**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

**NPTEL**
**NPTEL ONLINE CERTIFICATION COURSE**

**Refrigeration and Air-conditioning**

**Lecture -29**
**Cooling Load -1**

**With**
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Hello I welcome you all in this course on refrigeration in air conditioning today we will discuss the cooling load and how the cooling load is represented on psychometric chart.

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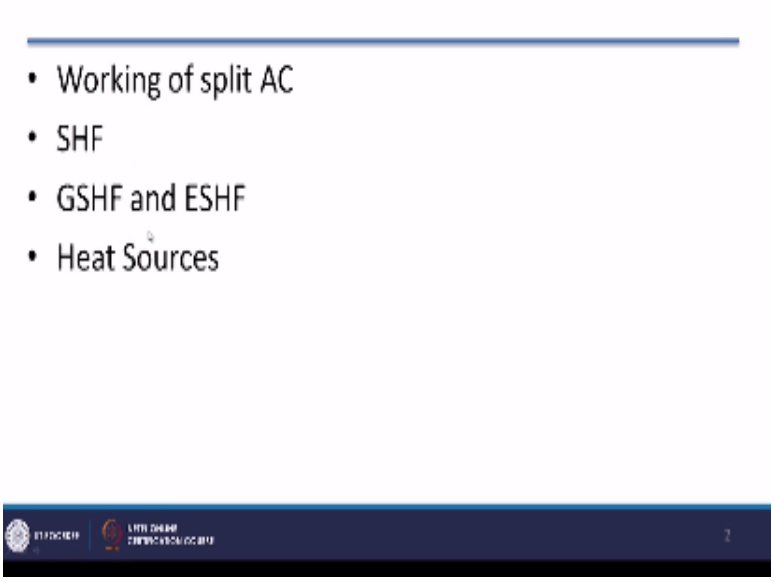


Today in this lecture we will discuss the working of any split AC then sensible heat factor grow sensible heat factor effective sensibly in factor and heat sources in the building now in split AC you must have observed that there is no arrangement for the fresh air in normally the ACS which

are available in market and it is very popular I mean a preferred kind of AC nowadays because it is convenient to use convenient to install the split AC is recommended for small size of building.

Where in filtration it is assumed that the infiltration load is sufficient to meet the oxygen requirement otherwise as there is no arrangement for fresh air100 percent recirculation of air takes place inside the split AC we will take how we will see how load in a split AC taken into account and will represent that load .

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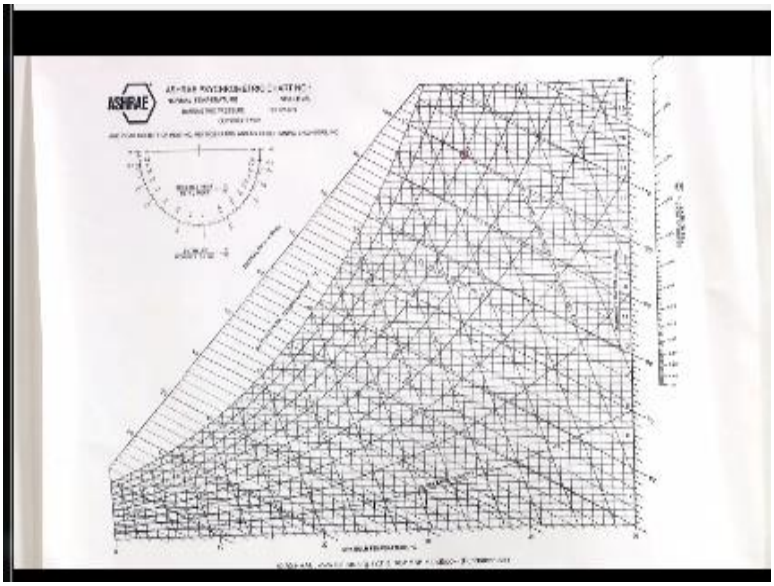

Into on a psychometric chart now we have assumed that outside conditions are 35 degree centigrade DBT and 70 percent RH a typical of coastal climate so if 70 percent DBT and 70 percent RH is to be located here then 35%.

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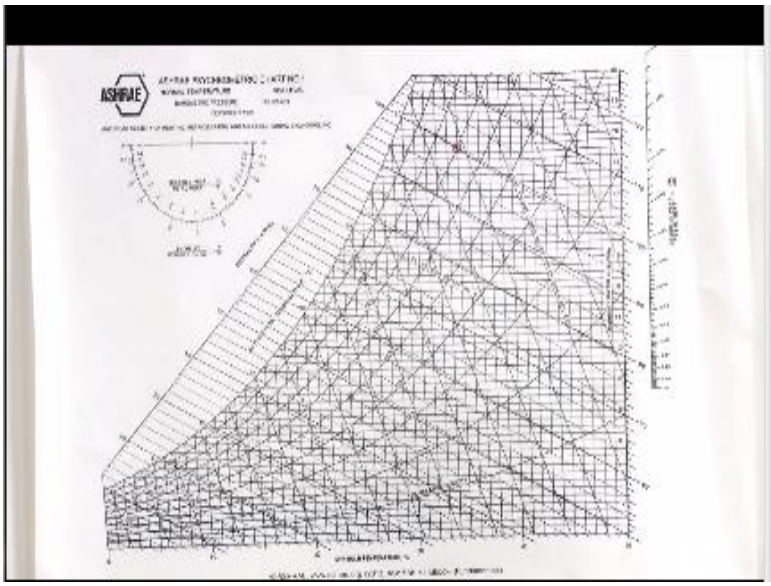

DVT and 70 percent RH it is going to be here that is outdoor condition right and then it says the return air return air means after taking heat from the room return air goes back to e C so return the air is 27 percent driver temperature and 60 percent RH so return here is 27% 27 degree.

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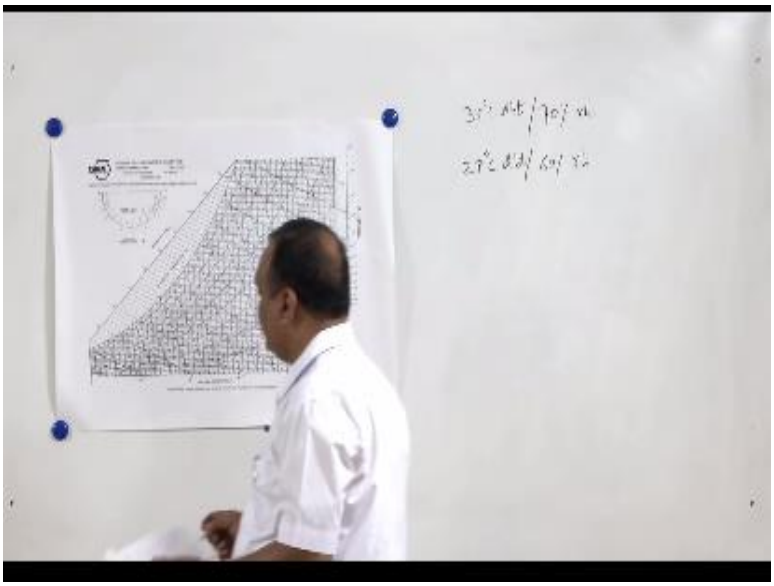

Centigrade dry bulb temperature and 60% relative humidity now if we consider these two states then one is 35 ,70 and another is 27 and 60 percent RH.

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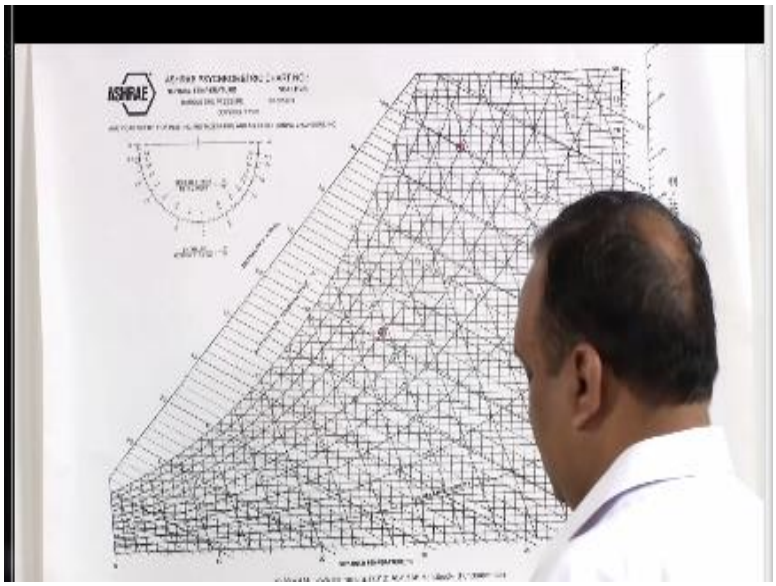


It is further stated that air supply to the room is 15 degree centigrade it means the temperature.

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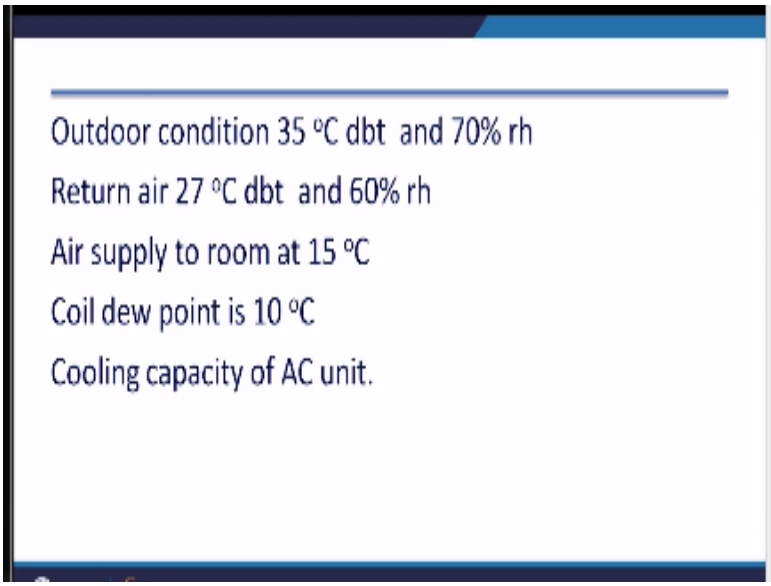


At which the air is supplied to the room is 15 so 15 degree can be located here somewhere here on this vertical line.

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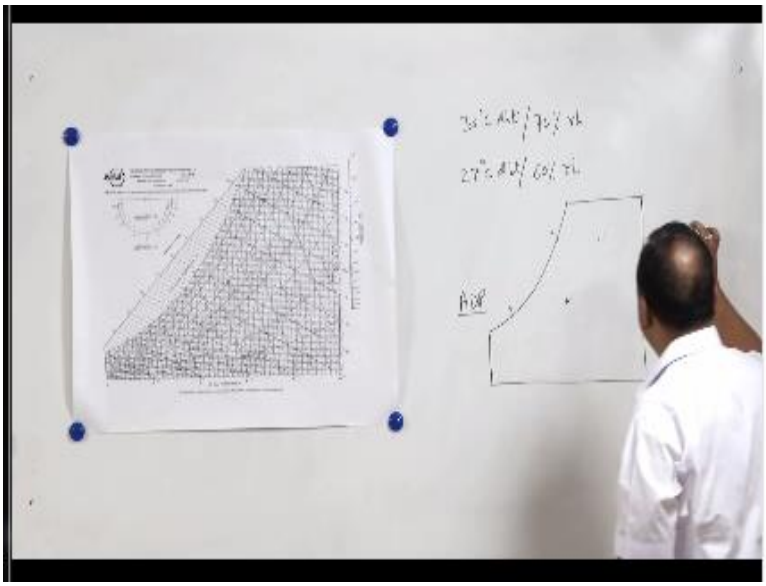

Somewhere on this vertical line coil do temperature is 10 digit temperatures is a new word here coil do temperature means coil temperature it is assumed that by the condensation over coil takes place air becomes 100% saturated if there is no bypass of here so it is 10ºC so I will draw this diagram on the board also now this is outdoor condition 35ºC 70% RH this is inside condition 20ºC tribal temperature and 60% relative humidity apparatus due point.

Temperature or coil due temperature it is also known as apparatus dew point temperature KDP so ADP is 10ºC why it is called ADP because this is the temperature of coil and it is assumed that it is a at this point the air is100% saturated so if the air moves over this coil now if there is no bypass factor air will be 100% saturated because air gets saturated the moment it comes here.

Now after when after reaching at this estate the air gets saturated during sensible cooling after sensible cooling then dehumidification start cooling with dehumidification starts so throughout this process let us say 1 2 A and B so throughout the process a to be the cooling of coil takes place because you can see the driver temperature keeps on reducing dry ball temperature keeps on reducing in this direction.

And at the same time specific humidity also comes down specific humid E is depicted here on the y axis it also comes down that is why when we reach at state B the air is 100% saturated provided there is no bypass off here if some bypass of air is there so it means air will be directly mixed with the saturated air and it will not no longer remain saturated here that is why when we join these two lines if bypass factor is there you will find that we will see that the air is not saturated anyway

So from air supply to the room is 15ºC so air supply to the room is 50ºC so we will draw a vertical line from 15ºC.

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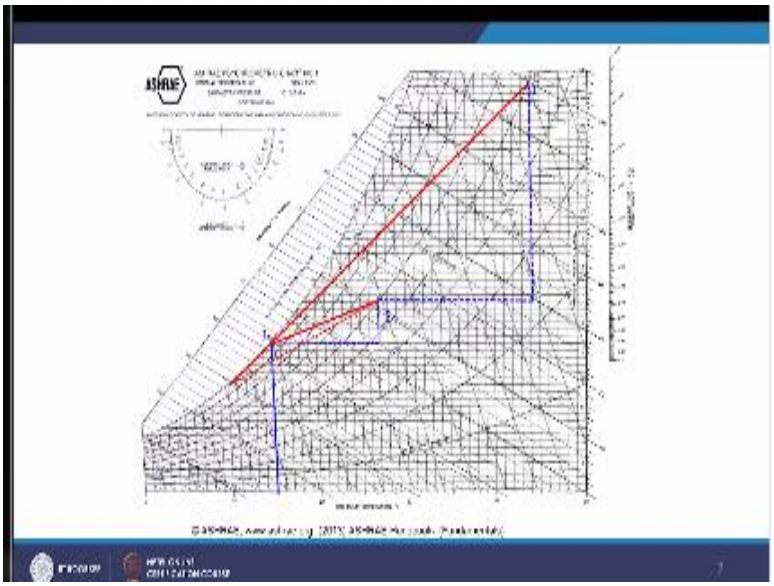

And where it cuts wherever it cuts it is the air supply to the room wherever it cuts it is the air supply to the room now this is 0.3 so the point 3can be located here also this is 10degree centigrade line and outside air is cooled first of all initially then air is supplied at 50 degree centigrade from here.

So that is 0.3 now when outside here means the event the when we start the AC when we start the AC then we assume that the room is filled with the outside air and the room condition is 3527

after running certain time this supply air now it picks heat from the room. Now this thing we did not discuss when we discuss about the psychometric processes we always assume that the supply is 24 50% 24 degree centigrade and 50 percent RH.

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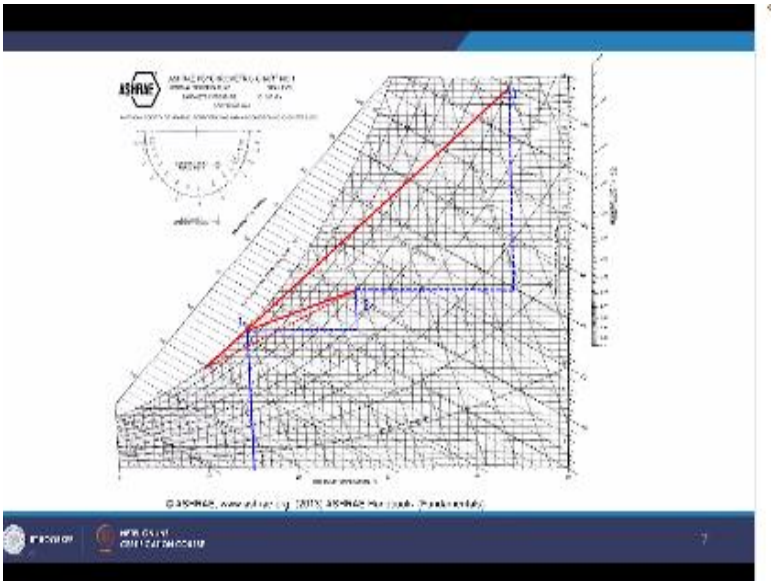

But in actual practice the air which is entering the room because it has to pick heat from the room also it is normally in 13 to 50degree centigrade and now this air enters the room and picks the room heat from.

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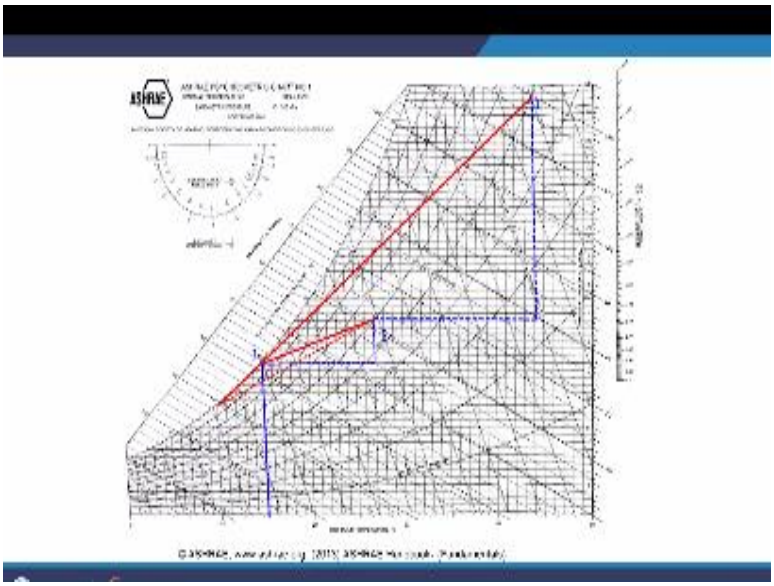

The room and return air attains the state of this is state 1 this is state 2 and this is state 3 now in this process 3 to 2 it is speaking heat from the room and now after attaining state 3 from air conditioning coil the air is supplied to the room and the return air is at 27ºC.

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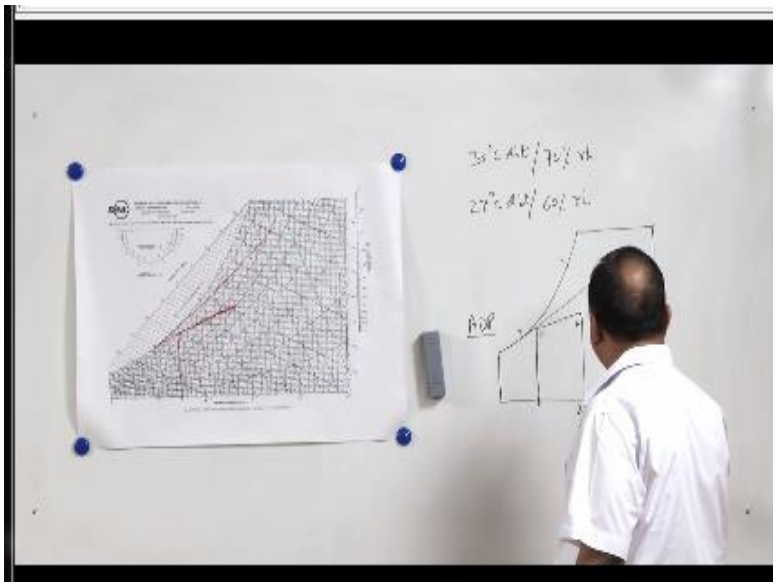

Now this air is getting re-circulated  I mean return air is going and coming from the room is again entering the coil and after entering the coil it gets cooled and then it is again re-circulated in the system now process 3 to 2 now process 3 to 2 is important for us because.

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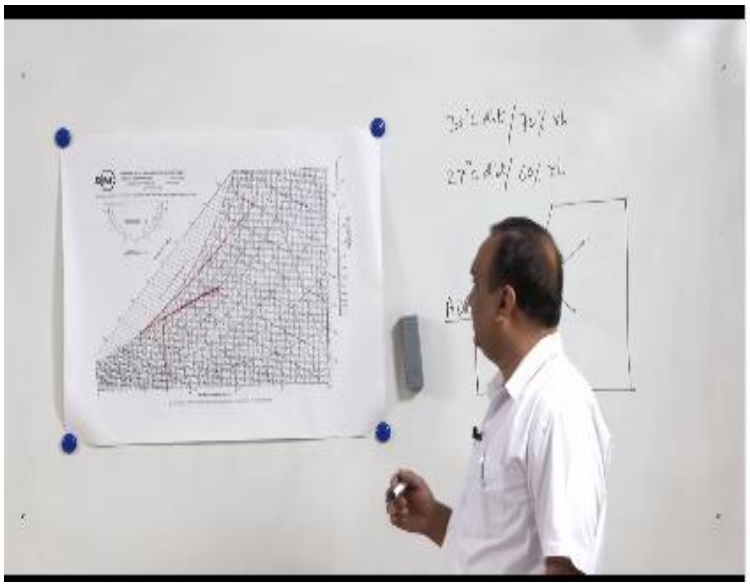

It shows load of the room it may include the load of the infiltration so I discussed I told you in the previous lecture.

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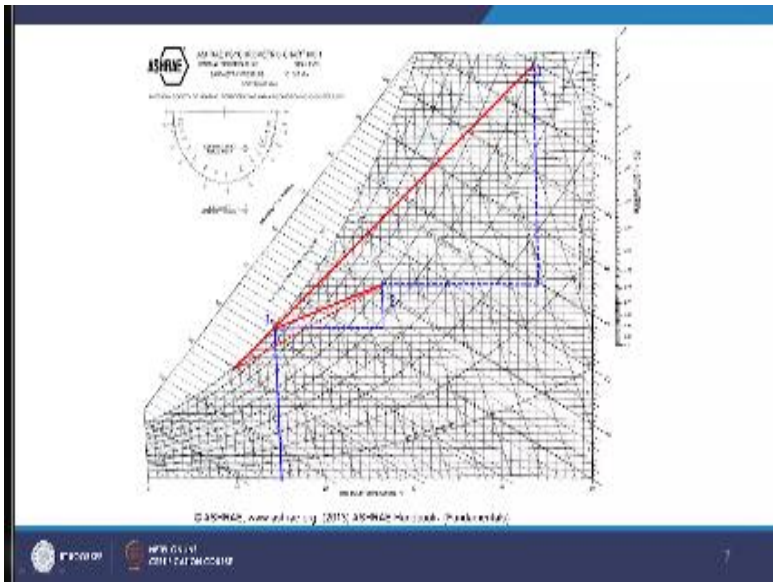

That infiltration load can be calculated if we know the amount of air which is getting in filtered into the room then how much sensible heat it is bringing to the room and how much latent heat it is bringing to the room it is calculated and that load also is also interpreted here.

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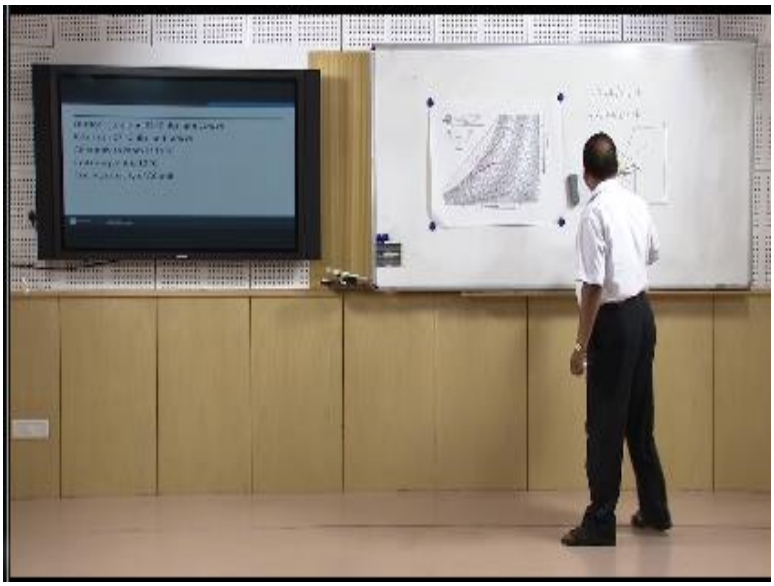

Now this process this three two has two components this is sensible heat and this is latent heat. So in a room there are two types of heat addition sensible heat addition and latent heat addition and during sensible heat for example the heat added by the lights heat added by the occupants heat coming through the wall these are all components of a sensible heat addition because there is a change in temperature during heat these additions.

But some of the heat additions there is no change in temperature or driver temperature of the room for example suppose water is boiling in this room so it will boiling water definitely add some sensible heat but it will definitely add some latent heat of the in the room because vapors will be added into the room.

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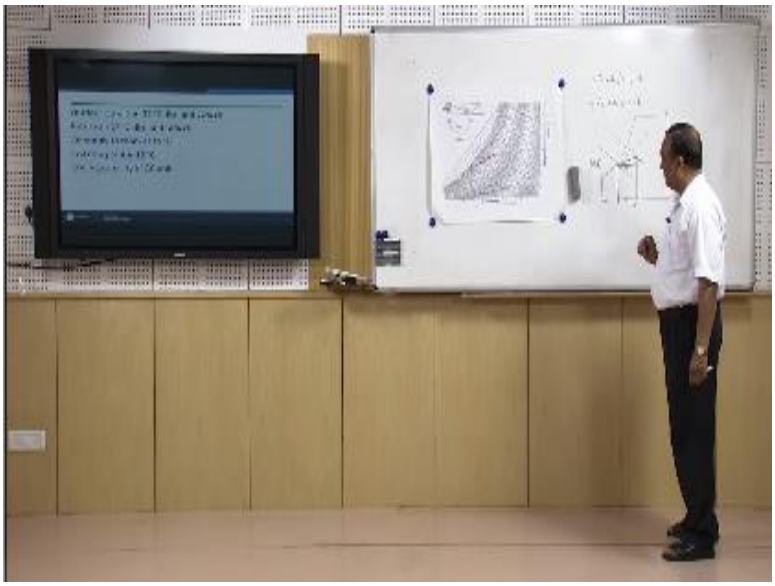

Now after working of a split AC we will talk about sensible heat factor.

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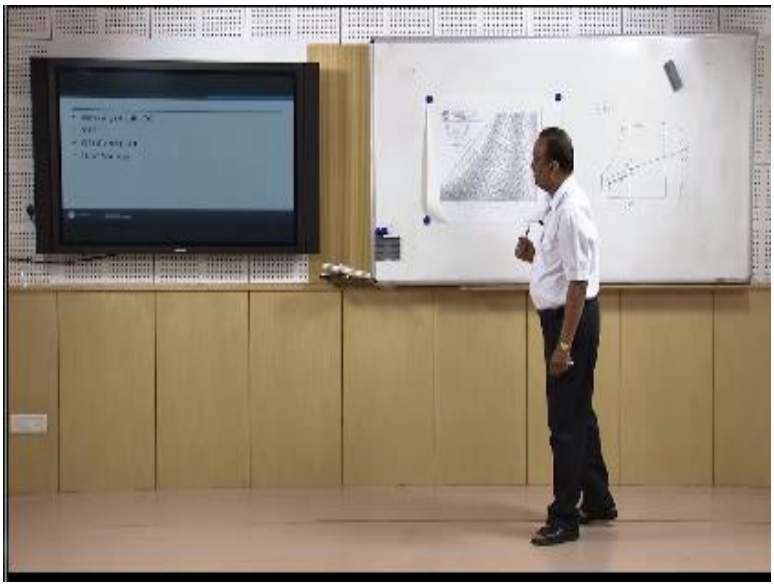

As I told earlier that this is the room load so if this is the room load air entering the room at this temperature leaving the room at this temperature this is the sensible heat added in the room this is latent heat added in the room the total heat say this Q it is equal to sensible heat plus latent heat and sensible heat factor is equal to sensible heat divided by sensible heat plus latent heat right.

And this line I will in next time and in next psychometric chart I will show you how to draw the sensible heat factor lines. So sensible heat factor gives the idea about the nature of the load for example, where there latent heat load is we know for example as a residential house sensible heat load factor may be 0.9 or greater than 0.9. For example in a restaurant or in the restaurant because a lot of cooking is there sensible heat factor may be let us say 0.8 in a discotheque or a dance floor the sensible heat factor may be 0.7.

So this the moment we keep on increasing the sensible heat factor the slope of this line keeps on increasing I will show you the sensible heat factor on a psychometric chart, in this chart they are certain dash marks on this scale and there is a half circle also you can use either of these two.

Suppose I want to have a sensible heat factor off line of 0.9 suppose I want to have a sensible heat factor of line of 0.9 or 0.8 right.

So what I will do I will say these divisions you can see they are not uniform here the distance between the say it is 0.4 in 0.3 so this is 0. 01 but here if you look at the 0.01 they are very close to each other. Now I want to have this constant sensible heat factor line of 0.7 so this 0. 7 I will be joining with this one this ideal condition and any line parallel to this line is 0.7 so we will be having the slope of 0.7.

So here on any psychometric the process if I want to show the constant specific sensible heat factor line so suppose this is our room condition room air-conditioned, so if I want to have sensible heat factor line of 0. 8 let us say I will pick a mark of corresponding to 0.8 I will join, suppose this is our ideal condition 24ºC temperature and 50% RH. So I will join this line with 0.8 and this is the sensible heat factor line.

Suppose by load point is here so what I will do, I will simply draw a line parallel to this and this will give me the load line same thing I showed you in the case of a split AC, so when there is a load in the room and we transform the processes on a psychometric chart these sensible heat factor lines are helpful they are very helpful.

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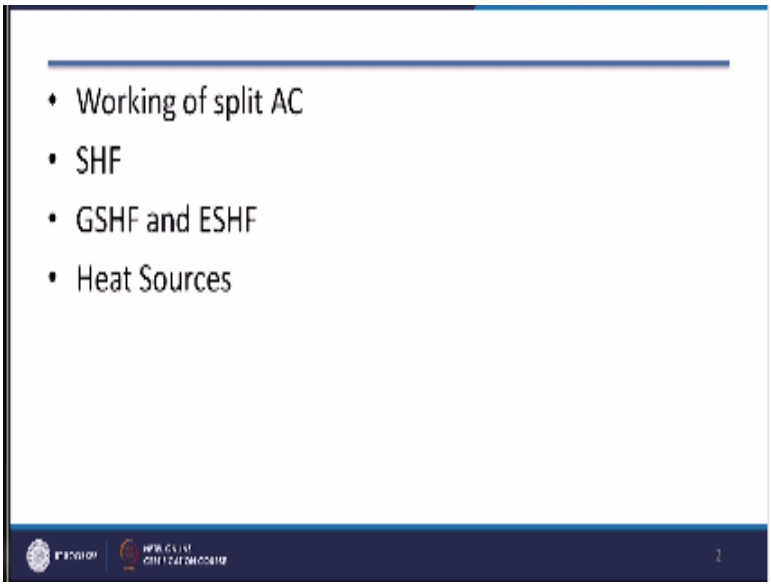


Now we will further discuss on this there is a gross sensible heat factor also there are two terms sensible heat factor, three terms sensible heat factor, growl sensible heat factor and effective sensible heat factor.

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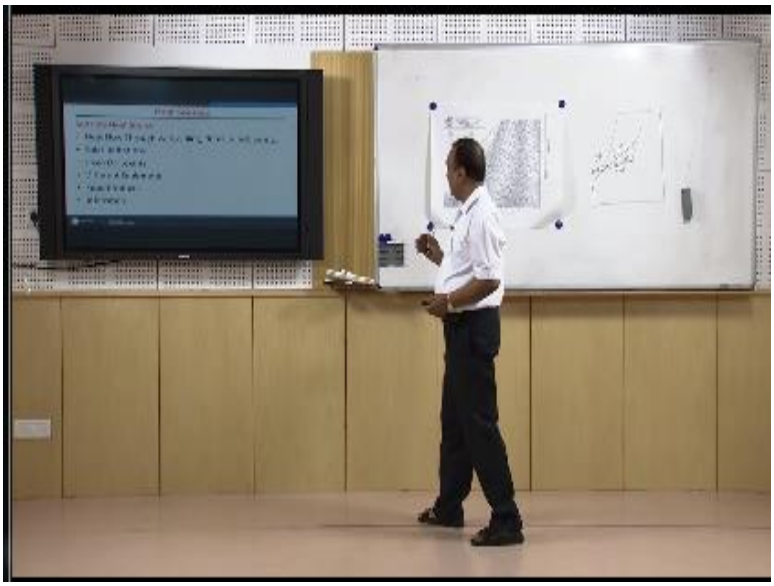

Now sensible heat factor we have taken from the load point now also outdoor condition is this one suppose and there is a mixing let us assume there is a mixing also so if there is a mixing, mixing condition is this coil temperature is this. Now this is gross sensible heat factor line this is gross sensible heat factor line as definitely the gross sensible heat factor line is it has higher slope than this one so gross sensible heat factor will be less than the sensible heat factor of the room.

This is apparatus dew point temperature and if we join this suppose air is supplied at this temperature then this temperature becomes room dew point temperature right, and this is sensible heat factor line and there is another term which is known as effective sensible heat factor. So effective sensible heat factor is drawn from here so that is the effective sensible heat factor line so these things will be useful when we solve some practical problems on air conditioning load.

Now heat source in building the heat source in a building can be divided in two parts that is sensible heat load in a building and latent heat load in a building. Now sensible heat load in the building is dead load when there is energy addition in the building there is a temperature rise so

there are many sources for sensible heat load that is heat flow through walls of the room, heat flows through the ceiling, heat flow through the floors and windows.

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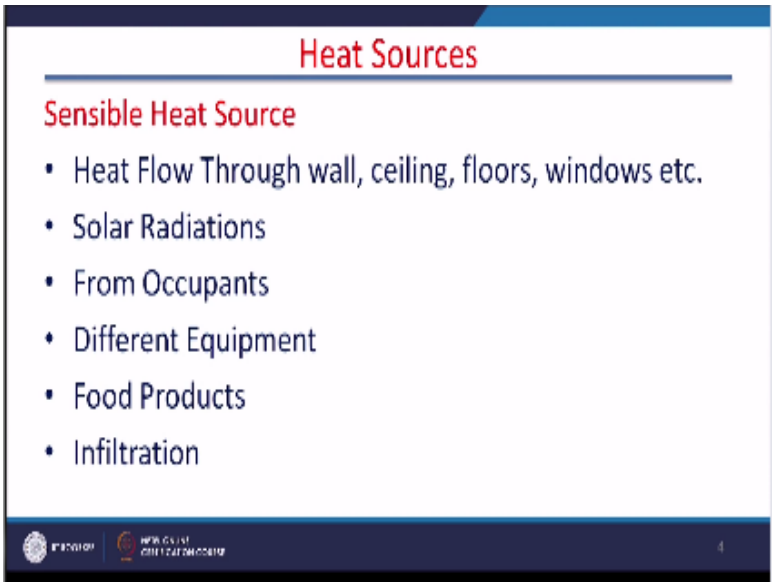


And through windows and doors there is infiltration also and infiltration also brings the sensible heat to the room normally in a single storied building maximum heat transfer to the room from outside takes place through the ceiling of the building. So if we are able to or any how if we do the roof insulation in that case cooling load on the air conditioning system can be possibly reduced even if we do not do the roof insulation if we put some sort of white type of white reflective tiles on the roof that will also bring down the cooling load on the air conditioning system.

So sensible heat the sources are heat flow through wall ceiling floor and windows through windows direct radiations also enter the room and these direct radiation they heat up the articles in the room and secondary radiations takes place and they are long wavelength radiations and they cause heating in the room it is sort of greenhouse effect is created in the room, solar radiations, solar radiations they fall on the building and then the part of the radiation is absorbed and that is subsequently transmitted to the building to inside transmitted, inside the room.

There is a load for the occupants also so each individual if it is if individual is sitting idle in that case he or she shall add 100 watts of sensible heat and approximate sorry 90watts, 90 watts of sensible heat and 30watts of latent heat approximately we will assume that each individual adds around 100 watts of heat so if this room is occupied by 100 persons together they will be adding 10 kilowatts of more than10 kilowatts of heat and the cooling load by the occupants itself is going to be more than 3 tons.

Because 10 kilowatts divided by 3.5 it is going to be more than 310 tons so approximately the 3 tons of cooling load will be due to occupants only they are different equipments even UPS, laptop, desktop they also emit, they are also heat source in a room and food products whether they are cooked in the room or they are brought into the room they also add heat to the room in the cold storages when we design system for cold storey, cold storey is the air change rate is very low maybe one year change or two air changes per hour.

But the heat liberated by the food products is high and this high heat liberation from the food products has to be taken away by the cold air coming from the air conditioning plant and per kg of food product I mean the heat in the form of let us say 600 or 800 kilo joules of heat I mean if there is a huge list for different food products there is a different value for heat liberated by the food products.

Infiltration I have already discussed now latent heat sources are cooking occupants and infiltration this I have also discussed.

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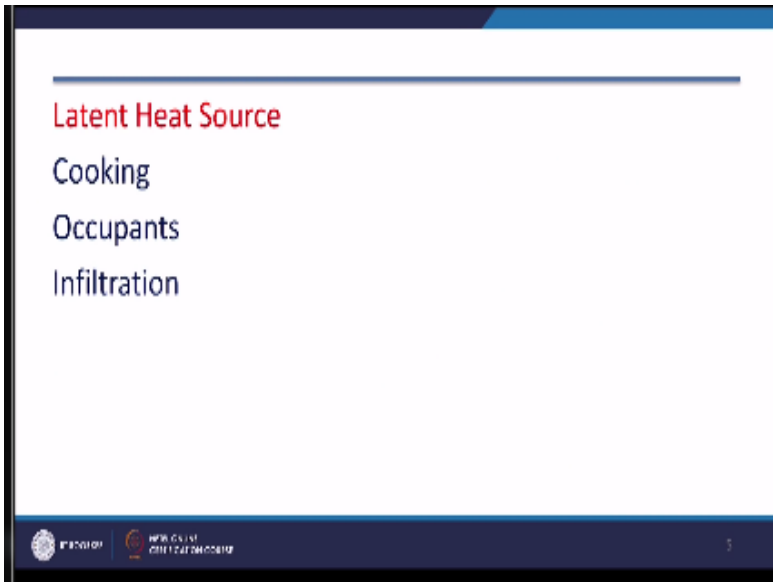


In addition to this other equipments in the room like some UPS is lying in the room so UPS is also adding heat even like tube lights each tube light is approximately in old tube lights the choke was of 60 watts. Nowadays we have new chokes which consume only 40 watts this 60 watt choke was earlier 60 watt choke was used for this is for information 60 watt choke was used for 40 watt tube lights.

But nowadays we have improved chokes they consume only 40watt for 40 watt tube lights so each tube light contributes 40 watts of heating so if there are 10 tube lights in a room then again the heat addition is going to be 40 watts sorry 400 watts. So this way we can find out I mean when we do the load calculation all these aspects are taken into account and finally sensible heat and latent heat in a room are calculated sensible heat factor is calculated.

And sensible heat factor line is drawn on the psychometric diagram and the designing of the system is initiated all these issues will discuss in the subsequent lecture because it is it is also on the cooling load this is all for today thank you, very much.

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