Micro Irrigation Engineering
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Lecture-17
Introduction of Water Lifts and Pumps

Hello, dear participants of micro irrigation engineering subject I welcome you to the lecture 17. Lecture 17 deals with water lifting and pump devices. This is an important topic, it deals with raising water from the source and this source could be surface water which is flowing in river through a streams, springs or it is the reservoir or pond or it can be groundwater. So, we need to lift this water from the source, bring it to surface, and provide enough pressure so that the water can be distributed at all points of the field, all points of the field I mean here these points could not be at the same elevation.

So some of these points could be at higher elevation, some points in the field it can be at lower elevation. Points which are at higher elevation it requires certain energy, it requires certain pressure so that water can reach there. Particularly in micro irrigation system it is a pressurized irrigation system, it is a sprinkler irrigation or it is a drip irrigation system, the irrigation is given by providing adequate pressure in the pipeline, and then the emission devices required enough pressure to operate or disseminate water from these points.

So let us discuss some more points related to this topic. So, here we will be discussing the principles which are used for pumping, classification of pumps, we will deal in detail about positive displacement pumps.

Now, these pumps, I mean it is working on involving certain parameters, these parameters which are involved in water lifting are atmospheric pressure, positive displacement, centrifugal force, movement of columns of water caused by different specific gravity of liquid or means basically water.

Now, when we come to water lifting devices, these water lifting devices can be classified. This classification can be indigenous water lifts, or it can be pumps. So, indigenous devices and water lifting devices can operate requiring a low head, it requires a medium head or it is taking water from a higher head. When it comes to the pumps, pumps can be classified as positive displacement pumps or variable displacement pumps.

The positive displacement pump can be a reciprocating type or a rotary type. So, these reciprocating pumps could be of lift pump or force pump. Single acting or double acting. Force pump can also be single acting or double acting. In today's lecture, we will be talking about reciprocating pumps and rotary pumps. When it comes to the classification under variable displacement pumps, these pumps could be centrifugal pumps, mixed flow pumps, propeller pumps, jet pumps, and air lift pumps.

Now, centrifugal pump could be of volute type, which can be single stage or multi stage. Diffuser pump could be another category of centrifugal pumps, and turbine pumps could be deep well turbine pumps or it can be submersible pumps.

So, as I told you that our main focus will be on indigenous type in today's class, as well as reciprocating type pumps. So indigenous water lifting devices can be further classified as low head water lift, medium head water lift, and high head water lift. So, low head, medium head or high head it could be made on the basis of the height at which water is being taken. So if it is less than 1.2, we put it under a low head, and between 1.2 to 10 meter, it is a medium head, and high head could be greater than 10 meter.

Swing basket, Don, Archimedean screw, Water Wheel these are the devices. So, swing basket as you see in this particular figure here it looks like a basket with this type of things, it is normally made up of mild steel sheet plate and this basket is having enough capacity and the two ends of this basket is connected with a rope or string and persons on two sides they lift and bring water at the land surface. Swing basket type devices are low head water lifting devices, and for a small area, for small plot irrigation, swing basket is used.

The Archimedean screw, which you see here is another device which is use for low head water lifting, and here these are the blades. Now, these blades are curved and they are made at a specific angle. So this is made spiral shape low angle made blades it is bringing water from the water source to the field level. So for low head water lifting device, Archimedean screw type of device is used.

If we see another device this is still being used for a smaller area and you can see here this is a counterpoise type of thing and this device is used where the surface water or shallow water exists. So, similar kind of baskets or a container which is of smaller capacity, it is pushed into the water by using the counterweight. So, it is pushed into and then counterweight what it does, it lifts this particular device and brings this container to the top of the field. So this is also used for small area irrigation.

Don is another device, which is by using the feet, the water is brought from the low head to the field, and then for a smaller area, this type of device is used.

Chain pump, this is a traditional thing which was being used when the water level is very close to the ground level. This device is manual driven. There is a drum, and on the drum, there is a pulley kind of arrangement where there is a chain and this chain has got rubber gaskets. When we are driving, we are providing enough driving force so that this water feeds the water gasket, lifting the water, and this is brought to the surface. The water is brought to the surface. So, for a smaller area, the water is bringing to the surface from the well using a chain pump.

Water wheel is another device similar to the chain pump only thing that the rotation here, it is done, there is a driving mechanism, there is a gear arrangement where the top of this gear there is a beam and this beam is pulled by a pair of a bull or a single bull, and it is a bullock drawn and it gives the circular drive. Here this drive makes a linear motion and it comes to another gear arrangement that drives this wheel and these wheels have got buckets. So, there are 10 number of chain buckets, and these chain buckets when it is being driven it brings water from the source. This source could be again, well, shallow or deep, which means shallow depth well and the water this gets filled in, and the water is brought from the well to the field.

So, these are the traditional devices which are still being used where there exist a small or shallow water level.

Hydraulic ram, it is a device, it is a special type of pump it utilizes energy of a large quantity of water falling through a small height to lift a small quantity of this water or part of this water to a greater height. It does not need any external power or external energy to operate. This hydraulic ram is also known as hydram. This hydram, can thus be employed when some natural source of water, like a spring or a stream is available at some altitude mainly in the hilly region.

So, lifting water from this stream to a higher elevation is brought by using hydram. Basically, hydram uses the principle of water hammer or inertia developed due to water hammering action in the supply pipeline, and thus, in principle, it is an impulse type pump. So, the momentum of long column of water flowing through a supply pipe is made force a part of water to a height greater than that of supply source itself.

So where the water source is available it is brought at the ground level. Now, in order to develop maximum impulse supply pipeline should be as long as possible this is important. So, installation of hydram too close to the source of water will not give enough impulse so this is important when we are deciding to install hydraulic ram.

So, hydram it involves a delivery valve, waste valve, it involves valve chamber, pressure gauge, compressed air, and non-return valve. So basically, these are the main components. What we see, there is a supply head and then from supply head there is a drive pipeline which we can say delivery pipeline and from delivery pipeline water comes to this particular chamber. This chamber has a waste wall so this waste wall operates. When it closes, it causes the opening of delivery valve and now this delivery valve what happened when it compresses, compressed air it pushes and then water from this particular chamber it enters to this pipeline and this pipeline delivers water at the higher elevation that is the storage tank. So this is the arrangement. This is the total delivery head here you can see from this chamber to the storage tank.

So, it could be a very high elevation and the only thing that the small part of the water is being used. So, it does not need and these are especially for suitable location where this is possible such type of device is used. Now you can see here the operation in this animation, that, how the water is pushing and this causes the lifting of waste valve, and that causes the further you know the delivery valve is opened so there is a simultaneous action of closing and opening of delivery value and then part of this water, which is going when this air is compresses the water is coming out and then it goes to the storage tank.

Now it comes to the pump; so pump is a hydraulic machine which converts mechanical energy into hydraulic energy. Hydraulic energy is present in the form of pressure energy. Now, these pumps when I was classifying one was positive displacement pump, another one was variable displacement pump. So, positive displacement pumps are also known as constant flow pump. It operates by alternating of filling a cavity and then displacing the given volume of liquid. It delivers constant volume of liquid for each cycle against varying pressure or head.

So, variable displacement pump, it is just reverse, it has an inverse relationship between discharge and pressure head means at low head discharge increases and hence power requirement remain high. Positive displacement pump could be a reciprocating type pump which is of piston type, plunger type, diaphragm type or it can be gear pump. Gear or lobe, or screw or vane type of a rotary pump.

So, reciprocating pumps these are also called piston or displacement pumps. They function by means of piston movement which displaces water in cylinder. Flow is controlled by valves. A piston or plunger is a cylindrical piece which moves backward and forward inside a hallow cylinder. The capacity of reciprocating pump depends on size of the cylinder chamber means how much is the diameter and what is the length and of course what it is speed of stroke.

So it means there are three things involved one is size. Size of the chamber it means it is the diameter of the chamber. Second one is the length, and the other important thing is at what speed this strokes it makes.

So here, one of the example which we normally see is hand pump, hand pump is one of the category it falls under the reciprocating pump. Now, a reciprocating pump or hand pump, it operates by using you can see here the crank and this crank is connected with the connecting rod and this is the cylinder. So, length of the cylinder, and then the diameter of cylinder, and then there is a piston.

So piston, it moves forward and backward. So when it is going backward, it creates suction and when it is going forward, it creates, you know, it is pressing the liquid which comes out of the delivery pipeline. So this total head developed will depend upon at what depth the water being taken from the source. So this is the way it works so this is a typical hand operated reciprocating pump where there is you can see here that your water level and then there is a suction pipeline and at the top of the suction pipe, there is a check valve and then this part in the cylinder where there is a piston and piston it has got a check valve. So water enters through the check valve and there is suction as well as the delivery the forward and backward motion it causes the water to get inside the cylinder and then when it is pushing then the water comes out of the cylinder. So this is the arrangement.

The rotary pump commonly used in pumping, lubricating oil's. It is also used as a booster in irrigation pumping. It has a driving gear which is rotated by an outside source. What you are seeing here, the water is coming from this end and then this is a driving gear, this gives drive to this driving gear and then driving gear it gives the momentum to the idler gear that is driven by driving gear.

So their movement, creates a partial vacuum and this brings in replacement of supply of water along inlet side. You can see here how the rotary pump in this animation, this is there, so water is coming, it is giving the drive, and then how the water is being pushed outside. So, it could be, you know water or any other liquid which is heavier than liquid. So, it can be the rotary pump.

Now, shallow well reciprocating pump as the name it says shallow well so they are operating at low head, where the water is available at a low depth. So, the reciprocating pumps of shallow wells are usually of the lift type, using atmospheric pressure to raise water in the pump column.

The piston, when moved up and down by the movement of handle that displaces air from the pump column.

This moment causes the creation of vacuum which permits forces of atmospheric pressure to push water from well up into pump column, and from it to the outside.

Deep well reciprocating pumps, by introducing pump cylinder with its plunger and valve into the water in a well, so water can be lifted to almost any desired height. It may be manually up to 45 meter or mechanically operated. So, when I say mechanically operated, mechanically operated means, it could be given a drive by engine or motor operated reciprocated pump usually imply a crankshaft arrangement placed at the top of the well to change the rotating motion of the power to that reciprocating motion of the piston. So it means the speed will be created depending on the requirement.

Now, type of reciprocating pump can be made based on the construction and how it operates. So we say that based on construction and operation. So reciprocating pump, it can be single acting pump. Single acting pumps have one discharge stroke for every two strokes of the piston. Water is delivered during alternate strokes of piston. So, during delivery stroke of the piston air in the vessel is compressed to a greater pressure than corresponding to the head of water at the bottom of the delivery pipe.

During suction stroke the pressure of the air in the vessel, it maintains flow of water through the delivery pipe, thereby ensuring nearly continuous discharge. So, this can be explained by using this particular figure. Here we can see, there is a sump and then water is being taken from this sump by installing a suction pipeline and in the suction pipeline, you see there is a arrangement there is a cylinder there is a you know, piston, and then piston is driven up and down so when it is being, you know it is operating. So, it creates when the air it being pushed compressed so the delivery valve is opens and then it supplies water.

So, it is similar to the reciprocating pump, which I have already explained. You can see here how this single acting reciprocating pump, it operates by this animation. You can see here the how the valves it opens and closes.

Double acting pumps, they are constructed with piston and valve which are arranged such that water is pumped on both the inward and outward moments of piston. There could be you know duplex or triplex type pumps. Duplex and triplex pumps consist of 2 or 3 pistons, respectively, and are designed to pump a continuous stream of water with the minimum pulsation often against high pressure.

Now we can see here double acting reciprocating pump. So, you can see here, these are the two delivery valves. Now, when water is being pushed, means pump is being brought back. So this valve is closed at this valve is kept open and when we are meant succession means what happened when we are pushing the cylinder in this direction then this valves gets closed this is your suction of water takes place, and then it pushes the water and then delivery of water.

So, this valve will be closed and this valve opens. So this is a double acting reciprocating pump. And this can be seen and this animation you can see a diaphragm type of reciprocating pump, where the water is, how these valves are opening and pushing in the respective directions. So this is another kind of a reciprocating pump. These are very commonly used devices, which are used for low water lift.

So we have discussed on these topics, and then you can refer detail in these two books and also a lot of lecture is available in internet.

Let me summarize this lecture, we discussed about different type of water lifting devices. We also discussed about principle of operation of reciprocating type of pumps. We are discussed about positive displacement pumps, single acting, double acting rotary pumps. Now, in forthcoming lecture we will discuss about variable displacement pump, thank you very much.