Cooling Technology: Why and How utilized in Food Processing and allied Industries

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Lecture 24
Psychrometrics Contd.

So, good afternoon. I am so happy, by this time, that you have done a lot of problems, at home and perhaps today, we will conclude on psychrometrics solving some more problems. If you have any problem, if you have come across with any problem, you are free to ask in your forum, right and you will be given the right kind of directions or answers. So, we have done more or less everything about psychrometrics. Now we are solving problem, one problem we have thoroughly solved. Now we will do some more problems, in the continuation class of the psychrometrics right.

Now, if we look at, this was our psychrometric chart, and we said that this was the problem, this problem, we have solved. Next problem, let us take and this problem is saying that, air in a house has a wet bulb temperature of 54 degree centigrade, and a dry bulb temperature of 71 degree centigrade. Now, determine the humidity, number 1, number 2, the dew point and number 3, the percentage relative humidity right. I repeat, so in a house, air has a wet bulb temperature of 54 degree centigrade and a dry bulb temperature of 71 degree centigrade.

We have to determine, the humidity, that is humidity ratio, or absolute humidity, the dew point, and the percentage relative humidity right. So, this, we can do here, first and then in the chart, then it becomes complete. First let us do that drawing of the psychrometric chart, sorry, drawing of the psychrometric chart. So, this is our psychrometric chart right. Now, whatever we have been given, that we have to find out.

We are given wet bulb temperature of 54 and dry bulb temperature of 71. So, obviously, this temperature scale, we have this, both 54 and 71, present otherwise you cannot do. So, at least it has to be between 50 to 80 right. So, if we do first, our thing is given, 54 degree as wet bulb temperature. So, Wb is equal to 54 and Db, dry bulb is 71.

So, let us take this point to be 71, this is 54 and this is 71. So two temperatures, we have located right, sorry, we have written here, it will be difficult. So we should not write here ok. Now, if we are given that, this is 51, this is 70, 54 and 71, 54 have been given as wet bulb temperature right. So, 71 as dry bulb temperature.

So, we can straight way go vertical. So, this is the 71 degree line and wet bulb is 54. So 54 we have identified. Now, we go to the saturation line, right, and in that saturation line,if we go along the x axis, the point, where, it is intersecting, is the state point. Why we are going along the x axis, because if you remember, when we had said about the wet bulb line, or wet bulb temperature, no, I am mistaken, sorry, I am mistaken.

Then, what we did? We need to do, I am mistaken, sorry, the mistake is here, that this was our line, this is our line, this is our 54 and this is our 71, and we went along the vertical 71, and from 54, we went vertical up to the saturation line, right. Now, I was mistaken, where I went along the x axis that is constant humidity line, but we are not said that what we were said that the wet bulb. So wet bulb means we have to go along the wet bulb line. So from here we draw the wet bulb line right and the point where it is intersecting is the state point. So, state point 1 is where dry bulb equal to 71, wet bulb is equal to 54 right.

We have been asked to find out, humidity, that is absolute humidity, if we go along this will be absolute humidity, right in kg water per kg dry air, say it will have a value of 0.1 say. So, absolute humidity H is equal to 0.1 and we are asked to do dew point. So along the absolute humidity line, if we proceed and go along this line, should be here, ok, otherwise, we will not be, sorry.

So this line will be here. So, along this line, it will be this. So here, coming across with the saturation line and from there we are coming down vertically to the intersection of x axis, and that is giving us the dew point right. Obviously, dew point is less than 54 wet bulb temperature. Now, how much less, that we can only know once we have the perfect scale and the chart, psychometric chart, but the process is like this and then we are asked to find out percentage relative humidity.

Now, this was 100 percent, then maybe 50 percent, then maybe 40 percent, maybe 30 percent, or it could be somewhere 20 percent, right. So RH maybe, could be 20 percent. So, what we get from this problem that out of 7, at least 5 properties, either given or found out, right either given, or we could find out that, what are the property values right. So property values, which we were given are dry and wet bulb temperature, and we were asked to find out relative humidity, absolute humidity, and dew point. So, these we have done, hopefully you also have done.

Now, let us go back to the actual scale, as I am again saying, the one, which I have, maybe that one is in Fahrenheit, but whatever be let us look into that in actual scale right. So here we are, we have said that, we have a 54 degree centigrade wet bulb temperature.

So, 54 is somewhere here right is 54 is somewhere here. Then we go vertical to the saturation line and 71, say here 71 is here. So we go vertical, may not be up to the saturation required, right up to the saturation line may not be required.

Then, we have to come down along the wet bulb line. So, this is the wet bulb line. So, this is also a wet bulb line. So, parallel to that, this is the intersection and that is the state point 1, right. From this intersection, and state point 1 along this x axis, we got absolute humidity here the value is somewhere 30, if I am not mistaken, and we are asked to find out dew point.

So in the x axis, we come and then, do the vertical, and that vertical comes to somewhere near to 25 right. So here, it is 30, here it is 25, and we have to find out the intersection of this and the relative humidity line will be, this is also written. Let me wipe it off. So that relative humidity, we can find out, yes, this is somewhere 30 percent relative humidity right. So this way we can determine the values, given the actual situation right.

Now, let us do few more problems quickly and if you practice it, at home, then it will be very easy. For you, this one we have done, right this one we have done just now. Then next one is from some more information are required to be shared what is that? Now, obviously, as you see that this is not according to the scale, or the diagram we use like, we use like this, that this is the actual way of presenting the psychometric chart right. But here we are not doing, it is in a say square, or rectangular thing, but we assumed it to be a absolute humidity line, right and this is the scale or thing which we are talking about like this. So, some more and that is, what it is the 100 percent relative humidity.

So, anything cooling beyond this line, that is called sub cooling, beyond the dew point right. So, in that, it goes again, similar to x axis, parallel to x axis right. So, that is sub cooling, and one more information is that if you are doing any adiabatic humidification or dehumidification, humidification dehumidification are very much required in stores like cold stores and others, where you need to use, either humidify or dehumidify, depending on your requirement. The moment you are doing dehumidification, you are adding water, by may be spray or many other ways, or if you are dehumidifying that means, you are taking off the moisture from there. The thing is, which to be remembered is that, both, if it is under adiabatic condition, means there is no dq, dq is 0.

So if that be true then the adiabatic humidification or dehumidification, both follow the wet bulb line, right. These are wet bulb lines. So both follow wet bulb lines. So, this we have to keep in mind. Another thing, if you are heating, that is under constant humidity line, that is what here, we have shown this is under constant humidity line right.

Similarly, cooling to the dew point, that is also under constant humidity line, that we have shown, we have found out earlier also. So this information is additional. I repeat, first, let me clear the board. This information is very much essential, that when you are going beyond, when you are going beyond dew point, or saturation line, that time cooling below the dew point is parallel to the x axis, that is almost in the constant humidification, constant absolute humidity line right. Then you also have done many times that cooling to the dew point, that is also under constant humidity line right.

Third one is, heating, when you are heating, that is also going under constant humidity line, but, if you are doing adiabatic humidification or dehumidification, I have already said what do we mean by humidification or dehumidification. Humidification meaning you are externally adding moisture, maybe by spray or by some other means, or dehumidification means, you are taking away moisture from that. So in either of the cases, humidification or dehumidification, if it is under adiabatic condition, then, it follows wet bulb line right. So with this additional information let us proceed to the next problem and that is saying that, ambient, this is the perhaps last problem, we will be solving, rest you do yourself. You practice, as much as you can, all information, we have, shared, with you and hopefully, you can do it very nicely.

Ambient air at 25 degree centigrade and 50 percent RH, is heated to 175 degree centigrade determine, the percent relative humidity, the wet bulb temperature of the heated air. I repeat, ambient air at 25 degree centigrade, and 50 percent RH is heated to 175 degree centigrade. Then, the percent relative humidity, and the wet bulb temperature, if we do quickly, maybe one more problem, we can solve, that we have this ok. Now, what we are given, we are given 25 degree centigrade, that means dry bulb temperature is 25, sorry, not this one, dry bulb temperature is 25 degree centigrade right. So, if dry bulb is 25 degree centigrade, and 50 percent RH.

So RH line is this, so this is 50 percent RH. So, they have the intersection, at this point, so, this is the state point 1. Now, from here, it is said that it is heated to 175 degree centigrade, say this is the 175 dry bulb line right. So, this is another state point, that is state point 2, this was state point 1, and this is state point 2 right. Now, we are asked, from the state point 2, you find out percent relative humidity, and wet bulb temperature.

Obviously, percent relative humidity we can find out, parallel to these lines, and where, it will be cutting, that will be the relative humidity, and it appears, if it is,so far it could be around 10 percent relative humidity. Then the second one is remaining, that is, wet bulb temperature of the heated air. So, wet bulb temperature means, we will be going along the wet bulb line, right. This is of course, very very high angle, it has come up.

So, if we take again a little, like this, then, we are said, 25 degree centigrade.

So here, 25 degree centigrade, here, 175 degree centigrade. So both the verticals, right and we are asked that 50 percent RH. So, this is the state point 1, from there 171 degree centigrade is this, right. Now, we have come in the wet bulb, light and from there we are coming down to find out the wet bulb temperature. So, it is less than 25, somewhere, depending on, what it is, right.

So, with this, one more, if we can quickly go through, that is another type, that it is saying that, room air at 26.7 degree centigrade and 50 percent RH is heated to 200 degree centigrade and introduced into a spray dryer from which, it leaves at a temperature of 95 degree centigrade determine the humidity, and relative humidity of the air leaving the dryer. Assume, adiabatic humidification in the dryer, right that is why, I just wanted to show you this problem, that here, we are dealing with adiabatic, either humidification, or dehumidification. So, we draw, sorry, so we draw that, our, this is that, ok.

Whatever we have said, that 26.7 degree say, this is 26.7 degree, and 50 percent RH. So, 50 percent RH is this, 26.7 degree is this.

So this is the state point 1. Then it is heated to 200 degree centigrade. So, we are heating it to this 200 degree centigrade. This is the state point 2, right and it is introduced into a spray dryer, from which, it leaves at a temperature of 95 degree centigrade. So, this is the 95 degree centigrade, and it is being done by adiabatic humidification. So, if we, adiabatic humidification means, we know, that it will follow the wet bulb line.

So, if we proceed along the wet bulb line, come to this, right we have been asked to determine humidity and relative humidity right. So, what we are getting that this 95 degree where it is intersecting from there we are getting this is the absolute humidity, H and this is the percent relative humidity that is what is being asked for right. So on interpolation we can find out what is the relative humidity right. So, with this we complete psychrometric and I hope we could have imparted some knowledge to you, and if you do the solutions of different problems, you can easily master the subject psychrometrics right. So thank you for listening.