INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NPTEL
NPTEL ONLINE CERTIFICATION COURSE

Refrigeration and Air-conditioning

Lecture-20
Vpour Absorption Systems - 3

with
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Hello I welcome you all in this course of reflection in air conditioning, today we will cover the concluding part of vapor absorption systems in vapor absorption system today we will be covering Thermodynamic requirements of mixture.

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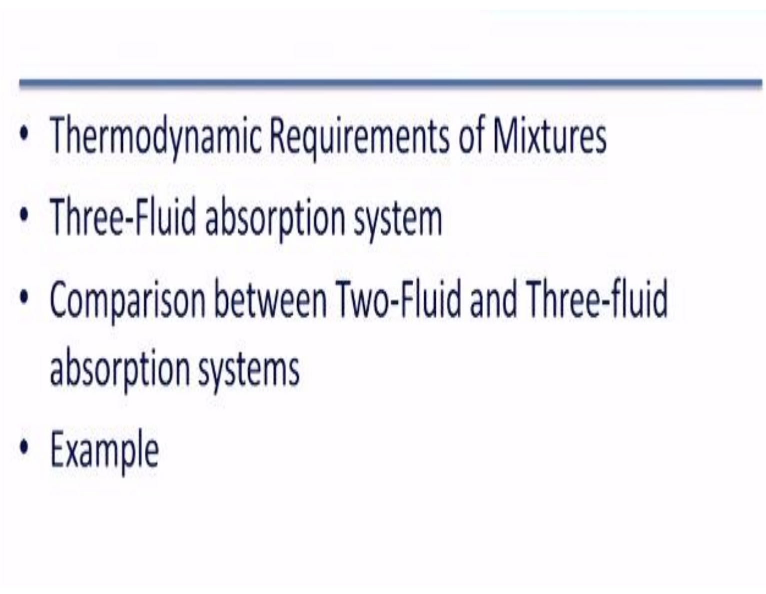

Three fluid absorption system that will interest you comparison between two fluid and three fluid absorption system and we will work out some example, properties of an idea of refrigerants in vapor compression system also we discussed the properties of ideal reference range, now here in the absorption system also there are certain desired properties of an ideal refrigerant, the vapor pressure.

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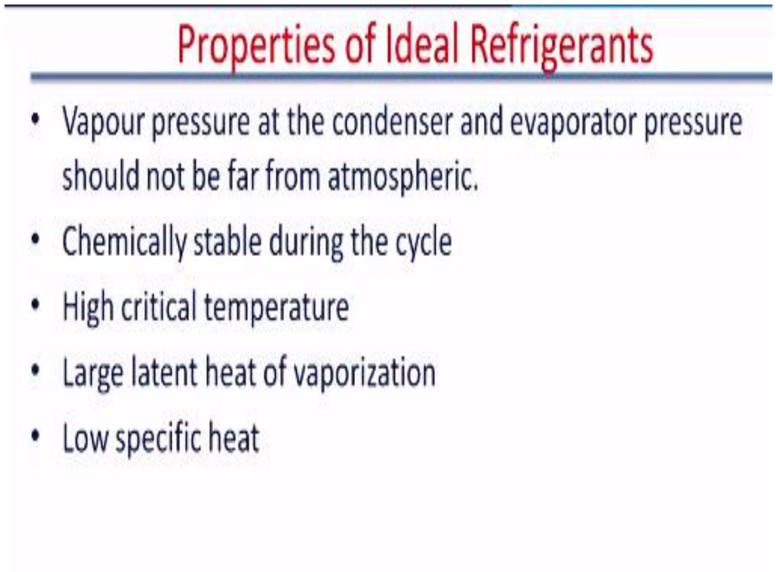

At the condenser and evaporator pressure should be should not be far from atmospheric that was also requirement in the vapor compression system there the pressure in the evaporator and condenser.

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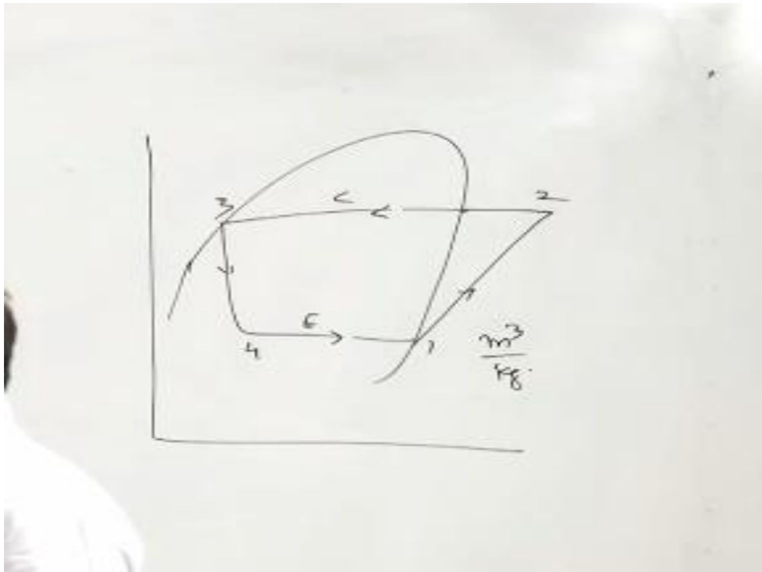

One two three four so this is evaporator and this is condenser so pressure should not be far from atmospheric because the pressure where the pressure is far for atmospheric whether it is high pressure or low pressure that causes problem because the pressure is high then system has to be robust and if the pressure in the evaporator is very low, in that case the specific volume of the vapors emerging at state 1 will be very low.

A specific volume is meter cube per kg so if 1 kg of refrigerant is in circulation if evaporator pressure is low then volume will increase and compressor will have to handle high volume of the gases or the sub pop the size of the compressor will be larger, so either way pressure should not be very high in the condenser and should not be very low in evaporator so pressure it is the ideal case is the pressure in the entire system is slightly above the atmosphere pressure.

In the evaporator is slightly above the atmosphere and pressure in the condenser is not very high that is the very comfortable situation, the refrigerant has to be in any case chemically stable during the process.

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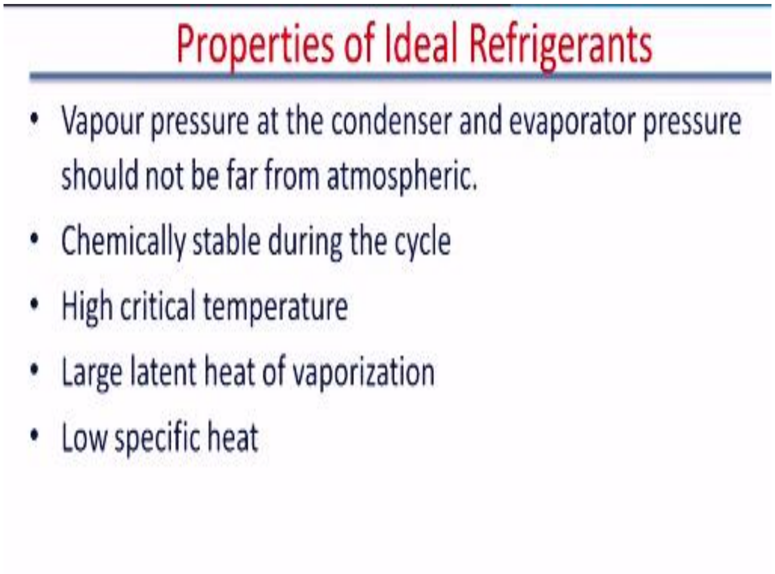

Critical temperature should be high critical temperature means temperature at this point farther you are operating from critical temperature.

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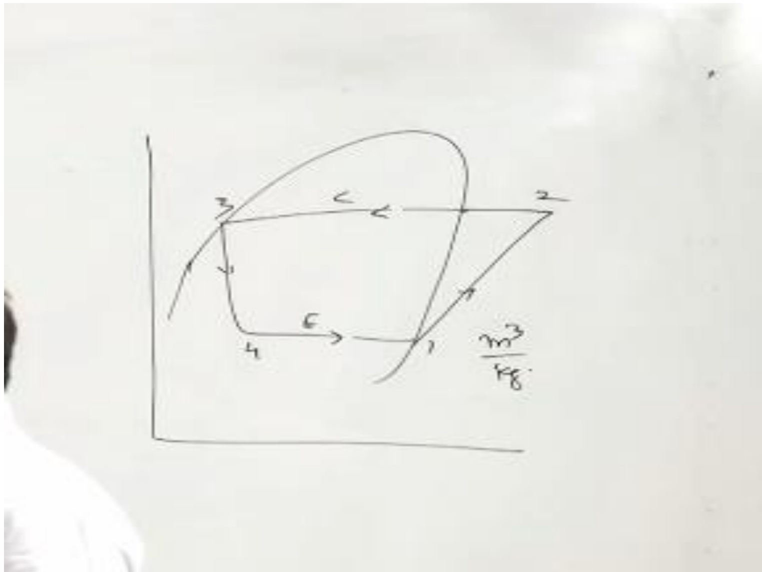

Higher is the CoP of the system same is the case in absorption system so critical temperature so the cycle should operate far away from critical temperature large radiant heat of vaporization if there is large heat of vaporization for the same amount of heat transfer less amount of refrigerant shall have to be circulated and definitely the we can go for smaller size of a compressor or a pump in absorption system in any case.

If the latent heat of vaporization is high we will have to handle or the system will have to handle small amount of refrigerant and that is always desired, Louis specific heat because if the specific heat is low then high specific heat means that more energy will go in the sense for more sensible heat so in any definition system it is not recommended that the considerable amount especially in the vapor compression system and I absorption system.

That considerable amount of energy goes in the form of specific heat that is why the system should have low specific heat, the properties of an ideal absorbent.

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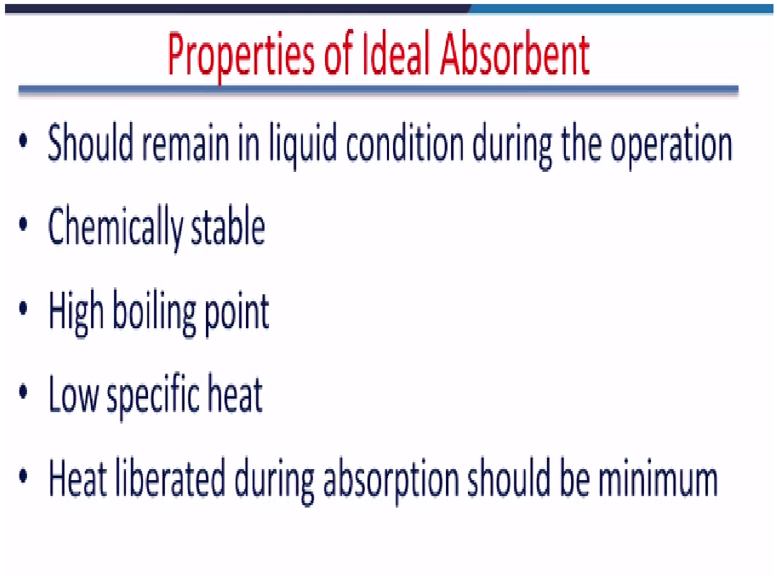

So absorbent should remain in liquid condition during the operation through the entire operation the absorbent has to remain in liquid condition however you must last time we discuss about the liquid this water ammonia system where traces of water were going with ammonia therefore at was not desired that is why a rectifier was used to condense the traces of water vapor and train them back to the generator.

Now Absorber has to be chemically stable in the entire range of operation we should have high boiling point Louis specific heat, heat liberated during the absorption should be minimum so during absorption process the heat liberated should be believed a minimum because the heat this is the heat loss from the system.

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Now make sure the properties of picture properties of absorbent and the refrigerant solubility should decrease the temperature that is always desired because in absorber the refrigerant is absorbed at lower temperature the pressure of the refrigerant is increased through a pump and then the mixture is heated in generator in generator the refrigerant is liberated definitely the solubility of the refrigerant reduces in generator.

Or it is required to be reduced in generator and that is why it is stated here solubility should decrease with temperature, so when we increase the temperature the solubility of reference should decrease otherwise we will be losing this effect refrigerating effect, chemically stable the mixture has to be chemically stable it should not react at any temperature reference should be more volatile.

So referee range should be volatile so that easily it can be converted into the vapor, so where refrigerant is required to be more one a time it has to be known corrosive that is obvious a fluid which is in the system has to be non corrosive whether it is refrigerant or an absorbent non-toxic, non-flammable this is a requirement that is why because ammonia is toxic so that is why ammonia cannot be used directly as a refrigerant.

So ammonia refrigeration system will again used a secondary refrigerant for providing the necessary cooling because ammonia for especially for the public uses or where the foodstuff is stored in the cold storage where food stuff is stored the use of ammonia is avoided, difference in boiling point between of refrigerant and absorbent should be around 200 degree centigrade, so that we find in the case of lithium bromide water refrigeration system that is why in that system we do not require any rectifier and when a heating of refrigerant takes place inside the generator only vapor water vapors are generated.

So this is the property of idle mixture, now we will come to the different type of reflection system which is known as three fruit refrigeration system, this system was recommended by undergraduate not recommended it was developed by the under agers friends in KTH Sweden so these two undergraduate students they proposed this system and in this system there is no moving part it is completely silent system.

And pressure in the evaporator is controlled with the help of hydrogen, hydrogen is another flute so it has three flutes that is why it is known as three food system.

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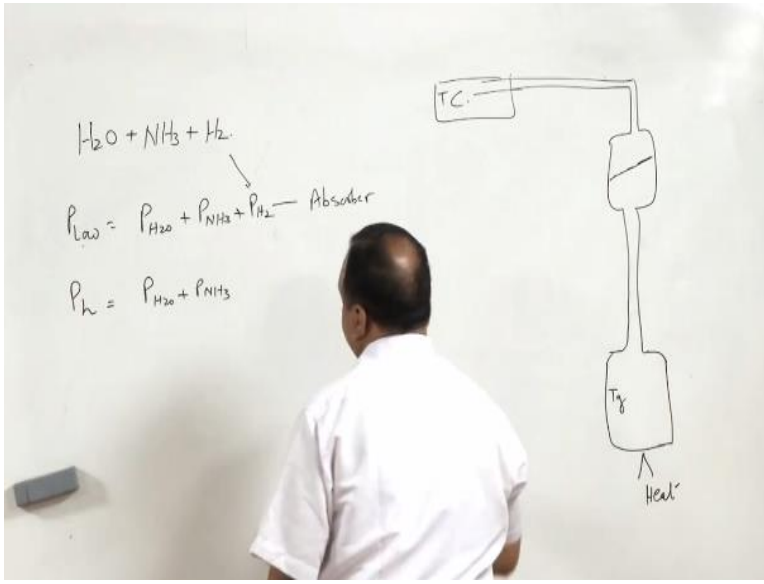

Water is absorbent there is ammonia which is refrigerant and there is hydrogen which is a driving fruit in low pressure side it is a mixture of hydrogen and partial pressure of water, partial pressure of ammonia and partial pressure of hydrogen. In high pressure side low pressure side means in absorber and high pressure side it is partial pressure of water and partial pressure of ammonia.

So hydrogen is confined to the low pressure side and total pressure of the system is remains constant now we will now I will draw the schematic of the system and the working of the system will be clear to you so we will be we will start with the generator so there is a generator which is at TG and heat is given to the generator in the generator the mixture of vapor and liquid it is transmitted to separator.

There is a separator, after generator there is a separator we are stratification of liquid and vapor takes place, now in this case the vapor goes to the condenser. Now condenser after condenser it is connected to evaporator.

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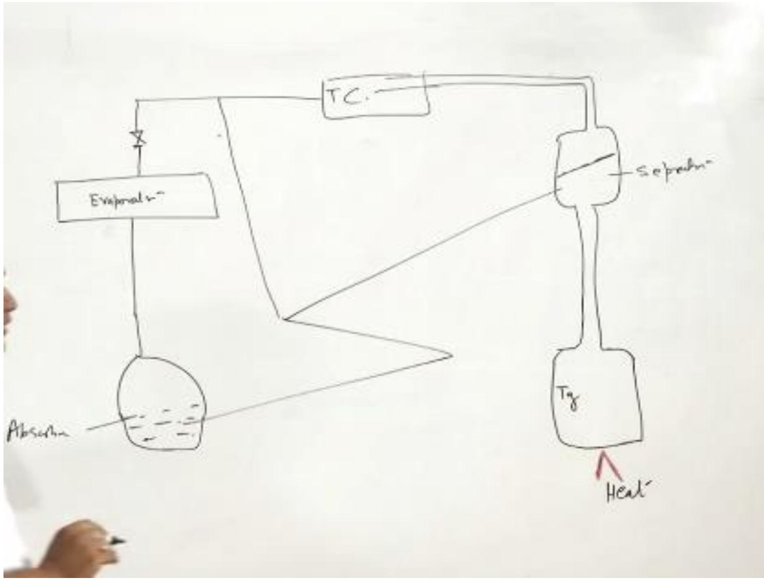

And from evaporator expansion takes place it comes to the sorry expansion takes place before you have returned so expansion takes place here and then it cook goes to the evaporator and from evaporator it goes to the absorber and this is absorber, system is not complete yet now this absorber is not connected to the generator here generator low heat I will show with the right one this is heat is going here.

So absorber is not connected to generator it is connected to separator, which this is a generator so here when the ammonia vapor eaves the separator we get weak solution and weak solution from here it has to be drained back to the absorber, so weak solution is great back to the absorber now this is a peculiar type of arrangement I am doing here and if you look at the PPT you will find a better arrangement is a same arrangement than here.

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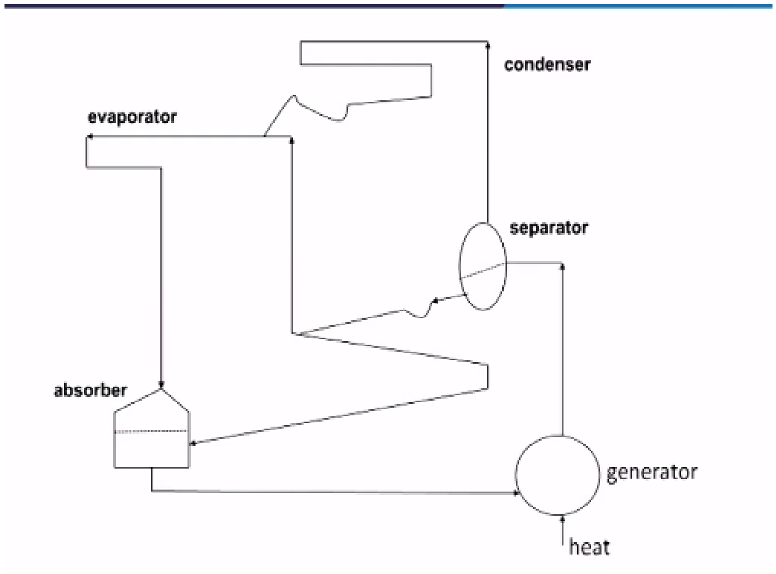

Now liquid from separator this is weak solution.

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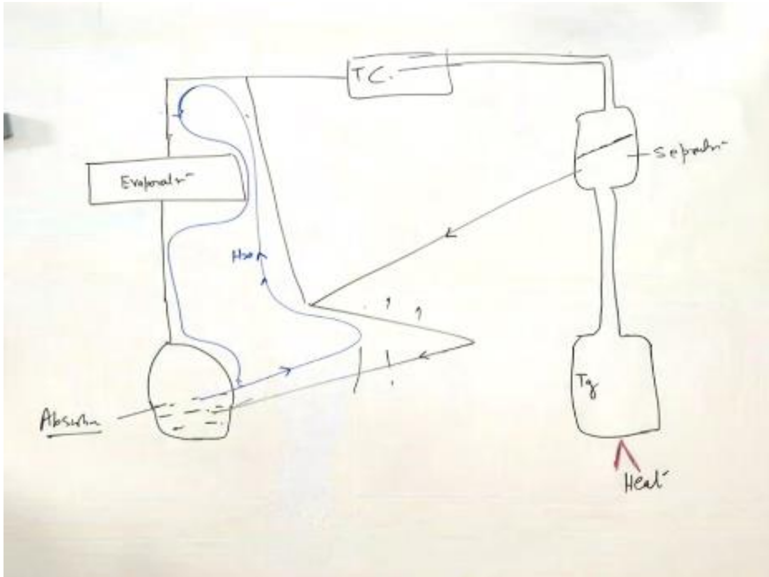

It here it is drained back to absorber now what is the function of hydrogen here because we have to maintain here pressure difference on high pressure side and low pressure side and expansion valve is already provided here okay, now if this system expansion one is not there it is expansion valve free system acceleration valve is not here, hydrogen is confined to this area. So hydrogen is confined to this area.

And it is a driving fluent and so it is liberated here it takes heat from the weak it takes heat from a weak solution of ammonia and water and it moves in this direction it goes here and in order to maintain the pressure in the system it against it drains back to the absorber so this is the circuit for hydrogen in the vapor absorption system and we have to maintain high pressure and low pressure side so the difference is very less but here in order to avoid that hydrogen does not escape in this direction if vapor lock is provided if vapor lock is nothing but we simply bend the tube so that vapor cannot enter this side.

So hydrogen is confined to this side this is hydrogen is confined to this side and it does not enter here if vapor lock is also provided here so that it does not enter on high pressure side from this from this channel so here one vapor lock is there here another vapor lock is there hydrogen is confined to this side and evaporator the total pressure total pressure in the evaporator will be the partial pressure which also include partial pressure of hydrogen this ammonia and partial pressure of hydrogen and Dalton's law of partial pressure is applicable here and that will give the total pressure in the evaporator.

Now here in separator the movement of the fluid this is this is a the heated fluid this is in generator the liquid add bubbles the vapor bubbles they move together in this channel and they come to the separator and the weak solution is drained back to the evaporator sorry absorber from this point so this is the entire circuit of a three fluid system it appears to be a little complicated because there is no moving part there are no walls only vapor locks are there now suppose I will give you another example of how these vapor locks are effective suppose in a pipe in a horizontal it is altogether different problem related with the fluid mechanics.

Suppose in a pipe I want to ensure that the during the flow the pipe is flow flooded I mean there is no vapor or air in the pipe irrespective of the flow rate normally what happens when the flow rate is slow if there is a tendency for stratification of the flow but if I provide u turn here in that case a u-bend with always ensured their the pipes are fully flooded at any flow rate similarly if I put a bund here under any circumstances hydrogen will not be able to escape through this message similarly.

Here hydrogen will not be able to flow through this package and it will be confined to the low pressure side and during the process the hydrogen takes heat becomes lighter and it moves in upward direction and subsequently it get mixed with the ammonia and it moves in the downward direction so it is a I mean driving fluid in the three fluid system now in this type of system since there is no moving part it is absolutely silent if there is no moving part it means external energy is not required in the system.

Once external energy is not required in the system it means simply if I heat provide heat some heat is available here or if you go for these type of refrigerators because electronics is a company which use this concept and develop number of they go for the bar they went for the mass production of electronics refrigerator working on the three fluid system so in this system if you it is very good for the rural applications where there is no electricity you simply heat the generator with the help of a Kendall maybe some way waste heat is available if in the rural area and in the refrigerator in the morning in the evaporator you will get the ice.

So it may sound very strange to the villages that you're burning some leaves or the sub Gordon here and you are getting eyes in the evaporator so it has immense applications in the area where the electricity is not there on the other side the cost of the system is high the cost of the system is high and it has to be handed with very clear it has to be carefully handed otherwise the mixing of fluid will take place the moment hydrogen enters this side the system will not work at all so comparison between 2 fluid 3 fluid absorption system if we compare this with the lithium bromide and water ammonia type system.

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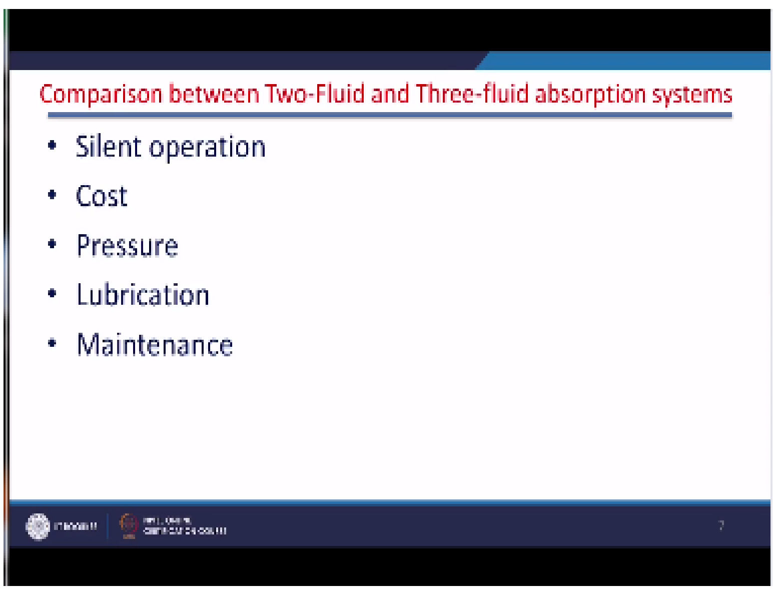

This is silent in operation I have already explained you the cost this system the three fluid systems is slightly closely than the two fluid system.

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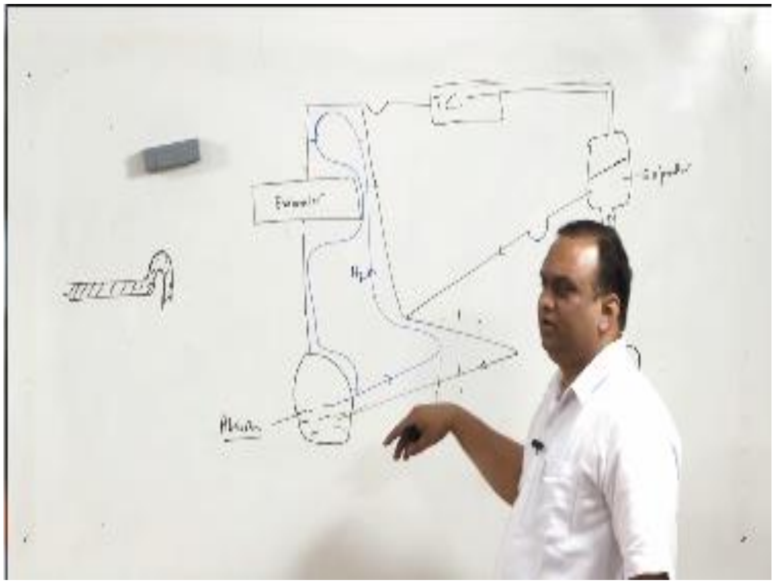

The pressure inside the system is variation the pressure is not very high variation in the pressure is not very high in the system from evaporator to condenser lubrication is not required because there is no moving part.

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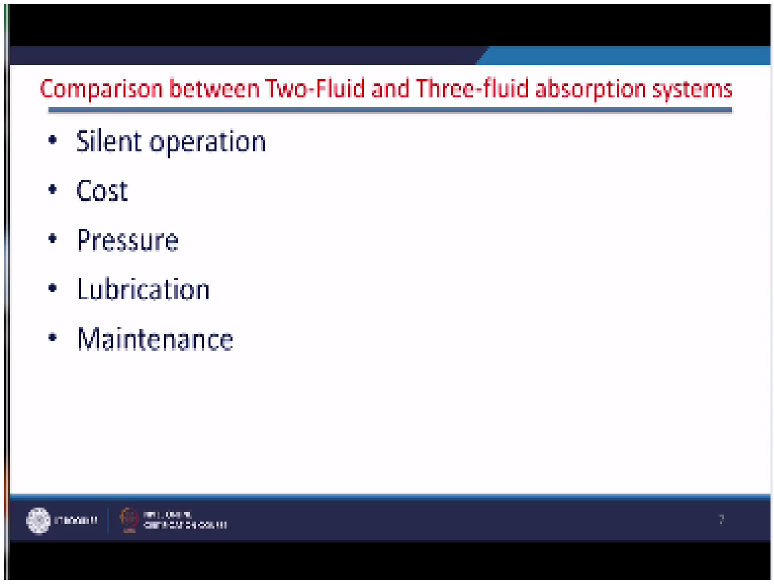

Lubrication is not required and it is this type of system is maintenance-free but the major drawback of this system is that the cost is high perhaps if we go for the mass production gauss can also be reduced but this is very good this type of refrigerator is very good for the rural applications where there is no electricity.

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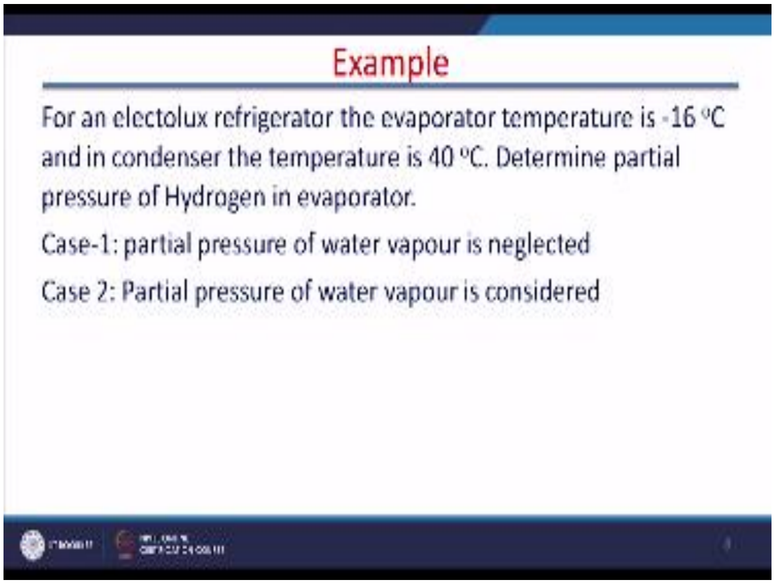

Now I will take one example to understand the working of an absorption system three fruit absorption system for Electrolux refrigerator the evaporator temperature is -16 degree centigrade so evaporator temperature is -16 degree centigrade and the condenser temperature is 40 degree centigrade.

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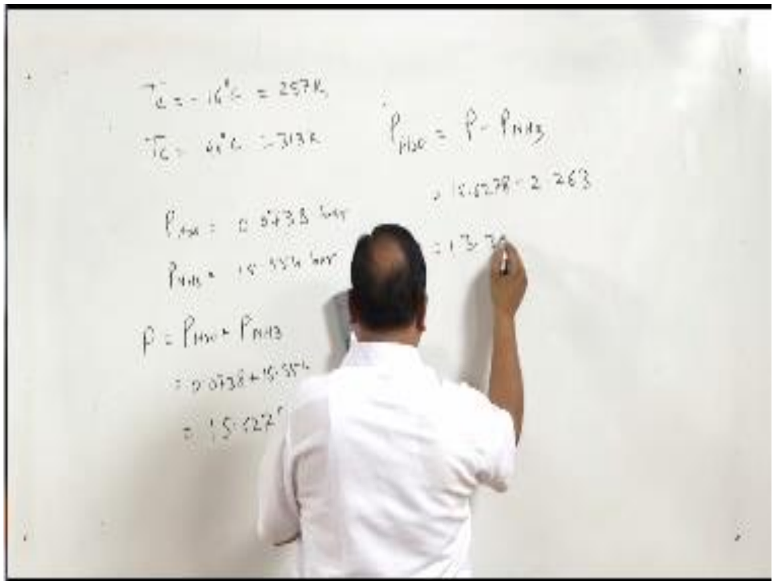

So the condenser is 40 degree centigrade so -16 will be 2703-16, 257k and this is 313K determine partial pressure of hydrogen in evaporator because evaporator will consist of hydrogen so here in this case we have to find the partial pressure of hydrogen the system pressure is equal to pressure at a body at 40 degree centigrade why the total system pressure is the pressure of ammonia at 40 degree centigrade because in condenser where temperature is 40 degree centigrade.

There is only ammonia that is an hydrous ammonia in and it means there is pretty ammonia which is existing inside the condenser and it when it is getting condensed it means saturation pressure at 40 degree centigrade is the total pressure of the system and the total pressure of the system is ammonia at 40 degree centigrade and that is 15.5 54 bar so ammonia is condensing in the condenser at 15.554 bar.

Now if we go to the evaporator case one partial pressure of water vapor is neglected now in evaporator in evaporator we have total pressure total pressure if the evaporator is equal to the pressure of ammonia plus pressure of hydrogen but it is not this pressure this is at 40 degree centigrade evaporator temperature is evaporated temperature is 257 K so at -60 degree centigrade the pressure in the evaporator of ammonia and hydrogen will be the total pressure now the total pressure of the system is 15.554 bar.

Right and that is equal to pressure of ammonia at -16 degree centigrade pressure of ammonia at minus the 16 degree centigrade is 2.263 bar pressure of ammonia 8-16 degree centigrade now this is equal to so the pressure in the evaporator of hydrogen at -16 degree centigrade is going to be total pressure 15.554 - 2.2 63 and that is going to be equal to 13. 291 bar this is the partial pressure of hydrogen in evaporator when water vapor is neglected both suppose we consider the natural system there are water vapors also now if we consider the water vapor then in condenser there is not going to be pure ammonia it is going to be the water vapor also.

So partial pressure of hydrogen oxide that is water shall have to be included that is 0.0738 bar so at 40 degree centigrade the total pressure of the system is not the pressure of ammonia at it is pressure of the ammonia partial pressure of ammonia at 40 degree centigrade that is 15.554 bar and because traces of water vapor are also present so the total pressure will be partial pressure of water per partial pressure of ammonia and if you add these 20.0738 + 15.554 and that will give the total pressure as 15.6278 BAR.

Now the total pressure of the system is going to be this much now with this total pressure if I remove the pressure of ammonia I will get the pressure of what the so pressure of water is equal to total system pressure minus a partial pressure of ammonia so total pressure is 14.6278 minus partial pressure of ammonia at -16 degree centigrade and that is equal to 2.263 and that will give the partial pressure of hydrogen 13.3648 so with the presence of traces of water in the system the partial pressure of hydrogen in the evaporator has slightly increased.

So we have completed almost so today we will be finishing the refrigeration systems and next class we will start with the air conditioning systems in refrigeration systems we have the word air refrigeration systems we have covered vapor compression refrigeration system we have covered multi pressure systems multi evaporator system multi compression systems and the previous including this lecture in these last three lectures we have covered vapor absorption system and we have covered water ammonia type of absorption system lithium bromide water system any way in the next class we will start with the introduction to air conditioning thank you very much you.

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