Unit 2

Installation of Sprinkler Irrigation System

A sprinkler irrigation system, which has been designed and installed as per the standard procedures and is operated within the set parameters, requires less maintenance. The block and pipe layout must be understandable from the plan. As already mentioned in Unit 1, an irrigation design plan has various symbols to indicate the positioning of pipes and other components. Usually, a key is provided with the symbols and their meanings. A table on the irrigation design plan provides information on individual irrigation blocks, including size, plant spacing, emitter delivery and application rate. The best place to start an irrigation plan is at a pump station or near the main line. The main line can be traced from the pump station. The sub-mains must be clear to the technician or the person installing the system.

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Session 1: Installation of Components in Sprinkler Irrigation System

Checks for installation

- Find out if the design or sketch of the designated plot is ready.
- Also, see if the physical conditions of a site meet the dimensions mentioned in the plan.

- Check if all tools, material and fittings required for the installation are available.
- Find out if the trenching is ready as per design and pipe specifications.

Tools and equipment required for installation

The following tools and equipment are required for the installation of a microirrigation system.

(i) Pipe wrench (18″, 24″or 36″)
(ii) Spanner set (preferably adjusting sly wrench)
(iii) Drill machine with drill bits of different sizes
(iv) Drill guide
(v) Screwdriver and pliers
(vi) Hacksaw blade with frame and one spare blade
(vii) Measuring tape and scale
(viii) Straight or ejecto punch
(ix) Hand punch
(x) S-hose pump
(xi) Plier punch
(xii) Take-off tool
(xiii) Solvent cement
(xiv) Teflon tape
(xv) Jute
(xvi) GI threaded joint’s synthetic compound
(xvii) Pencil or marker
(xviii) Pressure gauge with adopter and nozzle

Fittings and other accessories

Some of the important fittings and other accessories used in the installation of mains, sub-mains and sprinkler heads are as follows.

Fig. 2.1: Water meter

Water meter

It is used to measure the volume of water delivered. It is necessary to operate the system in order to supply the required quantity of water.

Flange, coupler and nipple

‘Flange’ is used to connect pipes with the use of bolted connections and gaskets. A ‘coupler’ is a short pipe with a socket at one or both the ends that allows two pipes to be joined together (Fig. 2.2). 'Nipple' is a short pipe, usually, provided with a male pipe thread for connecting two other fittings on either ends.

Fig. 2.2: Coupler

Pressure gauge

It is used to measure the operating pressure of the sprinkler system (Fig. 2.3). To ensure uniformity in the application of water, the sprinkler system is operated at a desired pressure.

Fig. 2.3: Pressure guage

Lateral cock, elbow, tee, reducing joiner, ring take-off and end cap

Bends and elbows are used for changing the direction of water. The water takes a curve path while flowing through a pipe bend. Tees are T-shaped pipe fittings, having two outlets at 90 degree connected to the main line. A reducer is a component that is used to reduce the pipe size from a larger to a smaller bore. A butterfly valve is a quarter-turn rotary motion valve that is used to stop, regulate and start the flow of water. A 90 degree rotation of the handle can completely close or open the valve. An end cap is used to bend the pipe into the two holes for stopping the water flow. Goof plugs can be used to plug holes from where emitters have been removed.

Fig. 2.4: Lateral cock

Fig. 2.5: Tee

Fig. 2.6: Reducing joiner

Fig. 2.7: Elbow

Fig. 2.8: Coupler ring take-off

Fig. 2.9: End cap

Installing sprinkler irrigation system

The components of the sprinkler irrigation system are tested before being installed. The entire system is tested once the installation is complete. The installation work must be carried out as per the installation guidelines. Guidelines to maintain the system and few precautions starting from the installation will ensure trouble-free operation.

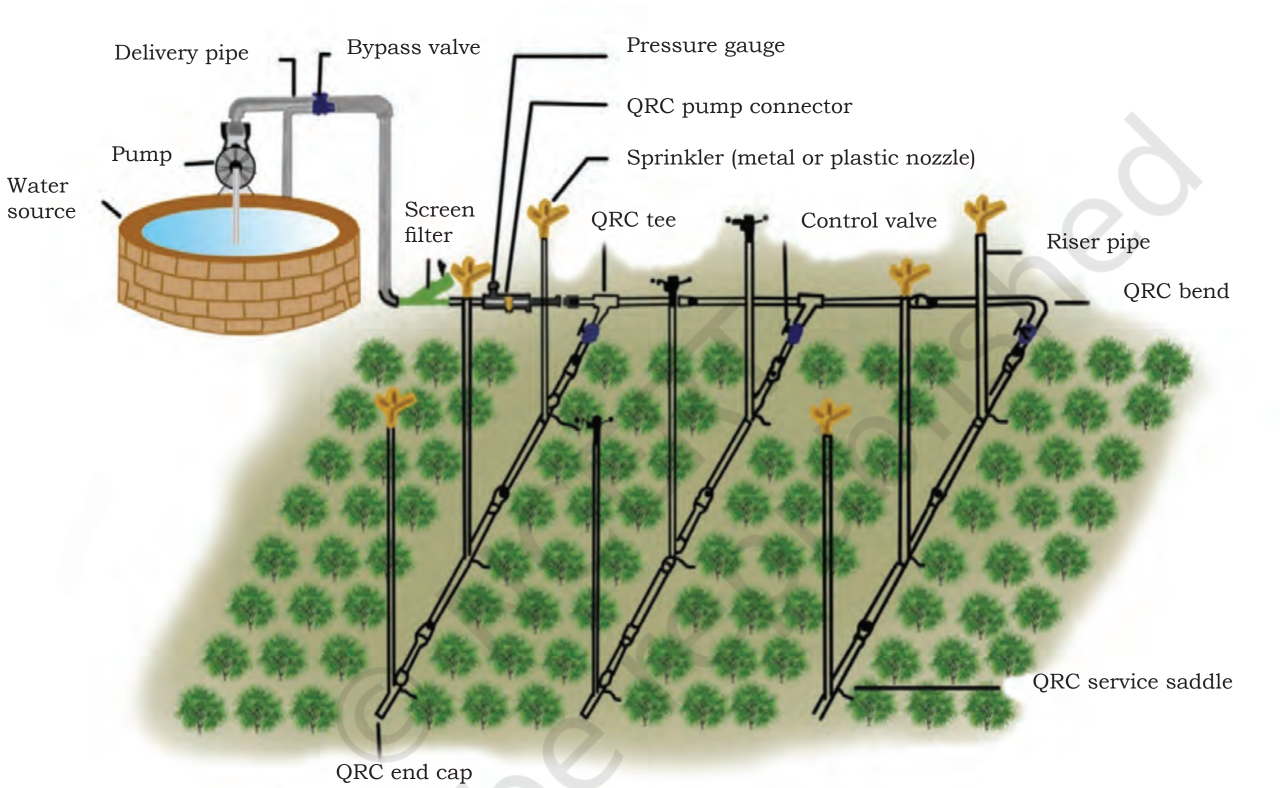


Fig. 2.10: Layout and components of sprinkler irrigation system

Installation of head control unit

The installation of head control unit requires a cemented platform. The size of the platform depends on the various components to be installed, such as pump, bypass mechanism, non-return valve, hydrocyclone filter, fertigation unit, media filter, screen or disc filter and air release valve. A layer of paint on these fittings is used to avoid rusting. Pressure gauges are installed wherever needed to check pressure readings. Fig. 2.11 shows the various components of the head control unit.

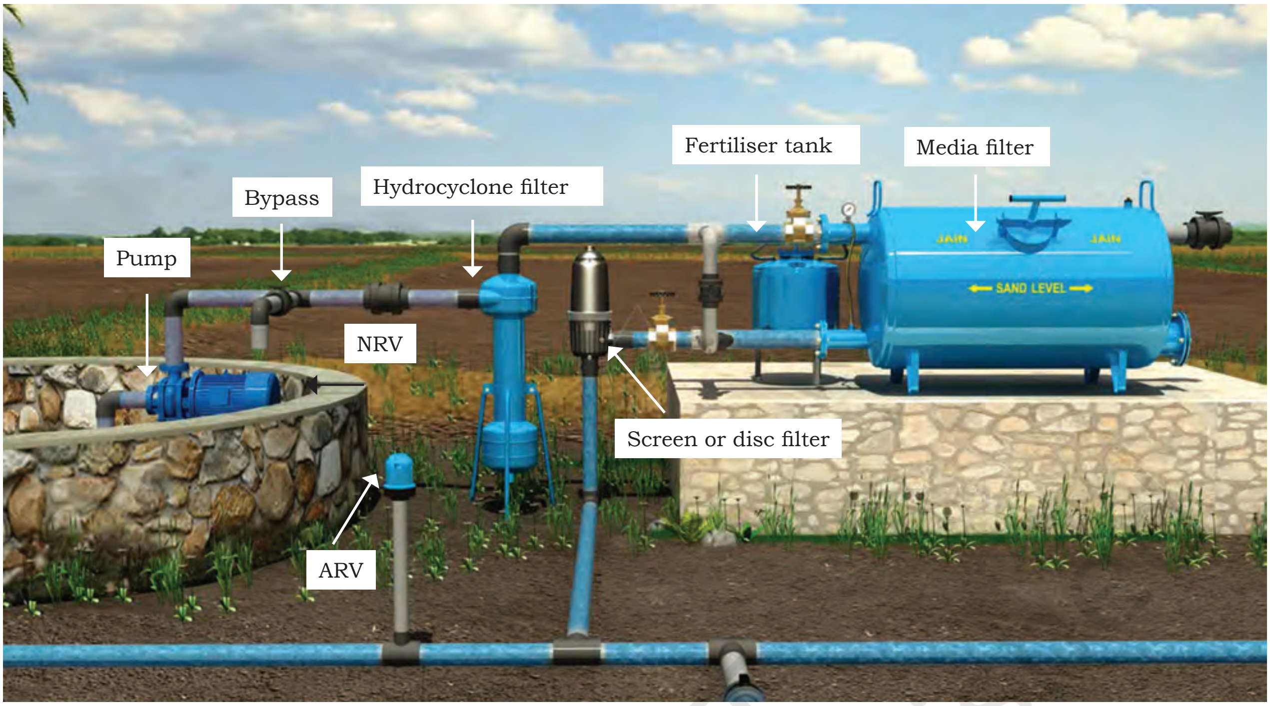


Fig. 2.11: Components of the head control unit of a microirrigation system

Preparation of trenches

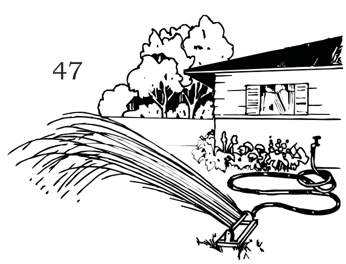
Trenches must be wide enough to allow easy handling of pipes. They must be deep enough to allow a 60-cm cover over pipes. The bottom of the trenches must be smooth and free of sharp objects, such as stones. During excavation, all large stones, which can damage the pipes, must be removed from the brink of a trench. The width of the trench must be 45–70 cm and depth 75 cm. The trenches must be dug in a straight line.

Installation of pipes

PVC pipes must be laid according to the size and class as specified in the design. Care must be taken while laying the pipes during a hot day. Contractions due to fall in temperature may loosen the pipes.

Before joining the PVC pipes, remove burr from the edges. The outer and inner surface of the pipes must be cleaned with a sandpaper before applying solvent cement. A clean cloth must be used to clean the joining surfaces of the joints. Solvent cement must be applied evenly around the spigot end of each pipe. The spigot


Fig. 2.12: PVC pipes



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end of the pipes must be pushed into the sockets to the depth of entering mark. Always store the solvent cement in a cool and dry place away from fire and reach of children. Use Teflon tape to avoid leakage through the threaded ends. Avoid over tightening of these fittings by pipe wrench. Give support or fill in the trenches immediately after joining PVC pipes and fittings on curves and valves. Back filling of trenches must be done only after the testing is over. All back filling material must be free of stones as they can damage the pipes.

Installation of valves

Air valves on the mainline must always be installed at the highest point of the pipeline or at a point of change in the slope. Control valves must be installed minimum one feet above the ground level and need to be straight, both vertically and horizontally. Use Teflon tape to wrap the threaded parts of adopters for fitting it into the valves in order to avoid leakage. Avoid over tightening by pipe wrench.

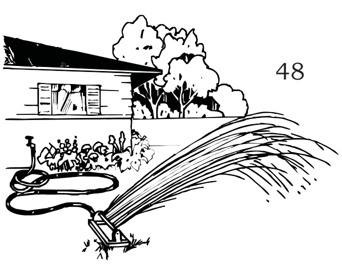
Installation of main, sub-mains and laterals

Main line

Rigid Poly Vinyl Chloride (PVC) and High Density Polyethylene (HDPE) pipes are, normally, used as main lines to minimise corrosion and clogging. Pipes of 63 mm diameter and above with a pressure of 4–10 kg/cm^2 are recommended for main lines. The main line is the primary artery of a sprinkler irrigation system, usually, laid along the length of a field, which serves as a conveyance system for delivering the total amount of water to the sub-mains at the required pressure. The main line is, normally, buried about 30 cm below the soil surface and supplies water to the sub-mains.

Sub-mains

Light PVC, HDPE or Linear Low Density Polyethylene (LLDPE) pipes are used as sub-mains. Pipes having an outer diameter of 32–75 mm with a pressure of 2.5- 4.0kg/cm^2 are, normally, used as sub-mains. The diameter of main and sub-mains depends on the water



requirement of a crop and size of the field. Both main and sub-mains are provided with flush valves at the outlets to occasionally flush the pipes in order to remove sediments and clogging. A flow control valve (ball valve) is fitted in the beginning of each sub-main. The flush valve must not be fixed vertically but horizontally, after fixing an elbow so that the water does not spill over on to the person carrying out the work while flushing.

Fig. 2.13: HDPE pipes

The sub-mains, which run perpendicular to the laterals, deliver water to the laterals. The sub-mains are connected with the main line using fittings like tee, elbow, etc., as per the installation sketch. Solvent cement must be used to ensure perfect binding at the joints.

Laterals

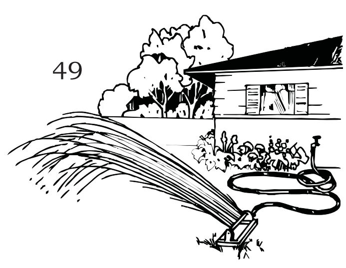
Laterals are tubes located between the shut-off valve and sprinkler heads. The laterals are, usually, made of LDPE, Linear Low Density Polyethylene (LLDPE) or HDPE pipes of 10 to 20 mm in diameter and with a wall thickness of 1–3 mm with a pressure rating of 2.5 kg/cm^2. Lateral pipes are, usually, flexible, non-corrodible, resistive to radiation and to the effects of temperature fluctuation. They are easy to install. Laterals are, usually, black in colour. The laterals supply water to a field through sprinklers. To install laterals, the following need to be done.

(i) To connect the laterals (poly-tubes) to the sub-mains, holes are drilled on the PVC sub-main pipes using a drilling machine. The holes are drilled at a distance equal to the row spacing of the crop. The size of the holes depends on the size of the laterals and the grommet take off (GTO).

(ii) Grommets are fixed in the holes and take-offs are fixed on the grommets. The laterals are then connected to the take-offs.

Sprinkler riser and head

Sprinkler risers connect the sprinkler heads to the lateral pipes or tubes. Sprinkler heads distribute water uniformly over the field without run-off or excessive



loss due to deep percolation. The most commonly used sprinklers have two nozzles, one to cover a farther area and another to cover the area near the sprinkler. The sprinkler heads are installed on riser pipes. To avoid turbulence in riser pipes, the minimum height of the riser is 300 mm for 25 mm diameter and 150 mm for 15–20 mm diameter. In general, 900-mm long GI pipe of 25 mm diameter is used.

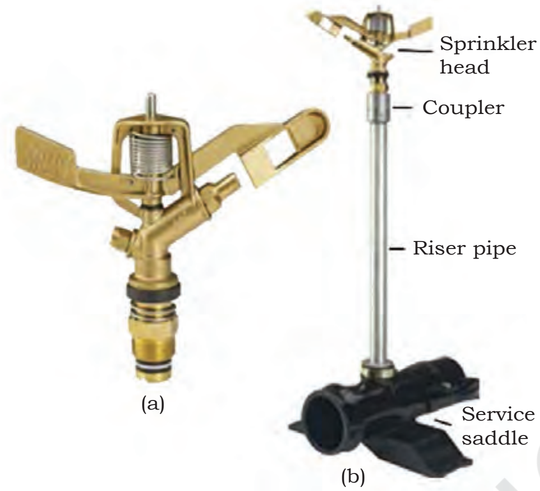


Fig. 2.14: (a) Sprinkler head (b) Sprinkler riser

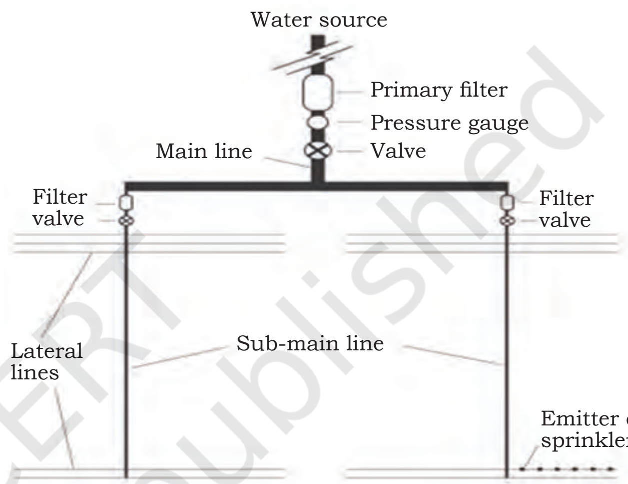


Fig. 2.15: Components of sprinkler irrigation system

The characteristics that need to be considered for sprinkler selection are jet trajectory, operating pressure and sprinkler body design. The sprinkler operating conditions to be considered in sprinkler selection are soil infiltration characteristics, desired irrigation depth, desired or appropriate irrigation cycle, crop characteristics, wind conditions and plant spacing.

The uniformity of water distribution from sprinklers depends on the pressure of water, wind velocity, rotation of sprinklers, spacing and nozzle diameter. The spacing of sprinklers in a lateral, and lateral spacing are adjusted considering all these parameters.

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Practical Exercise

Activity

Visit an agricultural farm and study the joining or coupling of various components with pipes. Familiarise with couplers and sprinkler heads used in microirrigation system.

Check Your Progress

A. Multiple Choice Questions

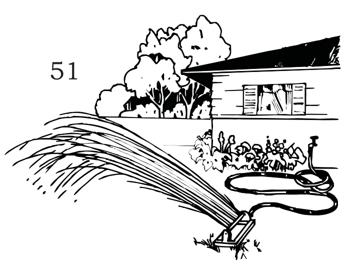
1. The sprinkler irrigation system, usually, consists of ___________.
   (a) pumping unit
   (b) mains, sub-mains and laterals
   (c) sprinkler heads
   (d) All of the above
2. A ___________ is used to measure the operating pressure of the sprinkler system.
   (a) meter gauge
   (b) pressure gauge
   (c) water meter
   (d) pressure meter
3. Bends and ___________ are used for changing the direction of water.
   (a) straight pipe
   (b) coupler
   (c) flange
   (d) elbow

B. Fill in the Blanks

1. The full form of PVC is ___________ Vinyl Chloride.
2. The full form of HDPE is High ___________ Polyethylene.
3. The full form of LLDPE ___________ Low Density Polyethylene.
4. Pipes of ___________ mm diameter and above with a pressure of 4 to 10 kg/cm^2 are recommended for main lines.
5. Laterals ranging from ___________ to 20 mm in diameter and with a wall thickness of 1–3 mm with a pressure rating of 2.5 kg/cm^2 are generally used.

C. Subjective Questions

1. Write short notes on the following:
   (i) Installation of head control unit
   (ii) Installation of mains, sub-mains and laterals
   (iii) Installation of sprinklers



What have you learned?

After completing this Session, you will be able to:

- describe the functions of various components of sprinkler irrigation system.
- describe the functions of main line, sub-mains and laterals.
- describe steps for the installation of a sprinkler irrigation system.

Session 2: Tools and Material for Installation of Sprinkler Irrigation System

A wide range of irrigation tools and equipment are available for use. Therefore, selection of an appropriate equipment or tool is essential for installing different components of a sprinkler irrigation system. The following tools, equipment and material are required for the installation of the system.

Fig. 2.16: Pipe wrench

Pipe wrench

It is a tool used for turning soft iron pipes and fittings with a round surface for assembly or disassembly (Fig. 2.16). Its adjustable jaws allow it to lock in the frame so that any forward pressure on the handle tends to pull the jaws together. It is available in 14″, 18″, 24″ and 36″.

Fig. 2.17: Spanner set

Spanner set (preferably adjusting sly wrench)

It is commonly known as 'combination wrench' (Fig. 2.17). A wrench (also called spanner) is a tool used to provide grip in applying torque to turn objects.

Fig. 2.18: Drill machine

Drill machine

A drill machine is used for drilling holes in PVC pipes (Fig. 2.18). Drill bits of different sizes are used for drilling holes in PVC pipes.

Drill guide

It is a tool that guides a drill to make a bore or hole in a PVC pipe (Fig. 2.19).

Fig. 2.19: Drill guide

Screwdriver

A screwdriver is a tool (manual or powered) used for turning (driving or removing from material) screws (Fig. 2.20). A typical screwdriver has a handle and a shaft, and a tip that the user inserts into the screw head to turn it. The shaft is, usually, made of tough steel to resist bending or twisting.

Pliers

It is a hand tool used to hold objects firmly with tongs (Fig. 2.21). It is also useful for bending and compressing a wide range of iron, aluminium and steel material, such as wires and sheets.

Fig. 2.20: Screwdrivers

Hacksaw blade with frame

A hacksaw blade is a fine-toothed saw, principally, used for cutting metals (Fig. 2.22). It can also be used to cut plastic and wood.

Fig. 2.21: Pliers

Fig. 2.22: Hacksaw blade

Measuring tape

It is a flexible ruler, consisting of a ribbon of cloth, plastic or metal strip with linear measurement markings (Fig. 2.23). It is a common measuring tool used for land measurement.

Fig. 2.23: Measuring tape

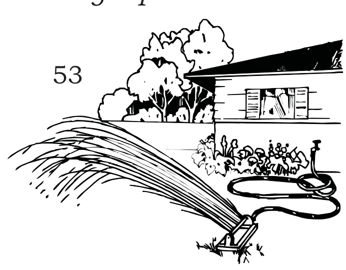


Fig. 2.24: Hose punch

Hose punch

It is a tool used to make a hole on polyethylene tubes or laterals to install different type of emitters or drippers. The punch size varies with the size of the connector (Fig. 2.24).

Take-off tool

It is used for dismantling and disconnecting the emitter from the lateral or poly-tube.

Solvent cement

It is a substance that is used to bind thermoplastic pipes together by softening the surface of the material being bound.

Fig. 2.25: Teflon tape

Teflon tape

It is a poly tetra fluoro ethylene (PTFE) film used for sealing pipe threads. The tape is sold with specific widths wound on a spool, making it easy to wind around pipe threads.

Jute

Jute is used to wrap around the threads of pipes to make them leak-proof.

GI threaded joint synthetic compound

It is an additive compound that prevents rusting of pipe, gives a certain grip during the installation of pipes and makes their joints leak-proof.

Fig. 2.26: Hot plate

Pencil or marker

Pencil or marker is used to indicate a position and mark necessary details on the components or equipment for easy identification.

Hot plate

Hot plate welding, also called 'fusion welding', is used to join plastic pipes (Fig. 2.26).

Practical Exercise

Activity

Visit a store selling agriculture tools, equipment and material or an institute providing training in agriculture. Familiarise yourself with the tools and equipment used in the installation and maintenance of a microirrigation system.

Check Your Progress

A. Fill in the Blanks

1. A __________ is a tool used for turning screws.
2. Solvent cement is a substance that is used to bind __________ sheets and pipes together.
3. A __________ is a poly tetra fluoroethylene (PTFE) film used for sealing pipe threads.
4. A __________ blade is used for cutting metals.

B. State True or False

1. A wrench is a tool that provides grip and mechanical advantage in applying torque to turn objects, such as nuts and bolts.
2. Marker is the second most important fibre, which is used to wrap around the threads of pipes and make them leak-proof.
3. Solvent cement is a substance that is used to bind thermoplastic pipes together.

C. Subjective Questions

1. Describe the functions of the following tools:
   (i) Hacksaw blade
   (ii) Wrench
   (iii) Hot plate
   (iv) Drill machine

Session 3: Classification and Suitability of Pumps

As already discussed in the previous sessions, a microirrigation system comprises five basic units — pumping unit, control head, main line, sub-mains, laterals and emission devices.

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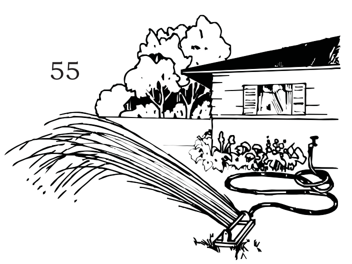

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A pump is used for irrigation purposes. It is an electro mechanical device, which lifts water from one level to another with pressure. The pump selected must be capable of supplying water at the required pressure and discharge the same for efficient functioning of a microirrigation system. In this Session, you will learn about the types of pump used for pumping water and irrigating fields.

Classification of pumps

A variety of pumps designed for specific applications is available in the market. Pumps can broadly be classified into two types — positive displacement and non-positive displacement pumps.

Positive displacement pumps

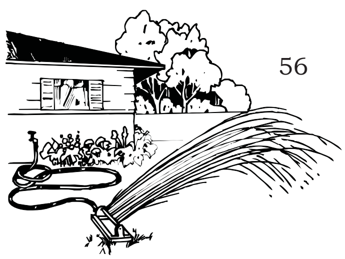
Positive displacement pumps make water move by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe. Pumping takes place by to and fro motion of the piston or diaphragm in the cylinder. Positive displacement pumps can be further classified on the basis of mechanical operation and working principle.

Table 2.1: Types of positive displacement pump

Rotary or continuous type	Reciprocating or cyclic type
Lobe pump	Piston pump
Screw pump	Bucket pump
Gear pump	Plunger pump
Vane pump	Diaphragm pump
Radial plunger pump	Petro pump
	Semi-rotary pump
	Gas or vapour displacement

On the basis of mechanical operation

On the basis of mechanical operation, positive displacement pumps are of three types — piston, diaphragm and plunger pumps.



Piston pump

In 'piston pump', the high-pressure seal reciprocates with the piston. The pump has a piston cylinder arrangement. As the piston goes away after the delivery stroke, low pressure is created in the cylinder, which opens the suction valve. On forward stroke, the water trapped inside the cylinder is compressed, which in turn opens the delivery valve.

Diaphragm pump

This pump uses a combination of reciprocating action of a rubber, thermoplastic or Teflon diaphragm, and non-return check valves to pump water.

Plunger pump

A 'plunger pump' is one, in which there is a high-pressure stationary seal and a smooth cylindrical plunger, which slides through the seal.

On the basis of the working principle

Rotary or continuous pumps

Rotary or continuous pumps move water using the 'principle of rotation'. The vacuum created by the rotation of the pump captures and draws in the water. These pumps are capable of pumping more water than reciprocating pump. The different types of rotary or continuous pump are as follows.

Lobe pump: It works like gear pump, except that the lobes do not come in contact with each other. Lobe pump has larger chambers than gear pump. The water flows into the cavity of the pump and is trapped by the lobes as they rotate. The water travels around the interior of the casing in the pockets between the lobes and the casing. Finally, the meshing of the lobes forces the water through the outlet port under pressure.

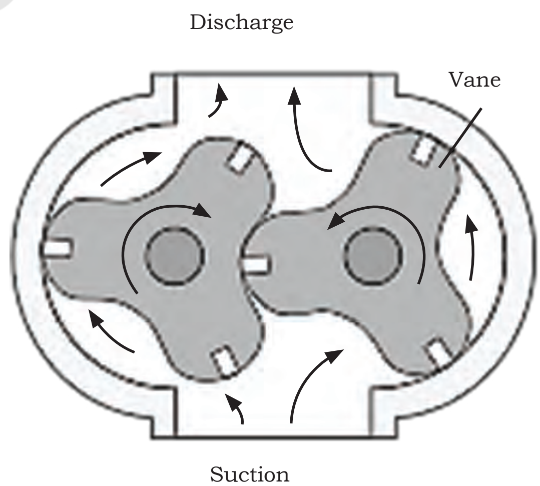


Fig. 2.27: Lobe pump

Screw pump: It is type of rotary pump, featuring two or three screws with an opposing thread, i.e., one screw turns clockwise and the other anti-clockwise. In screw pump, water is pumped by means of screw

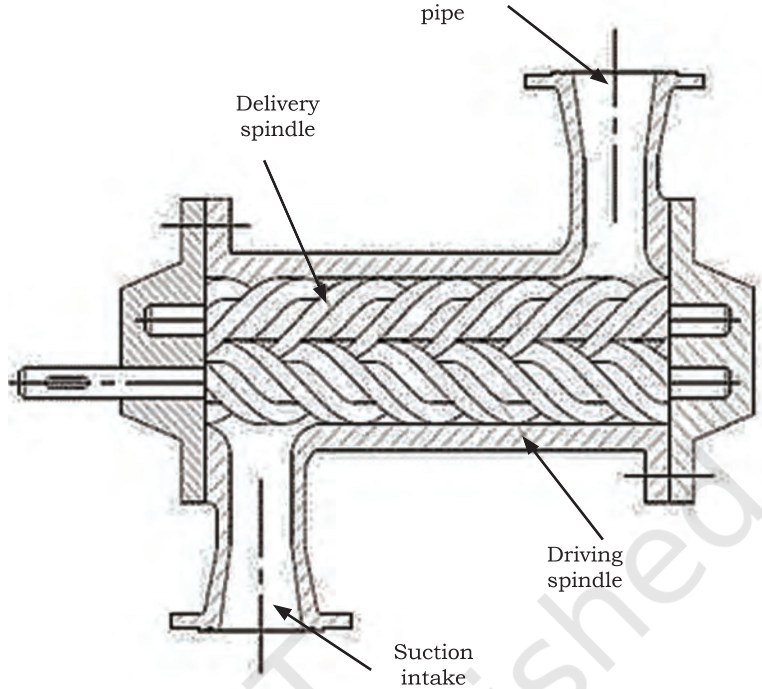


Fig. 2.28: Screw pump

operation (single-screw pump or several screws being in engagement). The performance capacity of single-screw pump can be calculated in the following way.

$Q = 4 \cdot e \cdot D \cdot T \cdot n \cdot \eta_V$

Q: screw pump performance capacity, m^3/s

e: eccentricity, m

D: diameter of rotor screw, m

T: pitch of stat or screw surface, m

n: rotor rotation speed, ms^{-1}

η_{V°: volumetric efficiency

Gear pump: It is the simplest type of rotary pump, consisting of two gear laid in a manner that their teeth are enmeshed for smooth rotation. The pump moves water by repeatedly enclosing a fixed volume using interlocking gear and transferring it mechanically by cyclic pumping action. Gear pump performance capacity can be calculated in the following way.

$Q = 2 \cdot f \cdot z \cdot n \cdot b \cdot \eta_V$

Q: gear pump performance capacity, m^3/s

f: cross-sectional area of space between adjacent gear teeth, m^2

z: number of gear teeth

b: gear tooth length, m
n: teeth rotation speed, s^{-1}
η_{V°: volumetric efficiency

There is also an alternative formula for calculating the gear pump performance capacity.

$Q = 2 \cdot \pi \cdot D_H \cdot m \cdot b \cdot n \cdot \eta_V$

Q: gear pump performance capacity, m^3/s
D_{H°: gear pitch diameter, m
m: pitch of a gear, m
b: gear width, m
n: gear rotation speed, s^{-1}
$\eta -_{\circ V^\circ}$: volumetric efficiency

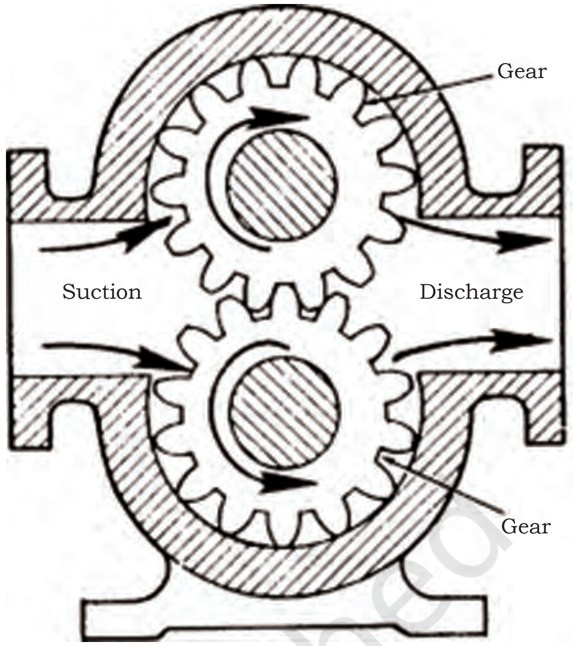


Fig. 2.29: Gear pump

Vane pump: It consists of vanes mounted on a rotor that rotates inside a cavity. Vanes are allowed to slide into and out of the rotor and seal on all edges, creating vane chambers that do the pumping work. Vane pumps are self-priming, robust and supply constant delivery at a given speed. They provide uniform discharge with negligible pulsations. These pumps do not require check valves.

Radial plunger pump: A radial plunger pump is a form of hydraulic pump. The working pistons extend in a radial direction symmetrically around the drive shaft. These are made up of valve controlled pump cylinders arranged in radial star shape.

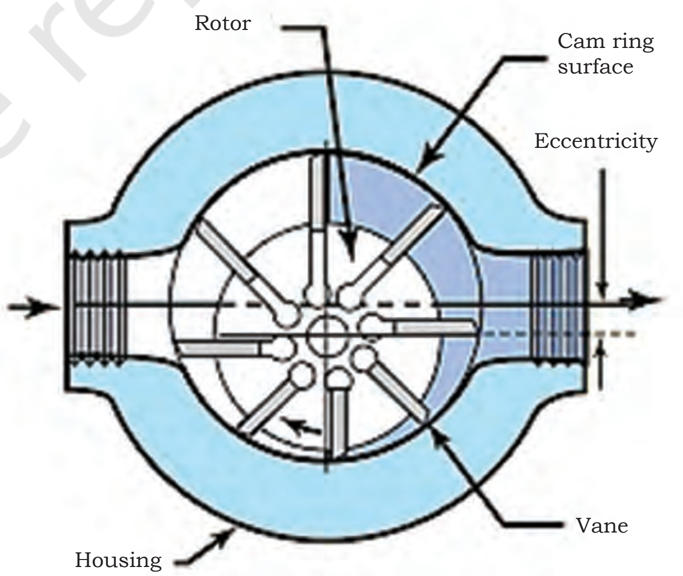


Fig. 2.30: Vane pump

Reciprocating or cyclic pumps

Reciprocating or cyclic pumps operate by drawing liquid into a chamber or cylinder by the action of a piston, plunger or diaphragm. The water is discharged in the required direction by the use of check valves. This results in pulsed flow.

Piston pump: As the piston goes down, the check valve in the pump

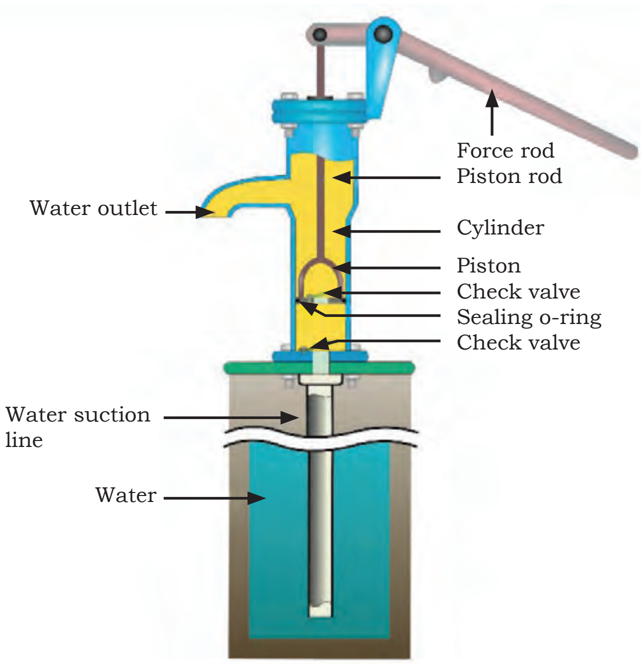


Fig. 2.31: Hand pump

opens, thereby, allowing the water to pass through. The check valve at the base of the cylinder remains closed, holding the water in the cylinder. As the piston moves up, the check valve in it closes, allowing the water above the piston to be lifted. The rising piston pulls up the water into the cylinder. This down and up motion of the piston enables the water to move up and out of the pump. Hand pump is an example of piston pump.

Bucket pump: It has a series of buckets attached to a chain or rope, which collects and lifts water, and dumps it into the spout as the handle at the top is turned.

Non-positive displacement pumps

In non-positive displacement pumps, water is pressurised by the rotation of propeller and the water pressure is proportional to the speed of the rotor. These pumps provide smooth and continuous flow of water.

Centrifugal pump

It operates when water is drawn into the central chamber of a spinning impeller. It is, then, engaged by the vanes that drive the water outside the pump volute casing. This process transforms the kinetic energy of the impeller into the pressure head used to discharge water from sprinklers or emitters located in the area to be irrigated. One of the limitations of centrifugal pump is that before starting, the impeller casing and intake (suction) pipe must be filled with water. This process is called 'priming'. It is necessary as differential pressure needed to draw water into the pump will be created when the pump is turned 'on'. As the water flows from the impeller into the delivery system, an area of low pressure is created at the impeller centre. This draws a continuous stream

Fig. 2.32: Centrifugal pump

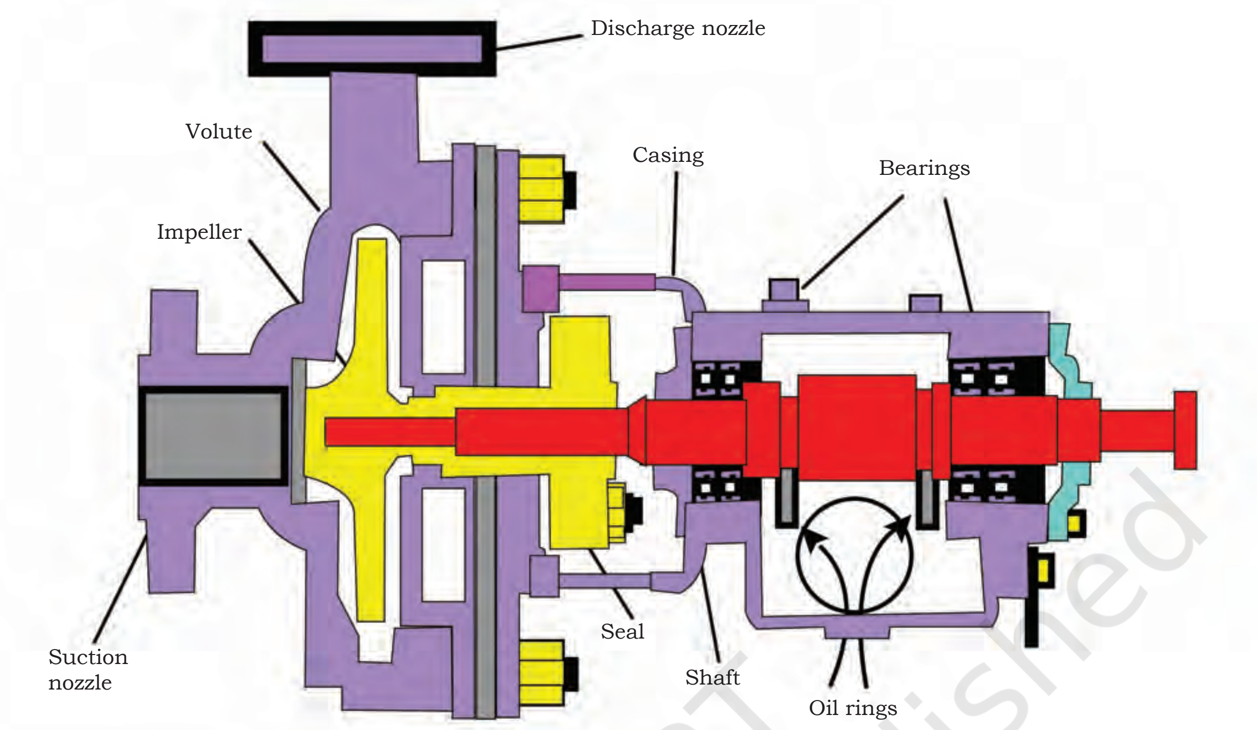


Fig. 2.33: Cross-sectional view of centrifugal pump

of water from the source into the impeller. Centrifugal pump performance capacity can be calculated in the following way.

$Q = b_1 \cdot (\pi \cdot D_1 - \delta \cdot Z) \cdot c_1 = b_2 \cdot (\pi \cdot D_2 - \delta \cdot Z) \cdot c_2$

Q: centrifugal pump performance capacity, m^3/s

$b_{1,2}$: widths of impeller pass through diameters D_1 and D_2,m

$D_{1,2}$: inlet external diameter (1) and impeller external diameter (2), m

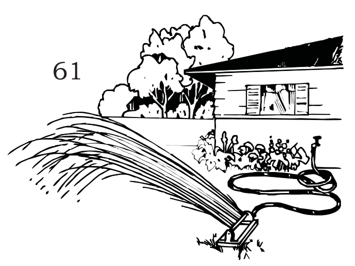
δ: thickness of blades, m

Z: number of blades

$C_{1,2}$: radial components of absolute velocities at impeller inlet (1) and its outlet (2), m/s

Installation of centrifugal pump

Guidelines, as regards to standards for electrical connections, foundation for installing the pump, number of bends on delivery, suction side and shelter to protect the pump in different weather conditions must be followed while installing and operating the centrifugal pump.



Notes

A centrifugal pump is installed close to a water source. It must be located at an accessible place in a clean, dry and ventilated area. To ensure the maximum utilisation of the pump's capacity, the site selected must permit the use of shortest and most direct suction and discharge pipes. The pump is installed on a concrete foundation, so that it can tolerate vibrations. It must have minimum plumbing fittings so as to avoid friction losses. The use of bends, elbows, tees and other fittings must be kept to minimum in order to reduce head loss in the discharge line. The current carrying capacity of wires used in pump installation needs to be sufficient to avoid excess heating of wires and hazards like fire.

Operation of centrifugal pump

If one is starting the pump for the first time, attention must be paid to the following.

(i) Check the alignment of the pump. Any misalignment is to be corrected by placing shims under the pump or driver.
(ii) Make sure that the engine or motor drives the pump in the direction indicated on the pump body.
(iii) It must be ensured that the gland is tightly and evenly adjusted, and the pump shaft revolves freely when turned by hand.
(iv) Check for air tightness of the suction pipe and leakage in the foot valve.
(v) Fill the suction line and pump with water and remove air from the pump casing.
(vi) Attend to lubrication requirements.

Submersible pump

It is a kind of centrifugal turbine pump, wherein long vertical shaft, connecting the motor and pump unit, is replaced by a short shaft. The prime mover and pump become closely coupled and submerged in water. Submersible pumps are suitable for tube wells with a bore of 100 mm or more. The impeller of the pump may be closed, semi-open or open. The principle advantage of submersible pump is that it can be used in a deep tube well, where using a long shaft would not be practical.

Solar-powered pump

A solar-powered pump runs on electricity generated by photo voltaic panels, which collect thermal energy. It is later converted into electrical energy for pump operation. Generally, a 5 HP (horsepower) AC (alternating current) solar pump sets with 4800 wp capacity must be used for lifting water from an open well or other surface storage structure.

Fig. 2.34: Solar-powered pump

Suitability of pump

Suction and lift are the factors that must be considered when pumping water. 'Suction' is the vertical distance between the water to be pumped and the centre of the pump, while 'lift' is the vertical distance between the pump and the delivery point like emitters and sprinklers. For example, the depth from which a hand pump will draw water is limited by atmospheric pressure to an operating depth of less than 7 metre. The size of the motor will depend on the depth of the well or water body (head or lift) and the volume of water to be moved by the pump.

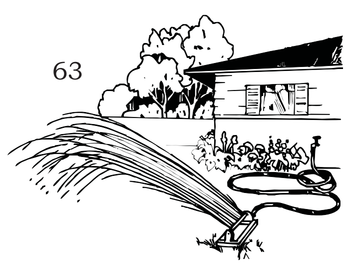
Pumps develop differential head or differential pressure. This means the pumps take suction pressure, add more pressure (design pressure) and generate discharge pressure. So, the discharge pressure is equal to the suction pressure plus the pumps' design pressure. Discharge pressure is determined on the basis of desired operating pressure, loss of pressure due to friction and change in elevation within the field.

While selecting a pump, one must take into consideration the maximum total head against which it is expected to operate and deliver the required discharge. This is be determined by:

$H_t = H_n + H_m \pm H_j + H_s$, where

H_t = total design head against which the pump is working, m

H_n = maximum head required at the main to operate the sprinklers on the lateral at the required average pressure, including the riser height, m



H_m = maximum friction loss in the main and suction line, m

H_J = elevation difference between the pump and the junction of the lateral and the main, m, and

H_s= elevation difference between the pump and the source of water after draw down, m

The discharge required to be delivered by the pump is determined by multiplying the number of sprinklers that are operated at a given point of time by the discharge of each sprinkler. Once the head and discharge of the pumps are known, the pump may be selected from rating curves or tables provided by the manufacturer.

Determination of total head

The total pressure head or dynamic head required for the normal operation of the system is the sum of the following heads.

Total head loss (H) = Suction + delivery (m) + filter losses + fitting losses + ventury head loss + operation losses + lateral + sub-main losses + main line losses

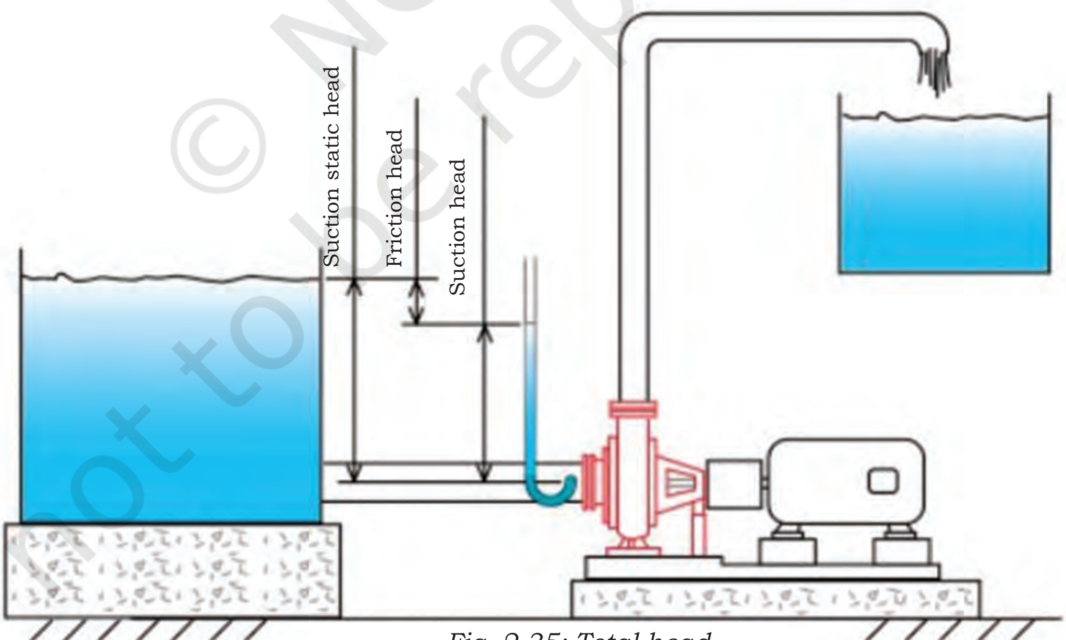


Fig. 2.35: Total head

source: www.pumpfundamentals.com

Determining horsepower of pump

This is the sum of the system's total head plus the pumping lift. The brake horsepower formula is:

$$\frac{HP = Q \times H}{75 \times a \times b}$$

Where,

Q: is the flow capacity in litres per hour

H: is the total head expressed in metres

a: is the pump efficiency

b: is the driving efficiency

- Pump efficiency: 0.5–0.8
- Electric motor efficiency: 0.7–0.9

Example

Main line flow (lps): 4.98

Total head loss (H) = Suction + delivery (10 m) + filter losses (5m) + fitting losses (2 m) + ventury head loss (5 m) + operation losses (10 m) + lateral + sub-main losses 1.6+0.8 (2.4) + main line losses = 1.65 m

Total head loss (H) = 10 + 5 + 2 + 5 + 10 + 2.4 + 1.65

$$= 36.5 \text{ m}$$

$$= \frac{HP = Q \times H}{75 \times a \times b}$$

$$\frac{= 4.98 \times 36.5}{75 \times 0.8 \times 0.85}$$

$$= 3.56 = 5 \text{ HP}$$

The required pump size is 5 HP.

Practical Exercises

Activity 1

Draw a diagram of a cross-sectional view of centrifugal pump and label the parts.

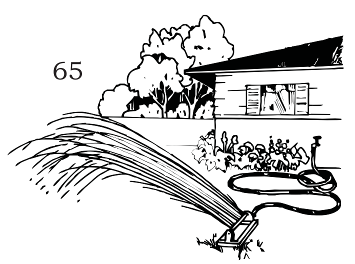
Activity 2

Visit an agricultural farm and study the type of pumps installed for irrigation.

Activity 3

Read the manual for the installation and maintenance of a centrifugal pump.

NOTES



NOTES

Check Your Progress

A. Fill in the Blanks

1. In piston pump, the high-pressure seal reciprocates with the ___________.
2. Pump is an ___________ device, which lifts water from one level to another with pressure.
3. A pump can be driven by an ___________ motor or an internal combustion engine.
4. Any misalignment in a centrifugal pump is to be corrected by placing ___________ under the pump or driver.
5. A radial plunger pump is a type of ___________ pump.

B. State True or False

1. The main operating component of piston pump is the cylinder, in which the piston does not move.
2. Hand pump is an example of piston pump.
3. Submersible pump is a type of centrifugal turbine pump.

What have you learned?

After completing this Session, you will be able to:

- differentiate between various types of positive displacement pump and their uses.
- differentiate between various types of non-positive displacement pump and their uses.
- determine the suitability of a pump for a microirrigation system.