Micro Irrigation Engineering
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Lecture - 30
Drip Irrigation: Filtration System

Welcome participants. Now we are coming to lecture 30. Lecture 30 is dealing with drip irrigation filters. Filters are one of the important components of micro irrigation system. We discussed in previous class about fertigation system. After the water passes through fertigation system, we find there are some chemical and their particulates it comes along with irrigation water.

Or the source of water has some concentration of silt, sand, clay, or undissolved chemicals which is coming along with the irrigation water. So these undesired chemicals or other compounds in the irrigation water are to be filtered out in order to prevent clogging of drip irrigation system.

So here the basic parameters which are important from the filtration point of view, what are the objectives of filtration, what are the different types of filters, and then how to prevent clogging of drip emitters after selecting appropriate type of filter?

So when we talk of filtration system means success of drip irrigation system, it depends on how good filtration system has been used. The clogging of drip emitters and other components due to a small diameter because the water is coming from a very small passage. So dirt available in irrigation water causes the clogging of drip emitters.

So there could be different types of elements which are available in water and these could be physical components means these are the suspended solid particles. These could be chemical precipitates. These could be the biological material or due to bacterial activities.

So physical components means the parameters which could be inorganic particles, it can be organic particles or it can be a non-aquatic organism. So inorganic particle it can be sand, silt,

clay, plastic, which is flowing along with irrigation water when it is coming from the river. If canal water is also used, a lot of silt and clay as well as sand is likely flowing along with water due to high velocity of flow.

There could be several the aquatic organism that is phytoplankton, algae. It can be snail, fish, or zooplankton. These could be the aquatic organism that are affected or that clog the drip emitter. And then non-aquatic organisms are insect, larva or ant, spider. These are the other physical materials which are suspended in the water.

Chemicals due to the chemical reaction means the in the water, calcium or the magnesium carbonates these could be present and mainly in the hard water such elements are available. Calcium sulfate or heavy metal, hydroxides, carbonates, silicates, and sulfates are other components. Oil and other lubricants when source of water is near some industry where such pollutants are flowing with the water.

And if this water is being used for irrigation by using the drip system, it is likely that this will create problem. Then we are using fertilizers and then fertilizers in the phosphatic form, aqueous ammonia, iron, copper, zinc, manganese, they also react with the water, and then they form precipitation. So they also cause the clogging problem.

Then biological elements means, these activities due to availability of filaments, slimes, microbial deposits means the iron ochre and then sulfur, as well as manganese ochre, these kinds of elements, their biological activities that cause the clogging. So once this type of problem it is caused. So this gets deposited at the outlet of the drip emitter and then it will decrease the flow rate and then slowly we will find that the thickness of the deposition it keeps increasing and that may cause the complete clogging of the drip emitter.

When we say the filtration system, so water filtration is the process of removing or reducing the concentration of particulate matter including suspended particles. This is what I told you about the physical material and then parasites, algae, the other kind of parasites, fungi means biological

material these could be the other undesirable contaminants from the contaminated water should remove to produce safe and clean water for micro irrigation system.

The basic objective of filtration system is to remove suspended solids particles from irrigation water. Avoid any problem caused by the obstruction. So prevention of clogging is one of the major objective of using filtration system. Means, how to prevent? So the need to prevent obstruction by means of adequate filtration unit means adequate type of filter is to be selected. Then under any circumstances, untreated water should not be used for drip irrigation system. So filter is one of the important components in the drip irrigation system. And depending upon the type of impurities and suspended solids available, one has to select particular type of filter or filtration method.

So these filters could be of these types it could be gravity type filter, it can be sand filter, it can be centrifugal filter, it can be screen filter, disk filter, or ring filter. So this is what you see here. In this particular corner, this is a sand filter and these are two vertical cylinders where the sand and other means gravel, as well as, coarse media and then the medium structure sand they are filled in this tank.

So these types of filters are vertical sand filter. This is a horizontal type of sand filter. This is also horizontal type of sand filter, this is also double filter this is being used. And then you see here this is a screen type of filter, we will discuss in detail. And this is a cartridge filter which is kept inside this particular housing of the filter. So inside this particular filter material. This is the disk filter. And this is a hydrocylcone which we call it as also centrifugal filter.

When we call gravity filter, the name it says gravity filter means water is allowed to pass through the medium and then water trickles or we know what happen when the water it comes it is stored in a settling basin where the particles slowly it gets settled. So that is one type of gravity filter. Here what you see there is a filter bed and water is allowed to pass through.

Then the material means the water whatever the impurities available in the water that will be deposited in the sand. And then you can see here on the top there is fine sand means fine sand

followed by gravel, then coarse gravel and like this packing is done and then water is allowed to pass through the filter bed and then it comes through, this filter water is supplied to the system.

So means there is a set of filters. Though it is a gravity filter, it is also making one kind of a sand filter. So water from the ponds, lakes, open ditches, irrigation channels, water reservoirs, they are the good candidate to use gravity filter. Gravity filter can separate the parts of the suspended solids from the water.

This method is not very reliable if the water has high concentration of microorganism. It gets deposited and further the cleaning process, means the water when it is passing through, it will be not giving the good filtration efficiency.

Sand filter. This is a pressure type. That was a gravity flow means the water was passing. There was nothing like any pressure but water was being allowed to pass through it, but here it is a pressure type means water is coming with pressure by using the pump. So pressure type, high flow sand or mix-bed media are more popular one used to clear the irrigation water for micro irrigation system.

So here this is a double cylinder. Double cylinder or duplex kind of a sand filter where two cylinders are used. So water is coming from the source. It passes through the gravel and then sand. So coarse gravel material. Then sand and then medium sand and then fine gravel they are used.

They are put up in the layer of a certain depth and then water passes from there and then finally, it is coming out. So when we have to take water means we need huge quantity of water when the size of the pump is large and we have to irrigate larger area in that case the double cylinder sand filters are used. Now, this is in the filtration mode means when the filters are working this is in infiltration mode.

Now when we have to see that the water should continue to flow in the system. In that case, you may find that the pressure means across the filter, it decreases because of the clogging of the filter. So backwashing is important. So back flushing is done.

So what we see here, one kind of a thing, that when water is coming from there, then the part of water it is going to the irrigation system and then part of the water it is allowed to flow to this particular filter. So this is a backwashing mode. So in backwashing mode or flushing mode, the water will come from this end. So, opposite direction water will flow, and then it will pass through the bed.

So whatever the dirt material deposited in the medium, this will be taken by the force of water and then the back flushing is done. So this valve is kept open. So this valve is kept open and then water is coming from this one. So part of water it will go. So the total supply of the water as it happens in this case on the left side it will be lesser in this case.

But this filter will be in the backwashing or flushing mode. And then once the head loss across the filter is within the recommended pressure, within the recommended value then this can be again brought under the filtration mode.

So gravity operating sand filter have low flow rate. That is what we have seen in the first case. Thus require large surface area to produce an equivalent volume of filtered water as a pressurized filter. When we want to compare with the gravity filter and pressurized filter, in that case the size of the filtration system means it requires more surface area.

Almost the full depth of sand is used in the pressurized filters compared with the gravity filters, where surface action is the primary filtration mechanism. So sand media filtration appears to be the simple process, yet many complex relationships have been formulated to explain the filtration and flow characteristics in the sand bed. Filter capacity is designated in terms of flow volume per unit of bed area.

So decision on when to backwash usually it is related with the pressure differential developed between the inlet and outlet section of filter system. So we keep pressure difference when we see the pressure across the filter is reduced and it exceeds the value more than 69 kilo Pascal then in that case the filter needs backwashing.

This type of sand filters are used in ponds, lakes, open ditches, irrigation channels, water coming from reservoirs.

Backwashing is a critical part of media filter. And then reverse flow velocity must be adequate to cause separation and suspension of sand material into individual particles. Media filter design must allow for the expansion of bed otherwise sand would be lost with backwashing mode. So this is the important part. And then we need to see that the initial backwash water is extremely turbid.

So we need to see that what is the quality of water which is coming out of the filter system. So time to time for 2 to 5 minutes, it should be brought in the backwashing mode after operation. So for 2 to 5 minutes it should be checked the quality of water and then it should be brought for the backwashing mode.

Now, this filter is a gravel filter also known as a sand filter. So gravel, as well as, sand of different grades means different grades means different sizes it is of and then if you want to see that whether this sand has been blocked with the suspended material. So because this place here this place you can see it is red, it got the iron coming with the water it gets deposited in the sand.

So it needs to be cleaned. So for cleaning operation, we need to close this particular supply valve. We will open this supply valve. And after opening this supply valve water will come from this and it will go to this place.

And then the cleaning will take place, water will come at this end and then because this is close so water will come at this end and then the materials deposited are attached with the sand, it will get washed. So this valve is open for backwashing of the filter. Now if the filter even after that

what we see that the pressure difference across the filter is too large, we are not getting, then we have to replace with the new sand and a new grade of the material.

Let us come to the hydrocylcone filter. These type of filters are also known as centrifugal filter. As you see in the diagram, in this particular figure this is the liquid and solid which is flowing or available in the water. It is fed. So this is the inlet end of the filter and then it comes here and then it because of the shape, this is conical in shape. So it creates a centrifugal force. So centrifugal force tosses the heavier material which are available in the water it goes in the perimeter of this, so this is what you see these dotted points you know here in the water these are nothing but the heavier material. So it comes. So it starts moving and it goes in the perimeter and finally, it gets settled in the bottom.

So solid-tree liquid is drawn through the separator vortex. So solids are purged based on the system make-up water. You can see here the animation. So when the water is entering, so this is the inlet end and then it is going there. So heavier particles get settled and the clean water it comes out of this.

Here you can see the diagram. In this diagram, this part is your inlet part. So water comes. So this is a tangential pipe. There is a pipeline which is coming from this end. This is a tangential pipe which carries water with solids into the hydrocylcone chamber. Means the water which is coming from the pump, it will be receiving water from this end. Then it comes to this end.

So there is a cylindrical section. This is the part where there is a cylindrical section. So it is given by the diameter Dc. And then rotational movement is created. The length and other dimensions of the cylinder are determined that how much force one has to create. So this particular dimension what should be the length, it will depend upon the how much amount of force we need to create.

So this part is your conical section, this is the cylindrical section, this is your conical section, where the rate of flow or separation of the particles takes place. And there is a other means the downstream end where the heavier particles are going and then they get settled in the settling

tank. So underflow and solid discharge outlet Du. The hydrocylcone is vertical and this underflow is at the bottom of the device.

So water comes from this end then it passes there. So once it comes to the conical section it creates the centrifugal force.

So a vortex finder that is the D naught is the diameter, where the small inserted pipe which is protruding slightly into the cylindrical section is part of the overflow. That is outflow rather I will say. This part, this part is D naught. So water is coming out of that. So there is another pipeline in the cylindrical part of this section. So the clean water is coming out of the system.

So overflow or discharge outlet is also labeled by D naught. This is the diameter which direct the clean or solid free water to its final destination. So one can decide the dimension that how much, what should be the capacity of the filter system. So that will be decided depending on the quality of water means, what is the percentage of the heavier particles or large sized particles which are available in the water.

And then what is the size of the pump where the flow is taking place. So discharge of the pump is also considered. So here according to Ketler and Lin, they have given certain dimension based on their study and what they say that the total length of the hydrocylcone is 5 to 8 times of the diameter of the cylindrical section. And then Di the water inlet that is taken from 0.15 to 0.33 times of the diameter of the cylindrical section.

And then outer diameter where the vortex finder takes place it is 0.15 to 0.30 times. And then solid discharge outlet this is given that is the lower most part where you see that it is given by 0.15 to 0.2 times. Accordingly these all the dimensions are decided and cone angle, this is another important thing that is should be within 45 degree. This is important from the centrifugal force creation point of view that will allow the material to come down.

Screen filters are another type of filter. This is what you see here. You know these are the components of the screen filter. So the top part it is a handle and this is a butterfly which is

placed over the cover. And this is used for tightening means, when we make the airtight, perfectly sealed. So this butterfly and then cover is kept on the top of this one.

And then this is a superior seal which is provided on the top so that the water will not come out of this particular screen filter. There is an internal sieve. So it is a double candle. This is a double candle system means there are two cylinders. So there is an inner cylinder on which the particular size of mesh means mesh is wrapped over the inner cylinder.

This is the outer cylinder sieve. And then this particular there is a nipple or union with joints for the system. And then there is a lower seal. And then there is a drain pipeline means there is a drainage system, where the water can be taken out. Or when we want to the make the without opening the entire thing we want to flush the filter then this particular unit it is used.

And then entire set up this particular assembly is fitted in this part, it is the entire system with this is a casing in which this one this is there. And then at the bottom end outlet is provided. And this end the water enters into the cylinder. So screen filters are most frequently used system in particularly in micro irrigation system.

And there are different types of you know sizes of the screens. Mesh sizes these are used. This varies from 60 mesh to 200 mesh. That is the normal thing.

And you can see here how the particular this is also a screen filter. Water enters from this and then it goes from this outer part. Then it goes to the inner cylinder and then it comes out at this end. And then here there is a flush valve. So these screens have been designed using the cross-flow principle to improve the load capacity where particles build up on the screen is washed away by flowing liquid.

So mess size in the order of 140 to 200 ranges they are good for removal of fine or very fine sand particles. But if there are further coarser particle then the further larger size is means your mesh size that is going 80 even 100 mesh size is also used.

These screens these are made up of stainless steel or some plastic material. And then one need to attach pressure gauges at the inlet and as well as exit end to know how much is the pressure loss, it has taken across the filter unit. Means this is an important part and then to take care of the self-cleaning screen, the pressure changes are less noticeable than the manual cleaning type.

So means one can use these as such flowing water and then allow the things are when there is a lot of sediment or sand deposited on the candle then one can use.

This is another filter which I told you there is a screen filter. So screen filter, this is the screen filter. So this is a double channel on with the stainless steel strainer is used. And you can see the dirt material which is accumulated and which is accumulated here. This screen filter is of means this is 120 mesh, 120 mesh and it is normally means it operates 2 kg per square centimeter pressure.

So these filters are further used to clean the water whatever dirt so that the water with impurities should not get into the lateral pipeline. Finally, it goes to the emitter that clogs the emitters.

Now this filter is another category of filters. These are popular. They hold back a greater volume of sediment than screen filters which I just discussed right few minutes back. So the filtration element is a disk filters consist of number of plastic or plastic coated metal disk. This is what you see. These are the plastic disk. And they are placed side by side on a telescopic circular shaft inside the housing.

So inside the housing this thing which we see there is a shaft which is circular in shape. When these disk are stacked means tightly together they form a cylinder filtering body which resembles a deep tubular screens. So water flows through the disk from outside inwards along the radii of the disk.

You can see here the diagram how these disk they are stacked and then when we see you see here a particular grooves are provided. So top grooves of each disk is at an opposing angle to bottom grooves of the previous disk. So this is what you see here in the disk. These are the

grooves which are provided and disk element can be manually or automatically cleaned during the manual cleaning.

And then it comes to this part. You can see how these grooves they look like. So they are triangular in opposite in the shape which you know this has got this particular shape and size which will trap the flowing sand as well as fine particles along with the water. So the telescopic shaft prevents individual disks from falling off the shaft during rinsing.

So you can see here at this part when it comes then it is in the particular way this particular component it is coming and then the individual element it can be seen over here.

So grooves of each disk are randomly positioned relative to the adjacent disk. So a matrix of various screen is formed and water passing through the cylinder will encounter 12 to 32 grooves intersections and depending on the size of the disk mesh. So extent of filtration depends on the number of grooves and individual grooved rings.

Typical filters are equivalent to 40, 80, 120, 140, 200 mesh screen filter. So it means that is equivalent to the screen filter when we are taking this type of disk filter when we are using.

A particular type of filter selection it is made. So it is based on the how much is the capacity which should have the capacity. So that will depend upon the total irrigation demand, determine the physical, chemical or biological quality of water. Size and quality of suspended solids to be removed.

Then the different types of filters, what should be the size that particular type of filtration unit it is there. So if we are using sediment basin means settling basin, sediment settling basin, it can allow the particles to go down which are greater than 40 micron. Slotted cartridge means this is 152 microns. Sand filter it is 5 to 100 micron means, one can use up to 5 to 100 micron for the sand media.

And then there are some certain media which are where the smaller size particle greater than 20 micron this is used. Screen filter 75 to 150. Like this you know and then cyclone separator single stage, double stage. So these particle size one can choose.

And then we are using water from the different sources. Municipal water supply, well water, water from a river or creek. So these are the category of filter one can use. So screen filter, centrifugal filter, disk filter all you know means they are brought under the category of your secondary filter say or primary filter. So centrifugal filter, sand filter these are falling under the primary filter.

Screen filter, disk filter, so all kinds of filter these are needed. So one need to know what is the source of water which we will be used for irrigation purpose. So accordingly, appropriate type of filter or group of filter is to be used. One cannot avoid taking without filter one should not use micro irrigation system. It can have one particular type of filter if the quality of water is very good or it could it can have more than one or two filters.

So for more details please go through the references given here. These are the books as a textbook.

So we discussed in this lecture about what are the different causes of emitter clogging means biological, chemical, physical, those are the elements. So these are the reasons for the clogging. What is the objective of filter, what are the different types of filter, and which type of filter one should select? So these are this is in summary, nutshell we can say these are the things we discussed in this lecture.

Now in the forthcoming lecture, we will work out some problems which we have dealt in the particularly in micro irrigation system components, fertigation. So we will discuss the numerical problem. So we will solve in tutorial 6. Okay, thank you very much.