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

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Module No 04

Lecture 18
Psychrometrics

Good morning. In the previous classes, we have covered basics of thermodynamics that is one very very essential part which we have covered. Now, we will also take up another very important one, with respect to our cooling that is called psychrometrics. I hope you have heard the word psychrometrics, even if you have not then let us start it and let us understand. Because, this is one of the, again fundamental thing, which we should know whenever you are dealing with the cooling technology, or this psychrometrics is not only in cooling, but also may be in drying, in freezing, in drying mostly, in vapour, liquid, all these are, psychrometrics is a part and you must know psychrometrics right. So, let us start psychrometrics, right as you, it is a colorful one, yes, it is a colorful one.

So, what are the objectives? Why should we know psychrometrics? If we know psychrometrics, then we can be able to define what is psychrometrics, and we can understand, the importance of psychrometrics. We can find out the properties of air, they are needed for psychrometrics. We can be able to define properties of air, and we should be able to read a psychrometric chart. Afterwards, I will show you how a psychrometric chart looks like, but these are the objectives.

that we should know, we should know, we should define psychrometrics, we should know the properties all these are supposed to be known. Then utility of psychrometric chart is that you should be able to locate a state point. I have told earlier many times about state point. So, here it is more emphatic that we should be able to locate a state point on a chart when value for any two properties are known. Why two properties? Why not only one property? Since, I have no reply from your side, I assume that you have rightly said, but just take it in this way that whenever we are talking about any chart, whatever be the chart, which is visible in books and many other places, we see, and these charts or figures or similar things are all two dimensional right.

They are two dimensional, one is x, or rather, one is y and another is x right. So, this y versus x this we have seen all the charts, all the figures, everything that is why at least two properties are supposed to be known, then only you can locate the state point right.

You should be able to determine values for the other properties of air, once a state point is located in the chart right. You have located one state point from two property values, from that state point, you can find out many other property values, which are associated at that state point. Mind it, every time, we had said earlier also, we will not repeat that, these state points are thermodynamically in equilibrium condition right.

The equilibrium conditions, these state points are right. So, you should be able to move from one state point to other state points. So, we have now, we have the pen. So, we can use. So, we have one graph, like this, right anything like ph, fine normally it is of course, not ph, this is PV right.

So, if it is not PV it should not be said let it be PV right. So, if we know one pressure and one, that is P 1 V 1 then this is the point, and this is the state point 1. We want to move to another point, called P 2 V 2 right. How shall we move? Shall we move like this, shall you move like this, shall you move like this, how shall you move? Once, we know that how we have to move, then we can move from point 1 to point 2 right. So, that is both the state point properties are supposed to be known then only, and the way you are asked to move, you can reach the point 2 right.

So, this is how a psychrometric chart is useful right. Now, some more things which we also need to know are that what are psychrometrics as definition. By definition, we can say, psychrometrics is a term to describe the relationship of the 7 properties of air and how these properties change as the heat and moisture content of air changes. That means, we have air, we have air ok. So, we said that psychrometrics is a term to describe the relationship of the 7 properties right.

7 properties of air and how these properties change as the heat and moisture content, fundamentally, heat and moisture content, of air changes right. So, we can then define what is psychrometrics, right and after this we will see what are the 7 properties we are referring to. The 7 property, importance of psychrometrics, before coming to the 7 properties, importance of psychrometrics are like this. The principles of heating and cooling are based on psychrometrics right. For example, we have a beaker where we have some water, and if it is a closed one right.

So, there will be heating into the beaker. So, moisture will come out from there and accumulate right. So, if outside, there is a cooling jacket, then this moisture will condense and drop back. How these changes are happening? Psychrometrics can be used and you can easily tell the properties of the air water or air moisture combination. Now, another thing, which we need to know is that psychrometrics can be used to predict changes in the environmental or environment, when the amount of heat and or water in

the air changes right.

So, this is another way of saying the usefulness of psychrometrics, and the third one could be the psychrometrics can be used to predict the cost of drying a biological system. Now, this is, in most of the cases, very difficult, because, cost is not dependent on some single parameters. It may be functions of many many parameters, but however, we can have some idea about the cost involvement. Now, here we come to the properties which we are referring to, that the properties of air required for psychrometrics are, dry bulb temperature, wet bulb temperature, saturation temperature, relative humidity, humidity ratio, volume, and lastly enthalpy. I repeat, the seven properties, which are obtained or available from psychrometrics are dry bulb temperature, wet bulb temperature, saturation temperature, relative humidity, humidity ratio, volume, and enthalpy of the air water mixture or combination right.

So, these seven properties of enthalpy, volume, humidity ratio, relative humidity, saturation temperature, wet bulb temperature and dry bulb temperature are the seven properties associated with psychrometrics. Now it comes, what we understand by dry bulb temperature. I have given earlier also, this reference that, when somebody is sick having temperature, every house has a thermometer, generally that thermometer is glass in, rather, rather, rather, mercury in glass, that is mercury in glass thermometer having a bulb like this right. So, if we draw, it becomes like this and then here, your bulb is there, right and there is graduation in this and you can see through the movement of the mercury right. So, this bulb, when it is empty, only the bulb, that time, the temperature recorded is known as the dry bulb temperature.

So, the temperature recorded by a dry bulb mercury thermometer, that can be either in Fahrenheit or in centigrade right. Because, nowadays, particularly, for household capacity, or household use, the thermometer available is graduated both in Fahrenheit and in centigrade. Only the difference is that Fahrenheit you have universal line sorry, Fahrenheit you have universal line this is 99, this is 98, this is 97 like that and of course, in between they are graduated right. So, these are whole numbers easy to remember whereas, if you convert 99 to centigrade this will become somewhere some 36 point something this is not exact I am just giving idea 36.

5 or maybe 36.8 or maybe 37.1. So, it is very very difficult to visualize that what is the range of temperature how it is important to consult doctors right that is why still today though SI units are there, but Fahrenheit is so useful because of its digital digit means unit that you whole number that whole number you are using 98, 97, 96, 99. So, these 97 these numbers are very very useful and the bulb which is recording it is called the dry bulb temperature. Then another property which we have said is wet bulb temperature.

The same thermometer which you have used for finding out your body temperature if you wrap with one cotton or some maybe cloth and put it in water right deep in water and now you if you blow a little layer a little air or force some air then what will happen the latent heat of vaporization of the water from the cotton or cloth will be taken from the bulb right. So, that will bring down the temperature right. So, is it that if we have the cotton here and if sufficient water is there and if we go on blowing will the temperature go on decreasing there is a question perhaps not. It will not go beyond certain temperature and that certain temperature is known as wet bulb temperature. So, the temperature recorded by a mercury thermometer which has a wet cloth cover and the bulb will tell the temperature in either Fahrenheit or centigrade right that is the wet bulb temperature.

The question which I asked that if you go on blowing air will the temperature go down? Yes, it will go down till it attains the wet bulb temperature. It will not go further below wet bulb temperature right under that condition situation. So, dry bulb wet bulb we have seen, then it comes other properties, like saturation temperature, right we have already talked all, many times about saturation. So, saturation temperature, by definition is the temperature at which air is saturated with water commonly, called the dew point, and this can be expressed in degree Fahrenheit right. This is the time when you see it, if you go outside in the very early morning, and if you see some leaves, you will see some droplets of water are there right where from that droplet came, you do not find any water here there.

So, where from that droplet came? That droplet came from the air surrounding that leaf and the temperature came to the temperature, known as saturation temperature. So, the moment it attained saturation temperature, air attained saturation temperature, at that condition, the moisture condensed, and fell on to the leaf, which you are seeing in the early morning. Obviously, with little late morning, you will not be able to see because by the time the sun will dry it out, or sunlight, or sun ray, heat will dry it out, and there will be no such. But in the early morning if nowadays it is the time that October, November you see that mist or moist in the or water droplet on the leaf right. This is because the air, at that time came to the temperature, which is the saturat,ion temperature, and the moment it becames saturation temperature the saturated water vapour condensed and came out as a droplet right.

Then relative humidity, right. Now the air condition is very good, air I mean dot, the air, AC air condition outside air condition is very good, it is neither hot nor cold more or less everywhere in India more or less except some part of Tamil Nadu, and Kerala and many other high altitude places, except those. Now, in normal cases, all over India it is very

pleasant, weather neither hot nor cold. So, you have already crossed that time that situation when you had lot of sweat you had lot of sweat you are outside lot of sweat were there and you were totally wet right that is one condition of the relative humidity right. That is one condition of the relative humidity that outside relative humidity is so big that you are not able to vaporize your sweat which is coming and that is what is wetting you.

This has happened very recently in couple of months within couple of months in any part of India right. So, relative humidity is a very important parameter and why it is called relative that is also another question should come to our mind. Humidity, we understand that the moisture in air is called humidity that is by definition moisture in air is humidity, but why it is relative, whose relative, right. The moment we call relative, that means, we always have a comparison between either one or two or more right. So, it is that the amount of water in the air compared to what could be in the air if it is under saturated condition.

This is expressed in terms of percentage right. So, the amount of air in the amount of water in the air compared to what could have been in the air had the air been under saturated condition. That means, you are comparing, that relative word, is coming here that you are comparing with what it could have been under saturated condition than what now is right. So, this is what is the relative with respect to the saturation, mine one is present one is this. So, this is what is relative humidity right.

So, I hope you have understood why it is relative, humidity we know is the moisture which is in the air, that is called humidity. But what about that what is in the air at this moment, with respect to that what it could have been under saturated condition ok. So, our time today is, at least this class is over. So, I am very thankful for your attendance in the class, or for you, which you are learning ok.

So, thank you very much. Thank you.