or wells, surface water, through rivers, lakes, or reservoirs, or even other sources, such as treated wastewater or desalinated water. As a result, it is critical that farmers protect their agricultural water source to minimize the potential for contamination.

1.7. Occupational Health and Safety (OHS) hazards

The Occupational Safety and Health Administration describe five categories of occupational hazards: physical safety hazards, chemical hazards, biological hazards, physical hazards, and ergonomic risk factors.

- **OHS and regulatory requirements**

The OHS Act seeks to protect the health, safety and welfare of employees and other people at work. It also aims to ensure that the health and safety of the public is not put at risk by work activities. Some examples of OHS and regulatory requirements are:-

Personal protective equipment and clothing

Workplace environment and safety, safety equipment

Enterprise first aid and first aid equipment

Hazard and risk control and hazardous materials and substances electrical safety

Elimination of hazardous materials and substances

Manual handling, including shifting, lifting and carrying

Emergency procedures

Use of tooling and equipment

Handling of material

Self-check 1	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer (4 point)

1. A network of pipes supplying water to drip and sprinkler irrigation system is called____________.?
   A. Water metering C. Valves
   B. Pipes D. Fittings
2. One of the following is odd
   A. Basin irrigation C. Sprinkler irrigation
   B. Farrow irrigation D. Border irrigation
3. One of the following is used to maintain an adjustable set-point pressure within certain levels in pipelines.
   A. Leaner valve C. Self actuated valve
   B. Rotary valve D. Sprinkler valve

Test II: Short Answer Questions

1. List the three types of positive displacement type pump(6pt)
2. List at least five source of irrigation water(10pt)

Satisfactory>15 ptsun satisfactory rating <15pts

Operation Sheet -1	

1.1 Techniques/ procedures of Measure the amount of water that is applied on a specific irrigation filed

A. Tools and equipments

- Water pump
- Water meter
- Pipes
- Irrigable area/filed

B. procedure

- Put an irrigation pump on a proper place
- Connect pipes to the pump
- Connect water meter to the pipe

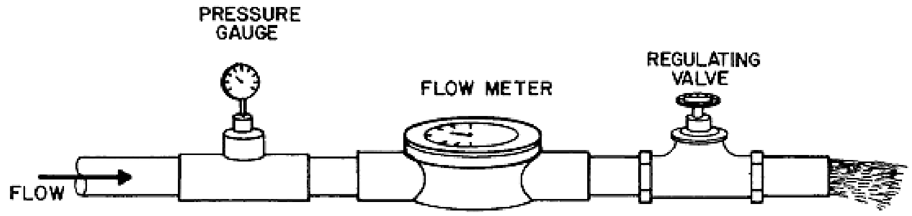
Hint

1Full rotation of the dial equals 1 cubic foot of water or 7.48 gallons.

Water meters measure cubic feet of water used.

To convert cubic feet to gallons, multiply the number of cubic feet by 7.48

Water metering



Pump capacity measuring apparatus

LAP TEST-1	Performance Test

Name………………………………. ID……………………………..

Date…………………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task I. Measure the amount of water that is applied on a specific irrigation filed

LG #24	LO #-2 Prepare irrigation pump and equipment

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Performance characteristics, components and working capacity of irrigation pump
- Selecting and using Appropriate Personnel Protective Equipment
- Pump type, size and associated accessories
- Pump selection procedures
- principles of hydraulics
- Securing and positioning of Pump to receive and deliver water supply
- Performing basic diagnostic procedures
- Conducting cleaning of equipment and Routine pre-operational checks
- Replacing and reporting damaged or worn components
- Identifying and reporting environmental implications

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify performance characteristics, components and working capacity of irrigation pump
- Select and use Appropriate Personnel Protective Equipment
- Identify pump type, size and associated accessories
- Identify pump selection procedures
- Identify principles of hydraulics
- Securee and position of Pump to receive and deliver water supply
- Performing basic diagnostic procedures
- Conduct cleaning of equipment and Routine pre-operational checks
- Replace and reporte damaged or worn components
- Identify and report environmental implications

Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks 5. Perform Operation Sheets 6. Do the "LAP test"

Information Sheet:2

2.1. Performance characteristics, components and working capacity of irrigation pum

2.1.1 Performance characteristics

Performance characteristics are qualities, traits, or individual characteristics that are required for satisfactory performance. As a manager, select the characteristics that best emphasize the qualities that are needed for employees to perform duties and objectives successfully.

2.1.2 Components of irrigation pump

While many factors influence how well a pump performs, the construction of its components is perhaps the most important. Understanding these basic principles can help you ensure that your pumps operate effectively and efficiently for years to come these component parts are:-

- Impeller. The impeller is the most important and central part of pump design.
- Shaft. The shaft is another important pump part, as it transmits power from the motor to the moving parts inside the pump housing.
- Casing.
- Sealing.
- Bearings.
- Couplings.
- Suction Nozzle.
- Discharge Nozzle
- Water Meter. The water meter, as you would assume, measures the amount of water used to irrigate the property.
- Pump Controller.
- Valve box.
- Sprinkler Shut-off valve.
- Backflow Prevention Device.

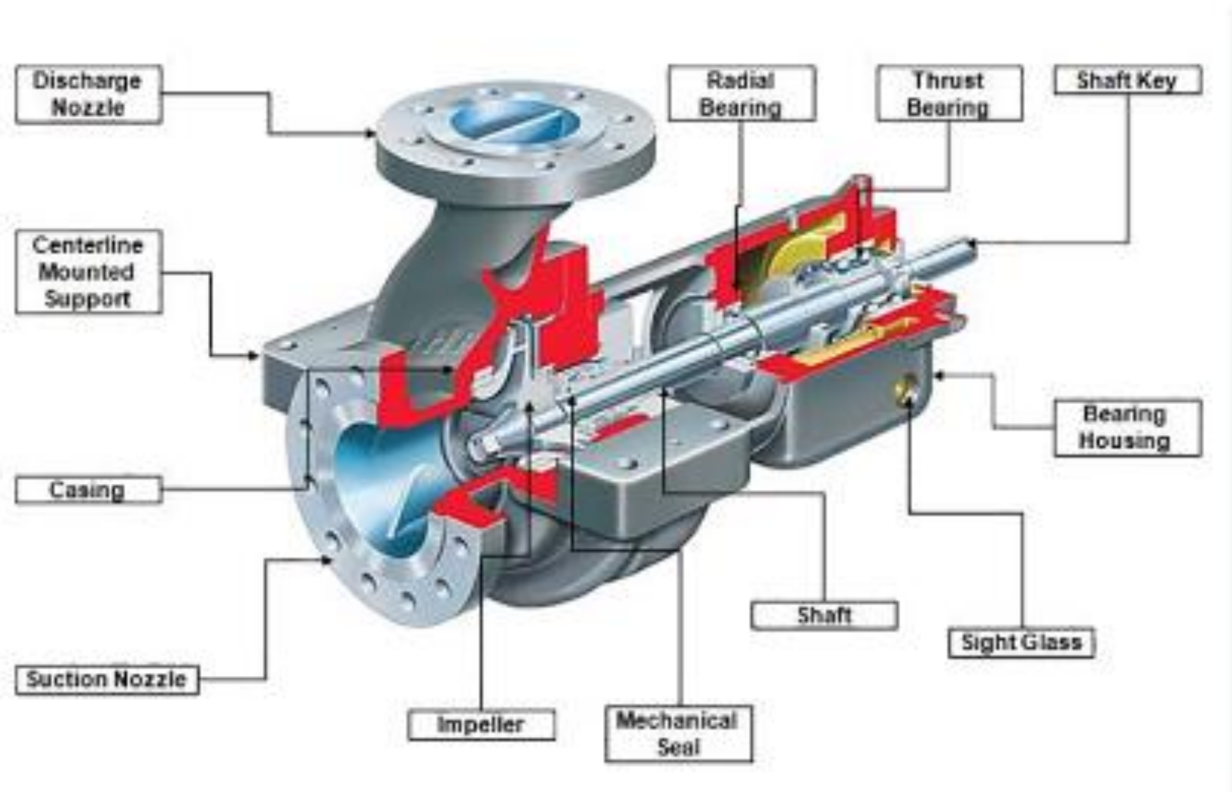


Figure 2.1 parts of pump

2.1.2.1 Impeller

The impeller is the most important and central part of pump design. It is responsible for producing the pumping action that moves water or other fluids through the system. The impeller's shape, size, and design determine how well a pump will perform.

Figure 2.2 Impeller

2.1.2.2 Shaft

The shaft is another important pump part, as it transmits power from the motor to the moving parts inside the pump housing. Most pumps have either a simple straight shaft or an offset shaft in one form or another to optimize performance.

Figure 2.3 Shaft

2.1.2.3 Casing

The casing houses all of the internal components of a pump and forms its outermost shell. Casing designs vary depending on whether they are dry-pit pumps or submersible pumps, but both types should be designed for optimal functionality and performance.

Figure 2.4 Casing

2.1.2.4 Sealing

The seal is a vital part of any pump design because it helps protect the internal components from damage or overheating by preventing water from entering the shaft housing area. Different seals are used based on the pump design and the pump application.

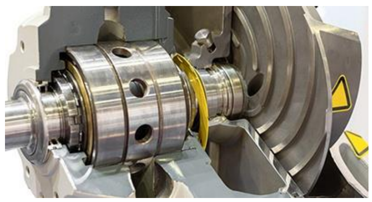


Figure2.5 Sealing

2.1.2.5 Bearing

The bearings are important pump parts that allow the rotating shaft to turn smoothly while transferring power to other moving parts within the system. Modern pumps typically use either ball bearings or roller bearings, which vary in their durability, efficiency, and other properties.

Figure 2.6 Bearings

2.1.2.6 Couplings

The coupling serves as an intermediary between the motor and pump shaft, allowing them to rotate together without slipping or producing too much vibration or noise. Couplings are usually made from plastic, rubber, or metal and come in various shapes and sizes, depending on their application.

Figure 2.7 Couplings

2.1.2.7 Suction Nozzle

The suction nozzle is what draws water into the pump housing so that it can be pressurized and moved through the system. Most nozzles have a specific shape to optimize flow rate, efficiency, and other performance characteristics, but they are also highly customizable for different applications. Getting the design of the nozzle is important to ensure that the pump serves its application in the right way.

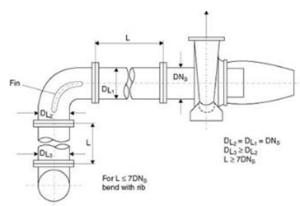


Figure 2.8 Suction Nozzle

2.1.2.8 Discharge Nozzle

The discharge nozzle is responsible for controlling the direction and velocity of the pressurized water being pumped out of the system, which directly affects how much force, will be applied to whatever needs to be moved by the pump.

Therefore, specific pump design details should be considered when selecting a nozzle type for a particular application.

Figure 2.9 Discharge Nozzle

2.1.2.9 Check Valve

An important pump part, the Check Valve, is a special one-wave valve that stops water or other fluid from flowing back into the pump housing after discharge. This is an important safety feature that protects the pump from damage and ensures that it continues to operate correctly.

Figure 2.10 Check Valve

2.1.2.10 Strainer

The strainer is a device that helps remove solid particles from the water or the fluid before they can enter and damage the pump components. It is typically located near the pump's inlet so that water must pass through it before entering the system.

The size and quality of the strainer play an essential role as it guards the pump.

Figure 2.11 Strainer

These are just a few essential pump parts that make up a typical pump design. We need to acknowledge that pumps are complex machines with many moving parts. The auxiliary pump parts include the inlet and outlet check valves, the recirculation valve, the priming valve, and the pressure relief valve. These parts are essential for ensuring that the pump operates properly and efficiently. It is vital to ensure that these pump parts are always in good working condition to rely on your pump for years to come.

2.1.3 Working capacity of irrigation pump

Proper design of an irrigation system requires that the pumping system be precisely matched to the irrigation distribution system. Then the pressure and flow rate required can be efficiently provided by the pumping system.

When an irrigation system is designed or modified to use an existing pumping system, it is necessary to measure the capacity of the existing pump. The irrigation system can be properly designed only if the flow rate and pressure of the pump are accurately measured.

It is not adequate to visually estimate pump capacity or to use the manufacturer's specifications to determine current pump capacity. Visual estimates are normally not accurate, and manufacturer's specifications do not include the effects of site-specific factors such as well characteristics or suction and discharge pipe sizes. Manufacturer's specifications also do not include the effects of age and wear on pumping system performance.

2.1.3.1 Measuring pump capacity

The capacity of a pump has two components, the pump discharge rate and the discharge pressure. The discharge rate is normally measured in gallons per minute (gpm) in English units or liters per second (lps) in metric units. Pressure is normally measured in pounds per square inch (psi) in English units or kilo Pascal (kPa) in metric units. It is necessary to measure both discharge rate and pressure under normal operating conditions in order to determine how the pumping system will operate as a part of an irrigation system.

2.1.3.2 Discharge rate

The discharge rate can be measured using one of the following three methods.

- Flow rate meter is the most direct method because it measures the flow rate directly in gpm or lps. The cost of flow rate meters varies widely. Costs range from about $50 for small pitot meters which measure only flow rate, to several hundred dollars for impeller meters which measure flow rate and totalize the flow through the meter.
- Pitot meters are inserted through a hole drilled into an irrigation pipe. They divert a small stream of water through the meter and float a ball or disk flow indicator. The flow rate is read from a graduated scale at the height of the flow indicator.. An impeller flow rate meter measures both the flow rate and the total flow through the meter. The flow rate is read directly from a needle similar to a car speedometer, and the total flow is registered on a meter similar to the odometer (mileage gauge) on a car. An impeller meter is used as a component of the pump capacity measuring apparatus.
- A totalizing flow meter measures the total volume of water that has passed through the meter in gallons (gal) or liters (l). Totalizing water flow meters are relatively inexpensive because they are commonly used for many applications ranging from metering homeowner's water use to metering agricultural irrigation systems. Their costs range from about $50 for 1/2-inch meters which have capacities up to 10 gpm to $2,000-3,000 for large meters with capacities of several thousands of gpm.
- To determine pump discharge rates with a totalizing flow meter, a stop watch or other watch with a second hand is needed. The volume of water metered must be divided by the time during which the volume was measured to determine the flow rate.

- For example, the meter register reads 200.0 gal at the beginning and 395.0 gal at the end of a 10 minute measurement period. Then the flow rate is (395-200) gal / 10 min = 19.5 gpm or 1.23 lps.
- Flow rates can be measured using a container of known volume and a stop watch. For example, flow is directed into a 50-gal graduated tank for 10 minutes. The volume of water collected is 47 gal. Then the flow rate is 47 gal / 10 min = 4.7 gpm or 0.30 lps.

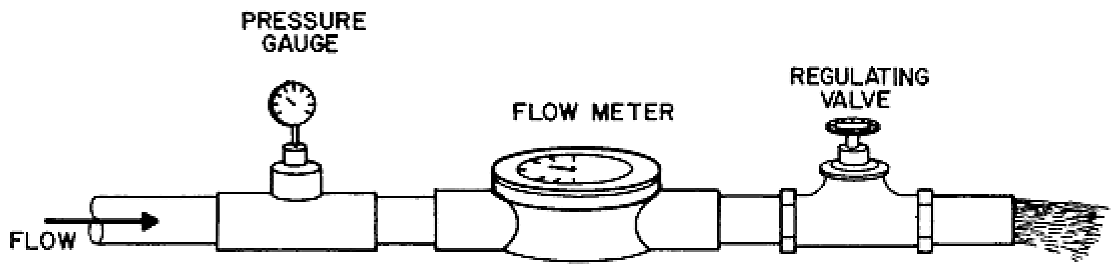


Figure 2.13 Pump capacity measuring apparatus, including a pressure gauge, flow meter, and regulating valve.

- **Discharge pressure**

The discharge pressure can be measured easily and inexpensively using a standard pressure gauge. Select a pressure gauge that is accurate within the range of pressures that the pump can produce.

- **Measuring head-discharge curves**

For centrifugal and turbine irrigation pumps, the discharge rate depends on the pressure that the pump operates against. If the pressure is high, the discharge rate will be low, and conversely, if the pressure is low, the discharge rate will be high. The relationship between pressure and discharge rate is known as the head-discharge curve for the pump. The head-discharge curve may be different for each pump because of the pump characteristics and many site-specific factors.

An apparatus which can be used to measure a pump head-discharge curve is calledPump capacity measuring apparatus, the apparatus consists of a pressure gauge, flow meter, and regulating valve installed on a section of straight pipe. The pipe must be long enough so that the flow meter works properly. Many flow meters require certain minimum lengths of straight pipe upstream and downstream of the meter for accuracy. See the flow meter manufacturer's specifications. Common straight pipe lengths required are 10 pipe diameters upstream and 6 pipe diameters downstream of the meter, although these lengths may be reduced if the flow meter is equipped with straightening vanes. Straightening vanes are installed inside the meter tube and help improve meter performance by reducing extreme turbulence as water is directed through the meter.

A pipe fitting or connecting hose is needed so that the head-discharge measurement apparatus can be connected to the pump discharge. All components must be sized and pressure-rated to permit the measurement of the complete range of pressures and discharge rates that the pump produces.

- **Measure the head-discharge curve in the following steps:**
  - ✓ Connect the head-discharge apparatus to the pump discharge with sufficient lengths of straight pipe to obtain an accurate flow rate measurement.
  - ✓ Operate the pump to remove air from the pump and pipelines and to reach normal operating conditions.
  - ✓ Slowly close the regulating valve and measure the shut-off head. (**Warning**: Be certain that all components are pressure-rated to withstand the maximum pressure that the pump can deliver). The shut-off head is the maximum pressure that the pump delivers when there is no flow. Record this pressure.
  - ✓ Do not leave the pump operating under no-flow conditions for long periods of time, as this may overheat and damage some pumps.
  - ✓ Open the regulating valve a small amount and measure the pressure and flow rate at this valve setting.
  - ✓ Repeat Step 4 at other valve openings until the valve is completely open. Valve adjustments should be made to produce at least 6 to 8 pressure-discharge data points over the flow range from completely closed to wide open.

It is convenient to use the pressure gauge to uniformly distribute the measured data points over the range that the pump can produce. For example, assume that the pump shut-off head was 45 psi. Then, for convenience, adjust the regulating valve to set 5 psi changes in pressure as the valve is opened. First, open the valve until the pressure drops to 40 psi and measure the discharge rate at that pressure. Then, open the valve until the pressure drops to 35 psi, etc., until the valve is completely open and the final pressure is 0 or nearly 0 psi. The final pressure may not reach 0 depending on the specific design of your head-discharge measurement apparatus.

The following figure shows a graph of the data shown in notice that the relationship between pressure and discharge rate is a curve rather than a straight line. This is the reason that at least 6 to 8 data points are necessary to accurately describe this relationship.

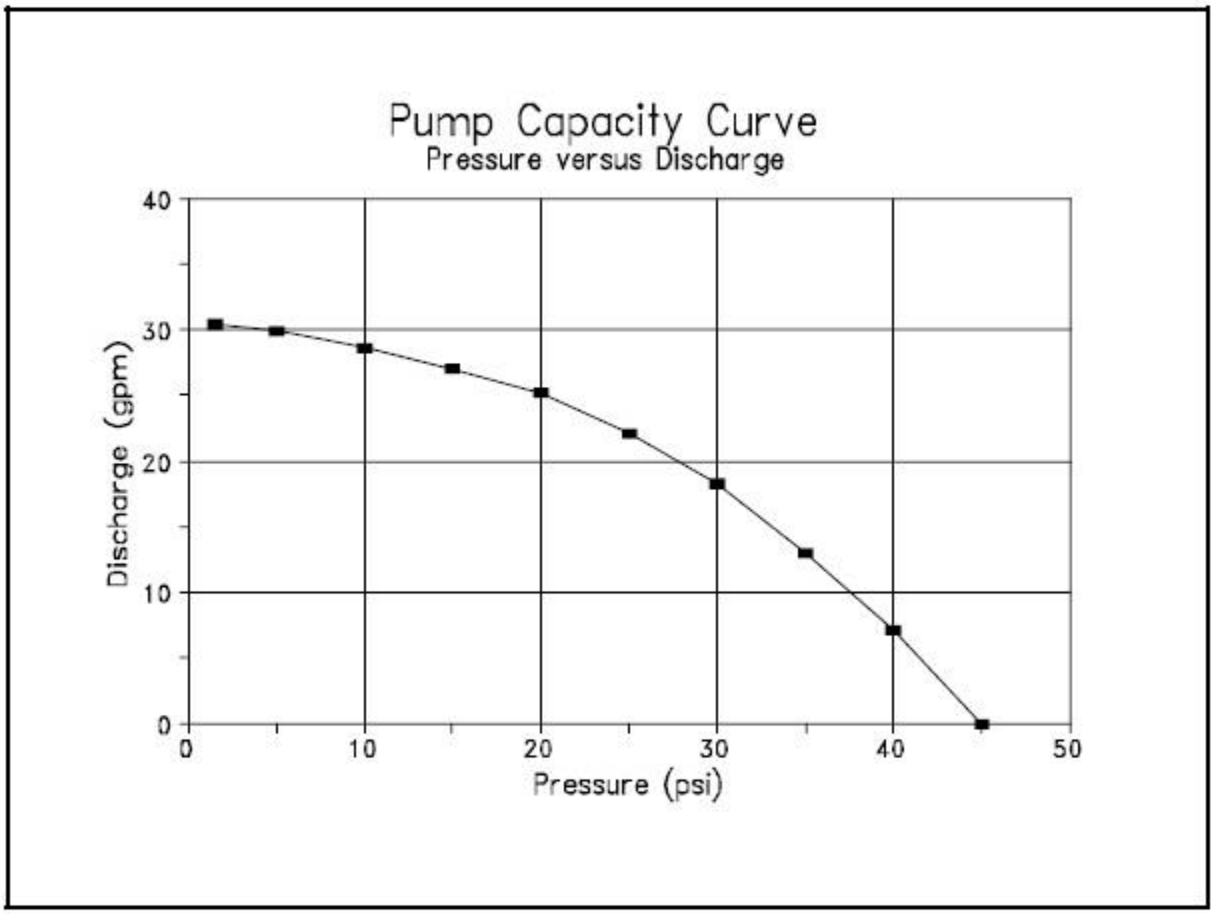


Figure 2.13 how measure pump capacity curve

Factors affecting head-discharge curves

Many factors affect the pump head-discharge curves measured, including the design of the pump and the size of the pump and power unit. Other factors include worn impellers or other components, speed at which the pump is operated, size of well, aquifer characteristics, depth to water table or surface water level, and size of suction and discharge pipes. The size, design, and maintenance of intake screens and check valves also affect pump capacity.

The measurement procedures described in this publication allow the effects of all of these factors to be included, and the results are valid only when the same conditions exist during the operation of the irrigation system. If operating conditions change greatly from the test conditions, then the pump may produce much different outputs when connected to an irrigation system. In the following paragraphs, several examples are given to illustrate changes in pumping conditions that could cause changes in pump capacity.

If water is being pumped from a pond, and the pond water level drops greatly during the irrigation season, the pump output will be reduced as the water level drops. Likewise, if the water level in a well drops, then the pump output will also drop. Thus, pump capacity tests should be scheduled when water levels are low so that the minimum pump output can be measured, or tests should be made at both high and low water levels so that the effects of water levels can be measured.

If the pump is driven by an internal combustion engine, its output will be greatly affected by the engine speed (RPM). Therefore, pump capacity tests must be run at the same RPMs that will be used during irrigation.

If the intake strainer on the suction pipeline becomes partially clogged by debris in a pond, the pump capacity will be reduced. Thus, pump capacity tests should only be conducted after strainers have been cleaned and other maintenance has been performed. Likewise, routine maintenance is required so that the pump capacity is not reduced for this reason during irrigation.

When an existing pumping system will be used as a component of an irrigation system, it is necessary to measure the capacity of the pump so that the irrigation system can be designed to operate efficiently using the available flow rate and pressure. This requires measuring pump discharge rates and pressures at several points over the available range. Flow meters or volumetric methods can be used to measure discharge rates, while pressures are easily measured with pressure gauges. Procedures for measuring pump capacity were presented, and factors affecting pump capacities under field conditions were discussed

2.2. Selecting and using Appropriate Personnel Protective Equipment

Typical PPE and their uses

- ✓ **Head protection** (hard hats, helmets, sun hats) shall be provided where there is a risk of injury to the head, such as a person struck on the head by a falling object, a person may strike his/her head against a fixed object, there may be inadvertent head contact with electrical hazards.
- ✓ **Eye protection** (goggles, safety glasses) shall be provided where a risk of eye injury exists. Typical hazards might include flying particles, dust, splashing substances, harmful gases, vapors, aerosols, and high intensity radiation from welding operations.
- ✓ **Hearing protection** (ear plugs, ear muffs) shall be provided where a risk of noise induced hearing loss exists. The need for hearing protection may be accessed through noise monitoring or surveys.

Figure2.14 ear plugs, ear muff

- ✓ **Respiratory protection** (respirators, face masks, cartridge filters) shall be provided where
  there is a risk of airborne contaminates. This will minimize the risk to of exposure to an atmosphere that is or may be injurious to health.

- ✓ **Hand protection** (gloves, gauntlets) shall be provided where there is an identified hazard associated with a potential for hand injury. A list of hazards shall be compiled for each workplace and suitable hand protection obtained to minimize risk.

Figure2.15 gloves, gauntlets

- ✓ **Protective footwear** (safety boots, gumboots, enclosed shoes) shall be provided where the nature of the work exposes the employee to a medium to high risk of injury to feet, eg occupations such as workshop/maintenance and gardening staff.

Figure2.16 safety boots/enclosed shoes

- ✓ **Body protection** (high-visibility garments, thermal wear, overalls, aprons, safety harnesses) shall be provided to minimize risk of injury occurring to the body. Examples may include those who are required to work outdoors and are exposed to the sun's rays for continuous periods in a day. Direct exposure of the skin to UV radiation from outdoor work shall be minimized by providing hats, long sleeves/trousers and an adequate supply of sunscreen.

Figure2.17 overalls, aprons

- ✓ **Outer wear** (high visibility safety vests, reflective vests, flour jackets) shall be provided to highlight the worker in the area often used where there is a risk of injury associated with working on or near roadways or near moving traffic or moving plant

2.3. Pump type, size and associated accessories

2.3.1 Different types of irrigation pump

Pumps used for irrigation include centrifugal, deep-well turbine, submersible and propeller pumps. Actually, turbine, submersible and propeller pumps are special forms of a centrifugal pump. However, their names are common in the industry.

Pumps can be classified by their method of displacement into positive-displacement pumps, impulse pumps, velocity pumps, gravity pumps, steam pumps and valve less pumps. There are also different types of pump these are:-

- **Portable pump**

Portable pumps are independent pumping units that can be carried by one or several firefighters. They are usually centrifugal pumps powered by a small diesel, or two- or four-stroke, petrol engine.

Figure2.18 Portable pumps

If you need a pump that's easy to transport between projects or around different areas of the same site, a portable pump can be the right solution. Portable pumps are easy to transport and set up without additional accessories or parts. As stand-alone units, portable pumps are smaller than many other models and can be carried and moved around by one or more people.

While portable pumps provide mobility, the trade-off is that they generally offer lower output capacity compared to mounted or permanently installed pumps. However, because they're portable, these machines are easy to reposition as needed to ensure you get the thorough dewatering you need. Small portable pumps are also sometimes called self-priming because they do not need a separate pump primer. However, the pump casing does need to be filled with water to prime it before pumping.

Portable pumps range in size, with smaller ones being much easier to position precisely. You can choose from a range of maximum flow rates and discharge head sizes to get the right functionality you need.

- **Submersible pumps**

Submersible pumps are positioned underwater to push water to the surface, where it gets collected and removed. The pump motor is hermetically sealed, making it waterproof so that it can operate directly within a body of water. To operate a submersible pump, you submerge the entire assembly into the water, making it useful for confined spaces. A submersible pump must remain completely submerged during operation for it to function properly.

Being submerged, a submersible pump operates more efficiently than other types of pumps that use jet-streams because it doesn't require priming. This is because it operates directly in the water. Without needing separate priming, submersible pumps can save your operation time and effort.

Because submersible pumps push rather than pull water, they conserve more energy and reduce power costs compared to units that remain near the body of water. For this reason, submersible pumps can be used as basement sump pumps in commercial and industrial buildings.

- **Electrical pump**

An electrical pump is a machine or device for raising, compressing, or transferring fluids.

✓ **Working principles of electric air pump**

An air compressor turns power (gasoline or an electrical motor) into potential energy. This potential energy is stored in a tank and forces air into the tank creating positive pressure. Normally a hose is connected to the tank and then when opened with a valve or switch air is shot out of the hose at high speeds.

✓ **The difference between mechanical pump and electrical pump**

The biggest difference between electrical and mechanical fuel pumps is that mechanical pumps rely on moving parts to pull fuel out of the tank and into the engine, whilst electrical pumps use electricity and computer power to push fuel to the engine.

✓ **Advantages of an electric pump**

Electric motors have less vibration and lower heat than diesel powered pump equipment. In other words, electric pumps have less chance of breakdowns and malfunctions. It needs less time to maintain equipment and more time getting the job done.

Figure 2.19 electric pump

✓ **Reliability of electric pump**

Electric pumps are far more reliable than their diesel counterparts, especially in cold weather or high elevations. Traditionally, basic diesel engine problems could often be sorted by a mechanically minded worker within your quarry, but now days with more complex equipment and new regulations, this is rarely practical or safe.

✓ **Increase in production**

Because electric pumps are so reliable and require less maintenance than their diesel-powered cousins, they can increase production by allowing you to spend more time working on other tasks. Whether that means spending more time finding new quarries or simply completing more jobs each day, an electric pump will help you get more done in less time – which means more cost savings for your company.

✓ **Electric pumps are more efficient**

Electrically driven pumps are more efficient than diesel pumps, meaning you use much less power to achieve the same amount of water transfer or head pressure. Despite a century of improvement, even the most modern diesel engines lose 60-70% of their energy through heat, noise and friction, meaning they are only 30-40% efficient. Compare this to electric motors converting over 70% of energy into mechanical power. Whilst installation of electrically powered equipment might take additional time initially, this is mitigated by saving you the task of repeatedly re fuelling.

- ✓ **Reduce cost**

The cost of diesel has gone up significantly in recent years and months, with the perfect storm of oil supply issues coupled with duty rates penalizing emission-emitters. In some areas, electric power is already cheaper than diesel. There is approximately 10Kwh of energy per litre of diesel so as an example of the fuel savings you could make:

- ✓ **Better for the environment**

Electricity is made from an increasing variety of sustainable sources – wind, solar, hydroelectric dams, and nuclear power plants, with green-hydrogen generation on the horizon too. However long diesel will be around for, clean energy will become continually more available and incentivized as we push towards net-zero. Therefore, an electric pump is a better choice for the environment and business now and into the future.

Electric pumps have zero emissions and fuel pollution risks on site and require less decontamination when they are decommissioned or recycled at the end of their lifespan. The importance of carbon footprint and emission reduction is well appreciated by companies in the quarrying, mineral processing and recycled aggregate industry. When you choose an electric pump, you are working towards a greener future for your business and the planet.

- **Diesel/ gasoline engine pump**

A diesel pump, which is usually referred to as a diesel fuel injection pump, is a somewhat complex mechanical piece of equipment. It is the mechanism that is used to pump fuel from the fuel tank into the carburetor, so it does just as the name suggests.

Figure 2.20 Diesel/ gasoline engine pump

As the majority of fuel transfer pumps are intended for commercial use, there is an especially wide range designed for diesel. However, pumps are also available for use with all kinds of fuels & other liquids, including petrol, & even food products.

✓ **Types of diesel pump**

There are 4 types of diesel fuel pumps

- Common rail fuel injection pump. An electronically controlled diesel fuel supply system, this pump was developed to meet the strict 21st century exhaust gas regulations.
- Distributor (rotary) fuel injection pump.
- In-line fuel injection pump.
- Distributor injection pump.

- **The main difference between gasoline and diesel engines**

The only difference between the two is how the explosions occur. Gasoline engines use a perfect mix of fuel and air that are compressed by the pistons and ignited from the sparks created by spark plugs. Conversely, in diesel engines the air is compressed before the fuel is directly injected into the combustion chamber.

- **Axial pump**

Axial pumps are used for the promotion of incompressible fluids and are employed for large volume flows at relatively low delivery heads. As with all types of centrifugal pumps, the energy transmission in axial flow pumps is carried out exclusively through flow-related processes. Axial pumps are used for the promotion of incompressible fluids and are employed for large volume flows at relatively low delivery heads. As with all types of centrifugal pumps, the energy transmission in axial flow pumps is carried out exclusively through flow-related processes.

Axial flow pumps are centrifugal pumps in which the fluid is pumped parallel to the pump shaft. The flow mechanism in a centrifugal pump can generally be described as follows: Through a suction flange the liquid flows through the suction hub into the rotating impeller due to an energy fall. The pump unit absorbs mechanical energy from a drive motor through a shaft. The blades of the impeller which is permanently fixed on the shaft exert a force on the fluid and increase its angular moment. Pressure and absolute speed increase as a result. Consequently energy is being transferred to the fluid. The energy which is present in kinetic form as an increased absolute speed is usually converted into additional static pressure energy by a diffuser device. Nowadays volute casings or bladed diffusers normally are being used as diffuser devices. In combination with the impeller the diffuser device represents the so-called hydraulic of the pump. To maintain the flow there also has to be an energy fall directly behind the pump after the outlet from the discharge flange, analogous to the pump inlet. Losses occurring in the system for example due to friction or leakage flows require an increased power consumption of the pump.

Axial flow pumps differ in their constructive and functional characteristics due to their pre determined installation location and the liquid to be pumped. For pumps of one model range various installation types may be implemented. The hydraulic characteristics and the pumping performance remain nearly unchanged. Main characteristics are the design of the shaft in the horizontal or vertical position, the position of the pump connections and the connection type of the pump to the drive unit using a coupling or direct assembly on the motor shaft (block design).

- **Solar pump**

The solar centrifugal pump is designed for pond management, farm irrigation, garden water transfer, domestic water supply, and tower water supply.

- ✓ **Features of solar centrifugal water pump:**
  - ➢ Power input type: Solo Direct Current.
  - ➢ Less noisy & high efficiency operation.
  - ➢ The solar pumps take permanent magnet Brushless motor.
  - ➢ The Current of it is controlled electronically, as these results in less electro-magnetic noise and high-efficiency performance.

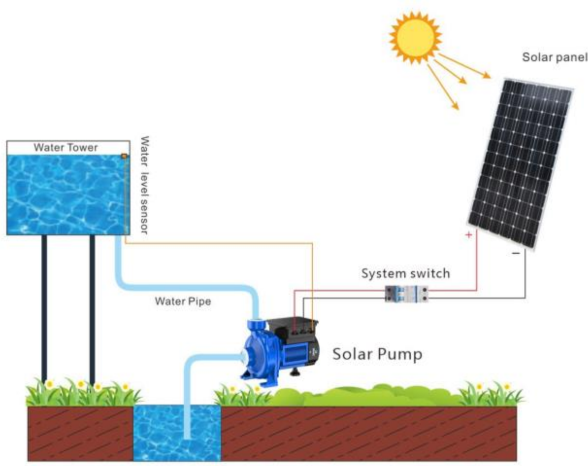


Figure 2.21 solar centrifugal water pump

- ➢ Battery is not necessary in the solar pumping system. If a battery is planned to be to connected in it, a battery charger is required.
- ➢ The wiring between solar pump and controller is finished by manufacturer before go to market. The controller and pump is not separable.
- ➢ A system switch is equated to control the ON/OFF of the pumping system.

- **Function of solar surface pump**
  - ✓ Thermal protection.
  - ✓ Anti-dry run protection.
  - ✓ Anti-block protection.
  - ✓ Voltage & Current & Power protection.

2.3.2 Accessories of irrigation pump

- Pressure Switch. The controller for automation of the garden pumps
- Water filter & accessories.
- Water tank hose kit with pressure switch.
- Pro Max floating withdrawal.
- Sealing materials and hose clamps.
- Hose.
- Hose tails.

Quick couplings are some examples of accessories of irrigation pump.

2.4. Pump selection procedures

- **Selecting an irrigation pump**

We can select our irrigation pump based on the following information

- ✓ Discharge and pressure (or head) required.
- ✓ Suction conditions.
- ✓ Frequency of operation.
- ✓ Reliability required.
- ✓ Source of power available.
- ✓ Cost per unit of power.
- ✓ Capital cost, depreciation and interest charges.

A step-by-step guide to choosing the right pump for your agriculture needs

Pump selection plays a vital role in meeting the requirements of your irrigation needs. The right irrigation pump ensures that the water requirements are met for your crops as well as provides the best efficiency to get the most out of the layout of your field. Here, in today's article, you can find all that you need to know to find the right type of pump for your agriculture needs. Understanding the basics though there are several types of irrigation techniques in practice, the goal is the same to pump water from the source and to distribute it evenly within the field. The aim here is to keep the energy requirements low while ensuring that all plants receive adequate amounts of water neither too low nor too high. Modern irrigation techniques can meet these goals with the help of the right water pumps. To ensure uniform irrigation of a field, the entire cultivable area is divided into smaller regions called as zones. Zones can be segregated based on soil types, crops cultivated, and irrigation requirements and so on. Each zone is watered with the help of pipes, tubes, sprinklers, and valves, which are connected to a pump. The entire field is divided into zones because a single sprinkler doesn't have the required pressure and flow to irrigate the whole area at a time. An irrigation controller (it can either be mechanical, electrical, or digital) is responsible for turning on and off the sprinklers in a particular zone at a specific time.

Step 1 – Choose your Irrigation Equipment

Different equipment requires different amounts of water and pressure. Hence, it's vital that you choose the equipment first before selecting your pump. While choosing irrigation equipment, make sure to consider the controller. The controller plays a crucial role in turning off and on water supply at specified periods, or during rains, heavy winds, direct sunlight, etc. The controller is responsible for water conservation, as it turns off the pump at a pre-set time, so that water seeps adequately into the soil. This reduces runoff and infiltration. Today, smart pump controllers are gaining popularity. These devices use plenty of data like soil humidity, weather, moisture and rain sensors to determine optimal water requirements for your crops.

Step 2 – Consider the Water Source Type

The rule of thumb for successful irrigation is adequate access to water. Just a few decades ago, water was considered as an infinite resource. Sadly, the situation is reversed today, and there is an acute shortage of water in all regions of the country. This means you need to take the right steps to ensure that water is managed efficiently in your field. The general sources of irrigation water include groundwater from wells, springs or bore wells, surface water from lakes, rivers, reservoirs and other non-conventional sources of water like reclaimed water, drainage water, desalinated water, waste water and so on.

Step 3 – Determining the Irrigation Pump Type

The location of the water source plays a crucial role in determining the type of pump. Here's a general guide on what pump works well for different water sources:

Turbine pumps and deep-well submersible pumps are suitable to draw water from deep underground, think wells, bore-wells, etc.

When it comes to surface water, you can use several different types of pumps. One advantage of using submersible pumps with groundwater is that the pump is not visible, thereby reducing chances of theft and reduced pump operation noise.

Two elements necessary to ensure uniform flow of water are – availability of adequate water and the crop's specific requirements. While choosing water pumps, it's considered a best practice to use more than one pump. Instead, of a single large pump, using several small pumps offers various benefits like – reduced aquifer drawdown, decreased energy consumption, easy cut in/cut off pumps based on varying requirements, etc.

Step 4 – Figuring out the Right Pump Size

Generally, irrigation pump used in irrigation are either over-sized or under-sized. Choosing the correct pump size is essential for the success of your irrigation system. Some factors to consider while deciding on the pump size are:

- Power consumption
- System pressure
- Variable speed controls
- Motor protection

Step 5 – Calculate the Efficiency of the Pump

Calculating the overall efficiency of the system is a must before the final irrigation pump selection is made. The electricity costs depend on how many kW the motor runs on. The pumps and the motors in the system have varying efficiencies. Here's a simple formula to calculate the efficiency: **Efficiency% = Q * H / 3.67 * P1**

Here, Q = water flow measured in m^3/h

H = head pressure measured in meters

P1 = the kW of the motor

Most pump manufacturers provide you with all the required data. This helps in calculating the right efficiency. Remember that your pump must do more than delivering water to the pipes and ultimately the crops.

Step 6 – Don't forget System Integration Today, pumps are no longer stand-alone devices. They have to be integrated with the rest of the irrigation system. This means the pump you choose must match the irrigation equipment perfectly for the best results. All the elements listed above must be integrated to provide the maximum cost savings to the modern farmer. You can reduce operational costs by ensuring that the water pressure is not higher than required and by using the right controls. Similarly, maintaining the correct water flow and pressure translates to more energy savings. Water delivered at the right precision and at the right time to the crops results in higher yields, better harvests, thereby increasing profitability. Apart from profits, the right pump also ensures better water management, thus making sustainable agricultural practices a possibility. The Last Word We hope this article helps you in finding the right irrigation pump for your irrigation requirements. For any further clarifications, shoot your queries to our experts here at Sintech, India's largest pump manufacturer and supplier.

2.5. Principles of hydraulics

The basic principle behind any hydraulic system is very simple - pressure applied anywhere to a body of fluid causes a force to be transmitted equally in all directions, with the force acting at right angles to any surface in contact with the fluid. This is known as Pascal's Law.

According to Pascal's principle, in a hydraulic system a pressure exerted on a piston produces an equal increase in pressure on another piston in the system.

2.6. Secure and positioning of Pump to receive and deliver water supply

Sprinkler System Installation Guide

STEP1.

Place a stake or flag at every sprinkler location as indicated on your layout. Use string to show where the pipe will run.

STEP2.

Dig trenches following the string. Mark the sprinkler locations with flags or the stakes.

To run pipe under existing walkways you can "drill" using water pressure. Get a piece of PVC long enough to go under the walk, glue a slip-female thread adapter to one end and attach a hose. On the other end glue a slip-male thread adapter and connect a Jet Spray Nozzle (available at most home improvement and home & garden retailers).

Dig your trench up to the walk on both sides. Now turn on the water and work your way through. It may take a while, and it will get muddy so turn off the water once in a while to let the water soak in.

To make trenching easier ask your local tool rental supplier about a "power trencher." If you are using a Poly Pipe, ask about a pipe pulling machine, which will bury pipe without digging up your lawn. Be sure to put enough space between valves on the manifold so that they can be removed in case they ever need to be replaced.

STEP 3.

Hook up your water supply. Did you check with your Rain Bird Dealer to find out which connections are right for your local codes and conditions?

STEP 4.

Assemble your valve manifold. Connect the back-flow preventer if required.**PVC pipe** is available in a variety of diameters and wall thickness'. Your system will operate better and be more durable using a larger diameter

Poly pipe is mostly used in colder climates. Poly pipe is more flexible and is less likely to be damaged by freezing. Rain Bird does not recommend using poly pipe for the main line connecting pipe.

PVC cement is applied to the inside of the fitting and the outside of the pipe. Quickly insert pipe all the way, giving a 1/4 turn to distribute the cement and hold a few seconds.

A **primer** is available to prepare the pipe and fittings for gluing. Read the manufacturers instructions before using PVC cement.

Poly is assembled by sliding a clamp over the pipe, insert the fitting all the way then bring the clamp into position and tighten.

STEP 5.

Place lengths of pipe along the string after laying out the right sprinklers and connectors at each stake. Note: Using swing joints or EZ Pipe makes positioning sprinklers easier.

STEP 6.

Start assembling moving from one sprinkler location to the next. Don't connect the sprinkler until everything is assembled so that you can flush the system with water to clear out any dirt that got in the pipes.

STEP 7.

Manually flush the system.

Turn on the water at the "shut-off" to supply your system, then operate the valves manually to flush the system. Open each valve to flush the pipe with water, then close.

Refer to the valve instructions for manual operation. You should do this with each valve.

STEP 8.

Attach the sprinklers after flushing the system with water.

STEP 9.

Wire the valves to the timer following the instructions that come with your timer. Be sure to write down which timer "station" runs which zone and keep these notes near your timer.

Now test each zone, using the timer to control the valves. Make any adjustments to the distance and directions of the sprinklers.

When everything is working right, bury the pipe.

2.7. Performing basic diagnostic procedures

These are **diagnostic** tools necessary to properly analyze **pumping** plant operations and provide information for adjustments or possible changes in equipments.

- Discharge, lift and water pumping are used to determine hourse pawer out put of the pump

The procedure during the test is:-

- ✓ Start pumping plant and bring the system to normal operating condition
- ✓ Check and not the pumping water level
- ✓ Check the pressure and water flow rate to see if it is at normal condition, if not change it
- ✓ Check and not water pumping level
- ✓ Reapit it until the water level has stabilized
- ✓ Make sure the engine and gear head are at their normal operating condition
- ✓ Begin testing by recording engine rpm (use operating manual)
- ✓ Begin fuel measurements for diesel
- ✓ Check and record pumping water level
- ✓ Reapit flow rate measurement by using flow gage/water meter

Test is valid if pump rpm did not change more than +/_(0.5)% rpm during the test and if pumping water level did not change more than 1%during the test.

If not valid reapit the test.

- The 5 Leading Causes of Pump Problems

Typical problems with pumps usually fall under 5 key causes:

- ✓ Cavitations
- ✓ Fouling

- ✓ Wear
- ✓ Motor issues
- ✓ Water (i.e. aquifer) level

2.7.1. Cavitations

Cavitation refers to bubbles forming in a fluid. This happens any time the local pressure drops below the vapor pressure of that fluid for that temperature. This is the same phenomenon that causes boiling

Another way to look at this is to say that for water at ambient pressure, you would need a roughly 40X pressure drop to cause cavitations. This is absolutely possible for a pump to do. Let's see what happens when it does

Figure 2.22 Impeller damage from cavitations

Cavitations within a pump can cause pitting in the pump's impeller, volutes, and casing, which weakens the metal and also hugely increases resistance to flow within the pump. This in turn wrecks pumping efficiency.

When vapor bubbles form within the fluid, they tend to exist only for a short time before collapsing again. When they collapse, they cause intense shockwaves which stress the pump's internal surfaces. Repeated application of these stresses is what causes the pitting and fractures we see in this image. Cavitations can also introduce shock loads to the shaft and motor, which will decrease their service lives.

2.7.2. Fouling

Fouling happens most often in the distribution lines connected to the pump's intake or outflow, but it is possible for the pump itself to experience fouling as well, when:

Very fine particulate matter adheres to the pump's internal surfaces, or

When a pump ingests coarse particulate matter that it cannot expel out the outflow.

Negative Effects:

Fouling will greatly decrease a pump's efficiency and may cause it to fail completely.

Figure 2.23 Fouled pumps and irrigation lines.

2.7.3. Wear

Groundwater contains **particulate matter**. And particulate matter can be rough on irrigation pumps:

Sometimes this is present in very small amounts, and sometimes in very large amounts.

Regardless of the size of particulates or their concentration, these particulates scour the interior surfaces of a pump and roughen them.

Just like with pitting, over time this leads to reduction in pumping efficiency because the pump must work harder and harder to move water.

Eventually the pump can become so worn that it is unable to produce enough lift to supply water to crops.

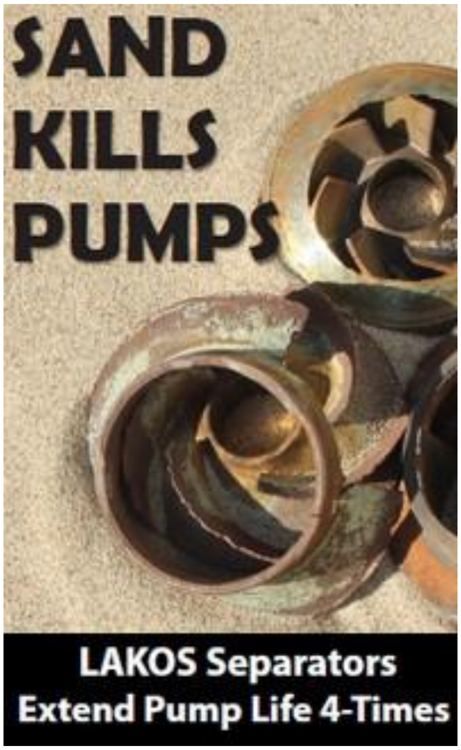


Figure 2.24 Sand-damaged pump impellers.

2.7.4. Motor issues

Electric motors can **overheat**, causing damage to the stator's insulation.

If **water** is introduced into the motor housing this can also damage the insulation and may cause some components to rust.

These problems can typically be addressed with a rewind and refurbishing process which restores the motor to its original efficiency.

Figure 2.25 electric motor stator that has experienced extreme heat damage

Bearing wear may allow the rotor to come into contact with the stator's surfaces. This is a more serious problem and in extreme cases can result in catastrophic failure of the motor and/or pump. Issues related to this typically cannot be repaired, and require motor replacement instead.

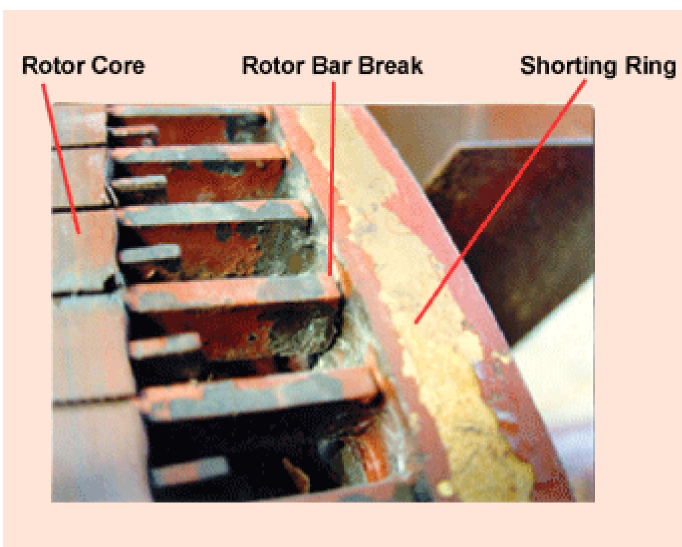


Figure 2.26 Damaged electric motor rotor

2.7.5. Water level

As long as the **groundwater** level is above the intake of the pump, water can be continuously drawn into the irrigation system as seen in this diagram:

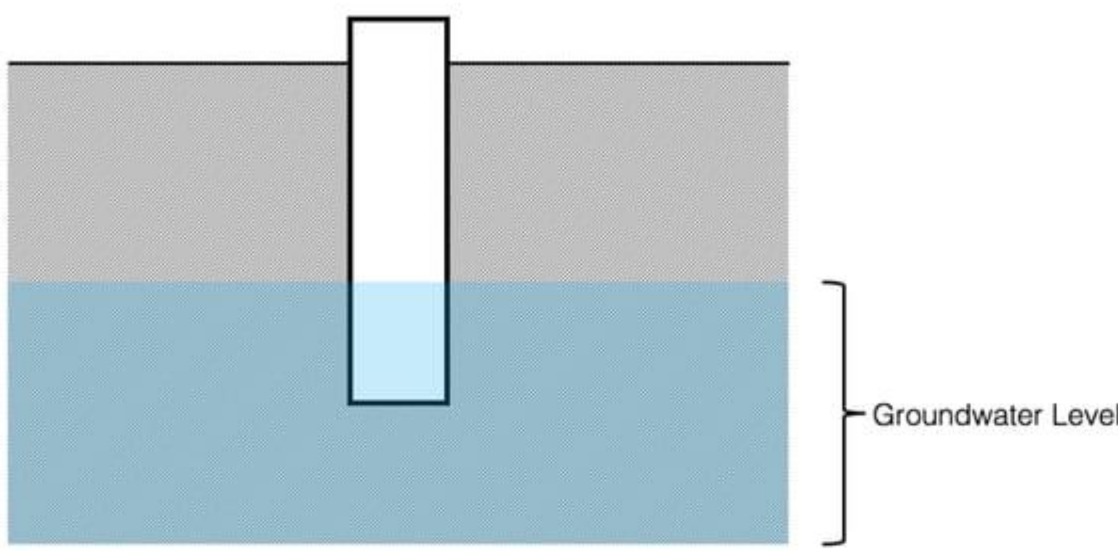


Figure 2.27a Water level

When the pump begins operating, however, there is some amount of dip in the water level locally. This is called ***drawdown***. Sometimes drawdown can bring the water level below the pump intake, resulting in the pump sucking in air. This in turn can cause problems similar to capitation, as seen in this diagram:

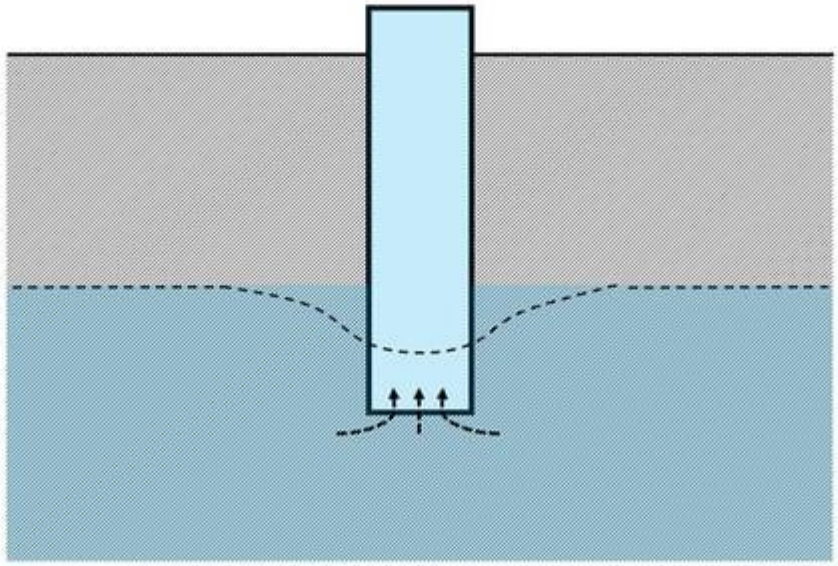


Figure 2.27b Water level

The aquifer can also become **depleted**. If this happens, the water level throughout the entire aquifer is simply too low for the pump to reach it, and the well must be dug deeper if it is to extract more water.

Aquifer depletion has been an major issue over the last several years during California's unprecedented drought. More growers have had to drill deeper wells to reach ever-lowering water levels in their local aquifer. This in turn causes a need for more energy usage to extract that deeper water, which increases stress on the utility grid and increases growers' utility bills.

2.8. Conduct cleaning of equipment and Routine pre-operational checks

If water is dripping from the unit, that is a sign of a problem with one of the check valves. The device is actually functioning properly

Daily maintenance involves checking for wet and dry areas, monitoring the pump system and checking the central controller to ensure it is properly programmed. Weekly maintenance often includes observing sprinkler operation to make sure they are properly rotating and that there are no leaks or clogged nozzles.

2.9.Replacing and reporting damaged or worn components

Bearings, couplings and seals are the most common pump components to fail. Experience has shown that overlooking these items will not only cost in maintenance dollars but also in resources and downtime that will increase operating costs.

2.9.1. Irrigation Pump: repair or replace

This is one of the major questions that homeowners frequently ask when their irrigation pumps break down. But the cost of purchasing an irrigation pump compared to repairing an existing one can be costly. Therefore, it is recommended that as soon as your irrigation pump starts to malfunction, you should contact a licensed Irrigation Repair Technician near you. Your technician will advise you on whether you should repair or replace your irrigation pump.

2.9.2. Warning signs that Your Irrigation Pump Needs Repair

2.9.2.1. Irrigation pump is not turning on

If your irrigation pump is not turning on, don't panic. This can result from a tripped circuit breaker. Check your breaker; if it's tripped just reset it and try again to turn the pump on. If the pump refuses to turn on, then it might be one of two things. Either something is wrong with the pump motor, or the pump wiring and these are deeper electrical issues that will need professional attention.

2.9.2.2. Loud Screeching or Humming Sound

If your pump sounds like an airplane when in operation and causes you severe ear pain, then the motor bearings are getting bad. Bearings are joints that spin the shafts freely. If the shafts are not spinning freely, the motor bearings need to be changed.

A power surge or overheating can also blow the capacitor. If the capacitor is blown you will hear a humming sound. Not to worry, this is easy to fix.

2.9.2.3. Irrigation Pump is Older than 15 years

The cost of maintaining a very old pump, regardless of the type of irrigation pump, far outweighs the cost of replacing it. If your pump is older than 15 years it will start to breakdown and will need frequent repair. This is when you may want to consider replacing it.

2.9.2.4. Loss of water

This is one of the most obvious signs that your irrigation pump needs to be repair. But first, check your pipe valves and pipe lines to make sure that they are not the problem. If you cannot do this yourself; call the technicians.

2.9.2.5. Overall Poor Performance

Blockage will cause your irrigation system to perform poorly. Leaves and other types of debris can build up in the system and cause blockage.

2.10. Identifying and reporting environmental implications

The environmental effects of irrigation relate to the changes in quantity and quality of soil and water as a result of irrigation and the subsequent effects

Increased groundwater recharge, water logging, soil salinity. Increased groundwater recharge stems from the unavoidable deep percolation losses occurring in the

Self-check 2	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer (4 point)

1. When a pump ingests coarse particulate matter that it cannot expel out the outflow, this will greatly decrease a pump's efficiency and may cause it to fail completely this will cause____________?

A. Cavitations C. Wear

B. Fouling D. Motor issues

2. One of the following is not standard for selecting irrigation pump.

A. Suction conditions. C. Reliability required.

B. Frequency of operation D. Type of crop to be irrigated

3. One of the following is not to be consider while deciding on the pump size

A. Power consumption C. Variable speed controls

B. System pressure D. Soil type of irrigable filed

Test II: Short Answer Questions

3. List at least 10(ten) Components of irrigation pump (6pt)
4. List at least 10 personal protective equipment(10pt)

Satisfactory>15 ptsun satisfactory rating <15pts

Operation Sheet -2	

2.1 Techniques/procedurs of performing basic diagnostic procedures of irrigation pump

A. Tools and equipment

- Flow meter
- Water meter
- Regulating valve
- Pump
- Stop watch

B. Procedure

- Start pumping plant and bring the system to normal operating condition
- Check and note the pumping water level
- Check the pressure and water flow rate to see if it is at normal condition, if not change it
- Check and not water pumping level
- Repeat it until the water level has stabilized
- Make sure the engine and gear head are at their normal operating condition
- Begin testing by recording engine rpm (use operating manual)
- Begin fuel measurements for diesel
- Check and record pumping water level
- Repeat flow rate measurement by using flow gage/water meter

Test is valid if pump rpm did not change more than +/_(0.5)% rpm during the test and if pumping water level did not change more than 1% during the test.

If not valid reapit the test

LAP TEST-2	Performance Test

Name………………………………. ID……………………………..

Date…………………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task 1 Perform basic diagnostic procedures of irrigation pump

LG #25	LO #-3 Operate pump

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Assembling pump with power source and accessories
- Priming pump and get ready for operation
- Operation and function of pump and checking driving power unit
- Pump performance curves
- Head pressure calculations
- Checking pump controlling equipment
- Starting pump for operation
- Observeing and ensuring Pumpspressure, suction head, total head of flow
- Checking operational valves and valve assemblies for leaks
- Avoiding of personal injury and damage equipment during operation
- Reporting mechanical malfunctions
- Assessing and minimizing Potential risks to self, others and the environment
- Implementing Emergency Shutdown procedures

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Assembling pump with power source and accessories
- Priming pump and get ready for operation
- Identify Operation and function of pump and checking driving power unit
- Identify pump performance curves
- Perform head pressure calculations
- Check pump controlling equipment
- Startpump for operation
- Observee and ensuring Pumps pressure, suction head, total head of flow
- Check operational valves and valve assemblies for leaks
- Avoid of personal injury and damage equipment during operation
- Report mechanical malfunctions
- Assess and minimizezing Potential risks to self, others and the environment
- Implement Emergency Shutdown procedures

Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks 5. Perform Operation Sheets 6. Do the "LAP test"

3.1.Assembling pump with power source and accessories

A pump assembly includes all the components necessary for the pump to operate and is custom designed and manufactured to fit inside the intended equipment. Components typically include the: Pump, Electric motor, house etc. The operating principle of the pump is to convert mechanical energy to pressure. In operation, a rotating impeller accelerates a liquid and as the area of the pump casing expands the velocity of the fluid is converted to pressure. As a result pressurized fluid exits the pump discharge

Fast the bearing housing through the shaft and then fit the bearing in housing.

Fix retaining cir clip forbearing and apply required grease for the bearing.

Fit the bearing housing cover.

Renew the top and bottom o-rings for casing cover

3.2. Priming pumps and get ready for operation

Priming, or, the Priming Effect, occurs when an individual's exposure to a certain stimulus influences his or her response to a subsequent stimulus, without any awareness of the connection. These stimuli are often related to words or images that people see during their day-to-day lives.

In practice, self-priming pumps are previously filled with the relevant fluid through a small port located on the pump body (the chamber where the impeller is located). After this operation, the pump can be operated, triggering turbulence that allows the fluid to rise and “clear” the piping of air.

- **Priming centrifugal pumps**

In short, to avoid failures, centrifugal pumps must always be primed before operating. Positive displacement pumps are self-priming with suction lift capability, but always check the operation manual or confer with an engineer to ensure the pump will properly function at start up without priming first.

Priming of a centrifugal pump is the process of filling the liquid at the suction pipe and the impeller. Priming is done to put pump into working order by filling or charging with water.

3.3.Operation and function of pump and checking driving power unit

The operating principle of the pump is to convert mechanical energy to pressure. In operation, a rotating impeller accelerates a liquid and as the area of the pump casing expands the velocity of the fluid is converted to pressure. As a result pressurized fluid exits the pump discharge.

When the water hits the rotating impeller, energy of the impeller is transferred to the water, forcing the water out (centrifugal force). The water is displaced outward, and more water can now enter the suction side of the pump to replace the displaced water. Functions of pump

Irrigation pumps are used to pump water from a lower to a higher level from which the water then flows through channels to the fields requiring irrigation (lift operation) or to raise it to the required pressure head so that it can be sprayed on the fields via piping systems (sprinkling).

A pump produces liquid movement or flow: it does not generate pressure. It produces the flow necessary for the development of pressure which is a function of resistance to fluid flow in the system.

3.4.Pump performance curves

A pump performance curve indicates how a pump will perform in regards to pressure head and flow. A curve is defined for a specific operating speed (rpm) and a specific inlet/outlet diameter.

The nozzle of the sprinkler(s) dictates the total flow produced by the pump. Once you know the total flow needed by your sprinkler, the pump curve or performance curve will tell you if your pump can: Provide the necessary flow. Produce the desired flow at a high enough pressure to get all the way out to your sprinkler.

All four types of performance curves (i.e., decelerated, accelerated, S-shaped, and linear) can reflect important persistent (i.e., long term) and transitory (i.e., short term) improvements in motor learning

- **Factors affect the pump performance curve**?

Out of those, the main (major) factors which affect the performance of the pump are:

- ✓ Impeller design.
- ✓ Improper priming.
- ✓ Insufficient NPSH.

- ✓ Reduced capacity.
- ✓ Wrong direction of rotation.
- ✓ Clogging of suction pipeline and impeller.
- ✓ Improper shaft alignment.
- ✓ Packing troubles.

3.5.Head pressure calculations

Understanding How to Calculate Water Head Pressure

In infrastructure hardening, particularly when sealing against water, field professionals may be required to calculate water head pressure. This paper explains how to calculate water head pressure to help project planning.

Water head pressure at a specific location is simply determined by the height (or depth) of the water above that location. Below, we walk through a few examples.

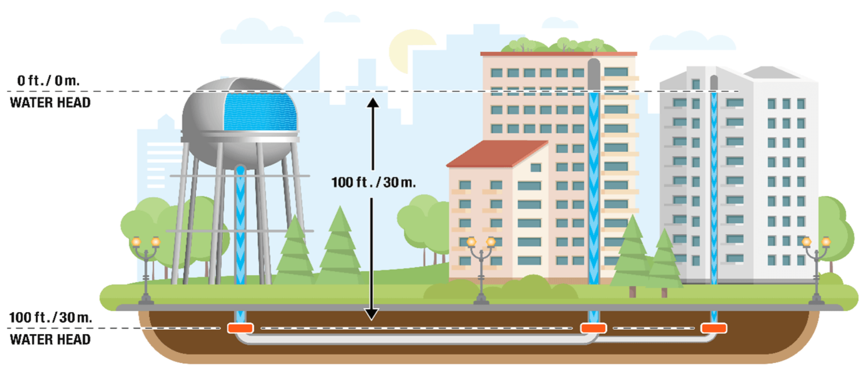


Figure 3.1 Water head pressure

A 20-foot (6-meter) diameter water tower is 100 feet (30 meters) tall and is full. Thus, the water level is 100 feet (30 meters) above the ground. The water head pressure at the ground would be 100 feet (30 meters). The water head pressure is not affected by total volume of water, only by the height. Nearby, there are two ducts rising 100 feet (30 meters), a 2-inch (5 centimeters) and 4-inch (10 centimeters) duct. Both ducts are filled with water. The water head at the ground for each would also be 100 feet (30 meters). The total amount of water does not factor into the calculation of water head pressure, nor does the duct diameter. The only factors that matter are the height and depth of the ducts.

3.5.1. Widespread duct system

A manufacturing plant has a seal at the bottom of a complex duct system. The system spans hundreds of feet (meters) laterally at multiple heights with various diameter ducts. At one point, this system is filled with water to 20 feet (6 meters) above the seal. The water head pressure at the seal is 20 feet (6 meters). The size of the ducts and the lateral distance covered has no effect on the water head pressure. A second seal placed 100 feet (30 meters) away at the exact same depth also has 20 feet (6 meters) water head. Only the height of the water above the seal matters.

If, in this same plant, there were a seal connecting two sections of duct and both duct sections contain water, the water head pressure on the seal would be the difference between the height/depth of the water on each side. 20 feet (6 meters) of water on side 1 versus 15 feet (4.5 meters) of water on side 2 would yield a water head pressure of 5 feet (1.5 meters), pushing from side 1 toward side 2. The 15 feet of pressure on side 2 is effectively resisting and offsetting the 20 feet of pressure on side 1.

3.5.2. Comparing manholes

Two manholes with identical depths (say 12 feet or 3.6 meters) are set at grade level, but due to a change in elevation, manhole 2, a city block away, is 5 feet (1.5 meters) higher than manhole 1. If the ground water level is the same depth for both manholes, the water head pressure for a sealed conduit at the bottom of manhole 2 is 5 feet (1.5 meters) lower than that of manhole 1. This is because when measuring from the bottom of the manholes, the water is 5 feet (1.5 meters) deeper for manhole 2. Note that, in this scenario, the conduits are empty, and the water head pressure is from the ground water pushing up on the seal.

However, consider two identical manholes, both 12 feet (3.6 meters) deep. Manhole 1 is located in Denver at 5,300 feet (1,615 meters) above sea level, and manhole 2 is located in Minneapolis at 830 feet (253 meters) above sea level. Both manholes are filled to the top with water. The water head pressure for a sealed conduit at the bottom of each manhole is 12 feet (3.6 meters). Elevation has no effect here. The information that matters is the depth of the water at each location.

3.5.3. Directional bores

Jupiter Island, Florida is served by electrical power supplied through conduits bored under the inter coastal waterway. The elevation of Jupiter Island is 15 feet (4.5 meters) above sea level, while the mainland has an elevation of 22 feet (7 meters). Regardless of the depth or shape of the bore, or the current tidal conditions, a seal on the island placed at 15 feet (4.5 meters) above sea level will be under no water head pressure because there is no water above it. Water head is always dependent on the water depth at that specific location. If, however, there is a sealed conduit exposed to the ocean at a depth of 10 feet (3 meters) at low tide, the water head at that seal is 10 feet (3 meters) at low tide. The water head pressure will increase as the water depth increases with the incoming tide.

- **Water head is the height of the water**

Water head is simply based on the height of water in the system. A mechanical or foam seal can be made to keep water out of a system or to keep water within the system. In either case, the pressure on the seal is based on the water height. Though systems vary in their complexity, calculating water head is a straightforward concept.

Despite the information available on water head pressure, it is not affected by the following:

- ✓ The total amount of water,
- ✓ The diameter of the duct or conduit,
- ✓ The horizontal length of the duct or conduit, nor
- ✓ The geographical elevation of the system.

The examples in this paper illustrate that, no matter the complexity of the system, water head pressure is dependent only on the height (or depth) of the water above a specific location. If there is no water above the seal, there is no water head pressure.

The pressure head is defined by $H=p/\gamma+z$,

Where p is the pressure,

Y is the fluid specific weight,

And Z is a vertical coordinate, positive upwards.

3.6.Checking pump controlling equipment

A control system is a system that is used to control the behavior of a device or process. It is made up of three main components: a sensor, a controller, and an actuator.

A Pump Control Panel includes power components to control the pump motor, sensors to protect the pump, and pilot devices for operator control. Additional sensors are used to monitor the process for automatic pump operation.

The controller controls the pump speed and thus the output of the pump. The input variables are given by various sensors, such as flow meters and level sensors. Then information triggers the pump controller, which then adjusts the speed of the pump to the optimal.

Liquid, solids or powders, gases or air, and steam are media choices. In terms of the user interface, pump controllers may include a digital front panel or have analog components such as knobs, switches, and meters.

Typical examples are:

- Reciprocating piston pump
- Positive-displacement pump
- Diaphram pump
- Gear pump
- Screw pump
- Vane pump
- Hose pump, etc. Their main common features are the flow rate varies with the rotational or stroke speed.

3.7.Starting pump for operation

Before starting the pump, do the following:

Step 1: Open the suction valve.

Step 2: Open any coolant lines present in the pump system.

Step 3: Depending on system conditions, you can fully or partially open the exhaust valve.

Step 4: Start the driver.

3.8. Observing and ensuring Pumps pressure, suction head, total head of flow

pump head pressure

You can measure the head pressure by installing a pressure gauge or manometer and comparing this with the manufacturer's documentation for the diameter of piping in the system. If this is lower than advertised then the pump is not performing correctly and mayneed to be repaired or replaced.

The total head of the pump is the difference between the total discharge head (point 2) and the total suction head (point 1). The term “total” indicates that it includes the static pressure head (h), the velocity head (hv), and the elevation head (Z). The equation for total head (pump)

The difference between total head and suction head

Total head the total pressure difference between the inlet and outlet of a pump in operation.

Suction head the inlet pressure of a pump when above atmospheric pressure. Suction Lift the inlet pressure of a pump when below atmospheric pressure.

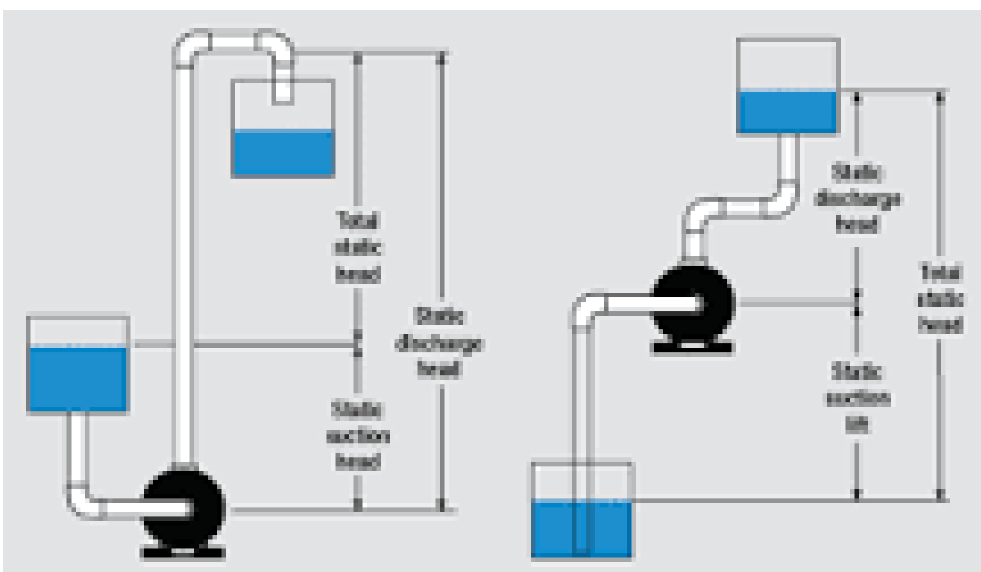


Figure 3.2 total head and suction head

3.9. Checking operational valves and valve assemblies for leaks

- Top 5 failures in pumps and how to detect them

Mechanical seal leakage, most leakages usually take place at the interface between the two seal faces, but there are occasions when leakages also come from the secondary sealing area.

- ✓ Process issues.
- ✓ Bearing issues.
- ✓ Impeller wear and tear.
- ✓ Coupling-related issues.

Valve leakage is tested using either a hydrostatic test (i.e., the test medium is a liquid, such as water or kerosene) or a pneumatic test (the test medium is a gas, such as air or nitrogen)

Critical check valves are inspected/tested using three main methods: externally, internally and, in unique situations, in-line function testing.

Systems, Critical Check Valves (CCVs) are defined as check valves in piping systems that have been identified as vital to process safety. CCVs can be found throughout every facility's processing-equipment units and systems. They are check valves that need to operate reliably in order to avoid the potential for hazardous events or substantial consequences, should reverse flow occur. A good rule of thumb for determining whether a check valve is "critical" in your process is, when using your site's risk matrix, if the failure of a check valve causes a consequence of concern or if a check valve is identified as a safeguard to reduce the likelihood of a consequence of concern, hence lowering a specific risk to an acceptable level, then that check valve should be classified as critical.

- **Common Types of Check Valves**
  - ✓ **Piston Check Valve**

A piston check valve is a type of valve that is used to prevent reverse fluid flow. This type of valve is mechanically automatic and thus it does not need an actuator or valve operator. Piston check valve manufacturers design this valve to allow fluid flow in one direction only.

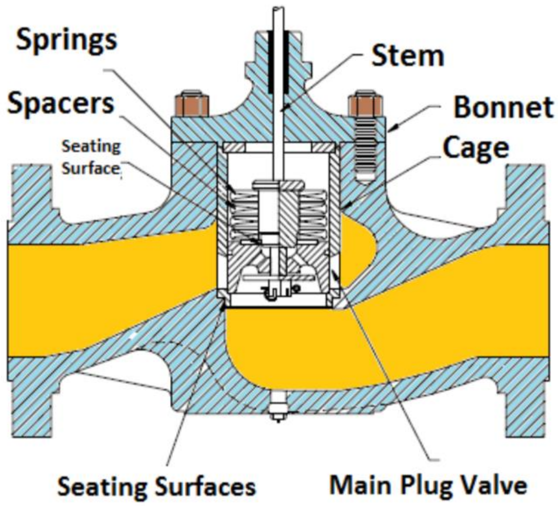


figure 3.3 Piston Check Valve

- ✓ **Ball Check Valves Disc Check Valves**

A ball check valve functions by means of a ball that moves up and down inside the valve. The seat is machined to fit the ball, and the chamber is conically shaped to guide the ball into the seat to seal and stop a reverse flow.

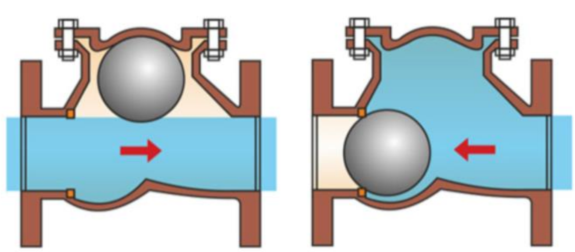


figure 3.4 Ball Check Valves Disc

- ✓ **Butterfly Check Valves**

The butterfly swing check valves are self-acting and fast-closing valves which prevent a working medium from flowing back in a pipeline. They are used in order to prevent from backflow the pumps, fans etc. The check valve is not a shut-off valve.

Figure3.5 Butterfly Check Valves

3.9.1. Inspect Critical Check Valves

Critical check valves are inspected/tested using three main methods: externally, internally and, in unique situations, in-line function testing.

3.9.1.1. External Inspection

External visual inspection of check valves is part of the external visual inspection for piping circuits. The scope of this type of inspection includes a visual inspection of the piping and all the piping components, including check valves.

3.9.1.2. Internal Inspection

Internal visual inspections typically involve removing and disassembling the bonnet cover and inspecting for fouling, corrosion, and worn or missing parts. Larger valves can be removed from service and inspected. Smaller, welded valves can still be inspected by removing the bonnet during a shutdown.

Internal visual inspection typically includes the following steps:

Check to ensure the flapper is free to move as required, without looseness beyond tolerance due to wear.

The flapper stop should not have wear beyond tolerance. A worn flapper stop will allow the flapper to move past the top dead central position and remain in an open position when the check valve is mounted in a vertical position.

The flapper nut should be secured to the flapper bolt to avoid backing off in service.

Backflow leak checks are not normally required, but might be considered for special circumstances. This test, also known as a bubble test, is usually performed in a valve shop by applying air to the downstream side of the check valve while the upstream side is submerged in water; then, the number of bubbles is counted and the data is compared to specific acceptance criteria.

Furthermore, when a nut is used to assemble a disc or plate to the hinge arm, the nut must be positively secured to prevent separation. A single tack weld, lock washer, or lock nut is not acceptable. Also, check valves with external shafts require an inspection of the condition of the shaft retainer mechanism and seats. Check valves with internal shafts must be inspected to ensure the shaft cannot work its way out of the body.

3.9.1.3. In-line function inspection

In-line backflow testing is not as common as external and internal inspections, but some companies do require in-line testing (function testing) to take credit. If necessary, in-line testing requires a specific piping configuration to simulate reverse flow and measure such backflow on the upstream side of the check valve.

- **Integrity Management**

Ensuring the mechanical integrity (MI) of critical check valves is now a requirement ("shall") under; but more than that, history has proven that reliable check valves prevent process safety incidents. If you do not know where to start, here are five steps to establishing your CCV MI program.

Identify and validate the check valves that should be considered critical.

Determine the risks associated with the failure of those identified check valves.

Based on identified risks and process conditions, develop inspection strategies, associated frequencies, and an appropriate level of inspection to ensure the proper function of each CCV.

Inspect and document the inspections for each CCV.
Adjust inspection frequencies based on previous results and lessons learned.

3.10. Avoiding of personal injury and damage equipment during operation

3.10.1. Operational safety of pump

It's important to ensure pumps do not overheat; to avoid the problem, always leave the suction and discharge line open during operations. However, if overheating occurs, stop the pump immediately and allow it to cool to the air temperature. Then vent the pump at the drain plug, slowly and cautiously, before restarting.
Pumps can break and become hazardous if you try to use them to pump substances they weren't designed to handle. Acids, corrosive substances and flammable substances should never be pumped using an ordinary water pump.

3.10.2. The risks of pumping equipment

The potential hazards associated with operating and maintaining pumps' seal systems improperly include fire, explosion, contamination and adverse health and environmental effects. The results can be catastrophic. By understanding seal systems and operating them correctly, users can minimize safety hazards.
Centrifugal Pumps can overheat and damage internal components. On top of that, they can also cause serious burns to workers servicing the pump. Don't allow a Centrifugal Pump to overheat. Leave the suction and discharge lines open during operation.

3.10.3. PPE required for centrifugal pump operation.

The standards will be specific to your equipment and operations but consider things like safety glasses, hearing protection, proper gloves, no loose or baggy clothing, and protective footwear. This is crucial to centrifugal pump safety. Even the best and most reliable equipment requires service.

3.11. Reporting mechanical malfunctions

Report all types and all sizes of mechanical fitting failures which result in a hazardous leak regardless of the material composition of the fitting.

3.11.1. Causes of pump malfunction

- Root causes of this are generally:-
- ✓ Undersized suction lines,
- ✓ Plugged suction strainer or valve issues and
- ✓ **Cavitations:** when liquid pressure falls below vapor pressure, bubbles form and implode on impellers and interior surfaces, damaging pump internals, disrupting flow and leading to seal failure.

- **Common failures in pump system**
  - ✓ **Overheating** is one of the most common causes of pump failure. It can be caused by several factors such as:-
    - ➢ Incorrect installation,
    - ➢ Insufficient lubrication or
    - ➢ Foreign objects blocking the cooling fins.

3.11.2. Common failures of centrifugal pump

Centrifugal pumps, which are a common pump used in industry, are known to fail as a result of problems that arise within the fluid, such as cavitations, and mechanical faults, such as found in bearings and seals. Vibration monitoring has been found to be suitable in determining faults within pumps.

- **Mechanical water pump failure**

Water pumps can fail prematurely due to corrosion inside the cooling system or from an imbalanced water-pump shaft. If there's a mechanical fan mounted on the water-pump shaft, vibrations are the result of a bent fan blade, which can lead to the shaft cracking or breaking. A bent pulley also can cause the same damage.

There are 3 top causes of water pump failure caused by external issues and techniques for prevention.

- ✓ Contaminated Coolant. Engine coolant protects a vehicle's engine from extreme heat and freezing temperatures.
- ✓ Too Much Sealant.
- ✓ Defective System Components.

3.12. Assessing and minimizeing Potential risks to self, others and the environment

There are a number of risks associated with pumping a liquid at a high pressure, and these need to be minimized to ensure that installations are as safe as possible.

3.12.1. Minimizing risks

However, there are a number of risks associated with pumping a liquid at a high pressure, and these elements need to be minimized to ensure that installations are as safe as possible. In view of this, it is generally better to consider the pumping system as a whole rather than a collection of components from a variety of suppliers. Working with a company which takes overall control of the safety requirements is often a desired route. Ensuring the highest levels of safety can be considered.

Consider the application

The fundamental questions, of course, are: what liquid needs to be pumped and what task needs to be accomplished, Key factors that have to be considered are:

Selection of the right materials of construction for the application which will depend on the liquid that is to be pumped.

Physical location of the pumping system and whether it should be fixed or portable, factors here include overall size, plumbing to and from the pump, atmospheric conditions, available power, noise, emissions and

System design and installation basics

When constructing high pressure pumping systems there are a number of basic guidelines that should be followed for a safe installation and operation. They include:

Always install a primary pressure regulating valve and a secondary safety relief valve in all high-pressure systems.

True positive displacement pumps generate liquid flow and, whatever happens downstream, that flow always needs to go somewhere

Use properly pressure-rated fittings for all connections.

Seal all fittings securely

3.12.2. Pump design

Pump design considerations aim to ensure reliable operation and maximize the length of the intervals between services. It is also imperative that the pump itself does not suffer catastrophic failure, not only because this could endanger personnel, but also because it could cause a production line to shut down, with potentially major cost implications for the user.

Reducing system failure by design

Cat Pumps manufactures triplex reciprocating piston and plunger positive displacement pumps. The triplex design is able to give a smoother flow than single and two-cylinder designs.

In a two-cylinder design, the pressure variation in the output flow is 60% above the mean pressure and 100% below the mean pressure, giving a total pressure variation of 160%. In the triplex pump (Figure 1), the pressure variation is 15% above the mean and 7% below the mean. This gives a total pressure variation of

3.12.3. Seal design

Seal design remains a vital ingredient in maintaining pump integrity. No matter how sophisticated a design may be, a seal is still considered to be a wear item and must be replaced periodically.

Each system will experience a different seal service life. This depends on the duty-cycle, the liquid and other chemicals that are being pumped, fluid temperature, how well the system is installed and maintained, and the established pump servicing schedule.

Seals on the plungers or pistons usually rely on

Reducing the likelihood of leakage

Potential leakage problems as the seal wears are self-evident. One way of overcoming this problem is to use a double seal system, with a secondary seal on the atmospheric side.

This approach significantly reduces the likelihood of leakage of the pumped fluid to the outside world by providing a natural containment region for the seepage between the two seals. The seal chamber is configured so that this seepage is channeled back to the inlet port of the pump.

3.12.4. Lubrication and cooling

In some applications, the pumped fluid does not have sufficient inherent lubricity for the seals to function, so the double seal arrangement can be reconfigured to allow a compatible flushing liquid to be circulated between the seals. This provides both lubrication and cooling.

In this case, the seepage is not returned to the inlet port. Instead it is recirculated or piped away (so the recirculation channel shown in Figure 3 is no longer present). This flushed system is also particularly

- **Monitoring**

An additional benefit offered by this system is that with the addition of suitable instrumentation, the contained fluid can be monitored, and changes in the condition provide early warning of seal degradation. This allows timely intervention for replacement and avoids catastrophic failure.

Typical monitoring parameters that can be used to check for changes in the flushed fluid include looking for an increase in volume because greater quantities of pumped fluid pass through the high pressure seal

- **Computer modelling**

The use of computer modelling to reduce product development times not only brings benefits to pump manufacturers but also has significant safety implications.

Finite element analysis techniques are used to generate a geometric model of the pump which is then broken down into smaller elements of simple shapes connected at specific node points. The software allows fluid pressure loads to be applied to different surfaces to produce stress plots that reveal the regions of highest stress.

The complete picture

There are many areas that can be addressed by manufacturers of high pressure pumps to make their products as safe as possible. However, it is vital that high pressure pumping systems are viewed as just that complete systems. Seeking advice on the design of the system as a whole is invaluable in minimizing risk.

3.13. Implementing Emergency Shutdown procedures

Emergency shutdown systems work by determining when there is a critical condition within a system and then activating to quell possible leaks, explosions, or other types of major malfunctions. The activation of an ESD may include:

Figure 3.5 emergency shut off valve

Shut down of part systems and equipment. Isolation of hydrocarbon inventories

- Resonance Multiphase Flow meter apparatus:
- Turn off gas. Turn the air pressure control valve off by rotating anti-clockwise. ...
- Turn off water pump. Switch off power at wall.
- Turn off oil pump. Press red 'stop' button; Switch power lever up.
- Close tank outlets. Close the IBC outlet valves (as shown).

Self-check 3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer (4 point)

1. One of the following is not **Factors affect the pump performance curve**

   A. Impeller design C. cost of the pump

   B. Improper priming D. Insufficient NPSH

2. Head pressure is not affected by the following except:

A. The total amount of water, C. The horizontal length of the duct

B. The diameter of the duct or conduit, D. The height that head is applied

3. One of the following is not top causes of water pump failure caused by external issues

   A. Contaminated Coolant. C. Defective System Components

   B. Too Much Sealant. D. type of the soil to be irrigated

Test II: Short Answer Questions

4. List at least 10(ten) factors affect the pump performance curve (10pt)
5. List at least four Emergency Shutdown procedures(10pt)

Satisfactory>15 ptsun satisfactory rating <15pts

Operation Sheet -3	

3.1 Techniques/Procedures/Methods of performing emergency Shutdown procedures

A. Tools and equipment

Suitable PPE

Pump with emergency shut off valve

B. Procedures

- Resonance Multiphase Flow meter apparatus:
- Turn off gas. Turn the air pressure control valve off by rotating anti-clockwise. ...
- Turn off water pump. Switch off power at wall.
- Turn off oil pump. Press red 'stop' button; Switch power lever up.
- Close tank outlets. Close the IBC outlet valves (as shown).

3.2 Techniques/procedures of cleaning filters

A. Tools/equipments

- Pump filter
- Water
- Sop/detergent

B. procedures /Methods

- Remove the reusable air filter from the unit.
- Rinse off the reusable air filter with plain, warm water.
- Soap up the reusable air filter with a gentle household detergent.
- Scrub the reusable air filter with a soft bristle brush.
- Rinse off the soap and reusable air filter with water.

LAP TEST-3	Performance Test

Name………………………………. ID……………………………..

Date…………………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task. 1 Perform emergency Shutdown procedures

Task. 2 Clean pump filters

LG #26	LO #- 4 Finish pump operation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Completing Pump operations
- Following Shut down procedures
- Collecting, reinstating and storing Pump accessories
- Documenting and completing operational records
- Carry-out periodic operator level servicing and maintenance measures
- Checking and maintaining flanges, gaskets and seals
- Checking and cleaning Pump filter systems
- Identifying and reporting malfunctions, faults, irregular performance
- Carry-out periodic operator level servicing and maintenance measures
- Checking and maintaining flanges, gaskets and seals
- Checking and cleaning Pump filter systems
- Identifying and reporting malfunctions, faults, irregular performance

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Complete Pump operations
- Following Shut down procedures
- Collect, reinstating and storing Pump accessories
- Document and complete operational records
- Carry-out periodic operator level servicing and maintenance measures
- Check and clean Pump filter systems
- Identify and report malfunctions, faults, irregular performance
- Carry-out periodic operator level servicing and maintenance measures
- Check and maintain flanges, gaskets and seals

- Check and clean Pump filter systems
- Identify and report malfunctions, faults, irregular performance

Learning Instructions:
7. Read the specific objectives of this Learning Guide. 8. Follow the instructions described below. 9. Read the information written in the information Sheets 10. Accomplish the Self-checks 11. Perform Operation Sheets 12. Do the "LAP test"

Information Sheet:4

4.1.Completing Pump operations

When things are running smoothly it's easy to overlook common maintenance chores and rationalize that it's not worth the time to regularly inspect and replace parts. But nothing could be farther from the truth. The reality is that most facilities have several pumps performing a variety of functions that are integral to the successful operation of the plant. If a pump malfunctions it can be the cause of an entire plant shut down. after completing pump operation check the following for service.

- Pump flow meter rate.
- Motor amps.
- Suction pressure.
- Pump vibration.
- Head pressure and pump discharge pressure.

4.2.Following Shut down procedures

The shutdown procedure is the reverse of the startup procedure:

Gradually close the discharge valve. If there is no discharge valve and the pump has a rotational speed governor, then gradually decrease the rotational speed of the pump motors until the pump is no longer rotating.

Turn off the pump's power supply.

The following should be done before stopping an operating pump

For low to medium specific speed pumps (below values of approximately 5,000), close the discharge valve prior to stopping the pump. This takes the load off the motor and, if any check valves leak, it may prevent reverse flow through the pump. Next, shut down the driver and leave the suction valve open.

The shut-off head of a pump indicates the amount of pressure required to reach a condition

If you're not familiar with how irrigation systems ow rate in a vertical pipe connected to the operating pump becomes zero.

4.2.1. An irrigation shutdown

As its name implies, an irrigation shutdown is the process by which all irrigation system components are completely turned off for a given period of time (i.e., throughout winter). During this process, any remaining water inside your irrigation features must also be thoroughly drained. It's critical to perform these shutdowns prior to winter, though optimal dates will vary depending on the region and the given year's outlook. While property owners can handle certain aspects of an irrigation shutdown on their own, hiring professional irrigation services is always the best course of action.

4.2.2. The reasons for shutting down an irrigation systems

Operate or what freezing conditions can do to them, you might not understand why you'd want to shut down your irrigation system in the first place. Simply put, you never want water to freeze inside pumps or distribution lines when this happens, your irrigation components can undergo serious damage, rendering them faulty (if not entirely useless) by the time you need them again in the spring. As autumn transitions to winter, temperatures gradually decline until this freezing is more and more likely to occur. Shutting down your irrigation system and removing all water from its lines greatly reduces the risk of these negative outcomes, saving you time and money in the long run.

While you don't want to shut down your irrigation too soon (since you still want to keep your landscape properly hydrated during the warmer months), you don't want to wait too long, either the cold weather often arrives sooner than we think. As mentioned earlier, the arrival of freezing temperatures varies from region to region. Generally speaking, those in northern areas should consider shutting down their irrigation systems as early as October, while those further south can usually wait until November or December. The urgency with which you shut down and winterize your irrigation system also partially depends on the type of system you're working with. Backflow-type systems can typically handle cold temperatures better than their counterparts, meaning they can usually go a bit longer before needing to be turned off for the season.

Professional irrigation and lawn care services will know the best course of action regarding the timing and method for turning off your particular system in preparation for winter.

4.3.Collecting, reinstating and storing Pump accessories

Allow the clean pump parts, bottle brushes, and wash basins to air-dry thoroughly before storing to help prevent germs and mold from growing. Once completely dry, the items should be stored in a clean, protected area to prevent contamination during storage.

Carefully pack your assembled pump and any additional pumping accessories in a clean, protected space – such as a new box (you can usually grab small cardboard moving boxes at stores like Wal-Mart) that can be tightly sealed or a large, sealable food storage bag.

You can store your breast pump accessories long-term in a clean, sterile and air tight food grade container or snap lock bag. You should clean your breast pump parts as you normally do, and allow them to completely air dry prior to storing them.

Storing hydraulic pump

Store them indoors in a clean, dry area. This is stating the obvious and is easy enough to do for more compact components like pumps, motor and valves. But in the case of large or long cylinders, the warehouse department may find it more convenient to store them outdoors. This should be avoided if at all possible.

4.4. Documenting and completing operational records

Document of record means written or graphic materials however produced or reproduced or any other tangible permanent record including records maintained by computer or other electronic or digital means, maintained by the Franchise in the ordinary course of conducting its business.

The operational value is the usefulness of a record in the conduct of an organization's business. Examples include mandates, procedural records, or records that give direction.

4.4.1. The importance of documenting records

Records support openness and transparency by documenting and providing evidence of work activities and by making them available to the public. Records support quality program and services, inform decision making, and help meet organizational goals.

There are 4 components of documentation they are:-

- Tutorials,
- How-to guides,
- Technical reference and
- Explanation.

They represent four different purposes or functions, and require four different approaches to their creation. Understanding the implications of this will help improve most documentation - often immensely.

4.4.2. Procedures of documents and records

There are 5 Essential Records Management Procedures

- Step 1: Set-up a Records Retention Schedule.
- Step 2: Policies and Procedures.
- Step 3: Accessibility, Indexing, and Storage.
- Step 4: Compliance Auditing.
- Step 5: Disposal of Obsolete Records.

4.5.Carry-out periodic operator level servicing and maintenance measures

Safety is the first step before performing maintenance work on pumps, make sure machines are properly shut-down before performing your maintenance and/or systems check. Proper isolation is important not only for electrical systems, but for hydraulic systems as well.

4.5.1. Preventive maintenance of pumps

Preventative Maintenance is inspection and repair scheduled at specific intervals (daily, weekly, monthly, yearly) or based on the number of hours run. Visual inspections are made externally and internally by dismantling the unit, replacing seals such as gaskets and mechanical seals, with pump parts checked for wear.

4.5.2. Periodic maintenance

Periodic maintenance is a form of planned upkeep that ensures timely and coordinated servicing of equipment or objects so that they always perform to their best. It's a way to prevent breakdowns and to ensure both safety and reliability. From its practical uses to how it can be implemented, this guide will explain everything you need to know about periodic maintenance.

Periodic maintenance helps to prolong a piece of equipment's life-cycle and enhance productivity.

Periodic maintenance is fine-tuned to an individual piece of equipment and is best calculated on historical maintenance logs and not just manufacturer recommendations.

This type of maintenance is one of the easiest and most cost-effective predictive programs to implement.

Simply put, periodic maintenance is one of the most important forms of preventative maintenance. It is utilized to extend a piece of equipment's lifespan and to avoid any downtime or asset failure caused by damage or general wear and tear. As it doesn't rely on letting problems appear before action is taken, it can help reduce overall costs by isolating dormant issues before they become serious. After all, most equipment is prone to depreciation through use, especially when overused. By routinely checking and inspecting conditions, you can catch these small issues before they get worse.

Also known as time-based maintenance, it includes any form of maintenance that takes place at specific intervals. These can include weekly, monthly or annual checks, among other delimitations, which are usually set by a maintenance manager based on the equipment's optimal performance. These can be recommended by the manufacturer, business or even be a legal specification. You can keep track of equipment maintenance in several ways to stay on top of its condition, as we'll outline in this article.

4.5.2.1. Periodic Maintenance work-flow

A general workflow consists of the following time-based maintenance activities:

Isolate the piece of equipment that needs maintenance. It's often best to begin with the most valuable or vulnerable piece you have. More assets can be added as you go.

Check the item's manufacturer's servicing guidelines, including the mean time between failures (MTBF) or mean time to first failure (MTFF). You should also analyse any historical data you have on your chosen piece of equipment.

Isolate the period or timescale for performing maintenance based on the above. For most assets, this is as simple as going with the manufacturer's suggestions.

4.5.2.2. Schedule your time-based maintenance slots.

A computerized maintenance management system (CMMS) like tool sense is ideal for keeping track, monitoring progress and storing maintenance data on each piece of equipment. Some tools are more complex than others, requiring extra paperwork or data inputs – hence why a competent management tool is recommended.

4.5.2.3. Perform the maintenance as planned

With a professional and implement any upkeep procedures that come up. Log the data in your system.

- **Goals of Periodic Maintenance**

There are plenty of reasons to implement a periodic maintenance scheme, from fulfilling safety protocols to ensuring longevity. The main reasons for carrying out such regular maintenance processes are as follows:

- ✓ Extending the lifespan of equipment by isolating small problems before they get worse.
- ✓ Improving the reliability of equipment by ensuring it's performing at its best.
- ✓ Limiting unplanned downtime, which can be costly and time-consuming.

Definition of Intervals

Time-based maintenance schedules differ from equipment to equipment, and from business to business. The equipment's history, age, model, and type all factor into how regularly it should be maintained. While the manufacturer is always the best starting point for implementing a time-based maintenance program, you can also look at historical data. That's because the manufacturer's data doesn't always take into account the differences in business use.

Most maintenance departments utilize some form of computerized maintenance management system to track how equipment performs.

Maintenance Management Based on Actionable and Data-Driven Insights

Managing maintenance across an entire fleet is quite a challenge. Build custom workflows in our

Periodic maintenance works by calculating the period in which equipment failure is expected. By identifying averages from historical data and manufacturer specifications, you can set up checkpoints before issues occur. The idea is to preserve equipment before any serious issues occur. This not only keeps equipment in excellent condition, but it prevents downtime that would come from serious equipment failure.

The metrics used to calculate periodic maintenance differs from equipment to equipment. In many cases, this is taken from the manufacturer's specified mean time between failure (MTBF). However, you can also use your own lab-based analyses of equipment like filters to determine how soon they need replacing. Having software that can effectively gather, analyze and predict this is useful for producing reliable periods for equipment maintenance.

4.5.2.4. Implement a periodic maintenance program with tool sense

To implement a successful time-based maintenance program, it all begins with an effective equipment management software like tool sense. After logging the data for equipment as specified above, this will automate maintenance tasks for you. Equipment and service management software effectively de-clutters office space and provides an all-in-one space to log and perform periodic maintenance. As a fine first step, you'll want to simply identify the equipment, upload their maintenance logs and calculate up a time period.

Once you've implemented a periodic management program on a piece of equipment, you can then track and adjust it through. Look at how much preventative work has been performed on the equipment in the past and when any failures occurred. If equipment is performing particularly well without failure, the period between maintenance can be prolonged. Once you've applied periodic maintenance to one asset, it can be simply increased to include all assets.

The purpose of pump maintenance is to make sure that pumps are running as efficient as possible, reduces down time, and reduces equipment costs by extending the life of the equipment ensures that your pumps are not being neglected

- Standard checklist for pump maintenance:
  - ✓ Check pump exterior for any leaks.
  - ✓ Clean pump and nearby region to remove any debris.
  - ✓ Check for excessive pump vibration or unusual noises.
  - ✓ Check for foaming or oil discoloration.
  - ✓ Check bearing temperature for overheating.
  - ✓ Inspect all gaskets to ensure there are no oil leaks.

4.6.Checking and cleaning Pump filter systems

If you choose to refrigerate pump parts between pumping sessions, rinse the parts first to remove milk residue, if possible, and then keep the parts in a sealed bag to prevent contamination. If rinsing is not possible, wipe milk residue off the parts with a clean, disposable paper towel.

The cleaning of filters is essential to the process of removing contaminants from fluids prior to them being released into a downstream process. The use of ultrasonic cleaning can improve this process by ensuring that no harmful substances are left behind.

- **Cleaning filters**
  - ✓ Remove the reusable air filter from the unit.
  - ✓ Rinse off the reusable air filter with plain, warm water. ...
  - ✓ Soap up the reusable air filter with a gentle household detergent. ...
  - ✓ Scrub the reusable air filter with a soft bristle brush. ...
  - ✓ Rinse off the soap and reusable air filter with water

Soak the filter in cold water for 15 minutes. Hand wash pitcher or dispenser, lid and pour tray with mild soapy water. Rinse well. Hold filter under cold running tap water for 10 seconds.

4.7.Checking and maintaining flanges, gaskets and seals

Checking flanges seal

Flange joints are made by bolting two flanges together with a gasket between them to form a seal. Many types of bolted flange connections have been designed for different equipment including pipe flanges, valve bonnets, site gages, man ways, hand holes and heat exchangers.

Maintain a gasket

Store gaskets correctly avoid exposure to sunlight as UV accelerates aging. Temperature extremes will do the same, so keep them away from heat sources and in winter protect them from freezing. Humidity can damage some materials too. Don't hang gaskets because they'll stretch.

If you rent your home, you'll know property managers conduct inspections. It's probably the most diligent inspection you'll ever see, walking around your home, nosey-ing about and watching every wall, corner and skirting board like a hawk.

If they could put their inspection skills towards something useful, like inspecting your gaskets are one of the most important pieces of equipment on your machinery, preventing leaks and ensuring it runs smoothly.

Check for leaks

The first step is to check for leaks in your gasket. If there are no signs of leakage, it means your gasket is doing its job properly. If there are leaks, then you'll need to go about fixing or replacing the gasket, which we discuss a little later in this post.

Check to see that they fit correctly

Over time, gaskets are prone to becoming misshapen and thus not fitting correctly over your equipment. When inspecting your gaskets, ensure that they fit nice and tight over your equipment and that they're the exact right size. Misshapen gaskets, or ones that are not the exact right size, are far more prone to leaks.

Apply sealant if necessary

There's an art to using sealant on your gasket. It takes some practice and experience but if you stick to the manufacturer's suggestions, your endeavour should be successful.

The right amount of sealant

If you don't use enough sealant, you're risking leaks out of your gasket. But if you use too much, then you could clog other parts of your machine which is far less than ideal. That's where the experts at Steam line come in handy.

Consult an expert

If you need to use a sealant on your gasket, talk to the experts at steam line first. They're specialists in gasket sales and installation and can tell you exactly how to get the best results from your gasket when using sealant.

In some cases, you'll find that your gasket doesn't require a sealant especially if they provide a really tight sealing of your machinery. They apply pressure on the seal interface using bolt force, creating a very tight and effective seal. The seal can often be so effective that no other sealing agent is required – an ideal situation if you're using a gasket.

Steam-line Engineering are Australia's leaders in valves, gaskets, seals and a range of other industrial products. Focusing on quality products at affordable prices, steam line have helped businesses across Australia by providing the best value for money gaskets and seals. Contact the team at Steam-line to have one of their products shipped nation-wide

Maintain a seal

One of the best ways to tell if you have a faulty valve seal is to conduct a cold engine test. After your machine hasn't run for a while even overnight the seal is now cool. Once you start the engine, the seal will contract. Damaged seals will leave a small gap.

Checking of seal during seal installation

Shaft and sleeve inspections to ensure that no deep scratches, sharp edges, or burrs are on the equipment. Inspect and empty the stuffing box, correcting any holes, burrs, or sharp edges and ensuring that adequate space is available to adequately fit the seal assembly

The purpose of the seal test is to determine the effectiveness of the sealing of components with internal cavities, i.e. to determine their hermeticity. Defective sealing may permit the entrance of contaminants, thus reducing the effective life and reliability of devices.

5 Ways to Maintain Mechanical Seals

1. Understand your Conditions. Pressure, temperature, and speed are all factors that can contribute to a worn seal or increased leakage rate.
2. Know Seal Face durability with Liquid.
3. Know the reason for Seal Face Wear.
4. Reduce Vibration.
5. Proper Lubrication.

4.8.Identifying and reporting malfunctions, faults, irregular performance

Causes of pump malfunction

Root causes of this are generally undersized suction lines, plugged suction strainer or valve issues. Cavitations: when liquid pressure falls below vapour pressure, bubbles form and implode on impellers and interior surfaces, damaging pump internals, disrupting flow and leading to seal failure

- **Common failures in pump system**?
  - ✓ **Overheating:**

Overheating is one of the most common causes of pump failure. It can be caused by several factors such as incorrect installation, insufficient lubrication or foreign objects blocking the cooling fins

The common defects in pumps and remedial measures

Top 5 failures in pumps and how to detect them

Mechanical seal leakage. Most leakages usually take place at the interface between the two seal faces, but there are occasions when leakages also come from the secondary sealing area.

- Process issues.
- Bearing issues.
- Impeller wear and tear.
- Coupling-related issues
- Pump will not deliver water or develop pressure

No priming water in casing (Fill pump casing) Mechanical seal leaking (Replace mechanical seal) Leak in suction line (Repair or replace) Discharge line is closed and priming air has nowhere to go (Open) Pump is down (Replace worn parts)

Centrifugal Pump Troubleshooting Guide

If you are experiencing issues with your Centrifugal Pump, the below guide can help you diagnose any issues, or speak to one of our Technical Sales Engineers for further assistance:

Table 1 **Centrifugal Pump Troubleshooting Guide**

Problem	Possible Cause	Remedy
	Air in Pump or Suction Pipework	Ensure Pump and Pipework are Completely Filled with

		Liquid. Pump can not prime with air in suction line.
	Suction Lift Too High	Check Inlet for obstruction. If there is not an obstruction calculate friction losses. If static lift is too high the liquid in the suction tank must be raised or pump lowered
Zero Flow after Startup	Insufficient Manometric Head	Actual head with friction losses is higher than pump design. Calculate head and friction losses in discharge. Check all valves are open. To correct increase pipe diameter, or increase impeller diameter, motor power or pump.
	Operation is Reversed	Check motor direction of rotation is in the direction of arrow on pump casing
	Speed Incorrect	Check supply voltage and frequency. Motor may also have open phase
	Impeller, strainer or check valve clogged	Clean impeller, valve and strainer
	Air ingress through shaft seal, suction piping, suction port. Pump lifts liquid with air.	Check suction pipework for leaks, including all joints and fittings. Check shaft seal and if necessary, increase pressure of sealing liquid. Check depth of

Flow Decreases or None at All		suction pipework or valve in liquid and deepen if required. Check inlet tank for vortexing.
	Air pocket in suction pipe	Check angle of suction line and ensure there is no possibility for an air pocket and if so ensure air eliminator valves are fitted
	Increase of Manometric Head	Check valves are fully open and there are no obstructions in discharge pipe
	Impeller, strainer or check valve clogged	Clean impeller, valve and strainer
	Pump operating at lower manometric head	The actual head is lower than originally specified. Reduce impeller size to diameter advised by supplier or utilise an inverter to reduce pump speed
	Speed too high	Decrease pump rotational speed or trim impeller to required size
	Mechanical Friction inside pump	Check pump rotor for any obstruction or deflection
	Packing wound too tight	Loosen nuts on packing gland
	Coupling Alignment	Check coupling rubber and realign pump and coupling
	Density or viscosity of the liquid pumped is higher than	Increase motor size

	originally advised	
	Motor Defects	Check for motor defects. May not be ventilated correctly and be in a poor location
	Poor Coupling Alignment	Check coupling rubber and realign pump and coupling
	Bearing Covers too tight	Check and loosen if necessary, bearing cover
	Pumped flow is less than minimum safe continuous flow	Increase flow. If necessary, use by-pass recirculating valve or line
	Too much grease	Remove excess grease
	Insufficient lubrication or lubricating oil / grease dirty or contaminated	Check the amount of oil/grease. Clean the bearings, bearing housing and lubricate
	Partially clogged impeller	Clean Impeller
	Worn or defective impeller	Replace impeller
	Poor Coupling Alignment	Check coupling rubber and realign pump and coupling
	Oblique Shaft	Check shaft and replace if required
	Unbalanced parts	Check and rebalance parts if required
	Air in liquid	Suspension pipe needs to be submerged to ensure vortexes are not created on the surface of the liquid. Check liquid level in suction

Noise level high		pipe or increase depth of suction pipe.
	Pump working in cavitation area	NPSH is too low. Check liquid level in suction tank, check suction losses. Check valve in suction line and ensure fully open. Increase suction head by lowering pump.
	Pump operating outside of duty range	Check duty point

Possible failures of pumps

A pump failure is a mechanical or electrical problem that prevents a pump from functioning correctly. This can be caused by various issues, including a broken impeller, a loss of power, or a clogged filter

How do you monitor pump performance?

Pump performance monitoring

Ideally five parameters should be monitored to understand how a pump is performing: suction pressure, discharge pressure, flow, pump speed, and power.

Self-check 4	Written test

Name………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer (4 point)

1. Preventative Maintenance **of pumps** is inspection and repair schedule of:-

A. daily C. monthly

C. Constant interval of the year only D. weekly

2. The advantages of gasket are

A. used as a coolant C. used as a lubricant

B. protects oil leakage D. used as a fuel

3. One of the following is not components of documentation

A. Tutorials, C. used as operation manual

B. How-to guides, D. Technical reference and

Test II: Short Answer Questions

4. List at least 5(five) cause of failures in pumps (10pt)
5. List at least 5(five) Cleaning procedures of filters(10pt)

Satisfactory>15 ptsun satisfactory rating <15pts

Operation Sheet -4

4.1 Techniques/Procedures/Methods **Implement maintenance of irrigation pump**

A. Tools/equipments

- Appropriate PPE
- Pump

B. Procedure

- Check pump exterior for any leaks.
- Clean pump and nearby region to remove any debris.
- Check for excessive pump vibration or unusual noises.
- Check for foaming or oil discoloration.
- Check bearing temperature for overheating.
- Inspect all gaskets to ensure there are no oil leaks.

LAP TEST-4	Performance Test

Name………………………………. ID……………………………..

Date…………………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task:-1 Implement maintenance of irrigation pump

Reference Materials

Books:

Pumping 101: How Do You Diagnose Irrigation Pump Problems (Part 4 of 4) by Nathan Taylor | Jan 25, 2017 | Efficiency & Technology

Home » Pumps » A Step-by-step Guide to Choosing the Right Pump for your Agriculture Needs Posted: 21/06/2018

World Pumps Volume 2005, Issue 467, August 2005, Pages 32-35

Web addresses

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