MARINE ENGINEERING

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Lecture30

Turbine Basics

Good morning everybody. Today I will start the topic turbine basics. So, basics of turbine, what is the turbine, what are the different reaction turbine, impulse turbine, how does it work, this simple calculation I will try to discuss in this lecture. So, first I will start with definition of pump and turbine because already I have defined pump in another lecture. I will differentiate pump and turbine here.

pump actually when you are talking about pump is taking energy and giving that energy to fluid. So, delivering fluid, taking energy may be mechanical or electrical, let us say electrical. Let us say you have one electrical motor that will be delivering torque to pump and pump will be taking energy and giving to fluid. But in turbine, fluid giving energy to machine.

So, fluid to machine to then machine will be converting to electricity. okay so one example is that like wind turbine all right you have seen wind turbine will be taking energy from wind and then it will convert to mechanical energy mechanical energy will be going to generator generator will be producing electricity but in pump like human heart i already told that there you are giving some mechanical energy or electrical energy and you are delivering fluid so that energy is transferred to fluid so this difference you must know so in that definition your propeller also a pump actually okay and in turbine wind turbine tidal turbine wave energy harvesting turbine and steam turbine there are different types of hydro turbine, hydro means hydro dam will be there, National Thermal Power Corporation, National Hydro Power Corporation, they will have turbine also because thermal power corporation will be having steam, steam will be running turbine in hydro power corporation, they will have high head from coming from river water. So, that water will be delivering, driving a turbine

that is called hydraulic turbine. So, we will have hydraulic turbine, steam turbine, gas turbines, wind turbine. So, different types of turbines are there. In pump aspect, already we discussed there will be like human heart also on pump I told and there will be centrifugal pump, axial pump. different types of pumps are there.

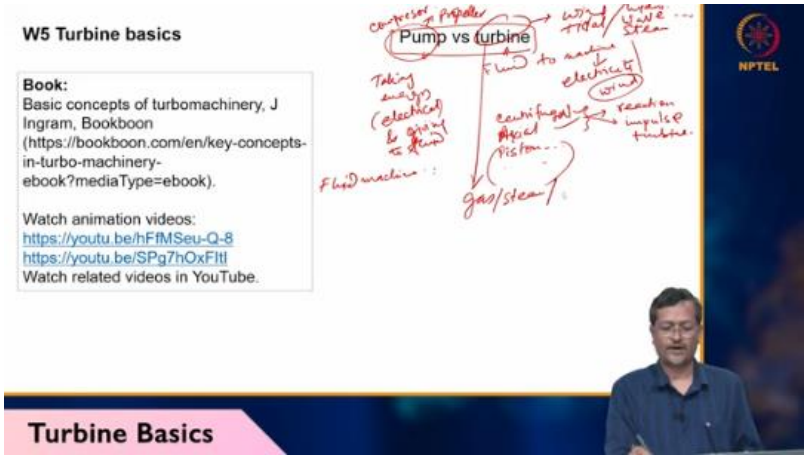
So, now you know the definition or difference between pump and turbine. Now, another definition is the fluid machine. fluid machine actually the fluid machine will be dealing with fluids so that fluid can be turbo machine pump or fluid flow through pipe or nozzle or jet anything that will be coming under fluid machine so anyone is talking about fluid machinery so they'll be talking in general of fluid machinery like say piping pumping systems turbine compressors actual fan everything so In marine engine system, we will be discussing lots of things about fluid machinery, fluid machinery, energy. energy and fluid interaction we will discuss and everything is coming from thermodynamics.

Thermodynamics second law you cannot violate. So, whenever you are designing any machinery or you are buying any machinery, you have to check whether it is following thermodynamics second law or not. second law will say some losses will be there and how much losses you are having. If you are having too high losses in some machinery element, then maybe fuel consumption will be very high. Again, if some companies claiming they say efficiency 100%, again you have to suspect whether they are following the second law of harmonics because there must be certain amount of losses.

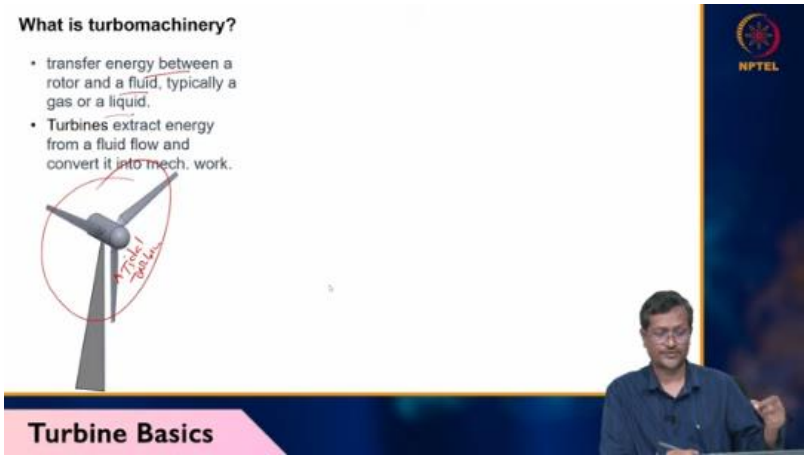
So that losses must be counted when you are talking about efficiency performance. Again, during discussion of pump, we discussed about centrifugal and axial. Centrifugal, axial and other type of fluid material you can consider such as piston pump. piston pump diaphragm pump many type of pumps we considered so here turbine also will have centrifugal axial type but piston type and other type pump those are will not come under turbine so those will be coming under maybe a hydraulic engine pump or something else okay so turbine will be normally centrifugal axial and they will have again reaction turbine and impulse turbine there will be different types of axial or centrifugal turbine there and they will have reaction turbine or impulse turbine or mixed of reaction and impulse turbine and whenever talking about pump pump will be including compressor also so pump will be including compressor because compressor takes energy and it will be compressing air so you are giving energy to fluid compressor okay

and turbine can be run using your gas in gas turbine system gas can be your working fluid we say working fluid means that fluid you are giving that fluid will be carrying lots of

energy that energy will be given to turbine okay gas turbine steam turbine a hydro turbine hydro turbine means like river water turbine you are giving height a tidal power turbine so those are hydro turbine hydro means water so water turbine so it can be run by gas steam or hydro or water or or any other liquid also possible for example ammonia also can be your working fluid so thermo machinery blade uh nomenclature okay okay so first we'll see the termination definition So, the termination difference is the transfer energy between rotor and a fluid and typically gas or liquid or steam, gas may be steam you can say, gas or liquid or gaseous phase and liquid phase. Turbine extracts energy from a fluid flow and converts into a mechanical work. So, here one example I have given from my research work actually, this is actually tidal turbine.



tidal turbine blades. same as wind turbine. So, instead of wind, water, ocean water will be driving or rotating this turbine blade. And when it is rotating, actually it generates torque. So, torque will be producing power. Torque into omega equals power.



Torque and omega means rotational speed of turbine. turbine and power in let us say torque in Newton meter omega in radian then power will be in Newton watt and turbo machining blade nomenclature. So, turbo machining blade will be looking like this. So, it will have one airfoil So, here I have one turbo machinery is not exact turbo machinery, but someone has designed and gave me like is similar to turbo machine you can say.

So, if fluid is flowing through this gap, so what will happen? fluid will be pushing these blades it will transfer momentum or energy and will be rotating continuously continuously it will be rotating if fluid is flowing from this side if fluid is from coming from this side then fluid will be hitting this surface when hitting its surface moment will be transferred or energy will be transferred and blade will be trying to rotate in this direction okay So, when fluid is flowing through the blade passage, these are called passage, two blades are there. So, I have one blade, I have another blade, this is called blade. So, these are called blades.

So, blade can be curved or different shapes will be there. And in between the space is called passage. And if I say top view, this one and this one, two blades this one and this one I am drawing here you can see this drawing okay so these are called blades and in between the space is called passage okay fluid will be passing through the passage it cannot pass through the blade because solid body okay the vacant vacant space is there through this one blade fluid will be flowing fluid may be gas steam water anything or aniline or petrol diesel anything can be possible so it will be passing through this one and it will be rotating okay so Now blade, this shape, these are blades and blade will have different shapes.

Some blade shape will be this top section if I see, this one is looking like this. This most probably hydro airfoil. Hydrofoil, I cannot say hydro airfoil, this is hydrofoil. In airfoil normally it will be shaped like this. One section will be thicker, one section will be thinner.

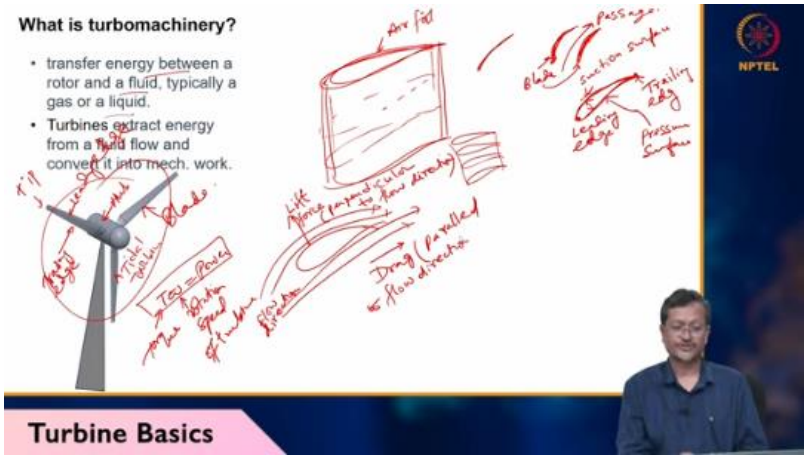
This is called leading edge. is called the trailing edge this portion leading edge is called trailing edge trailing edge and if this is bend like this this upper surface this surface is called suction surface and this surface is called pressure surface So, whenever you are discussing or writing, whenever you are discussing about turbine, so you should remember the names leading edge, trailing edge and the top portion is called turbine tip. So, if I assume this is my blade and whole blade is drawn here, this 3D you can see here I have drawn and I have cut from the hub, this is called hub section, this is called hub section. You see wind turbine hub, this is blade and this is leading edge, this is trailing edge and this is called tip.

So, in a turbine plane, I have blade tip, I have leading edge, I have trailing edge, I have suction surface, I have pressure surface. These are basic things you have to remember

whenever you are analyzing turbine. Now turbine, this shape can be very thin or maybe purely airfoiled shape. in many cases turbine blade shape can be like this like crescent shape okay some cases it can be like airfoil shape so presently i have drawn this one airfoil shape turbine blade okay so fluid from let's say if i assume on airfoil okay so in a turbine blade so fluid will be moving from leading edge to trailing edge okay so I have airfoil section so if I see this three-dimensional blade it will be lots of airfoil sections are there in this blade actually okay like one section second section third section fourth section and if I connect all this line it will be creating one blade okay if you know CAD modeling so normally we draw airfoil shape to one two three four then we loft we connect all the airfoils and it becomes blade

airfoil, airfoil leading is there and fluid will be flowing over it leading edge to trailing edge. It is like this. So, this is flow direction. when fluid is flowing over the blade, so blade will get lift and drag, lift is perpendicular lift force.

So, we say lift force or lift only and perpendicular to flow, perpendicular to flow direction and drag, parallel to flow direction, parallel to flow okay so whenever fluid is flowing through air over airfoil shape so airfoil will get lift and drag drag means fluid will try to drag along its path drag the airfoil along its path would lift lift means because of this cambered shape fluid will be pushing this airfoil towards one direction, perpendicular to its flow direction. this is called lift or lift force. whenever you are designing or you are looking at any airfoil, you have to see what is the lift and drag or lift and drag ratio.



This will be deciding whether your airfoil is very good, properly designed or not.