Unit 3

Operation and Maintenance of Microirrigation System

Session 1: Operation and Monitoring of Sprinkler Irrigation System

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A sprinkler irrigation system must be operated keeping with the recommended irrigation practice. It must be ensured that the prime mover and pump are in alignment, particularly, in case of tractor-driven pumps. Service and installation procedures with respect to pump and power units must be observed. While starting the sprinkler system, the motor or engine is started with the valves closed. The pump must attain the pressure stated on the type-plate, else there is a fault in the suction line. After the pump reaches the regulation pressure, the delivery valve is opened slowly. Similarly, the delivery valve is closed after stopping the power unit. The pipes and sprinkler lines are shifted as required after stopping, in case of portable sprinkler system. The following steps need to be followed for operating the sprinkler system.

(i) Start the pump and open the valve to fill the pipes with water.

(ii) Release all end caps and flush valves to clean the system of dirt and clogging. Before operating the system, the end caps installed at the end of the laterals and sub-mains are released so that dirt in the pipes is washed away and air is also driven

out. Open the control valve and let the water flow freely through the pipes for some time. Then, close the end caps and ensure that water comes out from each sprinkler.

(iii) Check the pressure and discharge of water, and ensure that all sprinklers are operational.

(iv) Operate the system according to the recommended irrigation schedule.

Operation and efficiency of sprinklers

The two main types of spray head installation are risers and pop-ups. Both the types are available in different spray patterns, including full-circle, half-circle, quarter-circle and fully adjustable. These spray head nozzles are made to deliver matched precipitation rates, meaning that a quarter circle pattern will deliver one-fourth as much water as a full circle. Each sprinkler delivers a metered amount of water over a part of the entire zone. It is essential that each zone has the same type of sprinkler heads as each type has a specific rate of application. If different types of sprinkler head are placed on the same lateral, the distribution will be uneven, leading to the emergence of dry or wet spots.

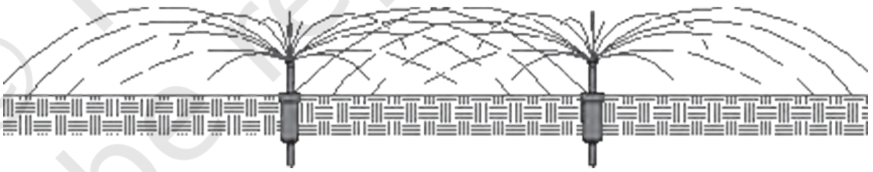
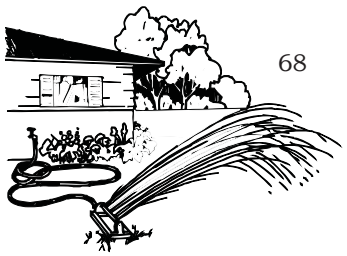


Fig. 3.1: Schematic sketch of overlapping sprinkler sprays

The operation and efficiency of sprinklers depend on the degree of uniformity of water application, which depends on the water spray distribution characteristics of sprinkler nozzles and sprinkler spacing. The sprinklers are installed in a manner that they overlap the watered area. This overlap may seem like a waste, but it is a necessity.

The spray distribution characteristics change with the nozzle size of a sprinkler and its operating pressure. At lower pressure, the drops are larger and water from the nozzle falls in a ring away from the sprinkler. For



higher pressure, the water from the nozzle breaks into fine droplets, which fall close to the sprinkler. Almost all sprinklers have an in-built radius adjustment device in order to reduce the radius of the water throw.

Operating a sprinkler at pressures above the design range results in excessive misting (small droplet size) and water is easily blown away or evaporated or may accumulate close to the sprinkler. The actual spacing, however, shall be guided by the size of pipes available in market. Generally, pipes of 6 m (full size) and 3 m (half size) are available.

Fig. 3.2: Overlapping sprinkler sprays in a farm

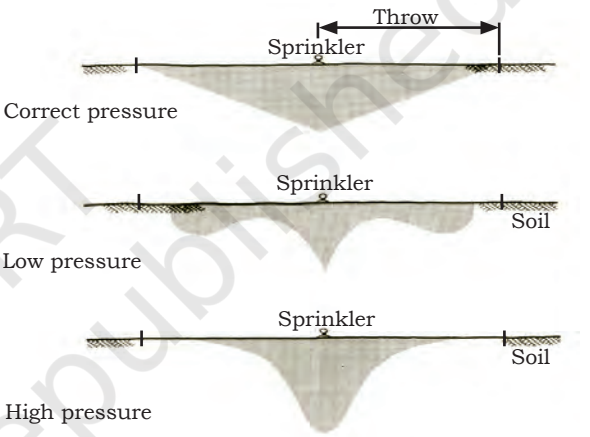


Fig. 3.3: Effect of variation in water pressure on sprinkler spray pattern

Maintenance of sprinklers

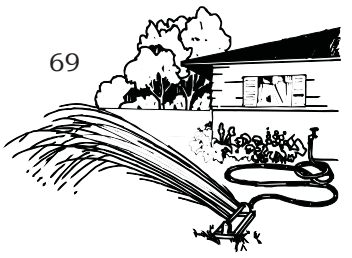
- Do not apply oil, grease or any other lubricant on to the sprinklers. They are water lubricated and using oil, grease or any other lubricant may make them defunct.
- Sprinklers, usually, have a sealed bearing and at the bottom of the bearing there are washers. Usually, it is the washers that get damaged and not the metal parts. The washers are to be checked for wear and tear. Replace the damaged washers.
- After several operations, the swing arm spring of the sprinkler may need tightening. This is done by pulling out the spring end at the top and bending it again. This will increase the spring tension.
- Check all equipment at the end of the season and make necessary repairs and replacements so that the equipment is ready for the next season.

Practical Exercises

Activity 1

Visit a farm, where a sprinkler irrigation system is installed and study the following.

(i) Distance between sprinkler heads



(ii) Types of sprinkler head
(iii) Wetted area around sprinkler head

Prepare a note based on your observations.

Activity 2

Visit a farm, where a sprinkler irrigation system is installed and study the following.

(i) Uniformity of water application
(ii) Maintenance schedule
(iii) Number of sprinklers functional and non-functional

Prepare a note based on your observations.

Check Your Progress

A. Fill in the Blanks

1. Each sprinkler delivers a _____ amount of water over a part of the entire zone.
2. The two main types of spray head installation are _____ and pop-ups.
3. Sprinklers are designed to _____ the watered areas.
4. Do not apply _____ , grease or any other lubricant on to the sprinklers. They are water lubricated and using oil, grease or any other lubricant may stop them from working.

B. Subjective Questions

1. Describe the operation of sprinklers.
2. Write a note on the maintenance of sprinklers.

What have you learned?

After completing this Session, you will be able to:

- describe the factors that influence the operation and functioning of a sprinkler system.

SESSION 2: MAINTENANCE OF SPRINKLER IRRIGATION SYSTEM

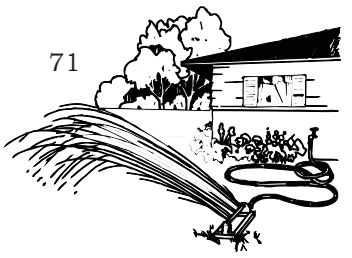
At the beginning of each growing season, check the irrigation line from the valve to the spray heads for leaks. Take a round of the entire field and check if there is leakage at joints or damage to any component of the system. Rectify the defects, if any, by replacing the spare parts. Remove folds or kinks on laterals or pipes, and make them straight.

Clean the irrigation system periodically to remove dirt and debris that have built up over time. There are few basic steps that one must take at least once in a year to ensure that water always gets through the system. Using a filter can prevent build-up of minerals and organic particles in pipes, risers and nozzles, and make it easy for cleaning. It is also important to follow these instructions in order to flush each zone in the system at least once a year.

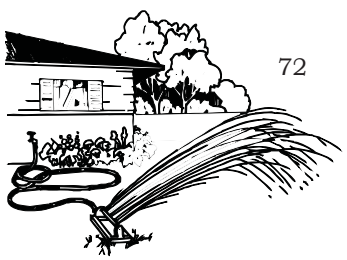
(i) Turn off water supply to one zone, and remove nozzles and sprinkler heads.
(ii) Run water through the zone for few minutes until the filter is clean and a clear stream of water flows from each sprinkler.
(iii) Take apart the nozzles (depending on the type, you can do this by hand or with a screwdriver or special key).
(iv) Clean the nozzles to remove dirt or deposits.
(v) Rinse the filter screen or basket.
(vi) Reassemble the filter and replace the damaged or worn out parts.
(vii) Turn on the zone again to check that everything is leak-proof and operational.

Table 3.1: Maintenance schedule for sprinkler irrigation system

Frequency		Action
Daily	Pressures	Check that pump and block pressures are within the prescribed limits.
	Emitter operation	Check for clogged, broken or misplaced emitters. Repair, replace, unclog or reposition the emitters.
	Leaks	Check for water wastage and leaks in pipes and other equipment, and repair them immediately.
	Primary filter	Flush primary filters as prescribed.
	Fertigation application	Check that fertigation applications are within specifications.



Weekly	Lateral lines	Flush the lateral lines as prescribed.
	Exposed joints	Check and repair them if needed, e.g., quick coupling rubbers.
	Secondary filters	Flush the secondary filters as prescribed.
	System pressure and flow	Check that the system pressure and flow are as per the irrigation design plan.
	Pump operation	Check that pump operation is within the prescribed parameters.
	Block pressures for automated valves	Check that the block pressures are within the prescribed limits where automated valves are used.
	Pump oil levels	Check pump oil levels as prescribed.
	Fertigation plant	Inspect the fertigation plant.
	Pipes	Check for leaks and repair them.
Monthly	Valves, water meter and gauges	Visually check the valves, water meter and gauges, and look for damage and vandalism.
	Filters	Open and inspect the filters as prescribed.
	Pump pipe work	Check for leaks at the pump station that causes water losses and airlocks.
	Pump motor	The pump motor must be greased as prescribed.
Annually	Valves	Check the service valves and replace them, if required.
	Filters	Clean the filters and replace them annually or in two years.
	Pump	Change oil in the pump.
	Water sampling	Take water sample at the end of lateral lines and send it for analysis.
	Emitter delivery tests	Test specific emitters for discharge and pressure.
	Sprinkler parts	Replace nozzles annually and the other parts when needed.
	Pump	Replace the bearings and other worn out parts of the pump every five years.
2–10 years	Hydraulic valves	Replace the diaphragms in hydraulic valves every three years.
	Poly pipe and emitters	Replace the poly pipe and emitters every 7–10 years.



Maintenance schedule for pumps

The following maintenance schedules, generally, apply to most pumps under average operating conditions.

Monthly

Check the bearing temperature, as the bearing may run hot due to lack of lubrication or its excess.

Quarterly

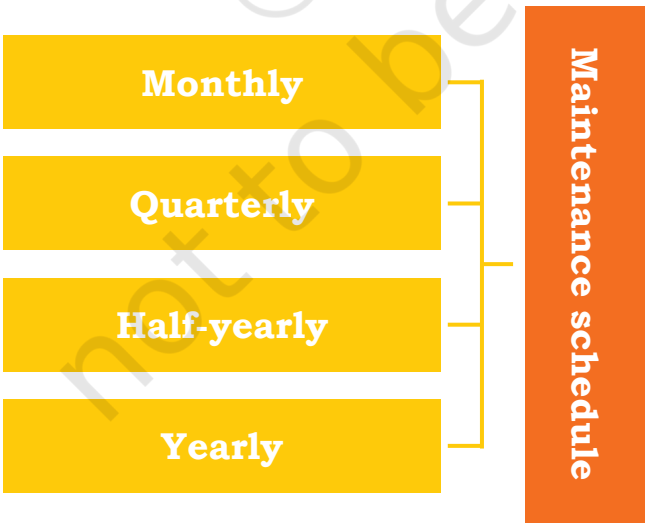
Drain lubricants in ring oil bearings and wash out the oil wells and bearing with kerosene.

Half-yearly

Check the alignment of pump and driver, and add shims, if required. If misalignment occurs frequently, the entire piping system may have to be checked and necessary corrective actions may have to be taken. Replace gland packing.

Yearly

Thoroughly inspect the unit once in a year. Remove bearings, clean and examine them for flaws. Remove the packing and examine wear and tear in the shaft sleeve or shaft. Disconnect coupling valves and check alignment. Inspect foot valve and check valves.



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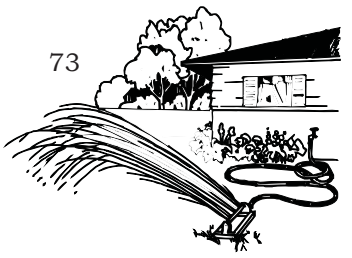
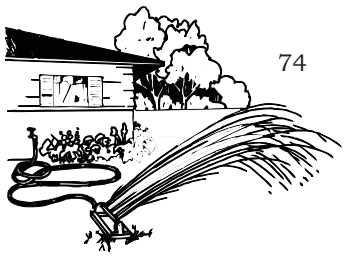


Table 3.2: General pump glitches and their causes

Glitches	Causes
No water delivered	(i) Pump not primed (ii) Speed too low (iii) Discharge head too high (iv) Suction lift too high (v) Impeller or suction pipe completely plugged (vi) Wrong direction of rotation (vii) Air pocket in suction line (viii) Air leakage in suction line or stuffing box (ix) Insufficient net positive suction head available
Not enough water delivered	(i) Air leak in suction line or stuffing box (ii) Speed too low (iii) Discharge head higher than anticipated (iv) Suction lift too high (v) Impeller or suction pipe partially plugged (vi) Wrong direction of rotation (vii) Insufficient net positive suction head available (viii) Foot valve too small (ix) Insufficient submergence of suction inlet (x) Bearings worn out
Not enough pressure developed	(i) Speed too low (ii) Excessive amount of air or gas in liquid (iii) Wrong direction of rotation (iv) Viscosity of liquid higher than anticipated (v) Bearings worn out (vi) Impeller diameter too small
Pump works for a while and then loses prime	(i) Air leak in suction line or clogging (ii) Excess amount of air or gas in liquid (iii) Air pocket in suction line (iv) Water seal tube clogged (v) Suction lift too high (vi) Insufficient submergence of suction inlet
Pump requires excessive power	(i) Speed too high (ii) Head lower than anticipated, pumps too much water (iii) Specific gravity or viscosity too high (iv) Wrong direction of rotation (v) Misalignment (vi) Stuffing box too tight (vii) Rotating element rubbing or binding (viii) Bent shaft (ix) Bearings worn out
Stuffing box leaks excessively	(i) Packing is worn out and not adequately lubricated (ii) Packing not as per recommendations (iii) Shaft sleeve scored (iv) Bent shaft



Pump noisy or vibrates	(i) Suction lift too high (ii) Insufficient Net Positive Suction Head (NPSH) available (iii) Impeller or suction pipe partially plugged (iv) Misalignment (v) Foundation not rigid (vi) Lack of lubrication (vii) Bearings worn out (viii) Rotating element out of balance (ix) Bent shaft

Principles for maintenance of pipes, fittings and sprinkler heads

The general principles regarding the maintenance of pipes, fittings and sprinkler heads are as follows.

Maintenance of pipes and fittings

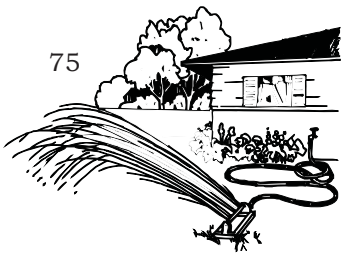
Pipes and fittings virtually require no maintenance but attention must be paid to the following.

(i) Periodically, clean dirt or sand out of the groove in the coupler, in which the rubber sealing rings fit.
(ii) Keep all nuts and bolts tight.
(iii) Do not lay pipes on new damp concrete or on piles of fertiliser.
(iv) Avoid trampling over the pipes.

Remove the end stop or end cap and flush the laterals or pipes for 1–2 minutes. Starting from the sub-main inlet, flush the first 4–5 laterals or pipes and proceed to the end. This will help in gaining higher velocity in the laterals and pipes for cleaning. Flush the sub-mains at the end of the irrigation process to remove debris.

Maintenance of sprinkler heads

(i) When moving the sprinkler lines, make sure that the sprinklers are not damaged or pushed into the soil.
(ii) Do not apply oil, grease or any other lubricant on the sprinklers. They are water lubricated and using oil, grease or any other lubricant may stop them from working.
(iii) Sprinklers, usually, have a sealed bearing and at the bottom of the bearing, there are washers.



Usually, it is the washer that wears and tears and not the metal parts.

(iv) Check the washers for wear and tear once a season or every six months, which is important in areas where the water is sandy. Replace the washers, if they are worn out.

(v) After several operations, the swing arm spring may need tightening. This is done by pulling out the spring end at the top and rebending it. This will increase the spring tension.

Backwashing

Backwashing is a process, in which the direction of the flow is reversed so that the water flows upwards through the sand bed. If backwashing is not done regularly, then impurities accumulate in the sand bed, thereby, reducing the efficiency of the filter. Besides, the system does not get water at the desired pressure.

The backwash operation is complete when clear water starts flowing out through the backwash valve. To resume the filtration process, perform the following.

(i) Open the inlet valve.
(ii) Close the bypass valve.
(iii) Open the outlet valve.
(iv) Close the backwash valve.

Cleaning of filters

Clean the filters every 5–6 hours or at recommended timings based on the water quality analysis report. After cleaning the filters, operate the bypass valve of the header assembly to obtain the desired pressure in the system. It must be about 1.5–2 kg/cm^2 at the inlet of the filter and 1 kg/cm^2 at the inlet of the sub-mains.

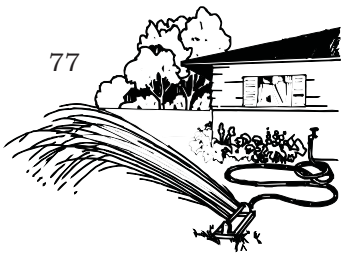
Maintenance of sprinklers

Check that each spray head covers the desired area of a field. The heads may have been knocked out of alignment by foot traffic, agriculture tools or machinery. To adjust this, move the nozzle of the sprinkler heads to redirect the spray and turn the spray reduction

adjustment screw on the top of the nozzle. Replace the spray heads, if necessary. Sometimes, spray heads produce mist or fogging action rather than larger drops necessary for watering. This indicates that the water pressure is too strong. Adjust it at the main shut-off valve. Turn the valve clockwise, manually, until large drops of water are seen at the sprinkler heads. Some automatic valves have a special knob for adjustment called 'flow control', which adjusts the flow to minimise misting and fogging.

Minor maintenance

(i) Periodically clean the coupler to avoid dirt or sand accumulation in the groove, which may cause leakage from the rubber ring.
(ii) Periodically, check the bolts and nuts, and keep them always tight.
(iii) Maintain operating pressure in the system.
(iv) Check the sprinkler heads at the end of each operating season and replace the damaged parts.
(v) Blocked nozzles must never be cleaned with sharp metal parts. They may damage the distribution pattern of the nozzles. For cleaning the nozzles, use a wooden stick like a toothpick.
(vi) Protect the sprinkler heads against striking with a hard surface or pressing into the soil.
(vii) Ensure sufficient spring tension for smooth sprinkler rotation. Spring tension can be increased by pulling out the spring end at the top and bending it.
(viii) Grease, oil or any other lubricant must not be used in the sprinkler nozzles as they are water lubricated.
(ix) The sprinkler nozzles and rubber sealing must be stored in a dry place after cleaning and drying.
(x) Protect the electrical motor from dust, dampness and rodents.
(xi) Rotate the impeller of the pump by hand at the beginning of a new season before starting.
(xii) Check the suction lift, air tightness, foot valve, gland packing and priming in case the pump is not discharging water.



Practical Exercises

Activity 1

Visit an agricultural farm, where a sprinkler irrigation system is installed and study the following.

(i) Are any sprinkler heads missing?
(ii) Are any sprinkler heads broken?
(iii) How many sprinkler heads are clogged?
(iv) Are any sprinkler heads tilted or spray water too far?
(v) Do the sprinkler heads spray water in a fine mist?

Activity 2

Prepare a maintenance schedule for sprinkler irrigation system.

Check Your Progress

A. Multiple Choice Questions

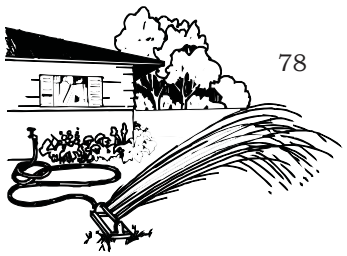
1. _____ is a process in which the direction of water flow is reversed so that the water flows upwards through the sand bed.
   (a) Backwashing (b) Flushing
   (c) Cleaning (d) Pumping
2. Do not apply oil or any other lubricant on the sprinkler as it is lubricated with _____.
   (a) oil (b) grease
   (c) water (d) glycerol

B. Fill in the Blanks

1. When installing sprinkler lines, we must make sure that the sprinklers are not _____ into the soil.
2. Do not apply oil, grease or any other lubricant to the sprinklers. They are _____ lubricated, and using oil, grease or any other lubricant may stop them from functioning.
3. Sprinklers, usually, have a sealed bearing and at the bottom of the bearing there are washers. Usually, it is the washer that wears and tears and not the _____ parts.
4. Maintained _____ will ensure maximum efficiency of an irrigation system by avoiding clogging of sprinkler heads.

C. Subjective Questions

1. Write the steps for backwashing of sand filter.
2. Why is the operating pressure maintained in a sprinkler irrigation system?



What have you learned ?

After completing this Session, you will be able to:

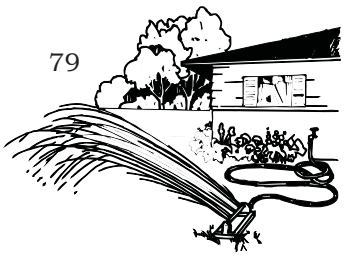
- demonstrate the tasks associated with the maintenance of pipes and fittings.
- demonstrate the tasks associated with the maintenance of sprinkler heads.

Session 3: Maintenance of Drip Irrigation System

An irrigation system requires minimal maintenance if it is planned and designed as recommended. It is advisable that all components must be checked as per the guidelines for installation of specific products. A maintenance plan and regular monitoring of the system ensures that minor problems do not turn into major ones.

The quality of water differs with its source. Higher rainfall in summer means that water sources are muddy due to increased content of silt and sand. Algae are more prevalent during warmer months, which increases the biomass that has to be filtered. The quality of water, usually, becomes poor because of lower water level as pumps tend to suck more dirt and there is little time for the silt and sand to settle out of the water. When the

Fig. 3.4: Drip irrigation system



water quality is poor, filters must be flushed at regular intervals. It is essential to keep a record of lateral flushing, filter flushing and water quality.

In 'preventive maintenance', a procedure or group of procedures is adopted to prevent obstructions from plugging, clogging or blocking of drippers. In 'corrective maintenance', obstructions that cause dysfunction to the system are removed.

Maintenance of distribution network

A drip irrigation system requires more attention and maintenance as compared to other irrigation systems. A drip irrigation system is vulnerable to over-pressurisation and clogging, both of which can drastically reduce the system's durability and performance.

For drip irrigation, turn on the system 20–30 minutes before inspection to allow enough time for emitter wetting patterns to show up. Check for leaks or clogged emitters from the valve to the end of the irrigation line. Check the placement of emitters near plants.

System flushing

System flushing is the process of opening flush valves on the main line, sub-mains or laterals while under pressure. Flushing increases the water velocity inside the pipeline or dripper line, which scours and removes contaminants off the walls or from individual emitters. The pressure of the regulating valve is increased to achieve enhanced velocities, nevertheless, care must be taken not to exceed the burst pressure of the emitter line and take-off adapters. Recommended flushing velocities are as follows.

(i) Main line: 1 metre per second
(ii) Sub-mains: 1 metre per second
(iii) Laterals: 0.5 metre per second

Fig. 3.5: Main or sub-main flushing

System flushing needs to be carried out at regular intervals. The frequency of flushing depends mainly on the water quality and weather. Table 3.3 indicates the starting point for flushing. However, individual site conditions influence the increase or decrease of flushing intervals.

Table 3.3: Flushing intervals

Quality	Water source	Flushing interval
Good	Bore water with no presence of iron or magnesium	6 months
Average	Rivers, dams or lagoons that are slow flowing Wastewater discharged from industries after treatment	4 months
Poor	Rivers, creeks or canals found in hot climates with increased biological growth and no chemical treatment Faulty placement of the pumping point in the direction of wind with little or no sedimentation Untreated effluent water after sedimentation	Monthly
Very poor	Bore water having high iron or magnesium content	Fortnightly

Types of filters and their maintenance

Hydrocyclone filter

In hydrocyclone filter, water enters the hydrocyclone via a tangential inlet, which creates a spiral flow along the walls of the filter. The centrifugal force separates the waste and sand particles and pushes them towards the walls of the sand separator. Particles gravitate downwards into the sedimentation tank, while clean water moves upwards and exits through the top outlet. A hydrocyclone filter requires least maintenance as regards to cleaning. For cleaning, flush the chamber by opening the flush valve or cap or open the main valve. The filter becomes ineffective once the dirt collection chamber is full.

Sand filter

Sand filter helps remove heavy organic and inorganic pollutes. Over a period, contaminants present in the water accumulate and clog the pore space of the sand bed, thereby, reducing filter efficiency.

Backwashing is a process, in which the water flow direction is reversed and the sand bed is lifted and expanded, allowing it to release the collected dirt mainly from the top. Daily backwashing of sand filter is desired. The dirt is carried away through valve opening. The backwash flow needs to be adjusted with care as excess flow may lead to removal of sand from the filter, while insufficient flow will not clean the sand. The steps of backwash operation are as follows.

(i) Open the backwash valve.
(ii) Close the outlet valve.
(iii) Open the bypass valve.
(iv) Close the inlet valve.

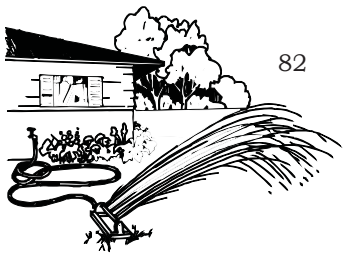
Few installations come with semi-automatic and automatic backwash options, where opening and closing of the valve is done at the same time. The sand filter must also be cleaned regularly in the following manner.

(i) Open the lid of the sand filter.
(ii) Start the backflush operation.
(iii) Put one hand inside the sand filter and stir the sand thoroughly.
(iv) Allow all water along with dirt to flow through the main hole of the sand filter.
(v) Close the lid for normal operation.

Screen filter

Screen filters remove sand from water. Flushing at scheduled intervals is necessary for the maintenance of screen filters. It is recommended to flush the screen filter

Fig. 3.6: Backwashing



when the pressure drops more than 0.5 kg/cm^2 (5 m at water head). The pressure difference can be observed by checking the inlet and outlet pressure by using a single three-way control valve at regular intervals. The process of cleaning the screen filter is simple. Flushing of a screen filter is done in the following manner.

(i) Open the drain valve, thereby, allowing the water force to flush out dirt through the valve.

(ii) Open the screen filter lid. Remove the screen and clean it under running water by rubbing it with a cloth or soft nylon brush.

(iii) Protect the metal parts of the filter from scratches, acid, chlorine or fertiliser spillage, and apply oil paint immediately on the scratch to avoid corrosion.

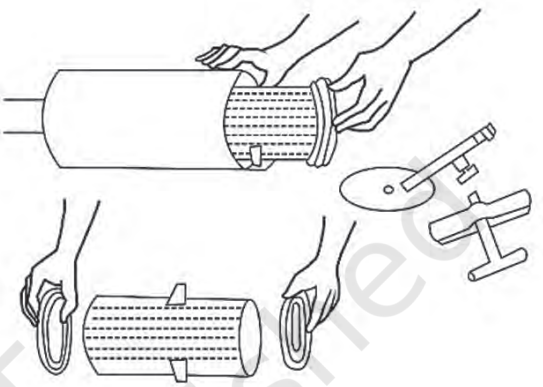


Fig. 3.7: Dismantling of screen filter

Disc filter

A disc filter serves as a primary or secondary filter for water, which contains high amount of organic or inorganic matter. It consists of a stack of discs, each with a series of microscopic grooves. The dimension of the grooves determines the effective mesh size of the filter, which generally, ranges from 40 to 600 mesh. Disc filter requires less maintenance. Flushing of the disc filter is done either by opening the drain valve or by back flushing. The steps followed for cleaning the disc filter are as follows.

Step 1: Remove the filter element and loosen the disc set by extending the spine element.

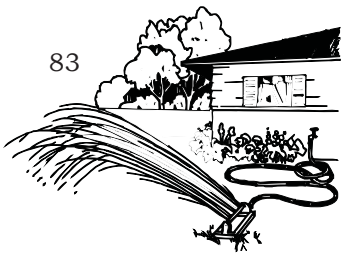
Step 2: Now, remove the screen and clean it with pressurised clean water.

Step 3: Replace the worn out discs with clean ones.

Step 4: If the disc filter is to be cleaned with an acid or a chlorine solution, use the recommended concentration.

Step 5: Assemble the filter after cleaning.

Fig. 3.8: Cleaning of disc filter



Practical Exercise

Activity

Obtain samples of used screen and disc filters, which need cleaning. Demonstrate the step-wise cleaning process for disc filter.

Check Your Progress

A. Multiple Choice Questions

1. Disc filters are designed for use as a primary or secondary filter when water contains high amount of _____.
   (a) organic matter
   (b) inorganic matter
   (c) both (a) and (b)
   (d) None of the above
2. Disc filters are available in _____ mesh sizes.
   (a) 20–100
   (b) 40–600
   (c) 30–150
   (d) 40–200

B. Fill in the Blanks

1. Drip irrigation system is vulnerable to over- _____ and _____, both of which can drastically reduce the system's durability and performance.
2. System flushing is a procedure of opening flush _____ on the main line, sub-mains or laterals while under pressure.
3. Flushing increases the water _____ inside the pipeline or dripper line, which removes contaminants off the walls or from individual emitters.
4. The _____ of the regulating valve is increased to achieve enhanced appropriate velocities, nevertheless, care must be taken not to exceed the burst pressure of the emitter line and take-off adapters.

What have you learned?

After completing this Session, you will be able to:

- describe the procedure of flushing for the maintenance of a drip irrigation system.
- demonstrate the procedure of cleaning filters in microirrigation system.
- explain the procedure for maintaining a distribution network in drip irrigation system.