Indian Institute of Science

Design of Photovoltaic Systems

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Let us now discuss about water pumping, most of you will be familiar with this water pumping application it is there in everybody's home, where you lift water from the underground sample at over at tank almost on a daily basis. So the objective here is that we would like to use the PV source, the PV modules, the PV panels to power the water pumping system. So that is the objective and that is what we plan to discuss and see how we go about doing that.

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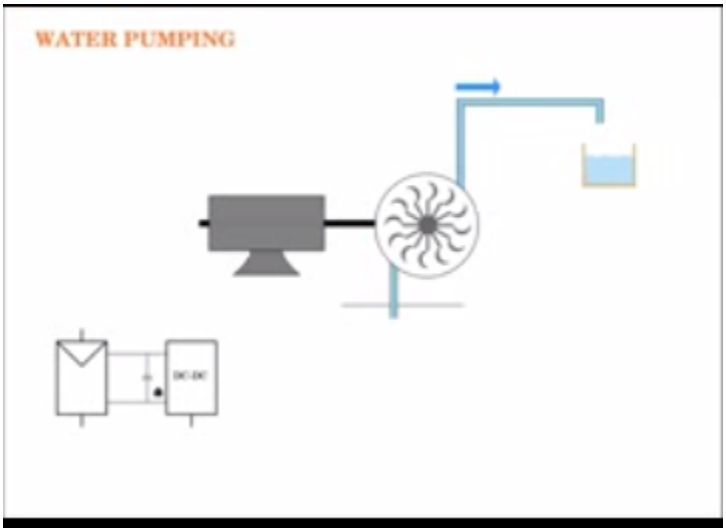

Let us see how a water pumping application looks like, it means first a prime mover, a prime mover in the sense that it needs to take energy electrical energy so that ultimately we can drive it from PV source and then convert it into a mechanical energy so that shaft of the motor can drive a pump to lift water from a lower level to a higher level; so that is the objective so we need a motor which can drive a pump so I will use a symbolic notation for the pump like this there are various types of pumps.

So I will just indicate let us say we use a centrifugal pump you have the dynamic pumps centrifugal pump comes under the class of dynamic pumps you also have the positive displacement pumps reciprocating pump comes under the class of positive displacement pumps reciprocating pump comes under the class of positive displacement, so this pump will have an inlet it will take water from the underground some or at lower level and you have this, this is called the suction pipe then you also have a delivery pipe where in tell you where is the water to a height to a or end tank, so you can probably have at more tank like this so in most homes the water is collected in an underground sump.

And the water as lifted from the underground sump and then goes through the center fugal pump and most to the homes have center figural pumps various pressure difference created between the inlet and the outlet which pushes the water up through the delivery pipe and then into the ore tank, so this is normally how the pump systems or set up and this is the direction of the water flow now the normally we are powering the motor through the AC mains so it is AC motor and it is powered through the AC main.

So most of the pumps that we have in our homes or single base induction motors and what is there in the irrigation or irrigation purposes and agricultural fields they are three phase induction motors, but for hold like integration what would be nice to have is a DC motor taking DC inputs and pumping the and driving the center figural or reciprocating pump, so let us say they have a PV module like this and the PVM module is connected to a DC, DC convertor you have the capacitor input buffer you have a control input for duty cycles.

So therefore you can always control the input of the Dc-DC convertor to present an appropriate input impedance to the PV panel the output of the DC-Dc convertor is connected in a fashion like this to the input terminals of this motor so what I have here indicated is the output is DC here and then it is driving a DC motor which will drive this pump.

So this is the scenario of a water pumping system where in the source is from a PV module through a DC-DC convertor, so let us see how we go about putting some numbers and see we can design the various components of this pumping system. Consider this water pumping system let us say that this pump is suppose to lift water from this underground some to a over a tank so let us mark and identify the various heads, so let us also mark some quantity of water in the sum

and let me take a point which is just in line horizontal with the tip of the succession pipe, this is the succession pipe.

And from the succession pipe to the center of the pump, pump access we will mark this as hs and this hs is called the head or the succession head when the literature you will see that hs is called the succession head or even it is called static lift in fluid dynamics here and piece and direct measure of the pressure indicates that so much pressure is needed to lift water up the static lift now found the delivery side we can use the variable Hd for the delivery head this is called delivery head or the discharge head.

So we will write it discharge head it is also called static height so remember static lift is water coming through the pipe up to the pump that is below the pump in the section pipe static height applies to the head or the height which is above the pump up to the point where it is discharge in into a tank arte the maximum height of the pipe up to which the water is lifted up, so above the pump it is called as the discharged end, below the pump on the section pipe side it is called the static lift. So for the pump for it do work it is both put together water as to lifted through this suction lift, through this suction head height, it should also get lifted up through the discharged head height.

So as far the energy is concerned the total head the better defense should pump water through h_s + h_d and there is another term used in the literature which is called the dynamic head. What dynamic head what dynamic head means is the total head plus where it is succession head plus the discharge head plus a head equaling to overcome pressure needed to overcome the friction losses in the pipe and water flows through the pipe water is in contact with the cylindrical pipe and there is defiantly going to be fiction loss and equivalent to that friction loss there is a equivalent head or head loss or pressure loss pressure drop all those things in terms of head it is HF.

So this HF is nothing but the equivalent head representing friction in the pipe due to the flow of fluid in the pipe so that is the dynamic head so in the literature they save succession head static lift same which is HS discharged at static height both are same which is HD the discharge head both total together is called the total head of the height to which the water is lifted dynamic head includes also one more termed called the loss which is equivalent loss due to the fiction HF.