MARINE ENGINEERING

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Lecture15

Pumps and its types

Good morning. Today, I will start the lecture on pump, especially fluid machinery, which will be delivering fluid from one point to another point or increasing pressure for your fluid machinery application. that machinery application can be in your main engine systems or your refrigeration systems or onboard cleaning operation, you need lots of water. And before I start, actually you have to understand what is pump. Pump actually you are adding energy

to fluid. And one of the oldest pump, you can see this human heart. And if there is any animal living more than say 100 years to 100 years, so that will be the longest one actually. uh i think some turtle they live several hundred years so that can be as the longest working pump without any failure so if something is failing and pump is failing that means your life is gone so you have to consult immediately to apollo heart center and in contrary turbine turbine actually fluid giving energy fluid is giving energy to machine.

So, pump example, human heart is one pump example, you are giving mechanical energy, your body is working and you are delivering fluid, fluid means blood to your whole body from brain to your toe. And if you see turbine, example will be like wind turbine or maybe tidal turbine, many other type of gas turbine steam turbine or nuclear power system will be i'll be teaching later so there also they will be using some turbine okay so turbine is having application on your shipping machinery or option machinery similarly pump is also having application on your shipping machinery pump will be used for your boiler feed pump application pump will be used for your refrigeration system application pump or compressor pump will be used for delivering liquid or water from sea surface to your deck for cleaning and other operations. So, there was ample applications there on your shipping machineries or offshore machineries.

So, in this lecture, I will discuss in details about pump and turbine. And pump we have already seen actually, human heart one example, another is that like Indian rural areas, people will be getting water using hand pump. uh in your hostels also you are getting water on your building top of the building okay some tank will be there right so that tank will be filled using some pump okay pump will be installed at the bottom and it will be delivering fluid to the top okay so that means some electricity or some energy will be required to deliver the fluid to the top because you are increasing static head or pressure of the water So, that water will be reaching to the tank height. So, you are giving energy.

And how you are giving? You are giving maybe you have IC engine, internal combustion engine. So, internal combustion engine, what is internal combustion engine? It is like you have truck, bus, train, tram, everywhere there will be some internal combustion engine which will be giving power. It will take diesel or petrol, some fuel and it will give power.

Even in machinery also, ship. engine so there will be internal combustion engine so that will be giving power so that power will be running some pumping system to deliver fluid from one point to another point okay or maybe electric motor okay sometime the ic engine will be giving power sometime electric motor will be giving power in many cases electric motor will be giving you power for example in a host application everywhere you cannot put ic engine separately it will be very much noisy so there will be a small motor a smaller being based on your requirement so that motor will be giving power to your pump so the pump will be delivering fluid to another place so pump will be giving energy to fluid, so that after that fluid will get more static head or dynamic head, head means pressure actually in fluid machinery system we see we specify pressure as a head, head means equivalent of water column height, equivalent of water column height.

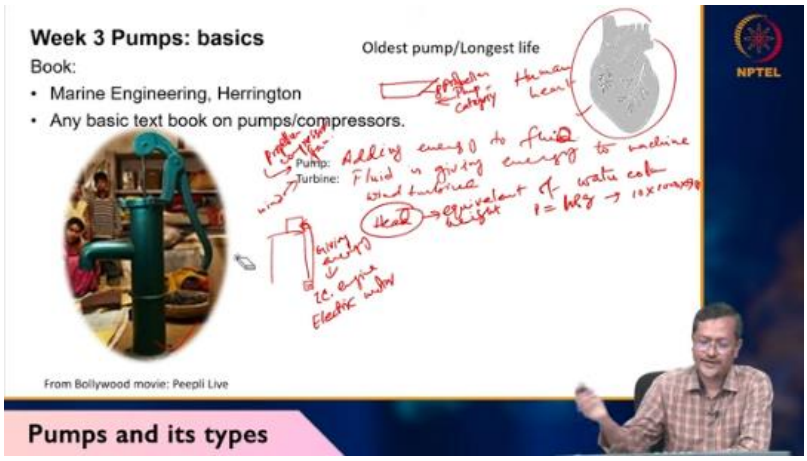
For example, if I say head 10 meter, 10 meter means your pressure will be 10 h rho g that means 10 into water density 1000 into 9.81. This will be your pressure in Newton per meter square. And whenever you are studying this pressure head, you have to remember units properly if you do any mistake in unit then your whole calculation will be wrong or or understanding will be improper so you have to remember how to convert unit from one unit to another unit what are the different unit for pressure temperature and all these things if you you have to recap every time i may not teach all the units every time but you should remember as an engineer you should remember the units how to convert it okay so another thing is that propeller you have okay In ship, you will have propeller.

Some propeller we will have. So, propeller will be propelling a ship. So, propeller will be coming under pump or turbine category. So, if you see propeller, actually you are giving mechanical energy, you are delivering fluid. So, fluid giving reaction.

Because of reaction, actually your ship will be moving. So, it will be coming under pumping category. Actually, first you are delivering fluid and fluid is giving reactive force or third law of Newton. Action equals, is equal and opposite to reaction.

Reaction is equal and opposite to action. So, it will be coming, propeller will be coming under pump category, propeller category, pump category. okay so if i have one compressor compressor will be also coming under pump category so pump will be like propeller compressor you have blower you have ceiling fan maybe in summer time in india you will be you will have ceiling fan in your hostel room or your houses so that will be coming under pump category okay pump means you are giving energy to the fluid okay propeller compressor or fan And turbine, turbine you will have wind turbine, already I have given example, wind turbine, tidal turbine, gas turbine, steam turbine. So, many types of turbines are there.

So, that will be under turbine category means you are giving energy, you are taking energy from the fluid. Energy, wind turbine, wind is giving energy to machine and then you are converting to electricity. So, that will be coming under turbine category. So, I am dividing into two category, one pump, one turbine. Pump,



Taking energy from machine, giving to fluid. And turbine, just doing opposite work. So, I said there are two type of machine, one is pump, one is turbine. So, let us start with pump. Later, we will discuss about turbine.

So, pump, basically there are two type. One will be positive displacement type. Another will be hydrodynamic or hydrokinetic or kinetic pump. Kinetic pump. okay so positive displacement pump means it is taking certain amount of fluid it will be delivering the same amount of fluid okay in hydrodynamic or kinetic pump in that case actually you are giving centrifugal force and that force will be delivering or giving energy to the fluid okay so one positive displacement pump example your human heart okay and that is reciprocating type okay so that is human heart is actually reciprocating type

Another will be rotary type. I will be showing some example. So, reciprocating type means like human heart giving pulse. So, one time it is taking blood, again pushing, taking blood, pushing. So, continuously it is doing like that.

So, that will be called reciprocating type pump. So, your injection syringe, you are giving, doctors will be giving, nurses. So, that is also actually reciprocating type pump. You are pumping fluid to your body. You have seen cycle pumper, roadside small cycle shops will be there.

So, manually pumping system will be there. So, there also you are actually pumping air or compressing actually. So, I can say pumping, you are pumping air to your tube, cycle tube. So, that is actually reciprocating time. One time delivering, again delivering, again delivering.

So, continuously you are giving reciprocating force and your tube is getting filled. or tube is getting higher pressure so you are increasing pressure there and reciprocating type again there will be many types like one single cylinder axial piston or multi-cylinder many type will be there okay single cylinder multi-cylinder multi-cylinder then diplex simplex quadruplex quadraplex. So, many type will be there, double cylinder, single cylinder, axial piston, so many types will be there, reciprocating type. Now, if you go to rotary type, rotary type will be gear pump, vane pump, lobe pump, screw pump and diaphragm pump, diaphragm pump will be coming at reciprocating, diaphragm here, diaphragm

okay pump okay and gear pump wind pump low pump screw pump single screw then again screw pump will have single screw multi screw multi screw So, there will be many types of pumps, but all type of pumps may not be used for your specific application. But first, before you buy or install any pump for your specific application, you have to know what are the different types available, what are the criteria, design criteria or flow rate criteria or pressure criteria. Based on that, actually you are buying or you are using or you are handling when ship is working. Another is the kinetic pump.

kinetic pump actually rotary pump one centrifugal impeller will be rotating continuously so that type of pump will have three type basically centrifugal axial flow and mixed flow type okay so centrifugal type actually okay centrifugal or radial i can say okay axial flow and mixed flow okay instead of centrifugal i should write radial okay i'll explain later So, pump will have basically two type, positive displacement, centrifugal or kinematic type pump, that is basically centrifugal pump. Positive displacement pump, it can develop very high pressure. So, this pump, very high pressure can be developed, high pressure, but flow rate is low. high pressure, flow rate is low, Q is low.

So, I will be using this symbol Q for flow rate every time, high pressure, P is high. But if you see hydrodynamic pump, there normally flow rate will be high, Q high and P is low. now you got like for blood flow for whole body you have to deliver fluid right for small amount of fluid it must reach to your finger toe everywhere so there you need very high pressure actually so you are using reciprocating pump pulsating you are giving pulsating flow to your body right that is why this older days Doctors were used to pressure this vein and they will be measuring pulses of your heart and based on that they will say fever is there or not. So, this is called reciprocating system or pulsating system.

But centrifugal type or hydrodynamic type or hydrokinetic type pump that will have continuous flow. So, that will not give any pulsed flow. It will be giving continuous flow. So, reciprocating positive discipline type is actually pulsed flow. Okay.

Pulsed flow. Even doctor says like this is pulse. Okay. Pulse flow. And this is continuous flow.

This hydrodynamic is continuous flow. Continuous. continuous flow okay now show one impeller centrifugal pump in positive displacement of human heart one biggest example so I will start with centrifugal pump centrifugal pump will have one impeller this is called impeller okay you can see this one impeller okay impeller will have lots of channels you can see the channels okay and it will be rotating at very high speed and speed will be having that impeller centrifugal pump. Impeller will have rotation rpm or revolution per minute, power per minute, maybe 1400 or 3000 rpm.

or small rpm or capital rpm whatever you write 1400 1500 2000 3000 3000 okay within that range so not less than like 400 or 100 200 it will be like 1400 1500 so that high speed pump actually so whenever it will be rotating at very high speed this is called impeller impeller will be covered by one casing okay this is called volute casing so volute casing will be like this impeller will be having my impeller will be like this okay and impeller

blades these are called blade okay fluid will be delivered like this fluid delivery okay so in your household application your gardening or everywhere you can see some small pump will be used there continuous flow pump So, that flow pump actually is called impeller diffuser pump or volute is called casing or sometime called volute diffuser pump. okay so what does it do impeller inside one casing metal casing this impeller will be there so impeller if you fill this area this is called impeller i okay this area this entry area of fluid this entry of fluid it called impeller i okay so i'll draw like this my impeller impeller blades are like this okay so this area is called impeller i Okay, you can see the picture I have drawn and here actual impeller you can see this area is called impeller I. Fluid will be entering through the I and this hole actually this is shaft.

Okay, my finger is working as shaft actually. When shaft is rotating, this motor will be there, motor will be rotating this impeller at very high speed. When it is rotating at very high speed, so fluid will be, if this area is filled with liquid, water maybe, so at very high speed that water will try to go out of the impeller okay because of centrifugal force okay the impeller i and let's say this area water will be going out okay okay this is because of centrifugal force of centi force water will try to go away from the i okay this is i and if you rotate a very high speed water will try to go away from the eye so because this area whole area is closed so water will try to follow the channel and it will go out okay so and we have blades these are called blades one blade two blade three blade four so one two three four five i have five blades

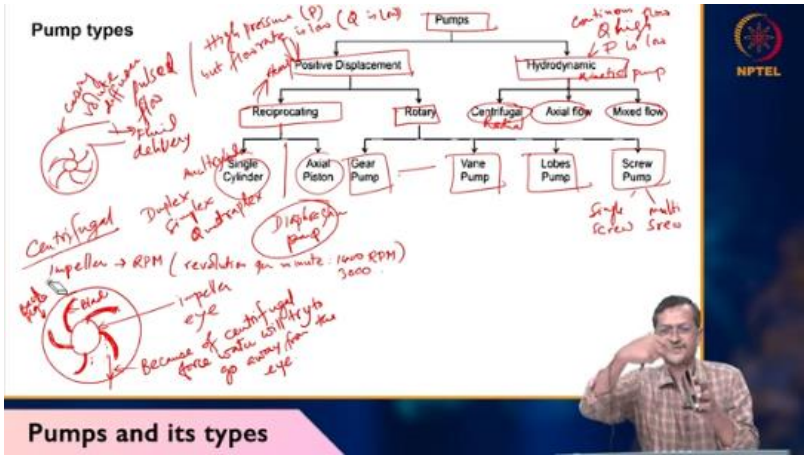
in this impeller i have five blades okay so these are called blade this is called blade okay so i'm just making little bit thicker blades okay and this is called back plate this this metal plate is called back plate okay this is called back plate okay So, one impeller will have one back plate, impeller, impeller eye, one hole for shaft, one hole for shaft, my finger is here, my finger is going to the hole. Now, shaft will be rotating this impeller at very high speed. When it is rotating at very high speed, water, if something, water is there, water will try to go away from the impeller. So, they will follow the channel or this path.

okay so but why this is like randomly cut actually this is actual impeller we cut this one just to show for uh so in class how this impeller blade and flow path look like actual impeller is like this okay this is made of softer material so this is impeller i can see okay one shaft is there shaft hole okay this black i i'm inserting you can see this one is shaft hole and if it is rotating a very high speed water if you have water pipe connection so water will be sucked from here and at very high velocity this sucked water will go out from the impeller okay when it is going out of impeller another casing is there you can see this slide

on the casing is there so casing will be collecting all the fluid and it will be delivering to other place okay so this area will have one pipe connection so this pipe connection will be called suction pipe because fluid will be sucked through this one. When shaft is rotating, impeller will be rotating, fluid will be sucked from this pipe and if this pipe is connected to one tank, water will be sucked and it will be going out of this channel. If you see lots of holes are there, one blade, two blade and fluid will be coming there and it will be collected in the volute.

This is called back plate. This is impeller eye. Opposite side, you see different design actually. This is, there is no eye section. Front side is having eye.

Fluid is entering, going out. So, this plate is called front plate this front side plate okay in this case I have removed this one just to show you there is no front plate I have only back plate but in this case I have both plates okay so it is creating one channel closed channel okay so one impeller this is called closed impeller okay whatever I am showing this is called closed impeller because front plate is there back plate is there okay impeller blades are there and fluid entering and coming out through this channel. This is called closed impeller.



I am showing this one as a closed impeller. there will be some open impeller also in that case front plate will not be there back plate will be there front plate will not be there it will be looking like this so that is called open impeller if it is like here i have removed the front plate so if some impeller is looking like like front plate is not there only blades are there and back plate is there that will be called as a open impeller okay there are different application for closed impeller and open impeller i'll explain later.