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

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Module No 04

Lecture 19
Psychrometrics Contd

Good morning. We have started in the previous class Psychometrics, right and we said that it is very very important, which we need to know. So, we are continuing that psychometrics because it was not over in a class. We came to the level of relative humidity. We said that there are 7 properties which are associated with psychometrics. And if you remember, we said that dry bulb, which we have defined, wet bulb, that also we have defined, saturation temperature, we have defined, or dew point, we have defined and then relative humidity, we started with.

And there are many, relative humidity, is the fourth, then fifth one will be your absolute humidity, or humidity ratio, sixth one will be volume,and seventh one will be enthalpy right. So, we are going one by one. Till now, we have done with a little relative humidity, and we have said, why, it is said, relative, isn't it, we have already said, why, it is relative. Now let us look into humidity, relative humidity, some more, that humidity reflects to the amount of moisture, that is water vapour in the surrounding air.

Then, relative humidity is a measure of the amount of moisture in the air compared to the amount of moisture, the air can hold right. How much air can hold? You ask yourself, that how much air can hold? Air can hold till it is coming to saturation, once, it is saturated, then it will drop, it will condense, but till, it is coming to saturation, that much, it can hold right. So, that is why relative humidity, in another word, is also said, it is a measure of holding the moisture, capability of holding the moisture. So, 40 percent relative humidity means 40 percent is full now another 60 percent to go to 100 percent. It can hold, that is what is 40 percent relative humidity meaning, if it is 95 percent relative humidity then already 95 percent is there then it can hold 5 more percent to become saturated 100 percent right.

So, it is called, water holding capability right, that is what we are saying here. The relative humidity is a measure of the amount of moisture in the air compared with the amount of moisture that air can hold at the same temperature, right. So, another way of saying relative humidity is like this, relative humidity is expressed as a percentage of how much moisture the air could possibly hold at the temperature it happens when you

measure it right. So, it is also a function of temperature right, It is also a function of temperature because we are saying that it is expressed as a percentage of how much moisture the air could possibly hold at the temperature it happens when you measure it right. It is a function of temperature surely then the wetter or damper you feel, the higher is the relative humidity, the wetter or damper, you feel.

If you feel the air is dry around you, the relative humidity is low. So, in this respect let me say that hopefully, many of you have visited, say Rajasthan, during summer, right and you have observed that if the outside temperature is say, 40, 42, 44, you are feeling that, yes it is not 44, it is something 50 around, why? Temperature is 42, and you are feeling that it is around 48, 50 why? The reason is that, the relative humidity there is very low. So, around you, the relative humidity being low, you are feeling very much dried, and that is why you are feeling more heat compared to the actual. The same is true when you go to high altitude, say Kashmir or Ladakh, or Darjeeling, or any such place, right, Ooty, any such place during winter. Then what you see that if the relative humidity is there, very high, that means, maybe some rain will be coming, or something like that, then, at that time, though the temperature is not so cold, maybe 4, 5 degree, but your feeling is very very cold, because the humidity there is very high, around 95, 97, 98 percent and you are feeling more damper or wetter right.

So, this is the reality, and relative humidity plays this type of important role. Then, we can say that we are very sensitive to humidity, sweating keeps out our body cool and maintains it current temperature right. If our sweat is evaporated, we feel comfortable, but if our sweat is not getting evaporated the extent of uncomfortability is very very high right. So, this you will see, mostly during rainy season, in paper also, that what is the relative humidity, and how much discomfort, what is the level of comfort or discomfort that is given in many papers right. So, sweating if it is evaporated from the body then that sweat is taking the latent heat of vaporization from the body thereby keeping it cool and you feel comfortable, but if sweating is not able to vaporize because of the high relative humidity then you feel that, no, I should not stay here, blah blah, right.

I hope I am correct. So, if the air is at 90 percent relative humidity then sweat will not evaporate into the air, as a result, we feel much hotter, than the actual temperature, when the relative humidity is high right. So, in many ways we have explained this. The other one is that if the relative humidity is low, we can feel much cooler than the actual temperature, because, our sweat evaporates easily cooling the body. This also, I have explained very carefully giving the examples of both Rajasthan and Kashmir or similar places, right.

So, we can say that, relative humidity is such a parameter, which is also telling us about

our comfort level right. Then it comes, how the relative humidity is measured? How can you measure relative humidity? So, humidity is measured by means of measuring device, called hygrometer. It is measured. It is available in the market. There are hygrometer, which are like clock, and that is why in industries you will see, people are saying to be, what is the relative humidity etc.

right. So, the most common hygrometer, there are different types of hygrometers and the most common hygrometer is wet bulb and dry bulb temperature and their use, and another one could be the hair hygrometer. So, with the help of wet bulb and dry bulb temperature, you can say the relative humidity, because wet bulb and dry bulb, that means, you are knowing two parameters, simultaneously. So, you can locate from the picture of the psychrometric data. So, from there you can say that what is the relative humidity. Whether there, it will be cool or hot or your comfort level will be very very bad, right.

So, if it is, by the help of wet bulb and dry bulb temperature, then, you have to have the wet bulb as well the dry bulb. Both the cases, we have explained what is wet bulb, what is dry bulb temperature in the previous class. So, wet bulb and dry bulb psychrometer consists of two identical mercury thermometer, one of which has a wet cotton, or linen wick around it. So, it contains one linen wick around it and then, you put some water, and then you blow some air, then you will get the wet bulb temperature. Whereas, for the dry bulb, you have this thermometer, and there is no wick or any other thing, only it is bare and you are watching the dry bulb and in couple of minutes you get the dry bulb and then the wet bulb temperature.

Similarly, this type of hygrometer is used in almost all the educational institutes. Here, evaporating water from the wick absorbs heat from the thermometer bulb causing the thermometer reading to drop. The difference between dry and wet bulb temperature is compared on a psychrometric chart. So, you have come to know the wet bulb as well as the dry bulb temperature, but you cannot find out the relative humidity because, then you have to ask for what is the then dry and wet bulb temperature and the psychrometric chart. So, unless you have the psychrometric chart you will not be able to find out the relative humidity.

Of course, as I told, you know, nowadays, many such, not instruments, but also the many people are working on it and, they are making the formulae or that is called, write up that, by which you can determine giving one dry and one wet bulb temperature you can find out what is the relative humidity. So, this type of software are nowadays available ok. So, the one which I was referring to you is that the wet and dry bulb temperature that can be measured with the help of a hygrometer. This is called

hygrometer, and perhaps in almost all the labs, whatever it be small or big, a small unit like this is available and this is called hygrometer, based on the wet bulb and dry bulb temperature right. As you see from this picture, that you have a handle, this is the one you have a handle.

I hope during your childhood you have used one such toy where a stick was there and after that there was a round thing which was wrapped with some paper and one stick was, when you are rotating that stick was striking to this and there used to be a noise or sound for the children it is obviously sound and they enjoy, but yes for seniors it may be some noise because the same sound same thing is coming and they become very much annoyed, but operationally it is the same. You have one holder like this and you have one dry bulb temperature mercury in glass thermometer right and you have another this one that is also mercury in glass, but here you have put some wick, Which is also having some moisture, some moisture you have added to this right. And now when you start rotating it, like the toy I just described, when you are rotating it like that, since dry bulb is open. So it has no change, but the wet bulb, it being having fully wet whether the wet is full or not that, also will be reflecting about the wet bulb temperature. If you put a little water, not sufficient, so that the moisture around the bulb, cannot be saturated, then there will be less vaporization, of the water and the appropriate temperature will not be recorded.

So it is better to put sufficient amount of moisture onto the bulb or do not allow that bulb to come across this type, of courses, because this is the very beginning, and if you are not able to understand, then it will be very difficult for you to subsequently adopt the new and new things. However, for dry and wet bulb temperature we have the hygrometer and in most of the colleges or universities this hygrometer is available, it is not costly, it is available. In really reality, when this dry and wet bulbs are used, typically in cold store, if you have ever gone there, and if you used to do that, then, this rotating of the wet and dry bulb, oh, what I was saying, in the industry, these two thermometers, are at different places and somebody is there, who will look after that all the time, some water is there in the wick and there is a fan to blow it and anybody, you me, or anybody can go and watch, what is the dry and what is the wet bulb temperature. Is it not coming to your mind why people will be so, intuitive, let it be what is there, let the temperatures be, one is sub 0 or 0 around another is above 0. Is it not making you very much annoyed? It is because, that hygrometer, which we are using here, nobody is there to make it rotate.

So, one fan is there, and that fan always blows out some moisture from that wet bulb and the thermometer reads correctly to the first or second or third decimal right. So, we can see that by dry and wet bulb temperature, the psychrometric chart can be used and psychrometric chart, I have not shown you, will show you in the next class. The

psychrometric chart unless you know the wet and dry bulb temperature, you will not be able to find out the other properties because this wet and dry bulb, these two properties, two values of the properties right. So, these two values of the properties will take you to the point which is called the state point 1 and you will not, you will maybe, or you may not be able to identify, but maybe after today, if you go and find out, then you will find out that these are very two friendly thermometers, which give you, because mercury in glass is, what we, by far the most useful or best type of thermometer. Its accuracy as well as its range is also very very good except, perhaps, the last one because, you have one definite length of this thing, temperature unit.

So, until and unless you are able to locate it on the psychrometric chart you will not be able to find out the rest of the properties of the chart right. So, with this I think we conclude here. With the wet bulb and dry bulb and relative humidity measurement, because there is, as we have already said, there is another way of measuring the relative humidity, but that is normally not used, because it is very complicated, it comes from the, you know, our here, everybody's here is a function of temperature, right and moisture content, sorry, moisture content, that is relative humidity. So, if the moisture content increases or decreases, either they increase in length or they decrease in length right. So, with the help of that the second type of hygrometer is working, or it is mostly used in the industry level, but this one is also industrial level, but much more useful than only handling with the dry and wet bulb temperatures ok.

So, we complete this class here we will come to the other type of hygrometer in the next class ok. Thank you very much.