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

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Module No 05

Lecture 23
Psychrometrics Contd

Good morning, my dear students. Hopefully, you have practiced a little about the psychrometrics, how the psychrometrics are to be read, not only that we have also said about the different lines, right, dry bulb line, wet bulb line, then saturation, then relative humidity, absolute humidity, volume, enthalpy. So, everything we have said. Now, we said that we will do certain problems. So, we come back this is psychrometrics again continuing, because it is a big one. So, we need to continue.

  Now, as we showed earlier, if you remember, maybe 1 to 2 class back, we have shown you the real psychrometric chart, which is available right. And, we also said, this is a function of pressure and that is why on the left side it is written that at sea level. The moment it is at sea level written, that means, it is under standard pressure right. So, it is a function of pressure.

  We also said earlier that psychrometric chart at sea level and psychrometric chart at high altitude will not be the same, it will be different. The nature of the curve could be similar, but the values are quite different, right. For example, I told you also that there are different temperature scales, here what is coming maybe 10, 16, 20, 24, 28 like that different temperature ranges are there ok. Similarly, no, this is not 10, I was mistaken, this is minus 32, plus 100, minus 32, plus 100 say, this is the temperature, 90 right. So, this is the temperature say 90.

  So, these are volume lines right, these are volume lines, this is absolute humidity line, again sorry, relative humidity, or saturation line, that is 100 percent relative humidity right and these are relative humidity lines. I am not drawing anymore because then it will be jumbled up and we, as we said, you see these lines are around 70 to 75 degree, right. Whereas there are the lines, like these lines, they are meeting up to the saturation line, whereas,   next to this line is meeting up to the scale. So, this is the wet bulb line and this is the enthalpy line, right. So, and we said, the angle between x axis and that line is somewhere around 45 plus minus, one is 40 another is 45 right.

  So we get the saturation, line we get the wet bulb line, like this and the enthalpy line

like this ok. Then we got these lines parallel to x axis, which are meeting with this absolute humidity right. So, all these lines are known and we have draw we have shown also right. Now, let us go back to do some problems, and those problems, you will be able to draw, you will be able to do, unless you are able to solve, the problems obviously, we can say that you have not learnt psychometrics, right. So, let us start say these are not the problem solutions, this is a problem.

Problem, here we are saying that air has a dew point of 40 degree centigrade and the relative humidity of 50 percent. Determine a) the absolute humidity, b) the dry bulb temperature and c) the wet bulb temperature, right. So, this is our first one, right. So we can, perhaps, take one, let me try, no, it is not going, it is not going. However so, let us try here itself, because our background is, oh my goodness our background is white.

So, we can use it. See, I will, I cannot draw a bigger one, because bigger one will take lot other space. So, here, so here, so we have drawn the outline. Next, what we have been saying that dew point is 40 degree centigrade, right and we said dew point is, meaning, what the point which is mixing with 100 percent saturation, that is 100 percent relative humidity, that point is the dew point. So, first from this scale, that is, we can call it to be temperature scale right.

So, from that say this point, corresponds to 40 degree centigrade, right. So, we identified 40. Now, vertical to that reaching the 100 percent line is the point where this is dew point, 40 degree. Now, this is one property given. Another property is required to identify the state point.

So, another property given is 50 percent RH right. Say, let us assume that this is the 50 percent RH line, right. So, if this is the 50 percent RH line, then, from this point we said that to go to the dew point, in the line parallel to x axis that will reach the saturation line and the intersection from there will go down to come to the temperature scale. Find out the dew point. So, this is the reverse, we are doing.

So, we know the temperature, we have come to saturation, now along this parallel line of x axis, where it is intersecting, is our state point 1. So this is the state point 1, right. Now. what we have been asked that from this state point 1 you find out absolute humidity. So absolute humidity.

we can find out very easily, how? You proceed along the x axis. So along the x axis, we are proceeding, where it is intersecting, is the absolute humidity may be say, 0.002 or whatever value it has. I am not concerned about the value. I am concerned about the method, whether you are able to identify correctly or not.

So, we have done. It is to be 0.002, perhaps, right. It can be any value, because, we don't have any scale, any value, where we don't know what is the exact value, but like, from here, one thing, one minute, from here the scale and values are there. So, what we could do we have found out this value right, we have found out this value, yes, from here, we have gone there, this is the 40 degree, say then, we have found out the interaction with 50 percent RH, say this is the 50 percent RH line. So this is the state point 1, and then we can find out from here, what is the value of absolute humidity, right this is how we have found out.

Now, what else we have been asked to do? Let us look into that. We will come back. We have been asked, the dry bulb temperature, right. So, what could be the dry bulb temperature from here?   So, vertical line from there reaching this is the dry bulb temperature. So, it was 40 degree so obviously dry bulb temperature will be higher than that, say somewhere it could be 50 degree, say right.

The same thing we can do in that scale, in that particular graph, that here we have come down to the x axis and corresponding to this value we assume it to be 50 degree centigrade. So, two things we have done and you can also do it, and you perhaps, have done it like me right. And then, the third one, which was asked to do and what is that? The third one which you are asked to do is the wet bulb temperature, right absolute humidity, wet bulb temperature right. So from here what we do, this is the point, so through which one wet bulb line is going. Suppose it is not going, one line was here and another line was here.

So, we have interpolated, which is passing through this line through this point. So, along that wet bulb line we went up to the saturation line, and from there, as we said earlier, we are coming down vertical, and this vertical may be somewhere 45 degree centigrade right. Obviously, saturation temperature is low, dry bulb temperature is high, and wet bulb will be somewhere less than dry bulb temperature. So, that is exactly is happening here, and if we look at that scale in the proper, yeah, if we look at this, then you see the wet bulb line which is going is like this, which is going, is like this, right, and this meeting the saturation line, and from the saturation line, a vertical line, like this, as we have assumed it to be 45, it can be anything because we are not doing to the scale. We are more concerned about the process, how you are doing.

So, we could have done, one problem very easily. I am not saying that, since I know it is easy.   yes, for a beginner, it may not be that easy, for which, I am repeating after scratching it off, so that we can redo right. So for redoing, let us first find out the problem. So we have been given two property values, one is the dew point temperature

and another is the relative humidity.

So, these two are given right and what we need to find out, one is the absolute humidity and one is the dry bulb temperature and third one is the wet bulb temperature. So, these three we need to find out. So, if we redo, redoing it, going to that exact scale, may not be, the values will be able to determine, right. So, we have come to that this is the real chart right. Now I cannot, obviously, magnify it here and to find out the values really, I need one magnifying glass because my power is high so I cannot see so close.

So, what we need here, we have been given dew point temperature, that is 40 degree perhaps, 40 degree, and I do not know whether it is in centigrade or Fahrenheit, yeah, perhaps it is in Fahrenheit, ok. So, assume that 40 degree is Fahrenheit so whatever 40 is here, so this is the 40 this is the 40 line, or temperature, right this point is the 40 point. So, from there, we have gone vertical to the saturation line, right, and we are given another property value, that is 50 percent RH. 20, 40, 50 this one is the 50 percent RH, the line this is 50 percent RH right. So, if this be, the 50 percent RH, then, we come from here to this line wherever it is intersecting is the state point 1, this is state point 1, right.

So, we have identified, our state point 1, and now, what we are supposed to do, we are supposed to find out the absolute humidity it is said. Now, absolute humidity, to find out, these are the x axis parallel lines. So along this line we will go to the x axis parallel, and y, to the y axis, this is perhaps somewhere between 40 to 50, somewhere between 40 to 50. So interpolation will give maybe say 47.

2 or 3 right. So, we found out the absolute humidity, and absolute humidity, if you remember, the unit what was the unit we used absolute humidity it was kg water per kg dry air right kg water per kg dry air, that means, 47.3 kg water per kg dry air ok. Moving to the table I, may be wrong, if the table is wrong, right. Then, we are asked to find out the dry bulb temperature, right. So, state point 1, is known now dry bulb temperature, we have to find out that, to find out the dry bulb temperature what we need to do? We go vertical from the state point 1, and if we go vertical from the state point 1, it is coming like this, right and what is the value? The value here, it is showing is to be 60 degree centigrade, or sorry, Fahrenheit, it was in Fahrenheit scale.

So, 60 degree Fahrenheit, right and the third one which we were asked to do, if you remember that the third one is the wet bulb temperature, right. So, the wet bulb temperature, how we will do? So, we have to proceed along the wet bulb line and we also said, if one wet bulb line is this and another wet bulb line is this, so if yours is in between, then, you have to interpolate. It is not necessary that, your point will go through

the line available, you may have to interpolate. So, by interpolating, you see this point is not coming on the line already drawn. So, we are parallel to this line, we are making one line which is going to the absolute relative humidity or not absolute, 100 percent relative humidity, right or saturation line.

Then from that saturation line if we go vertically down then the point where it is intersecting is the wet bulb line, wet bulb temperature, and according to this, the wet bulb temperature which is coming, maybe somewhere around 52 or 53, right 53 degree centigrade, I correct myself, Fahrenheit, sorry, 53 degree Fahrenheit. So, our dew point temperature was 40, our dry bulb temperature came to be 60 and our wet bulb temperature came to be 53. So, dry bulb is highest, dew point is lowest, wet bulb is in between right. In the other day when I showed you, the scale, not only scale I showed, you one table where, we said that the difference between the dry and wet bulb, if it is small, say, 1 degree, then the corresponding, if it is 1, then the corresponding humidity or relative humidity will be very high, and somewhere it was around 90s if I remember correctly and if you can go back to your previous class, then you will see that it was around 90s. So, if it is 1 degree then 90s, if it was 9 degree then it was somewhere 40s, right.

So, it depends, all are then interconnected, depends on the situation, depends on the state points you are defining and then finding out the all property values. Now, here we have done wet bulb, dry bulb and dew point is given and also we have found out the absolute humidity right. Now, if you are also asked that you find out from there the enthalpy. So, the enthalpy line will be somewhere here, so it is around 20, 26 so maybe around 23 kind of thing, the value will be somewhere 23 enthalpy, h right, and if you are asked say, find out the volume, see here one volume line is here, another volume line is here. So, it will be in between parallel lines, if we draw this will be the volume line, so that volume has to be found out by interpolating right.

So, volume, enthalpy, relative humidity, already given the absolute humidity found out wet bulb temperature found out dry bulb temperature found out. So all property values are known at the state point 1 right. So, this is how you can find out all the property values, if the state point you can directly determine, and you can properly read the values, right. So, I hope with this, you can easily find out the values from the, or you can identify that is the fundamental, right. So, with this let us stop today's class because time is up.

So, in the next class perhaps, we will try to complete this doing some more problems because if you do more and more problems you become really expert in the psychrometric. Thank you.