MARINE ENGINEERING

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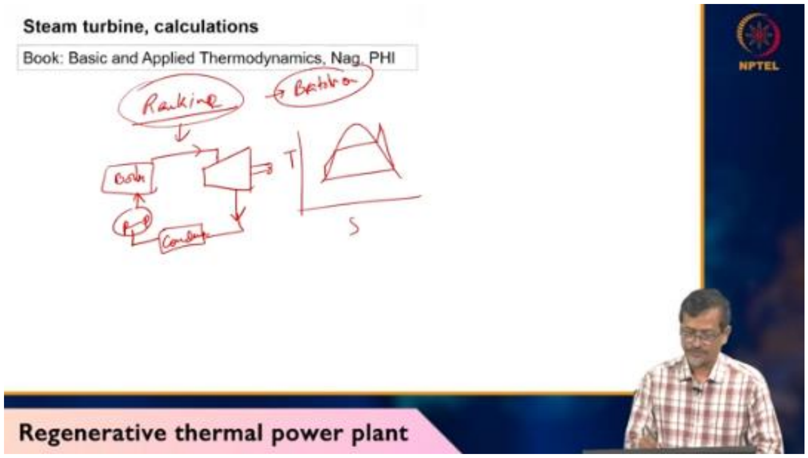
Lecture35

Regenerative thermal power plant

Good morning everybody today I will start some topic some calculation basically of whatever we learned in steam turbine and especially boiler system and steam turbine all together to be on topic so I have divided into a section one is week one week I have given related to boiler another week I have given related to turbines turbine means like whole steam cycle how fluid is flowing, how you are calculating energy, how much energy you are getting, how much heat you are giving into the cycle, so that calculation. again, whenever you are talking about steam turbine, so Rankine cycle, you should not forget. there will be many cycles, for example, auto cycle, diesel cycle you have seen, this is Rankine cycle, then again next time, in one week I will go to this Brayton cycle. this will be another week discussion so first this week we are continuing Rankine cycle so Rankine cycle will have one boiler so boiler will have turbine again fluid will be going to turbine hot steam or superheated steam again it will come to your condenser so from condenser to one pump

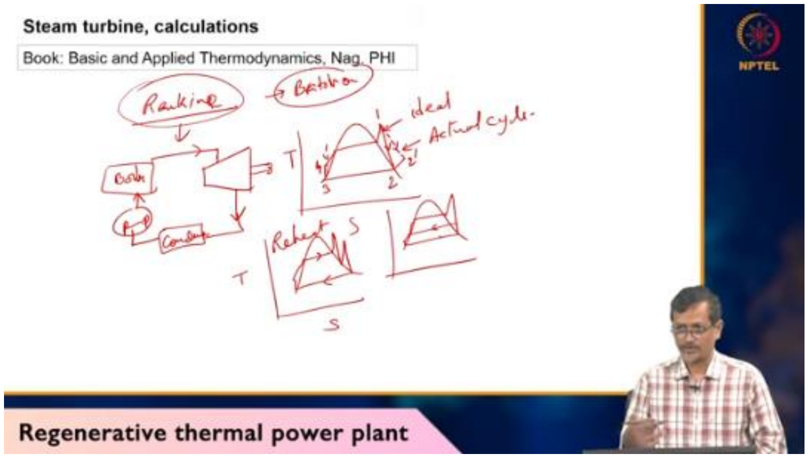
pump to boiler. So this circulation of fluid will be going on continuously. Now if you have regenerative or reheat cycle then this basic system will be modified. Now if we consider ideal cycle, so ideal cycle will have completely vertical power output, vertical pump input. So this is ideal cycle.



Now, if you have practical cycle or actual cycle, then this will change actually, it will be like this. So, let us say 1, 2, 2 dash, 3, 4, 4 dash. So, 4 will be moving to 4 dash if you have actual cycle. So, this is actual cycle. Now if you have regenerative or reheat you have seen this TS diagram.

So in reheat system we have steam going to turbine again it is being reheated before putting into condenser. Then one pump again the circulation will be like this, this is reheat cycle. Now if you have regenerative system, regenerative system in that case we will be bleeding some amount of steam. And then we will be giving to the system. So that way regenerative system will be working.

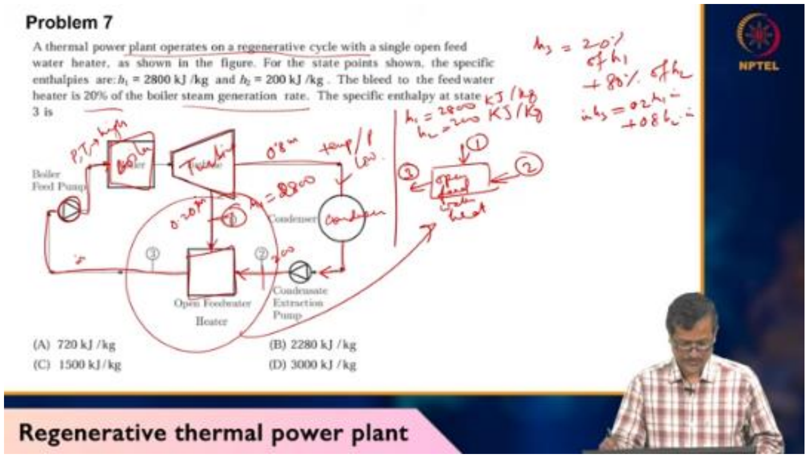
It will be improving performance of the system. so basically when if any problem is given you should try to draw the TS diagram so from TS diagram you can try to solve the problem so in previous lectures I have shown several problems now we have some more problems you can see here a thermal power plant operating on a regenerative cycle here regenerative is written there the regenerative cycle is a single open feed water heater so one feed water heater must be there, so one condenser is here, this is condenser, this is turbine, so from turbine fluid is coming to condenser, so this is if pressure and temperature is high, so after turbine it will be lower temperature pressure, temperature pressure lower. from condenser it is going to one pump, pump to going to open feed water heater. So your condensed water and bleed steam coming from turbine these are mixing and it is making a single fluid path.



Again another pump is there so that pump is transferring fluid to boiler. so this is boiler. now thermal plant power plant operating on regenerative cycle with single open feed water heater so you can see one feed water heater is here two to three as shown in figure for this state point shown specific enthalpy h1 is given 2800 h2 so h1 is here one so h1 is given 2800 kg per kg h2 200 h2 here 200 kg per kg the bleed to the feed water heater is 20 percent of the boiler steam generation rate okay so this is 20 percent so if total mass m dot then it will be 20 0.2 m dot and this one is 0.8 m okay so total mass must be constant okay Now solve the problem h1 is 2800 given h2 equals 200.

So every time you should remember the unit. So here kj per kg. So whenever you are solving the problem for your exam so you should write the unit every time. and open feed water heater open feed water heater so one is coming two is entering and three is exiting you can see the picture okay so this section drawn separately here okay so from the given diagram the thermal power plant one is directed from boiler from turbine to open feed water, 2 is coming from pump to feed water and 3 actually both fluids are getting mixed and it is going to boiler.

The breed of steam saying like 20%, so H3 equals 20% of H1 plus 80% of H2. So, you can write in this way also like m H3 total amount of energy equals 0.2 H1 m plus 0.8 H2 into m m dot mass flow rate. So, then m will be cancelled out. So, you are getting the value if I put here. So, H3 will be coming as



0.2 into h1 value is 2800 plus 0.8 into h2 value 200 so total the value is coming 720 kg per kg okay so this is the answer they are asking okay so another problem this is also from gate actually so consider a steam power plant using reheat cycle so here boiler is here i am doing it again because many time video does not display properly So, reheat cycle so turbine fluid is coming from here boiler to then turbine to condenser it is going to condenser here this is turbine then pump. So, it is going like this and turbine it will be like it is going here and it is going back. Now, steam leaves boiler and enters turbine at 4 MPa, 350 centigrade, H3 value given. After expansion turbine to 400 kilopascal, H4 value also given 2609.

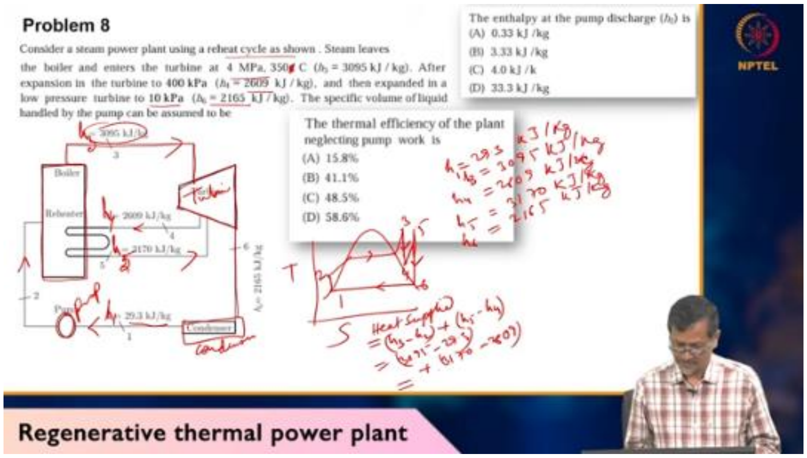
and then expands in low pressure turbine 10 kPa. Pressure given and Hc is also given. The specific volume of liquid handled by the pump can be assumed to be. Now, these things we have to calculate. So, H1 is 29, wait, where is H1?

So, in figure the values are given H1 equals 29.3, H3 is given, H4 is given, this is H5, this is H4, this is H3. So, you have to draw TS diagram, TS. So, after boiler is 3, So this is 3, then after turbine reheating is happening, so it is 4, again heated up, then again it is going down, going here, pump, then it is going here. So 3 to 4, 4 to 5, 5 to 6, 6 to 1, 1 to 2.

This is your cycle. So now you see the values. H1 equals 29.3. H3 equals 3095. It is given.

If you see here 3095 given. these are kg per kg per kg of mass kg per kg and h4 2609 it is already given kg per kg okay h5 equals 3170 this data also given kg per kg h6 also given 2165 kg per kg So, heat supplied to the plant, how much heat is supplied? So, 2 to 3 and 4 to 5 heat is supplied. So, heat supplied equals H3 minus H2 plus H5 minus H4.

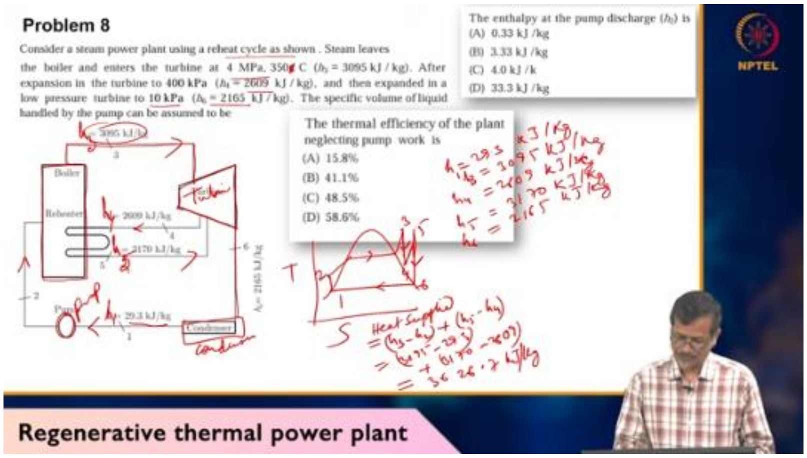
Okay, so if you write the values 3095 minus 29.3 plus 3170 minus 2609. So this is giving 3626.7 kg per kg. i will go to next page actually. So I have to draw the TS diagram again actually. TS otherwise it will be confusing.



it was three four five six one two let me check previous one two three four five six six one okay so every time you show the flow direction also so it will be clear okay now turbine power how much turbine how much power you are getting from turbine so turbine power is three to four H3 minus H4 plus H5, H4. So H5, H5 minus H4. H5 minus H6, not 4. is 3H4 now you put the values 3095 minus 2609 these are given in the problem plus H5 3170 minus 2165 so this is giving 1491 KJ okay now in the problem it is given like pump power you assume zero okay so now eta thermal

Turbine power minus pump power divided by heat input. So, turbine power, pump power already is 0. So, you are getting turbine power divided by heat transfer. How much heat you are giving? Okay.

So, here one small thing is that it will be 1491. So, WT14913626.7 is coming 41.1 percent. So, in this problem actually pump power is not given. So, H2 and H1 we can say assume same value. So, instead of H2 we will put H1 then we can calculate.



So, some other part I will try to discuss. So, steam engine although not Used normally in shifts these days, but still you should know the basic fundamental of the steam engine. Steam engine is like IC engine. IC engine you have seen one cylinder is here and piston is here.

Piston will be connected to one crank and combustion will be happening. IC engine. So IC engine means reciprocating IC engine. reciprocating IC engine in that case combustion chamber is here so burning will be happening okay and this piston will be moving up and down crank will be rotating all right so crank will be this will be in reciprocating IC engine but what happens in steam engine is like this I have piston I have same configuration piston here connecting rod here it will be rotating crank will be rotating this is crank you can remember and this is connecting rod okay and instead of combustion here actually steam you are injecting here

okay so in IC engine you have intake port exhaust port here also you have intake port exhaust port but in this case combustion is not happening inside combustion will be happening in boiler furnace so boiler will be producing steam that is steam you are passing through this cylinder and piston will be moving up and down when piston is moving up and down its crank is rotating and you are getting power okay so same way like multi cylinder reciprocating engine is there same way they had a reciprocating steam engine where multiple cylinder, V cylinder many different types of cylinder arrangements are there. And this is the end of this lecture for week 5. Next week we will start week next topic especially Brayton cycle. Thank you very much listening lecture.