MARINE ENGINEERING

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Lecture18

Cavitation

So, NPSH, net positive suction head. So, whenever, especially centrifugal pump, whenever you are running, you should know the net positive suction head. NPSH formula is like this, NPSH. npsha equals no npsha greater than npshr i will explain first write down the equation npsha equals p1 by rho g minus p pv by rho g plus vs square 2g okay p 1 is your absolute pressure pressure at the inlet of the pump vs is velocity of the fluid velocity of fluid in the suction pipe in the suction pipe

This is Vs and PV is amount of pressure required for specific liquid to stay in the liquid form. or vapor pressure stay in liquid form. As T goes up vapor pressure increases. and decreases in PSHA. So, what is NPCT?

Actually suction, this term says net positive suction head. pump, let us say I have one pump, this is my suction pipe, this is my delivery pipe. suction pipe, how much pressure available? M is available. If suction pressure is not sufficient, what will happen?

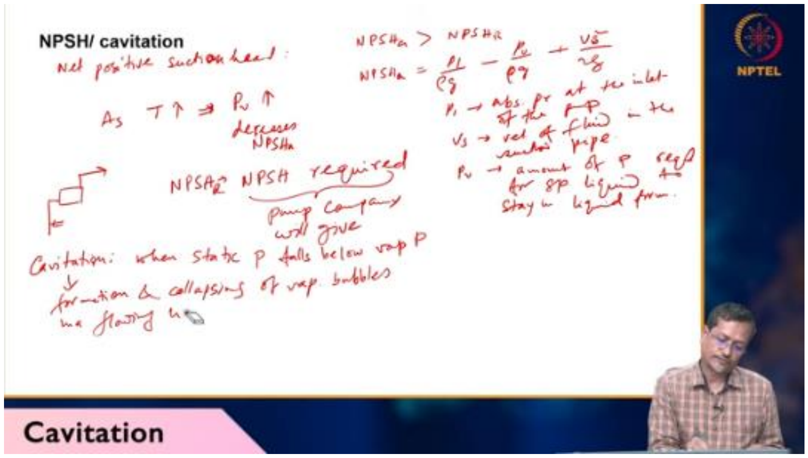
Pump is trying to suck and pressure is not enough. what will happen the water if you are pumping water water will be vaporizing or it will create a steam actually so that steam will not allow pump to deliver fluid and you will try to gravitate cavitation i'll explain so cavity means like if you don't have any sufficient pressure then water particle will be creating vapor vapor will be again collapsing so during that process so pump will be having violent noise it will have lots of bubbles formation it can fail also okay so just to avoid failing with the pump or running the pump or delivering the pump you have to keep sufficient amount of inlet pressure so that pump will be running smoothly and how to keep the sufficient amount of pressure so let's say my water surface is here so try to keep your pump nearby water surface so that inlet pressure will be sufficient if your water surface is here and you are keeping pump is here so this portion pump will be trying to suck so when pump is sucking liquid so pressure will be dropping actually when pressure is dropping so it can create evaporation and cavitation okay just to avoid cavitation you have to maintain sufficient amount of npc available but how much available pressure must be there pump company will be delivering or will be giving you the data called NPSHR.

NPSHR I have written. So, NPSH required. NPSH required. Who will give this one? Pump company will give.

okay so how they will get they will do testing of pump and they will check how much uh npsh required for their pump before cavitation starts okay if there's a five meter pressure minimum pressure required so actually you have to keep your pressure positive pressure more than five meters six seven eight meter maybe you have to keep okay so that's why whenever you are studying about pump you must know about your npsh and cavitation if you are not maintaining your npsh then pump will cavitate the whole system can fail So, cavitation term actually you will be hearing in many places in your marine engine systems. For example, for your propeller or when ship is moving, there also can be cavitation. Many other machinery also there, there cavitation will be one issue for your marine machineries.

So, what is cavitation? So, cavitation occurs when static pressure falls below vapor pressure. When static pressure falls below vapor pressure, low vapor pressure. Formation and collapsing of vapor bubbles, formation and collapsing of vapor bubbles. in a flowing liquid in a region of low pressure.

cavitation parameter or number. or cavitation number, cavitation number sigma equals P minus PV by rho V square by 2 pressure minus vapor pressure divided by inertial pressure. So, sigma less than 0 cavitation takes place. if I write in details the cavitation formula, it will be looking like this. NPSHA, small a capital A, you can write small a whatever I am writing.

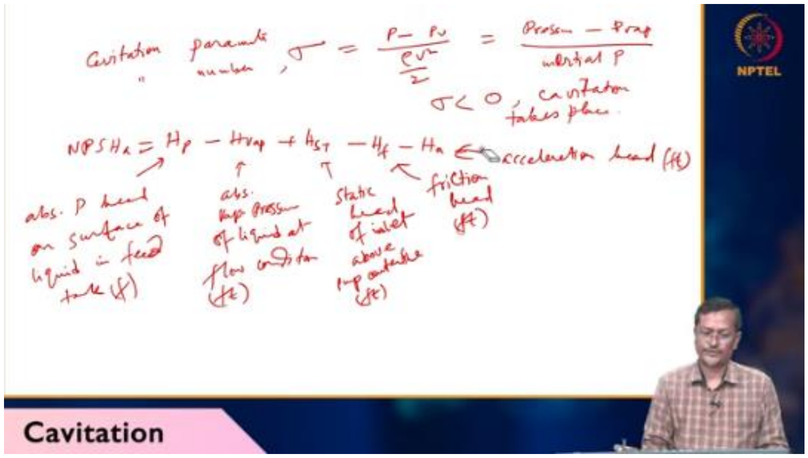


HP minus H vapor plus HST minus HF minus HA. HP is absolute pressure, absolute pressure head. on surface of liquid in feed tank. And vapor pressure, absolute vapor pressure of liquid at flow condition.

So, all units are in fit. So, NPSH also will be coming in fit. HST static head of inlet in Let above pump centerline. This is also fit.

All units must be same. HF is your friction head. I already told. again fit HA acceleration head. if fluid is having acceleration then that head also you should include.

if you have all the data you can calculate NPSHA then if the company has let us say 5 meter head required and you are getting NPSHA 4 meters then you can say this machine is unsafe you have to change your parameter and if in psh company asking for three meters you are getting five million pieces available it is good let's say centrifugal pump okay yes i am using only block or i should i can use formal notation also this is centrifugal pump sucking fluid and it is delivering okay when it is sucking Before start your pump, actually you have to fill your pump with liquid. Fill your pump with liquid before starting. So, that is called priming.



Now, you are sucking fluid from let us say water surface and you assume that there will be some debris, anything debris can come and it can block your centrifugal pump. Then what you do in that case? In that case, let us say you have one tank and you have lots of debris. So, in that case you put on some valve arrangement with some strainer. So, you fill your pump.

When you are filling pump, let us say initially before starting you are filling pump, but filling pump means maybe there is one hole and you are pouring from here, okay? Filling. When filling, so water will go out to the tank, right? So, how to prevent? So, just before entry of the, just after entry of the pump at the suction pipe, okay?

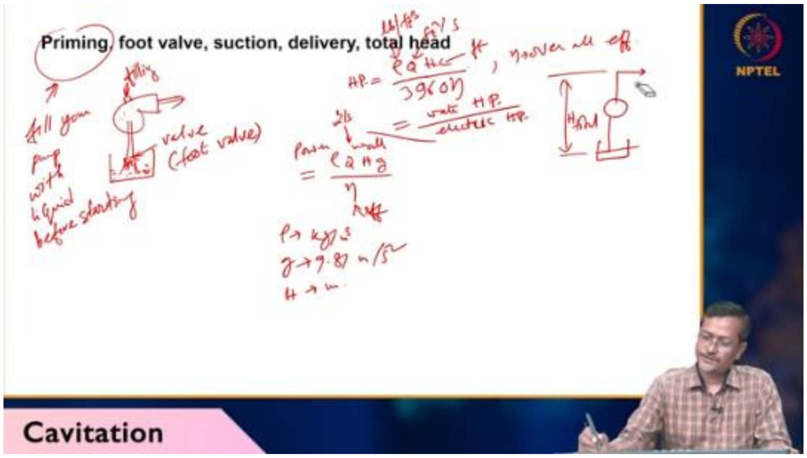
So, there will be one valve or food valve, okay? So, this is a one-way valve. When you are filling it, water will not go back to your tank. When pump will be starting sucking, so valve will be opening.

It will allow fluid to enter into the pump. But when you are filling from the top, it will not allow. when you take one bucket, you fill the pump. One bucket, two bucket, three bucket. After three bucket, your whole pump will be filled.

Now you close the filling channel or knob will be there. So just close it. Now, start your pump. When you are starting, valve will be opening and fluid, it will allow fluid to suck from there. it is called foot valve.

 many pump will be requiring that foot valve during initial starting. we have already seen that HP equals rho QH3960 eta, eta, this is overall efficiency eta, eta over all efficiency and h 396 h in feet and q in cubic feet per second and lb pound mass pound by cubic feet okay horsepower requirement so water horsepower water HP divided by electric horsepower. How much electricity you are giving?

Electric HP and power in watt equals rho Q Hg by eta efficiency and rho meter cube Q meter cube per second, rho kg per meter cube, rho kg per meter cube, g 9.81 meter per second square and h meter. let us say pump is here, you are delivering here, you are sucking from here. So, your total head will be water level to this. this is the delivery head I already told delivery this is suction.

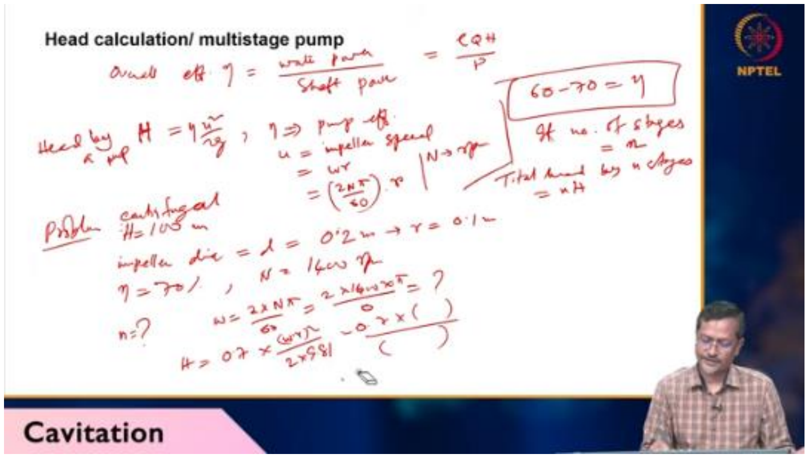


So, overall efficiency eta equals water power by shop power. rho Q H by T. So, impeller diameter and head relationship H equals eta u square by 2 g. So, head by a pump centrifugal pump H equals this one. eta is impeller efficiency or pump efficiency pump efficiency u equals impeller velocity impeller speed so impeller speed equals omega into r again omega equals 2 n pi by 60 into r n n is your rpm revolution per minute So, normally we assume 60 to 70 percent eta.

If number of stages n of stages equals small n, then total head by n stages equals nH. H already you have calculated, you can see left side head by a pump. Let us say simple problem, if a pump delivers water 100 feet, 100 meter, it is delivering water 100 meter centrifugal pump. If a centrifugal pump delivers a 100-meter head and impeller diameter 6-inch efficiency is 70 per cent, n equals 1400 rpm.

instead of d 6 inch, we can write in meter, maybe 0.2 meter. Then how many stages will be required? So, in that case, what we can do, omega equals 2 into n pi by 60 equals 2 into 1400 into pi by 60, we can calculate. I am not calculating, I am leaving for you. So, h equals eta, eta means 70, 0.7 into u square, u means omega into r, omega into r square by 2 into 9.81 equals 0.7 into omega.

I am already getting here r value, d is there, so r will be 0.1 meter. So, you can put the values, then you calculate. Very simple problem, I hope you can solve it.


Head calculation/ multistage pump
NPTEL
Cavitation