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

Prof. Tridib Kumar Goswami
Department of Agriculture Engineering
Indian Institute of Technology, Kharagpur

Module No 05

Lecture 22
Psychrometrics Contd

Good afternoon my dear students. In the previous class we have been talking about Psychometrics right. We also had shown you a chart of psychrometry. So today also we will continue in psychrometrics because still some more are there and you need to learn right. It is not that the chart I have shown that is good enough for you to learn, but what is required how to read it? Isn't it? You are given a chart how to read it, if you don't know, then no point of using the chart right. So, what I wish to say is that in the chart we had seen there are many lines.

So, we have to first identify those lines, right. For example, you see in this slide this is the psychrometric chart which we had shown you in the previous class in a bigger way right. So, in this chart, one thing is certain that, you see, the shape of the, ok, let it be white, does not matter, the shape of the chart is like this, like this, and like this, right. So, whenever you are appearing in any interview, or in any other classes, if you are asked to do a thing for psychrometric, whatever you will be asked and if you are in the board or maybe in pen and paper then first thing you need to draw, oh, this cannot be drawn there, ok.

Let me draw it here, that first thing what you need to draw is this, whether small or big, does not matter, but it has to be like this, unless you have this boundary diagram, the teacher will not ask you any further question, because, this boundary diagram is the indicator of the psychrometric chart right. So, you need to draw this first and then, subsequently, whatever questions will be asked you have to answer to them, but first thing you must do that the boundary of the chart you have to make right. Next, once your boundary is over, then it comes, how to draw the dry bulb temperature, our temperature, our chart is this, that we are supposed to draw this, ok, then this, then this, and finally, this. So, this is our x y plot, if it is x this is y right. So dry bulb, as it is shown here, I do not know whether you are able to look at it or not, but we say that this is the temperature axis right all the 3 temperatures we had told in the previous class, that all the 3 temperatures are represented in this scale, in this line, rather, or axis x and y axis is corresponding to, if you remember, we also said that this is the h or absolute humidity right.

So, if we now draw any, now, it is still blank ok. So, any vertical line from here will represent the temperature axis, any vertical line here, it, these are all vertical lines right, this is a vertical line, this is a vertical line, this is a vertical line, I am sorry, they are not becoming vertical due, because of drawing, but these are, this should be vertical, 90 degree, right. So, these are the dry bulb temperatures, dry bulb temperatures, right. So, dry bulb temperatures are from the x axis, here any vertical line is representing dry bulb temperature. Now this scale, right that is the fundamental in psychometric chart, they are available into 3 scales, and in earlier class also, I said here, I had shown you one thing that in the real chart, there is a pressure indicator, that is whether it is for sea level or whether it is beyond sea level.

So, corresponding to that the pressure, sea level means, it is atmospheric pressure. So, atmospheric pressure, that will have one kind of chart or values rather, and chart may be similar, but the values could be different. So, once we know the dry bulb temperature, then, from there, in this, what are you are saying that the scale, the scale can be anything it can be any temperature you want right. It can be any temperature you want. Here, at this, since we have given you as indicator, for the understanding of the dry bulb temperature, lines.

So, these are having no scale, but it can be, say 0 to 50 degree centigrade, or 0 to 50 degree Fahrenheit, anything you want that can be that psychometric chart, may be available in Fahrenheit, or degree centigrade, whatever you want you will get, but the basic thing remains same. There is no change that is you will get the dry bulb temperatures, whether it is in centigrade or in Fahrenheit. This (x, x) perpendicular to the x axis the lines are vertical and they are called dry bulb temperature, right. So, this is what exactly here, what you are seeing, right. So, once you are said that your dry bulb temperature, be it is between 0, sorry, if it is between 0 degree and 50 degree and your dry bulb temperature is 37 degree, then you will come, right maybe this is 35, maybe this is 40.

So, you have to interpolate and find out where is the 37. So, if it is 37 here, then you draw the vertical line and that is the dry bulb line, right or if it is, as, we said 0 to 50 Fahrenheit and if it is 20 Fahrenheit, means sub 0 in Centigrade, what is the scale of Fahrenheit? Fahrenheit is 212 in the upper side, and 32 in the lower side, like 100 & 0 is the boiling point of and freezing point of water in degree centigrade. Similarly, in Fahrenheit, it is 212 & 32 Fahrenheit, right that you can do all the time C by 5 is equal to F minus 32 by 9. So, from there if Fahrenheit is given, you can get centigrade if centigrade is given you can get Fahrenheit right. One more, one more simplification is there also c is equal to f minus 32 divided by 9 over 5 because this 5 will go up.

So, it will come down. So, that can also be written, f minus 32, 9 by 5 is 1.8. So, we can easily find out what is the value of centigrade if it is in Fahrenheit, like here it is, we said to be 20 Fahrenheit. So, 20 minus 32 divided by 1.

8 that is minus this is 12 right, 12 by 1.8 right. So, how many it is? It is minus minus point 1.

8. So, 1.8. So, it is you put this 120. So, 7 18s are 5 18s are 90 6 18s are 108 7 18s are 126. So, it is 6 point something right. So, we can easily find out what is the Fahrenheit and centigrade temperatures if one is given the other, but the vertical lines are the dry bulb lines right, and corresponding to this, sorry, corresponding to this axis, whatever value is there, that value will tell you whether you are in the right track or not ok. So, once we know the dry bulb temperature, next is the wet bulb or maybe some other like saturation temperature, yeah, this is saturation temperature, right.

So, again what we do? We draw that line. So, this is our boundary and this is our outline. We have already found out the vertical lines to be the dry bulb lines right. Now, we have to find out saturation temperature the moment saturation temperature, saturation word is coming, we are supposed to go to the saturation line. Now, which one is the saturation line, this line is the saturation, that is 100 percent RH.

100 percent relative humidity line right, and all other lines which we have not drawn here, at the moment, we can show you now, afterwards we will also do something else. So, these all parallel lines are going down. So, from 100 it is coming down, maybe this is 60, maybe this is 40, maybe this is 30, like that things are coming right. So, this is of course, we have done before and when relative humidity will come that time we will tell, but for saturation line, we had to show it right. So, we have this line, we have this line, and this saturation, line vertical lines, and now for saturation, means, it will be anywhere in this, right, it will be anywhere in this line.

So, how to go to that line there are horizontal lines also and these horizontal lines are intersecting with the y axis, this one at different points, y axis we have already said is the absolute humidity. So, it is maybe 0.001, maybe 0.1, maybe point something right 0.

3 etc. Whatever be the values. Now, once we are asked to find out the saturation line, we have to proceed in this line that is horizontal lines where it is intersecting   with the saturation line, this is the saturation line, right where it is intersecting, that line we have to get and once we get that, then, this is also here, perhaps, it is not so much visible. So, what we need, we need to find out this right. So, these horizontal lines are there   and

those vertical lines are for dry bulb. So, if we are said that you find out the dew point, and along this line if you are coming to this point, this is not the temperature, this is the absolute humidity line, not absolute, sorry, relative humidity line, 100 percent right.

So, from there, if you go down, and where it is intersecting with the x axis in that scale, you will get the saturation temperature. So, saturation temperature, we are moving along the horizontal lines, right parallel to x axis right. So, and where it is intersecting from there, a vertical line which was originally dry bulb, but now it is a saturation temperature, where it is intersecting with the x axis right. So, this is how we find out the saturation temperature, or saturation line right, but that is nothing, but the parallel to x axis, that line we have to follow, ok. Then once we know the saturation line then we have to find out relative humidity, right relative humidity as we have already said that our diagram is this this, and this is the board.

Now this is representing 100 percent saturation, right this was dry bulb vertical, right these were horizontal that is our saturation line or it can be said absolute, it absolute humidity line, also right. So, this is mixing with this, this one, you see here, it is mixing with the absolute humidity ok. Now as we said this is 100 percent relative humidity then parallel to this line, sorry, parallel to this line, the other lines are also like this, which is shown here also this is the 100 percent, here it is 100 percent right, another parallel line is, maybe 90 percent another parallel line maybe, say 80 percent another parallel line, maybe 60 percent, like that right. So, these lines are like that and accordingly the lines are drawn. Now, the question comes, if it is 100 percent and if it is 90 percent, we let us enlarge a little then it will be easier for understanding.

Let us enlarge a little then it will be easier for understanding what. So, first we have drawn the basic of the boundary of the psychrometric chart. So, this was 100 percent relative humidity, right and say this one is 90 percent relative humidity. Now, if I have 93 percent relative humidity what do I do again? You have to interpolate. So, this is 100 percent this is 90 percent.

So, simple interpolation, right that is linear interpolation. We assume here that the relative humidity is proceeding with linearity. So, 90 percent is here, 100 percent was here. So, in between say 95 percent that will be coming like this right. See, if it comes to 91 or 99, that will be obviously, 99 will be very close to 100 and 91 will be very close to 90 right.

So, by interpolation, I hope interpolation you know, right y minus y 1, y minus y 1 divided by x minus x 1 equal to y 1 minus y 2 by x 1 minus x 2, perhaps things like that x 1 minus x 2, perhaps this is the intermediate, one where y x is the intermediate, one,

and y 2 x 2 is extreme one and y 1 x 1 is the other one. So, if this point, this point, are known the intermediate point can also be found out and it is a linear equation and linearity, it is following. So, we can find out the intermediate one and we can draw the relative humidity line by interpolating and we can find out if required what is the relative humidity right. So, after the relative humidity, ok Regarding relative humidity another thing should be also told that in the relative humidity line when it is coming, sorry, when it is coming to 100 percent then it is saturated right 100 percent, then it is saturated line, and in that saturation you have to you have to get the line for saturation temperature right. So, saturation temperature will be a combination on the relative humidity 100 percent line and dry bulb vertical line where it is striking or where it is mixing with the x axis and you know the scale obviously, this scale is known before hand and whether it is 0 to 50 or even 0 to 20 depending on what type of psychrometric chart you have with you right.

There are many, if you want in the market, you will get, you ask for, may not be the scale you are looking for that is available, but I am sure I have seen in our institute also 0 to 50 is available 50 to 100 is available right, 0 to 100 will be again a compressed one. So, the more it is expanded the easier for you to identify isn't it. So, if it is 0 to 100 scale is very high big. So, the entire thing will be compressed it will be very difficult to identify, but if it is spitted like 0 to 20 or 20 to 50 or 0 to 50 at least then that compression will be released at least half of it or one third or things like that. So, this is how the relative humidity is obtained right.

So, what did you do today we have found out how dry bulb temperature can be identified, how saturation temperature can be identified and how relative humidity can be identified right. So, our time is up today at this moment. So, I thank you all for listening to the class. Thank you.