Principle of Hydraulic Machines and System Design

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Lecture – 24
Hydralic Turbine: Classifications

We will continue a discussion on Principle of Hydraulic Machines and System Design; we will discuss in this lecture about hydraulic turbine and its classification.

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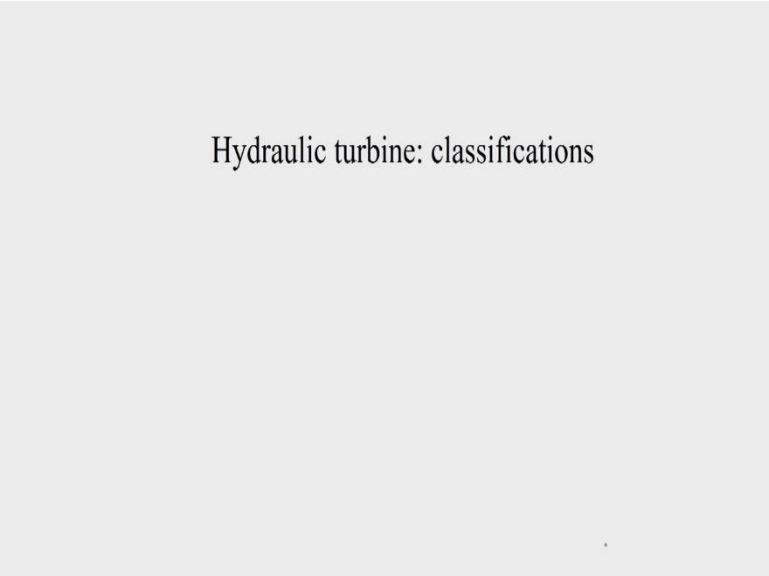

So, today I will briefly discuss about what is hydraulic turbine and how we can classify hydraulic turbine in different categories. So, as I said rather I have discussed very beginning of this you know course that we can classify tower machines in to different categories.

So, hydraulic turbine also a prime mover in which the, it is hydraulic turbine and palms deferred because of the change of direction of energy conversion. In one case mechanical energy is converted to increase the store energy of the fluid either in terms of velocity pressure something or velocity head or pressure head anyway or while in case of a hydraulic turbine reverse is to that is we are utilising the stored energy of the fluid to increase the to convert it into the mechanical energy.

So, as if were increasing the potential energy of the fluid and we are utilizing other we are changing the potential energy in a different other form. So, that the rotating component or the, you know rotor of a turbine is rotating and which is connected with some alternative regenerator and we are getting electricity. So, we will discuss now in detail about how we can classify based on the different features of the hydraulic turbine.

And then, we will surely possible to discuss about the you know details about each of the hydraulic turbine I mean which the category which what I will discuss today.

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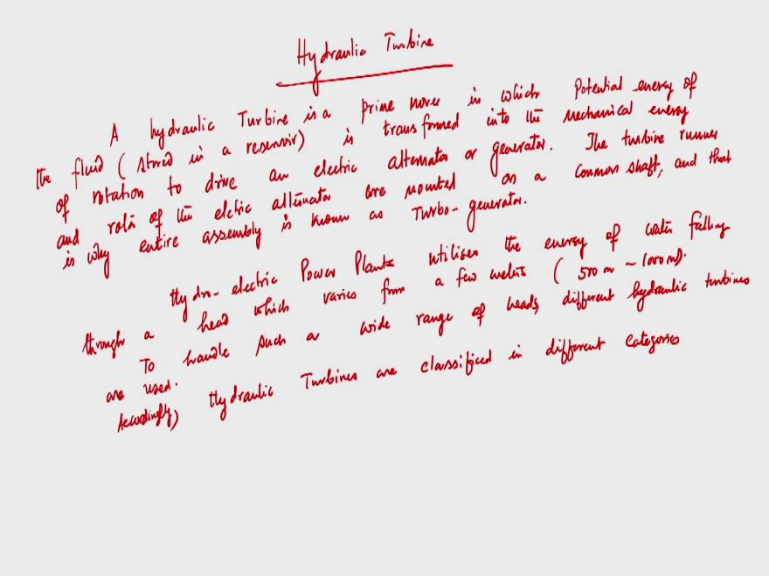

So, you know that I have discussed that hydraulic turbine so, it is a seems turbine may be hydraulic turbine, stream turbine, gas turbine, but today I mean in this course since it is only hydraulic machine. So, we will be focusing on discussion only to the hydraulic turbine so, hydraulic turbine hydraulic turbine so, it is a prime mover. So, hydraulic turbine is a prime mover and which transform potential energy, which is stored in terms of in a reservoir. So, internal molecular energy the potential energy of the fluid is getting transferred into the mechanical energy of a generator.

So, this is very important that how we can you know transform mechanical energy into the so, hydraulic turbine is a prime mover in which we are converting the potential energy of the fluid in to different from rather in the mechanical energy. And we are utilizing that energy to run to drive a rotor and in a set of that hydraulic rotor travelling rotor on a you know one generator is connected and from which you are getting electricity.

So, I write in briefly that hydraulic turbine; hydraulic turbine is a prime mover in which potential energy potential energy of the fluid, of the fluid stored the energy remaining stored in the fluid right; I mean rather stored in a reservoir in a reservoir. So, hydraulic turbine is a prime mover in which potential energy of the fluid stored in a reservoir is transformed into the mechanical energy is transformed into the mechanical energy you know to drive a mechanical energy of rotation other kinetic energy mechanical energy of rotation to drive an electric alternators or generators to drive an electric alternator or generator.

So, this is very important so, a hydraulic turbine is a prime mover in which potential energy which is stored in the reservoir is transformed into the mechanical energy of rotation rather kinetic energy to drive the generator or alternator so, we were getting electricity. Now, the turbine runner and the rotor of the generator is very important. So, as I said we begin that whatever it is I mean half plus blades so, whenever you are talking about hydraulic machines you are having half and there are blades.

So, half plus blades which is known as impeller for a pump, the same thing is known as runner for hydraulic turbine and we call it rotor for compressor. So, the runner of hydraulic turbine or sometimes we call it rotor, the turbine runner turbine runner and rotor of the electric alternator electric alternator.

So, the turbine runner and the rotor of the electric generator are connected or are mounted on a common shaft are mounted on a common shaft mounted on a common shaft common shaft that the same, shaft that is an inter assembly is known as turbo generator. So, the turbine runner the shaft of the turbine receptor the turbine runner is mounted on a shaft on the same shaft we are also having the shaft electric alternator.

So, there having common shaft and the entire assembly and that is why and that is why entire assembly is known as sometimes known as rather I mean we have rather frequently referred to the you know call it turbo generator so, this is very important right. So, the turbine runner and the rotor of electric alternator are mounted on a common shaft and that is why entire assembly is known as turbo generator.

So, what I am telling a hydraulic turbine is a prime mover in which potential energy which is stored in the reservoir is transformed into the mechanical energy of rotation to drive an electric alternator or motor. And the turbine runner and rotor of the electric the turbine

runner as well as the rotor of the electric motors are mounted on a common shaft and entire assembly is known as turbo generator.

So, what is I mean how you know energy is getting confirmed in a converted? So, in a headlight turbine only your having transformer potential energy into the mechanical energy of rotation or the kinetic energy. So, hydroelectric power plants, normally hydraulic turbines are used in hydel power plants. So, I am writing that hydroelectric power plant, hydroelectric power plants you know utilise so, we are utilizing the potential energy of the water which is stored in the reservoir.

So, we need to have sufficient head to rotate the runner of the hydraulic turbine and since there and since the runner of the hydraulic turbine is mounted on a shaft on the since that we are having the rotor of electric motors so, electric motor will rotor it will run and we will get electricity. So, hydroelectric power plant utilizes you know the energy of water falling through a height or head which varies from a few meters to handle few meters let us say; of 1000 meter to 1000 sorry 500 meter to 1000 meter to 1000 meter right.

So, hydroelectric power plants utilise the energy of water falling through a head which verifies from a varies from a few meters 500 meter to 100 meters and to handle such a wide range or the wide range of heads turbine various turbines are employed. So, now, to handle such a wide range of head so, hydroelectric power plant utilizes the energy of water falling through a head which varies from a few metres 500 meter to 100 meter.

And to handle such a wide range of head hydraulic turbine rather various turbines are employed various turbines are used. So, you know various or different hydraulic turbines are used different hydraulic turbines are used. So, since we are utilising a range of heads only to because we until unless we are having sufficient head we would not get sufficient amount of potential energy and if you do not have sufficient amount of potential energy, we would not get sufficient energy of mechanical energy of rotation that is the electricity that will be generated that will be produced will be in a very less.

So, we need to relay sufficient amount of head and now to handle such wide range of head you know you know wide range of heads rather we are we sometimes used different types of hydraulic turbines. So, different hydraulic turbines are employed are used. So, hydra means, hydraulic turbines based on that and that is why, this hydraulic turbine are

classified accordingly hydraulic turbines are classified in two different classifieds into different categories right and that is what is todays discussion.

So, now, we have systematically discussed that we have seen that I have discussed at the beginning of this course that depending upon the direction of energy conversion we can classified conversions into two different categories, one is palm where are having conversion of mechanical energy into the mechanical energy is converted to increase the store energy of the fluid. In terms of pressure or velocity whatever it is while in case of hydraulic turbine we have seen reverse scenario that is the potential energy of the water which is stored in a reservoir which may be situated a long distance apart from the axis of the turbine.

And that is allowed to fall freely through pipeline not released through pipe lines we will discuss in detail about how it can be conveyed from that reservoir to and can be connected to the inlet of the turbine. So, that water can be allow the water will the water can be allowed to fall from that height, and it will impinge that it will strike the turbine runner and the turbine runner will start rotating.

Since turbine runner as well as the electric motor alternator mount on the common shaft so, the moment at which turbine runner start rotating the electric generator will start rotating and we will get electricity. Since we are utilising a range of heads and its height of few meter let us say 500 meters to 100 1000 meter 500 meters to 1000 meters because, if you do not have sufficient amount of head, you would not get sufficient amount of potential energy and which will eventually culminates in to a electric less amount of electricity.

So, to handle such wide range of head different hydraulic turbines are used and accordingly hydraulic turbines are classified into different categories. So, now, I will discuss about that how we can classify hydraulic turbine?

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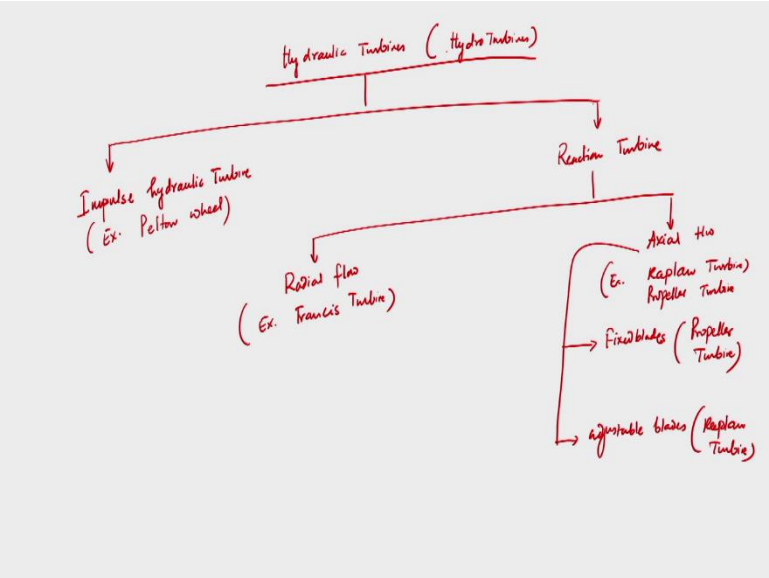

So, hydraulic turbine sometimes is known as hydro turbines so, hydraulic turbines sometimes they are known as hydro turbines like; steam turbine, gas turbine it hydro turbines so, working fluid is the water. So, the hydraulic turbine can be classified broadly into two categories as I said that to take into account wide range of it.

So, broadly into two categories, one category is known as impulse turbine rather impulse hydro turbine, impulse hydraulic turbine right example we will have to give. So, one example is Pelton wheel. So, Pelton wheel is an example of impulse hydraulic turbine or another one is called reaction turbine

So, these are two broad classifications; based on the head being utilised are in these two turbines. So, based on the head being utilised to generate electricity these hydro turbines are classified into two broad categories, one is impulse hydraulic turbine that is Pelton wheel and one is reaction turbine. Reaction turbine further can be classified into two categories, one is known as radial another is axial flow. So, reaction turbine further classified into two subcategories, one is radial flow reaction turbine example is you know Francis turbine example is Francis turbine another category known as axial flow turbine axial flow turbine example is Kaplan turbine.

These are the name of the scientist and or engineer and to one of the names of them we have the turbines are named like this Francis turbine and Kaplan turbine. So, axial flow turbine, Kaplan turbine, propeller turbine so, propeller turbine like this. So, excel flow

turbine for the classified into two categories, one is fixed blade another is you know adjustable blade, that is blades are adjustable, adjustable blade example is Kaplan turbine and fixed blade example is propeller turbine.

So, this is what is the classification of hydraulic turbine? That whatever we have discussed that hydraulic turbines are the prime mover, in which you know potential energy of what fluid is converted to the mechanical energy rotational energy is kinetic energy. So, essentially, we are having we need to have a reservoir which will be situated sufficiently long distance at a certain height from the excess of the impeller excess of the runner and then water is allowed to fall from the reservoir and that will strike to the runner through certain arrangement system and while it is impinging.

So, that time fluid will gain some amount of so, may be the stored energy of the stored energy which is remaining in the reservoir that will slowly converted to the mechanic kinetic energy and that whenever, it is you know striking the runner of the turbine the kinetic energy is trying to rotate the runner and we will get some rotational speed of the runner.

Since, the electric motor alternator is mounted on the common shaft so, that will rotate, and we will get electricity. And since we need to utilize sufficient amount of head and based on the head being utilised in a turbine this can be classified into two broad categories of course, not broad category depending upon the head. They are working principle also different that will discuss the impulse hydraulic turbine and reaction turbine impulse turbine example is Pelton wheel reaction turbine can be further classified radial flow and axial flow.

Radial flow is example is Francis turbine and axial flow again this is adjustable blade and fixed blade adjustable blade is a Kaplan turbine and fix blade is the propeller turbine. Now,;we will discuss about slowly discuss about, what is impulse turbine and what is reaction turbine why we call it impulse turbine and why it is reaction turbine very important. So, impulse turbine is a class of hydraulic turbine, which will have a fixed nozzle one or two fixed nozzle and in each of which the fluid pressure is converted to the kinetic energy of an unconfined jet unconfined jet.

So, whenever water is allowed to fall from reservoir that will initially enter to the nozzle the function of nozzle is to increase the velocity head and pressure. So, amount of height

that we had so, we are having pressure, that pressure is converted to the velocity head and one or two nozzles are there whenever fluid is flowing through the nozzle the fluid pressure is convert into the kinetic energy of unconfined jet, which then impinges or strike the blades of the hydraulic turbine buckets you know fluids of turbine and then it is start rotating.

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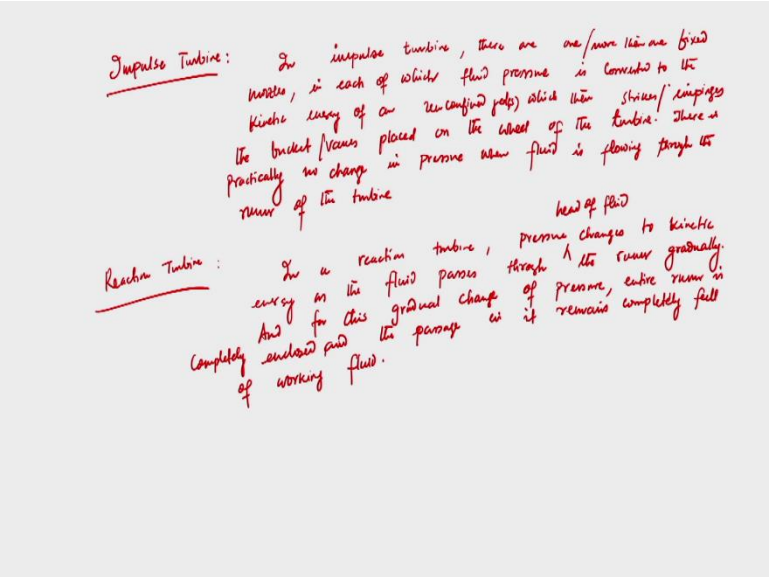

So, impulse turbine what is impulse turbine impulse turbine? Very important. So, in impulse turbine I am writing again in impulse turbine rather there is one or more fixed nozzles there are one or more than more than one fixed nozzle. And in each of which and each of which you know fluid pressure is converted to the kinetic energy to the kinetic energy of an unconfined jets.

Which then so, jet or jets which then which then strikes all impinges which then strikes or impinges the sometimes on a bucket or blade of the you know vanes of the hills of the turbine. So, impinges the bucket sometimes they known as bucket or vanes placed around the circumference of the wheel of the turbine place on the wheels, wheel of the wheel of the turbine of the turbine fine.

So, in impulse turbine there will be a nozzle by either way there will be one nozzle or two nozzles through which water is allowed to pass through which water is allowed to pass while water is passing through the nozzle pressure head is converted to velocity head. And

then velocity head of unconfined jets and then that jet strikes the or impinges the bucket or sometimes known as vanes of the wheels of the turbine.

And while it is impinging it is creating a thrust and that will start rotating right and there is practically no change in pressure end of the fluid there is you know as it force to the runner of the impulse turbine. So, it is very important, and this is the fundamental difference between impulse and reaction turbine. So, I am writing that whenever fluid is flowing through the runner of the turbine. So, there is practically no change in pressure when fluid is flowing through the runner of the turbine runner of the turbine.

So, whenever fluid is flowing to the runner of the turbine there will be no change in pressure practically. So, only all the pressure head is converted to the velocity head, whether it is equivalent to the velocity head that is very you know difficult to say. But most of the pressure head is converted to the velocity head while it is flowing through the nozzle and then and in a form of a unconfined jet and then the jet strikes the bucket and all the vanes placed on the heels of the turbine and its start rotating.

Because of the thrust, we will discuss how it is creating a thrust and how when it is impinging the buckets then how it is rotating and that is from there, we will try to calculate the efficiency of the impulse turbine. And there is practically no change in pressure when fluid is flowing through the runner of the turbine, but this is the difference, but we will see that in case of a reaction turbine pressure gradually changes as it you know you know as the water flows through the runner.

And infact all the pressure is made all the pressure head is not getting converted to the equivalent amount of velocity head while liquid is a fluid is flowing through runner and that is why you need to have another kind of you know special device known as dractive, which is connected at the you know trail of the hydraulic turbine that will discuss while will discuss while will be discussing about the reaction turbine.

So, this is about the impulse turbine now, the reaction turbine on the other hand is something you know they are repression is something than the impulse turbine. So, in a reaction turbine the change from pressure to kinetic energy so, in a reaction turbine in a reaction turbine, you know pressure changes in a reaction turbine pressure changes I mean to the kinetic energy to kinetic energy in a reaction turbine pressure changes to the kinetic

energy gradually pressure head of water rather pressure head of fluid changes to kinetic energy gradually as the fluid passes through the runner gradually right.

So, in a reaction turbine we have seen that in impulse turbine there is practically no change in pressure as the fluid is flowing through the runner of the turbine. But in a reaction turbine normally pressure head of the fluid is converted to the kinetic head not equivalently, but mostly pressure head is converted the kinetic head as the fluid passes through the runner gradually.

And for this gradual change of pressure to be possible and for that runner must be there is an important gradually and for this gradual change of pressure rather to make rather for this gradual change of pressure, entire runner is remaining enclosed in a reaction, turbine pressure head of fluid changes to the kinetic energy as the fluid passes through the runner gradually.

And for this gradual change of pressure entire runner is remaining enclosed and completely runner is completely closed that is not open to ambience completely enclosed. And the passage in it full of working fluid, you know completely you know mass runner mass be completely enclosed and the passage in it and gradual change of pressure entire runner is complete is completely enclosed and the passage in it remains completely full of completely full of walking fluid.

So, this is very important so, this is the fundamental difference that in a reaction turbine entire runner is remaining enclosed, not only that entire passage of fluid entire passage is remaining full rather filled with; working fluids and gradually takes place energy conversion takes place gradually. While in case of impulse turbine there is practically no change in pressure as the water flowing through the turbine runner of the turbine.

While most of the energy conversion takes place when liquid is flowing through the nozzle that is all the pressure head is converted to the velocity head. So, this all about the two types of impulse turbine impulse and reaction turbine and we have classified we will discuss slowly the working mechanism how we can convert the mechanical you know pressure head to the velocity head in impulse turbine.

And we will work out the you know we will exercise the mathematical form of the you know how we can get how we can convert that head to the you know mechanical energy

kinetic energy we will try to calculate the efficiency. And also, we will do for the same we will do the same for the reaction turbine so, with these to I stop here today and I will continue this discussion in the next class.

Thank you.