MARINE ENGINEERING

By

Prof. Abdus Samad

IIT Madras

Lecture25

Numerical problem

Now, enthalpy or internal energy, enthalpy or internal energy. So, thermal efficiency of a system, enthalpy already you know the definition, it is an internal energy actually, thermal efficiency thermal efficiency eta thermal equals W work output divided by heat input equals Q high temperature, Q low temperature by Q high temperature. High temperature is boiler temperature, how much heat you are giving. So, if I draw the TS diagram again, you can remember the vapor envelope

My pump is here. It is doing like this. Boiler is here. So, 1, 2, 3, 4. Sorry, this should not be like this.

This should be this direction. Now, this will be showing H3 minus H4. This is turbine work. This is turbine work. W turbine.

This is W pump. Turbine minus W pump. h2 minus h1 h2 will be higher because you have added energy h enthalpy h equals enthalpy h implies enthalpy okay and how much energy heat you have given h3 minus h2 okay so this is your thermal efficiency formula Now, if I draw same thing in pH curve, pH pressure and enthalpy diagram, so envelope will be little bit tilted and curve will be like this, 1 to 2, pump work as it is I am drawing and constant pressure process I told 2 to 3. So, 2 to 3 is my constant pressure process, 3 and 3 to 4, 4 will be here.

4 to here again. So, you can see 4 to 1 constant pressure process, 1 to 2 actually you are adding some energy. It will be like this. 1 to 2 some energy were added, so 3 to 4 you extracted energy this is turbine, you just compare with T-S diagram and P-S diagram it will be similar actually. And in normally this H values will be given in your problem, there will be steam table

Using steam table also you can find enthalpy values because if you know temperature and pressure you can find how much energy can be contained in a steam before going into further details let's solve one problem a simple rankine cycle uses water as a working fluid so first you draw rankine cycle okay so first draw rankine cycle like this boiler okay then pump will be there pump getting water from condenser, condenser getting steam from turbine and you show the arrow direction and you put number also after pump we put 1, no before pump we put 1, then after pump 2, 3, 4 then turbine work W turbine. Now, here enthalpy steam entering turbine 2785, enthalpy steam entering condenser. Here enthalpy values are given, but they are not saying whether my turbine is working within superheated zone or within two phase zone. Let us draw roughly one diagram TS diagram, TS and let us say my pump is here 1 to 2,

3 to 4 may be here. Now, here one point I would say that turbine will be working in superheated zone only. If you are not giving steam, superheated steam, the turbine will have erosion and performance will be very low. So, our target should be to run the turbine in superheated zone only. But here just no data is given. So, just I am randomly drawing one figure. So, for my own understanding. And we will be drawing isentropic 1 to 2, 3 to 4 also isentropic. We are assuming this is the ideal situation. So, H1 is given 174 kg per kg.

H2 is given 179.7 kg per kg. H3 also given 2785 kg per kg. H4 given 1840 okay now work done by the steam for turbine work done for by the steam to the turbine how much work is it has done so H 3 minus H 4 H 3 minus H 4 equals 9 4 5 9 4 5 K J per kg per kg means per kg of steam but if I give amount of steam flowing then you can multiply and you can say it is total amount of energy or total amount of power and pump work how much pump is working pump if you see h2 minus h1 h2 minus h1 means 179 179.7 minus h1 174 equals 5.7 kg per kg

So, I got turbine work, I got pump work. So, how much heat added in the boiler? So, Q added, boiler added means H3 minus H2. H3 value is 2785 minus H2 value 179.7. So, this much of heat is added.

So, 2605.3 kg per kg. Now, Carnot efficiency, eta Carnot equals 1 minus T cold by T hot, 1 minus 315 by 549. So, in this problem one data is missing, so cold temperature, condenser temperature is 315 and boiler temperature average temperature 549 in Kelvin. So, this is giving 50, 42.6 percent.

Now, Eta thermal Wt minus Wp divided by Q how much heat input so this is 945 minus 5.7 divided by 2605.3 equals 36.1 percent so this is your calculation result