Fire Protection, Services and Maintenance Management of Building
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Lecture – 29
Psychrometric Chart: Equation based Approach

Just to recollect what you have done yesterday I mean last class.

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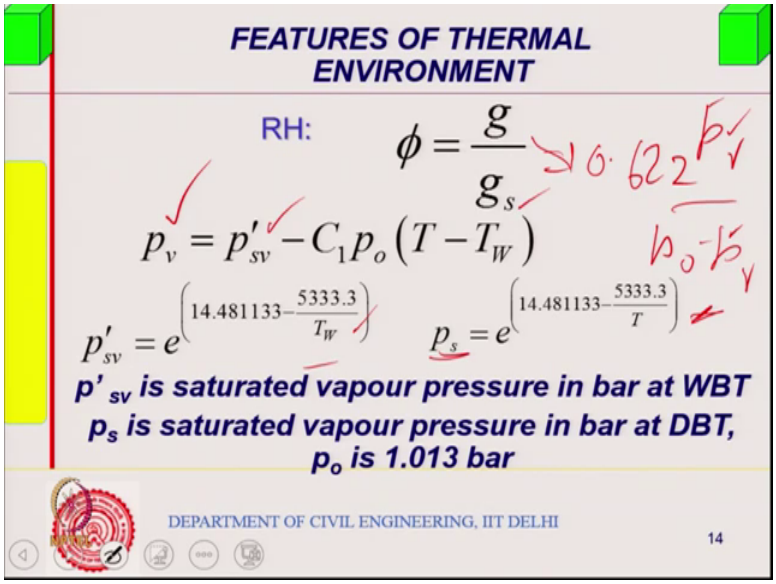

So, relative humidity is defined as the moisture content by saturation moisture content. And we said that we can calculate this out using some empirical formulae. So, the empirical formulae one of the empirical formulae you know that people are trying to, basically it is a psychrometric chart fit them into equation and get some empirical formulae. So, one of them is like this partial vapor pressure you know partial vapor pressure a pen has to be activated partial vapor pressure is a function of p s v, some constant p 0 is atmospheric pressure T minus T W right. And p s v this is calculated from this empirical formula so, this is only wet bulb temperature right.

So, this is depends upon wet bulb temperature, this is atmospheric pressure and this is so this constant actually depends upon wet bulb temperature and this anyway function of wet bulb temperature. So, wet bulb pressure is a function of wet bulb temperature right and difference between wet bulb temperature and dry bulb temperature.

So, that is what it is taken into account and then saturated pressure because we would need to calculate out g s also. So, when you want to calculate out saturated pressure p s this should be given this is given by this formula. So, instead you replace this you get p s actually saturated vapour pressure right and p s is what saturated vapour you know it is at W B T corresponding to W B T this one and p s is a saturated vapor pressure at the dry bulb temperature.

Now, g g s is nothing, but 0.622 p v divided by minus p v right. So, we so, this if you know the you know p v's vapor pressure this we know. Then we can find it out, then you can find out right so, but relative humidity we can find out actually.

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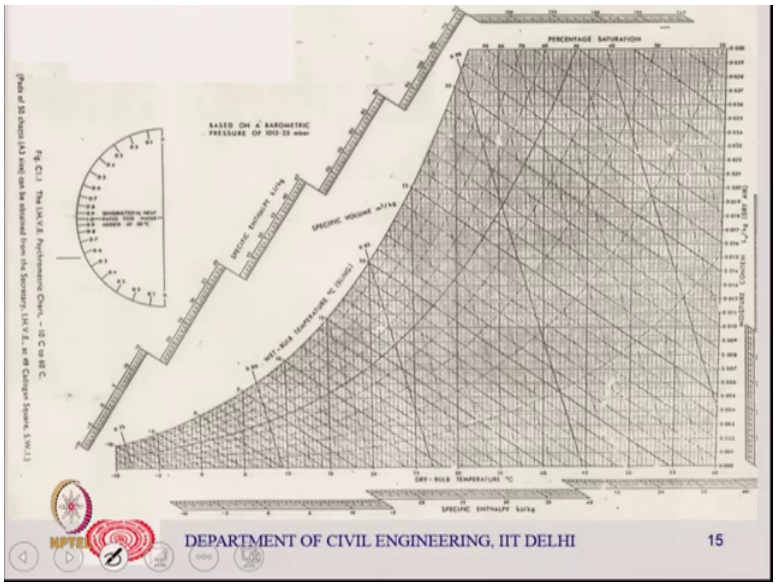

So, that is how we find out right. So, moisture content g divided by this divided by it would be divided by this is only g, this part is only g. And g s will be how much? Instead of this p b it will be now saturated vapor pressure, which will find out using p s which will find out using p s right. So, the relative ratio of this two will give me the relative humidity ok. So, psychrometric chart anyway I have talked about.

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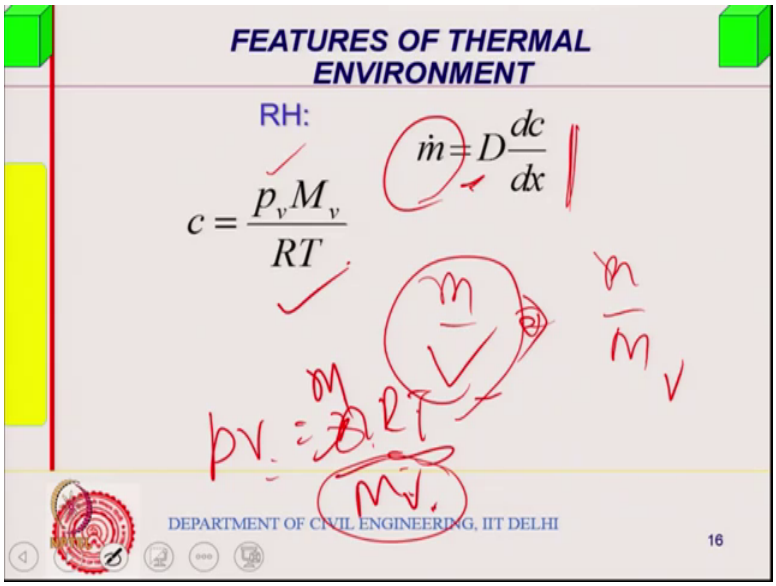

And so one may little bit look into some equation of dew point, because if you want to estimate out how much condensation you know. What is the temperature supposing the moisture content corresponding to dew point you are interested for a given conditions. So, that you want to reduce on the moisture content you would you like to know the information or you would like to have the knowledge of dew point.

As well as wet bulb depression just some ideas related to that, some of them would be for example, one is calculating the relative humidity that I have just mentioned earlier. Then dew point you want to calculate there is some empirical formulae, but before that less understand they little bit more. If this is a rate of moisture flow, moisture vapor flow that would be depending upon the gradient of concentration right, fixed law and this is diffusivity or diffusion co efficient right.

So, I have got let us say liquid water and surrounding air is there. So, vapor molecule will actually depending upon the concentration because at the liquid concentration is one and if the concentration is low. So, there is a concentration greater gradient existing so, moisture vapor will flow. So, wherever there is a concentration gradient, the molecular diffusion takes place. So, we can actually use this same formula and what is concentration here? Concentration because it would depend upon concentration is nothing, but mass per unit volume right. So, mass per unit volume if you remember, mass per unit volume and mass divided by m v is nothing, but n right n so p v equals to n

R T you know. So, I can replace this v from here, 1 by v would be p by you know so, m by v.

So, this will be simply m by m v so, p m by v will be p m v divided by R T, p m v divided by R T, because p is equals to p v equals to m R T by m v where this is the molecular weight of the vapor. So, m by v is a concentration can be written in this manner; can be written this manner right.

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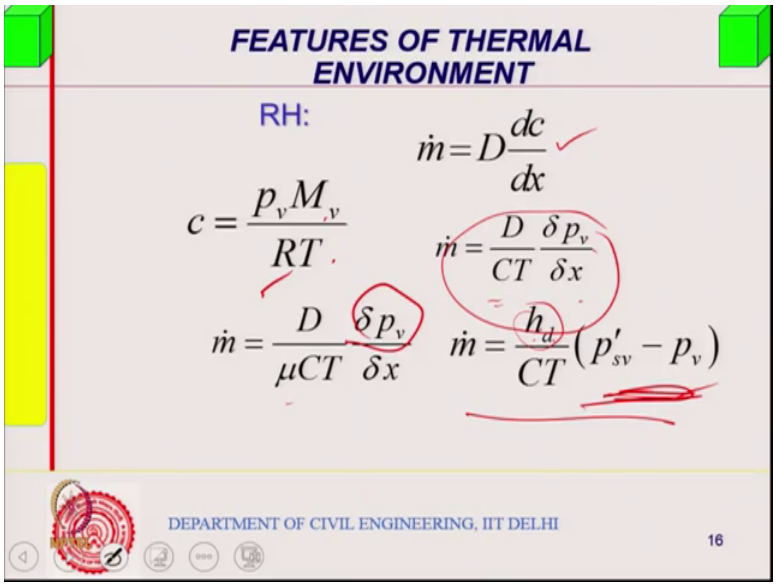

Therefore d c d x will be d p v d x d c d x, c is nothing, but this. So, m v I can you know these are all constant except that p v. So, partial pressure you know pressure partial differential of pressure. This is and C is nothing, but R by M v R by M v is this C. This was universal gas constant; this is the specific gas constant for the moisture vapor.

So, you can have an you know it will be related to this so, m dot can be combining this equation we get m dot in this manner. And there is a friction co efficient you can add mu, mu is a friction co efficient you can add right. So, this you know from law of convection or you can delta p v is nothing, but p s v minus p v saturated vapor pressure of the water surface close to the water surface minus the vapor pressure existing at some distance.

So, that is the this one this part is nothing, but this one right and all this we you can put in terms of a co efficient, vapor transfer co efficient you know convective sort of vapor

pressure. Which depends upon the vapor pressure difference C T remain so, h divided d by mu can be is something like h d right.

So, D by mu is something like h d. So, therefore, one can express this rate as a difference of vapor pressure difference, saturated vapor pressure near the surface. And the vapor pressure of the air away from the water surface or water body depending upon that one can express in this manner right.

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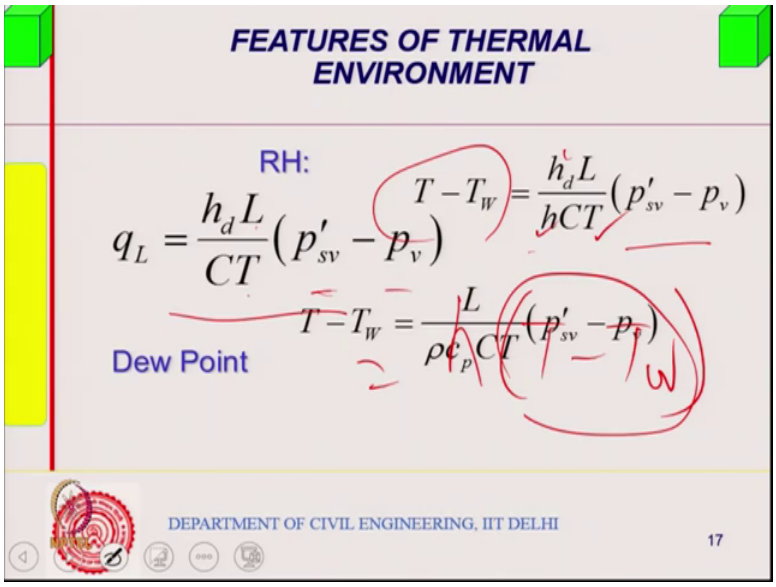

So, if I want to find out latent heat transfer corresponding to this simply multiplied by L, simply multiplied by L right. Now T minus T w is the wet bulb depression will be how much this is the amount of heat transfer. So, the actually the see the heat is taken from the basically, if I supply heat. So, h you know this T minus T w h into convective T w exists near the surface.

Wet bulb temperature is near the surface away from the surface it is dry bulb temperature because its fully saturated near the water body, where the evaporation is taking place, let us skin or wherever it is there is a wet bulb temperature will exists. Where it is you know near so, the heat transfer is given by this convectively transfer heat comes because of convection air and near the surface water body or whatever it is.

So, this is a h T W must be equals to this, h T W must be equals to h d L p s v. So, if I combine this I get an expression for wet bulb depression h d by h, where this convective

heat transfer co efficient L etcetera etcetera. So, this is what is so wet bulb depression can be theoretically calculated knowing that temperature right. Highest forgot to mention earlier that the C 1 and that was there in the empirical equation related to relative humidity.

You know this earlier we discussed about this his one, this values are given for this values have C 1 etcetera are given for type of hydrometer. You are using you know or type you know this values are available with us. This values are available with us, values of this ones are available are any available are this is anyways given.

So, this constant has given similarly these constants would be known to us this constant you know this values constant etcetera has to be known to us. So, what is dew point? Dew point corresponds to this is so anyway this is T W and you know the h d by h can be related to increasing you know this can be related to rho into specificate..

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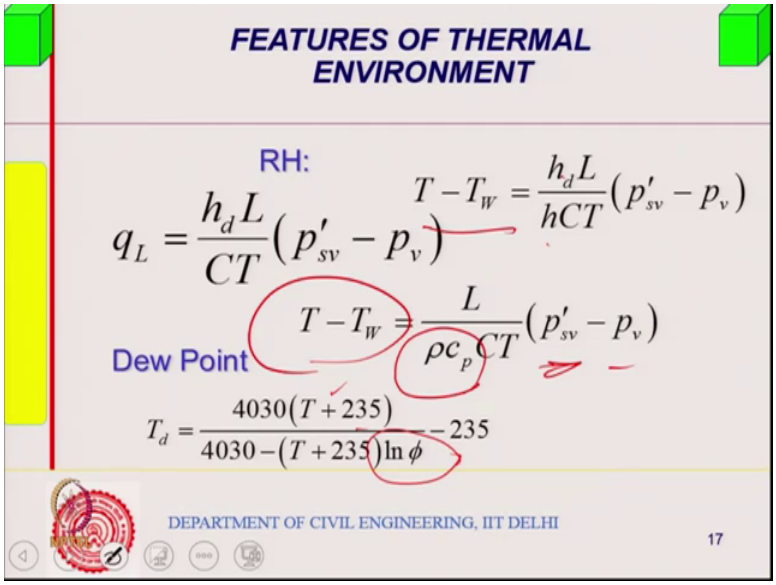

H d by h can be related to rho into specificate, because that is the amount of this is basically sensible heat transfer. And latent heat this is heat latent heat transfer the convective heat transfer was sensible heat transfer. So, if the density and specific heat of this one is known this multiplied by T, you know this multiplied this can be h d by h can be related to rho c p.

Now, dew point there is an empirical formula like this; for dew point there is an empirical formula like this, empirical formula like this. This is 4030 T temperature plus 235 and T l n 5, where this is the Pfizer relative humidity plus minus 235. So, dew point temperature this is an empirical formula from which you can find out. So, these are some of the equations which can be used to one to find out the relative humidity from wet bulb and dry bulb temperature I have said.

And for a given vapor pressure or saturation vapor pressure or given temperature, the wet bulb depression corresponding to p s v p b or in other words for the relative humidity also we can back calculate out. So, what is the wet bulb depression you can calculate out and this dew point one you can calculate out if required.

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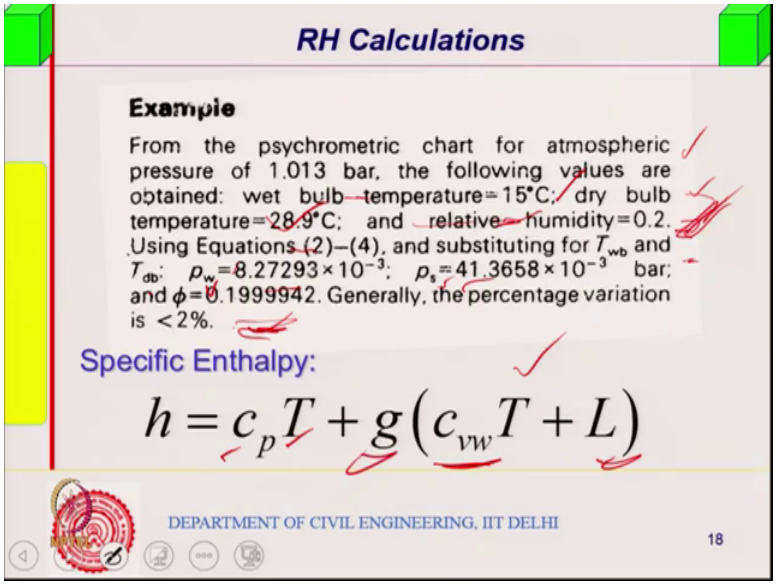

So, that is what it is right. So, let us look at an example say from psychrometric chart for atmospheric pressure of this the following values are obtained. This is this just an example to understand the use of the empirical equation to find out you know relative humidity rather than, a moisture content rather than psychrometric chart.

So, what you are doings from the psychrometric chart atmospheric pressure of course, you know following values are obtained wet bulb temperature 15 degree, dry bulb temperature 28.9 relative humidity is 20 percent. Now use equation those equations that I am I was talking about and substance substitute wet bulb temperature and dry bulb

temperature you can find out p you know separation vapor pressure etcetera etcetera p s saturation vapor pressure and p of the vapor p v that I was talking about.

So, you get the value you will find is by if you calculate so this is from psychrometric chart you get 20 percent as a relative humidity. Use the formula just check it yourself, you will find that p s value is this p v value is this actually and you calculate out five value it will turn out to be 0.199. So, error is about 0.2 percent this error.

So, you can validate this by calculation; you can validate this by calculation weather this matching and not. From the psychrometric chart for this dry bulb temperature, wet bulb temperature, this dry bulb temperature relative humidity is 20 percent. If you use the formulae you will get about 19.99 percent and all that so, we can check this usually error is more.

Now specific enthalpy I stated it and maybe I have given a formula earlier, this given by this formula c p into temperature because you take this temperature 0 degree centigrade as item. And this is a specific heat of water vapor into temperature plus latent heat and this is the moisture content right this is the moisture this is I have been mentioned earlier.

So, cooling load where you want to calculate out you can use this formula right . So, that is it related to you know example problems and relevant equations related to calculating the supply air, moisture content, quantity of supply air unit. And temperature differential anyway we decide, pre decided based on you know the decisions you know how we decide about that we have discussed this.

And based on how much is the amount of heat you would like to remove both sensible and latent heat. So, therefore, if you know if for example, you want to decide upon first of all if you want to decide upon for a space. Find out the design, latent heat to be removed and sensible heat to removed as a design condition because capacity is based on design condition not the detailed load that would be different. Detail yearly cooling load then you are because that would vary from time to time, but capacity is based on design right.

Now, first level of how much supply water you know air supply you require and what is his condition that is to be found out. Once you found out that for this room and other room etcetera diversity factor can be applied to find out the system that would actually

this air. The mechanical system of course, basic sums very simple basic principles you have discussed, but there are many modern mechanical systems that is there for refrigeration part that you know. That of course, you do not know you might select from a market road discuss with mechanical services engineer to select which one is right suitable for you.

So, that that kind of you know like a it will help you to make decision making related to h b s c, but such h b s c is a you know it could be something like it is a full subject may spanning around2 3 courses. So, we try to give a nut shell the kind of introduction to this one. And what is required from a building services engineer's point of view at least the information that is required where for you can take part in decision making.