**Lecture 46 Installation Operation and Maintenance of Drip Irrigation Systems**

Drip irrigation system consists of various components. All these components are to be designed properly as per their specifications. After designing the components these are to be installed properly. Many of the problems in drip irrigation system result in due to poor installation of the drip irrigation system. The system needs to be maintained and operated properly for obtaining the longer or expected life of different components of the system and trouble free operation of the system. The points that need to be considered while installation, operation and maintenance of the drip irrigation system are described in this lesson.

**46.1 Installation**

The main items in the installation of drip irrigation system include installation of the head assembly (control head), comprising the pumping set, non-return valve, water meter, filters, fertilization equipment, flow control, air release and pressure release valves. The other items of installation include connecting mains, sub-mains, and lying of drip tape or lateral with drippers. While installing the control head or the pipe network, the minimum number of accessories such as elbows, reducers etc should be used. This is required for proper maintenance of the system and to reduce unnecessary head loss in the system due to these connections.

**46.1.1 Installation of Filters and Fertigation Equipment**

1. A strong support in the form of hard base or concrete base along with the GI fittings should be used for the installation of the sand and hydro cyclone filters to avoid any vibrations due to load.
2. The filter size should be in accordance with the capacity of the system. This should match with the pump discharge under size will lead to loss and over size will add cost.
3. The delivery pipe of the pump should be connected directly to the hydro cyclone or the media or sand filter followed by the fertilizer equipment and the screen filter. All of these components should be installed in the main pipe.
4. Once the sand/screen filter is essential requirement. Suitable arrangement to collect and dispose of the bypass material should be made.
5. In pressurized irrigation system the fertilizer injection unit is located, between the sand filter (if required) and the screen filter. The general recommendation is that the fertilizer solution pass through at least two 90-degree turns to ensure adequate time for thorough mixing and for any precipitate to come out in front of the screen filter. It is must that fertigation unit is installed at the upstream end of the screen filter so as to filter the under solved matter present in the fertilizer solution.

**46.1.2 Installation of Mains and Sub-mains**

1. Except for fully portable system, both mains and sub mains if made out from PVC must be installed underground at a minimum depth of about 0.5m such that they are unaffected by cultivation or by heavy harvesting machinery. Even for systems, which have portable laterals that are removed at the end of each season, it is common practice to install permanent underground mains and sub mains. Generally sub mains run across the direction of the rows.

The United States Soil Conservation Service has recommended the following minimum cover of earth over for various pipe sizes (Fred Hamish, 1977):

|  |  |
| --- | --- |
| Pipe size | Depth of earth cover |
| 1.2 to 6 cm diameter | 45 cm |
| 6 to 10 cm diameter | 60 cm |
| Over 60 cm diameter | 75 cm |

2. If the mains and sub mains are made out of materials other than PVC such as HDPE or GI, these may not be the need to install them below the ground surface; however it is advisable to install them underground.

3. It is important to remove mud and other impurities in the pipe before fitting of mains and sub-mains and gate valves. A ball valve is provided at the inlet end of the sub-main. After the ball valve, the air release valve is provided. A flush valve facing the slope of the sub-mains is provided at the end of each sub-main to facilitate sub-main flushing.

**46.1.3 Laying of Laterals**

1. After the main and sub mains are installed, holes are drilled on the sub-main, according to the grommet take off (GTO) i.e., 11.9 mm dia drill for 8 mm ID GTO and 16.5 mm drill for 13 mm ID GTO.
2. Then grommet are fixed in it and theses take off are fixed.
3. Once the grommet take offs are fixed on the sub-mains, lateral/polytube laying is done as per the design.Lateral is fixed to one end of the take off.
4. 4.Lateral placement is done according to row distance, with sufficient shrinking allowance and extra lateral length is provided at the end.
5. The drippers are punched on the laterals as per the requirement.
6. Generally laterals are laid on the ground surface. Usually laterals are placed along contours on sloping field.  Burying laterals underground might be necessary or at least have some advantages for some installations. Where this is done, the emission devices should be fixed above ground level. except for the subsurface drip lateral.
7. The downstream end of the lateral can be closed by simply folding back the pipe and closing it with a ring of larger diameter pipe, known as end plug. This can be easily slipped for flushing.

**46.1.4 Punching of Laterals and Fixing of Emitters**

1. Punching of laterals should start from sub-main. Water should be allowed to flow through lateral so as to get bulging in pipe which makes easy punching.
2. Punch the lateral sideways.
3. The dripper position is fixed as per the spacing requirement.
4. All the drippers should follow the same straight line.
5. Do not fix the drippers on lateral until complete lateral is punched
6. Drippers are fixed on laterals as per the arrows marked (if having arrow marks) and it should be towards the sub-mains.
7. While fixing the dripper, push it inside the lateral and pull it slightly. The end of lateral should be closed with end cap.

Once the system is completely installed, it needs to be tested by allowing water to flow in to the system. Before allowing the water in to the system, ensure that all the valves are open. After main, sub mains and laterals are flushed completely close the flushed completely close the flush valve and end caps. After closing of the valves and caps check the pressure at pressure gages and ensure that the pressure at the selected points is as per the design pressure. It is also required to check the working of filters, air release valves and the fertigation unit. Once it is ensured that all the components are functioning properly and the required pressure exists in the system, the system is ready for use.

**46.2 Operation of Drip Irrigation System**

When the system is in use, it is required to operate properly for long and trouble free use of the system. The following guidelines may be considered for this purpose.

i) Keep all the design, evaluation and testing information from the designer, installer and dealer handy.

ii) Computer the time of operation of different sub units based on the climatological data of previous day(s) or from the average historical data; prepare the time schedules for different valves and operate the valves accordingly to release the desired quantity of water, compute the volume of water to be applied for each setting/subunit and ensure that the desire quantity of water is applied.

iii) Check the pressure at the pressure gages regularly.

iv) For the se\system involving the operation of valves hydraulically, ensure proper setting of the hydraulic metering valve.

v) Operating the head valve to begin irrigation.

vi) Checking the system all components for proper operation, beginning with pressure readings at the control header.

vii) Checking the emitters, randomly for its discharge.

viii) Measure the emission uniformity of the system at least at the start of the irrigation season.

ix) The chemical and fertilizer injection equipments to ensure the application of desired quantity and concentration (US Soil Cons. Service, 1984).

**46.3 Maintenance of Drip Irrigation System**

Periodic preventive maintenance of all the components of the drip irrigation system is required for successful operation of drip irrigation system.

**46.3.1 Emitters**

The emitter functioning, wetting pattern and leakage of pipes, valves, and fittings should be checked regularly. The placement of emitters should be ascertained.  If the placement is disturbed, place them in proper position. If emitters do not give the rated pressure, they need to be cleaned manually either by flushing or provide manual or automatic chemical (acid or chlorine) treatments. The chemical treatment is described later in these lesson emitters not giving the rated discharge even after flushing or the chemical treatments should be replaced. Leakage through filter gaskets in the lids, flushing valves & fittings etc. are monitored regularly.

**46.3.2 Filter Cleaning**

Filter is the heart of a drip irrigation system and its failure will lead to clogging of the emitters and in turn the poor performance of the system. Pressure difference across the filter is used as the indicator for deciding the timing of cleaning of the filter.

**i) Hydro Cyclone Filter**

Hydro cyclone filter should be installed before sand and screen filter in case there is heavy load of sand in irrigation water. Hydro cyclone filter requires least maintenance; however the dirt or sand, inside the under flow chamber should be removed daily. Flush the chamber by opening flush valve/cap are or open the main valve for thorough cleaning.

**ii) Sand Filter**

The sand filter should be backwashed every day for five minutes to remove the silt other dirt or any other organic matter accumulated during the previous day’s irrigation. Once in a week, while back washing, the backwash water should be allowed to pass through the lid instead of the backwash valves. The sand in the filter bed is stirred up to the filter candles without damaging them. Whatever dirt is accumulated deep inside the sand bed will get free and goes out with the water through the lid. The need of back washing can be detected by monitoring the pressure drop across the filter. When the pressure drops increased to a pre-determined level, the filter should be back-flushed. ASAE recommends that this pressure drop should not exceed 70 kPa. If there is heavy load of organic matter in irrigation water, the sand in the filter should be washed thoroughly with clean water. The sand filter should be filled with the sand if the level of sand in filter decreases. The sand may be lost in the process of backwashing or cleaning. It is advisable to procure 20% additional sand at the time of purchase of the sand filter.

**iii) Screen/Disc Filter**

Flushing at scheduled daily interval is necessary to maintain screen and disc filters. It is recommended to flush screen filter, if pressure drops more than 0.5 kg/cm2.  Before the start of drip irrigation system, the flushing valve of the filter link should be opened so that the dirt and silt will be flushed out. The filter element (screen or disc) is taken out from the filter and it is cleaned in flowing water. The rubber seals are taken out from both the sides and precaution should be taken while replacing the rubber seals, otherwise they may get damaged.

**46.3.3 Maintenance of Fertigation Equipment**

It is always advisable to allow clean water through ventury or other injectors for 10 to 15 minutes before and after fertilizer application for uniform application of fertilizers. It will also prevent clogging of suction port of ventury from clogging. It is important to note that equipment is resistant to acid. The lid of the fertilizer tank should be fully tightened while in operation. In order to check leaks between the body and bell housing in fertigation pump, clean the seal seating and put back the seal or change and keep the position of bell housing at upright.

**46.3.4 Sub-main and Lateral / Flushing**

It is possible that the silt or other dirt materials escapes through the filters and settles in sub mains and laterals. Also some algae and bacteria lead to the formation of slimes/pastes in the sub mains and laterals. The sub mains should be flushed by opening the flush valves to remove these formations. The lateral should be flushed by removing the end caps allowing water to pass through. Flushing also removes the traces of accumulated salts. The flushing process should be terminated once the water going out is cleaned.

**46.3.5 Chemical Treatments**

Clogging or plugging of emitters/orifices is due to precipitation and accumulation of certain dissolved salts like carbonates, bi-carbonates, iron, calcium and manganese salts. The clogging is also due to the presence of microorganisms and the related iron and sulphur slimes due to algae and bacteria. The clogging or plugging is usually removed by chemical treatment. Chemical treatments commonly used in drip irrigation systems include application of chloride and/or acid with water. The frequency of chemical treatment is decided on the degree of clogging and quality of water. Chlorine treatment is required to remove organic and any physical materials and acid treatment is required to remove the salt and any chemical precipitates from the system. As a general rule, acid treatment is performed once in ten days and chlorine treatment once in fifteen days.

**i) Acid Treatment**

Hydrochloric acid is injected into the drip irrigation system at the rate suggested in the water analysis report. The acid treatment is performed till a pH of 4 is observed at the end of pipe. After achieving a pH of 4 the system is shut off for 24 hours. The system is then flushed by opening the flush valve and lateral end caps.

**ii) Chlorine Treatment**

Chlorine treatment in the form of bleaching powder is performed to inhibit the growth of microorganisms like algae and bacteria. The bleaching powder is dissolved in water and this solution is injected into the system for about 30 minutes. Then the system is shut off for 24 hours. The lateral end caps and flush valves are opened to flush out the water with impurities. The recommended chlorine dosages are 0.5 to 1.0 ppm continuously or 20 ppm for 20 minutes at the end of each irrigation cycle for algae while for slimes, 1.0 ppm free residual chlorine is maintained at the end of each laterals. For iron precipitation, 0.64 times the Fe++content are used to maintain 1.0 ppm free residual chlorine at the end of each lateral. Efficiency of chlorine injection is related to pH of the water to be treated. More chlorine is required at a high pH. The rate of injection of liquid chlorine or acid depends on the system flow rate and can be determined by using the following expressions.

             (46.1)

where

qc     = Rate of injection of the chemical into the system,

K = Conversion constant, 6 ´ 10-3

u   = Desired concentration of chemical in irrigation water, ppm

Qs= Supply flow rate, Lmin-1

 C        = Concentration of chemical in the solution to be injected, per cent

**References**

Hamish, F. (1977). Main line installation, in Drip/Trickle Irrigation No. 5, Vol. 2, No. 2, 1977, Pub. International Drip Irrigation Asso., P.O. Box 288, Bloomington, California-92316 (714) 877-4405: 12.

United States Department of Agriculture, Soil Conservation Service (1984). Trickle Irrigation. US Dept. of Agriculture, Soil Conservation Service, National Engineering Handbook Chapter 15, Section 15. U.S.D.A., S.C.S., Washington, D.C: 129.

**Suggested Reading**

Michael, A. M. (2010). Irrigation Theory and Practice, Vikas Publishing House Pvt. Ltd, Delhi, India: 643-645.

Tiwari. K. N. (2009). Pressurized Irrigation, Precision Farming Development Center IIT Kharagpur Publication No. PFDC/ IIT KGP/2/2009: 27-32.

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1.  A strong support in the form of hard base or concrete base along with the GI fittings should be used for the installation of the sand and hydro cyclone filters to avoid any vibrations due to load.

2.  The filter size should be in accordance with the capacity of the system. This should match with the pump discharge under size will lead to loss and over size will add cost.

3.  The delivery pipe of the pump should be connected directly to the hydro cyclone or the media or sand filter followed by the fertilizer equipment and the screen filter. All of these components should be installed in the main pipe.

4.  Once the sand/screen filter is essential requirement. Suitable arrangement to collect and dispose of the bypass material should be made.

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                                                                       (46.1)

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         = Rate of injection of the chemical into the system,

        K = Conversion constant, 6 ´ 10-3

        = Desired concentration of chemical in irrigation water, ppm

 = Supply flow rate, Lmin-1

         = Concentration of chemical in the solution to be injected, per cent