MARINE ENGINEERING

By

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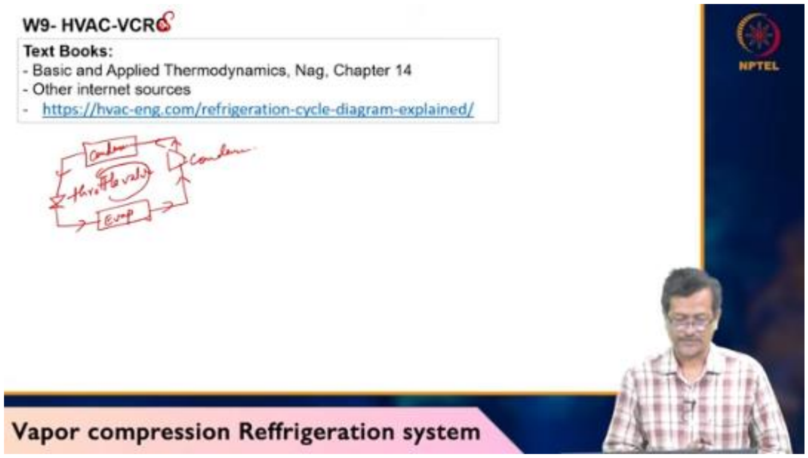
Lecture58

Vapor compression Refrigeration system

Good morning everybody, our lecture is on vapor compression refrigeration system, VCRSIC, vapor compression refrigeration system. later we will discuss about vapor absorption and other systems. first let us start with vapor compression system. vapor compression system we have seen that one compressor must be there, then compressor condensing refrigerant and you have one condenser, condenser to throttle valve. throttle valve to your evaporator evaporator to compressor again okay this cycle you must remember so this is condenser this is not compressor this is evaporator this is condenser this is throttle valve okay so fluid will be flowing in this loop in this direction

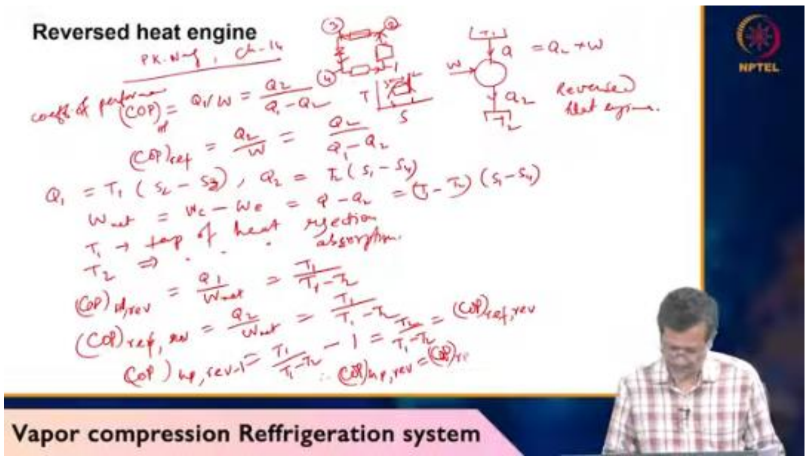
Now we have seen the different refrigerants and their names. Refrigerants normally will be like R112, R134A or water can be refrigerant, ammonia can be refrigerant, carbon dioxide can be refrigerant. So there are different types of refrigerant. for our specific purpose for example if i give any problem to solve for one refrigerant cycle to calculate heat and other thing then refrigerant name also will be given because different refrigerant will have different properties so you cannot use the same property for all the refrigerant so water will have certain property ammonia will have certain property or r11 will be certain property so based on the property will have to calculate let's go to basic of thermodynamics reverse heat engine so we have temperature t1 we have w we have q1 coming q2 plus w and this is q2 and it is going to t2 and this section is taken from your peak and arc book okay and chapter i think 14 you can go through this one



So this is the reversed heat engine. this term coming Q1 by W equals Q2 by Q1 minus Q2. COP means coefficient of performance. Coefficient of performance. COP of heat pump refrigerant refrigeration so Q2 by W so you should not get confused this is first one Q1 second one is Q2 so Q2 Q1 minus Q2 and Q1 equals if I draw this TS diagram

compressor again I have to draw TS diagram okay this throttling process then evaporation process this one going like this and TS diagram TS one two three four so TS diagram again vapor envelope you draw one is here two is here three is here four is here okay now t1 s2 minus s3 the q1 is heat addition okay so numbering is something wrong so we have to correct the number two is here actually two three four this is one so numbering have to change one two three four okay so s2 s2 minus s3 s2 minus s3 this is your heat addition process and the q2 equals t2 s1 minus s4 w net net power wc compressor minus w e equals q1 minus q2 equals t1 minus t2 s1 minus s4 because okay now t1 temperature of heat rejection so t1 equals temperature of heat rejection t2 temperature of heat absorption okay so COP heat pump reversible equals Q 1 by W net equals T 1 T 1 minus T 2

COP refrigeration reversible Q2W net equals T1 by T1 minus T2 so COP HP reversible 1 plus 1 equals T1 by T1 minus T2 minus 1 this is not plus 1 this is minus 1 so this is giving t2 by t1 minus t2 equals cop refrigeration reverse okay so therefore cop ref hp reversible equals cop refrigeration reversible minus one okay so you should remember if HP is given so refrigerator refrigeration of COP coefficient of performance value also can be found here one thing is there coefficient of performance doesn't mean this is efficiency efficiency is different thing coefficient performance difference efficiency means like compressor for efficiency will be there your whole system efficiency can calculate but COP coefficient of performance is that how much heat you are transferring so that it is indicating it is not indicating the losses in compression other systems so cop can be more than one also okay vapor compression refrigeration system or vapor compression refrigeration cycle v c r s also you can see okay this is cycle or this is system so sometime i am using vclc sometime we see rs s y s t m okay now again draw this cycle diagram compressing so it will be like compressing then your condenser is here condenser means heat is getting rejected then you have evaporator here evaporator will be taking heat q2 you have throttle valve okay now you should put arrow symbol one

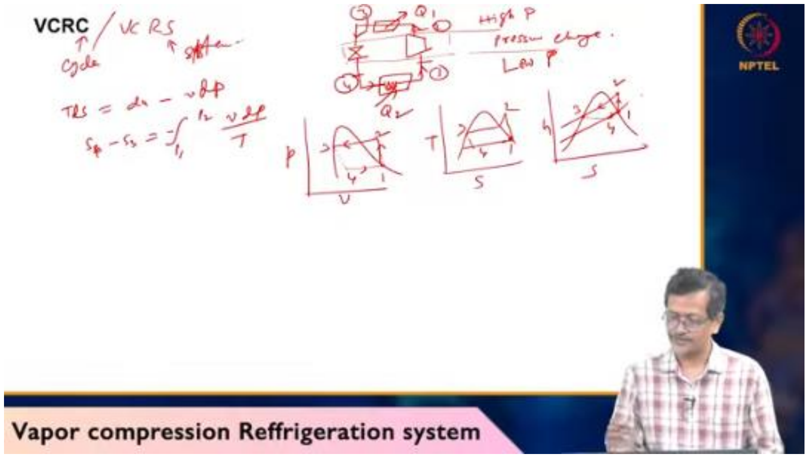


two three four . so t ds equals du minus v dp you know that so s4 minus s3 equals p1 p2 v dp t okay and if i see this part this upper part is high high pressure part these are high pressure and this lower part low pressure okay upper part high pressure means after compression the pressure is high and it will be the high pressure will be there till throttle valve after throttle valve your pressure changing to lower pressure okay so pressure change is happening in between these two okay and below this one actually low pressure okay so i can see like this low pressure and pressure change happening Now, this one I am going to draw in PV diagram. So, PV diagram is constant pressure pulses 2 to 3. You see 2 to 3 constant pressure pulses are very high pressure.

2 to 3 high pressure. 3 to 4 what is happening? Pressure change is happening. So, volume also changing, pressure also changing. And 3 to 4.

4 to 1 4 to 1 again constant pressure pulses 1 to 2 again pressure changing okay so if you if i ask you to draw pv diagram so you should be able to draw this one you must put l symbol you must put proper numbering okay now same thing if i draw in ts diagram already you know that one ts right then it is happening like this two three four one okay on the uh saturation line that must be it must be one here okay now hs diagram hs so pressure line is here okay so three is here saturation line and my two will be upper here The 2 to 1, 1 to 2, 1 is here, 3 to 4, throttling happening, so enthalpy constant, I said enthalpy, isenthalpic

process, okay, 3 to 4 and 4 to 1, okay. So, if I ask you to draw HS diagram, so 3 to 4 will be a horizontal line because it is an isenthalpic process, we are not changing any energy there.

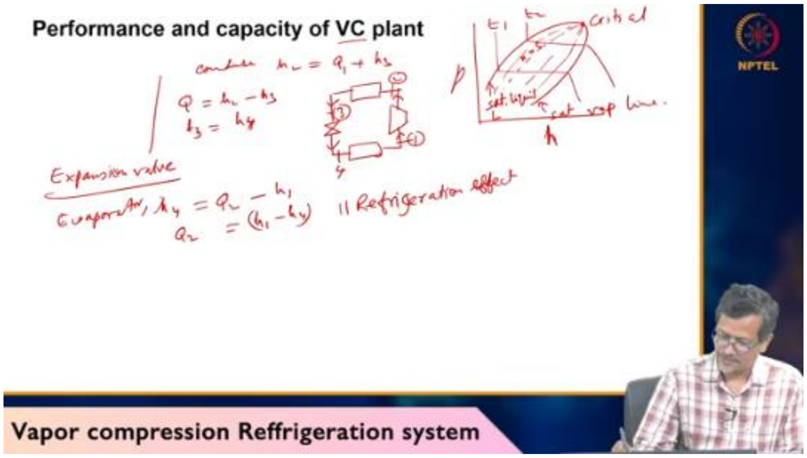


So, the performance and capacity of vapour compression plant or vapour compression refrigeration cycle or system, if you can write, is okay. the P-H diagram, they have drawn like this. This is critical pressure. so critical pressure knowing is very important because if you are increasing temperature pressure so high it is crossing critical temperature pressure the system will not work so you have to be below that okay so t t2 t1 and this is saturation line saturation line so the saturation left side one liquid right side one gaseous energy h means internal energy internal energy high means to be gaseous so simple okay so saturation vapor line saturation vapor line saturation liquid line you can see okay and this will be the pulse dryness fraction

certain how much liquid is there because inside envelope there will be liquid plus gas so how much liquid percentage is there they would be like these lines will be there inside dotted lines i'm drawing okay so condenser h2 equals q1 plus h3 i have to draw this diagram other than very difficult to understand this is condenser this is your throttle valve this is your evaporator compressor is going like this numbering like two one four three okay so q h3 q1 h3 Q1 equals H2 minus H3. H3 equals H4. H3 equals H4.

You can see the throttling happening. there is no enthalpy change. It is isenthalpic process. this is condenser. Now, evaporator.

Expansion valve. Expansion valve means H3 equals H4. The enthalpy change is not happening. then evaporator H4 equals Q2 minus H1 Q2 equals H1 minus H4 so this is called refrigeration effect refrigeration effect cop because q2 by w h1 minus h4 h2 minus h1 okay so this is your coefficient of performance of the system so mass flow rate of refrigerant mass flow rate



mass flow rate W, then W h1 minus h4, it will be in kg per second, kg per second, okay. Okay, thank you very much for today's lecture. Next day, we will continue this lecture. Thank you very much.