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

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Lecture 60
Ice Cream Contd

Good morning, my dear friends, my dear boys and girls. I am so happy that we have come to the last class end of the class, but the problem is, time is 30 minutes, and I have to complete the entire thing in this 30 minute, whatever is remaining. So, please pardon me if I am moving fast because, I have no choice, lot of things as you know, is required to be said and there is no end, right. So, obviously, selection, we have made in, I have made in such a way that most of the, most of the required things are told and you are equipped with all information necessary, right. So, it is the ice cream, a continuation class right. So, it is the commercial pasteurizer, right commercial pasteurizer, typically, right and this is also another type of pasteurizer, this is called plate heat exchanger, as it is appearing from here, that this is a plate type, right plate heat exchanger, with all control and other things, this is another way of pasteurizing right.

Then, we go to homogenizer, homogenizer this is a typical APV, APV is a multi, this is I mean rather, what we call international company, right and it has also perhaps, some Indian outlet, and India is also making nowadays, homogenizers. However, this is a homogenizer, it is having two stages, one stage is 2500 psig and another stage is 500 psig, two stages, I have no choice now, since it has come, why two stages are required? Because, in the first stage, say the sizes are 30 micron, right and in this, when it comes out, then what happened, it again agglomerates, you have made it to 2 micron, right, but it agglomerates again, it size goes up to maybe 3, 5, 10 whatever micron it is. Then, in the second stage, it is again, it is again shattered, and made to 2 micron, and now, it is becoming stabilized, that is another part of homogenization, this is not possible to do it here, if someday, I am allowed to talk to you with milk, then definitely, that is, of course, a dairy part, I am not sure whether it will be allowed or not, then I can discuss in detail. However, then we come to a typical ice cream freezer. As I said, that is inlet is 4 degree centigrade, it is entering into the ice cream freezer, and it is coming out at minus 5 degree centigrade at the outlet.

So, here it is at minus 5, here it is at 4 degree centigrade. Now, I should also explain the freezer, where you will come across with why cooling is required? This is supplied with, this is the part entirely for the refrigeration, right this is entirely refrigeration, and the one which normally used is ammonia, because of its high COP, right and this ammonia, in the

liquid form, enters into, and this is an insulated container. Number 1, first one is a barrel, where there is a shaft, and in that shaft, there is a blade. It rotates through drive, right and after, this is made of steel stainless steel, of course, and as I said in the freezing class, that the inside of it is so polished that the size of the ice crystal becomes very very minute, right. Obviously, once the ice crystals are formed, then this is called scraper blade, or shaft, along with a scraper blade. So, when it is rotating, it is scraping off this already adhered fine thin layer, which is scraped off and mixes with inside of the remaining ice cream mix.

Now, after this, there is ammonia. This ammonia is in the liquid form and it gives only latent heat, right, it gives only latent heat, and the vapour goes back to the compressor again. This is acting as the evaporator, right, this is acting as evaporator. Then, the other thing is that, what we were saying, so ammonia, and then this is the dasher, ok, with some blades, this is ammonia, and then it is insulated, highly insulated, right highly insulated. So, that the outside is ammonia, this cold is not wasted obviously, there will be a little, you cannot stop it, whatever insulation material you give, there will be a heat loss, or heat gain, rather, from the outside, again, depending on the temperature of the outside. However, this ice cream, which has been first like that, it is produced, it is a continuous one, so it is entering at 0th time, here, at 4 degree centigrade, and after sometime, because, as we said 300 litre per hour, or 700 litre per hour. That means, it is giving you, if you know the length of the freezer, then you know what is the retention time from the output, right.

So, this is coming here maybe in 5 seconds or 10 seconds, it will go to this side, where it will be exiting at minus 5 degree centigrade, right and it is a semi solid, right it is because, it is flowing, otherwise it cannot come out, if it is frozen inside, right, assume it is to be minus 10 degree centigrade, then what will happen? this will not be moving out. So, to have the movement of the frozen ice cream, it is not brought down below minus 5 degree centigrade, its initial freezing point, I had said earlier also minus 2.5 degree centigrade. So, from minus 2.5 to minus 5, it is brought down and then it is, it is packed in different containers depending on the pack, as you know, you nowadays, you have in the market, 100 ml, 50 ml, 25 ml, all these, there are 1 litre pack, there are 4 litre packs, and many other sizes.

So, accordingly it is done. So, the basic thing is that you are entering your liquid mix at 4 degree and it being a continuous one, it is coming out at minus 5 degree centigrade in seconds or minute, right, in seconds or minute depending on the length and depending on your viscosity that is why that 4 degree centigrade, which we have kept for some time and that is increasing the viscosity. The moment viscosity is high, it will have a good mixing with the remaining, once the ice is formed on the barrel, this is called the barrel,

that inner one, where your ice cream, this is the shaft, right where, the ice cream is mixing, this is called barrel, whose inside is highly polished, right this is called barrel. So, after barrel, you have the refrigeration with ammonia and then you have the necessary insulation right.

Then, one more thing here, we need to know is that, there is a two, double pump, right this is a double pump acting as pumping in the air, which is required and also pumping in the mix, ice cream mix, right ice cream mix, what it is. So, in the beginning, I had shown the solids liquids they are mixed, right and then it is pasteurized, then it is homogenized, then it is cooled, then it is stored at 4 degree for ageing and there it is 4 degree, and 4 degree, and it is a mix of all liquid and other constituents, right. So, then it enters into the freezer, and comes out at minus 5 degree centigrade where, it is a liquid, or semi, not liquid, semi liquid, semi solid, it should be, right. So, this acts as a dual pump, not double, better word is dual pump, which is pumping air as well as the ice cream mix in the two, both goes together, enters the entry point and this is the entry point, where you have 4 degree, your design has to be such that by the time it comes to the end, it is minus 5 degree. So, accordingly, the length and diameter, both length and diameter are designed, right as well as the flow rate because, that will depend whether you are having a 300 liters per hour, or 200 liter per hour, or 700 liter per hour, right.

So, that will give again in turn you the retention time of the ice cream mix in the ice cream freezer right. So, if we have understood this, we are skipping, some these are some parts, ok, that was a horizontal type of ice cream freezer, this is a vertical and this is done by our Indian company, like alpha laval, right that was perhaps an APV, entering at 4 degree and leaving at minus 5 degree, but in the horizontal one, you did not have to take care of the of the gravity, right you did not have to take care of the gravity. So, here you have to have the gravity also. So, accordingly the design is made accordingly, diameter accordingly, the length is designed, right.

So, this is why then vertical, because in many cases, as I said, when we were in Bombay, right, Quality ice cream was there, there the place who is, where the space is a problem, very high floor space price there, this vertical one is very very helpful, right, it does not take much space right. And that is why, otherwise this will be, may be couple of meters from this side, to that side, but here may be in a meter it can be accommodated right, that is the advantage of it. So, this how the vertical one, ok. Now, if we look at the other one, this is one which, we have already said that eutectic point, eutectic mixture, right. So, that eutectic mixture, this is a brine tank, this is a brine tank, whose temperature is minus 30 to minus 40 ^{o}C, depending on your requirement.

So, there with the brine, that brine, what are the components, that normally does not

come out of the company. I was with 2 year, but I also could not make it out what it is made of right. Now, inside is a vapour compression refrigeration system, system means that evaporator is there, and that is cooling this whole liquid brine to minus 30 or 40 degree centigrade and the ice cream lollies, which we take so, they are put in mould and the moulds are floated or just immersed into that, may be for some hour, depending on what you are making, it will take some hour, but the thing is that whole thing is liquid. In our childhood we had in our school around may be 2, 3 buildings after the school, after the school and since it is very close, and you had very, of course, we did not have any, like you have, the pocket money, we had no such thing during our childhood, no pocket money, etc., but in spite of that parents used to tell that do not go to that ice cream factory, there it was only like, this is circular that was a rectangular kind of thing, this kind of thing, we were told that do not go there because this ice cream is made from dirty water or nali kapani. You know the thing is that why a person instead of taking water may be from the tap, why will be using nali kapani right, it is because, we do not take, right and you obviously, you are curious, we used to go almost every other day and that time the owner of the this brine tank that, who is making ice cream lollies, he used to say please remain away from this tank and by no means do not put your finger into it, then it will be cut he used to say, it will be cut, right. So, we were afraid of, we did never put, of course, our hand, but it being minus 30, yes, there could have been a cold frosting.

So, that is how I still remember that, we used to say, we used to be told that do not take ice cream like lollies, right ok. Then we come to another very important one that is called overrun, which I said that 90 to 100 percent 105 percent air, and this is measured by overrun, this is called 90 percent overrun is 90 percent, or overrun is 105 percent, it can be calculated by volume. So, overrun, percent by volume is like this obviously, ice cream has more volume than ice cream mix, because there is no air. So, more volume is ice cream so, volume of ice cream minus volume of ice cream mix over ice cream mix into 100 is the percent overrun. So, I have given some example that if volume of ice cream is say 9.5, whatever be the unit of volume, and if 5 is the ice cream mix volume, then 9.5 minus 5 over 5 into 100, that is 90 percent is the overrun right. So, that 90 to 105, which we had said in the beginning is nothing, but overrun right. So, this overrun is to be maintained at either, not less than 90 or not more than 105. If it is less than 90, then the manufacturer has to give more material right. So, that will be a less profit for him, and if it is more than 105, then you are fooled, you buyer is fooled, because you are giving, you are given more quantity of air than required.

So, that is why the control unit or control system has given this the dictum that it has to be 90 to 105 percent considering both the sides right, both means consumer and the manufacturer, right. So, this is how and of course, it can also be expressed in terms of by weight, but normally, by weight is not used because that number is much lower and may

be some decimal, that is why here 90 to 105 is more unique to remember. So, by weight overrun, the obviously, weight of ice cream mix is more having the same volume, ice cream mix has more weight than that of ice cream. So, volume of 1 gallon of ice cream mix minus volume of 1 gallon of ice cream over, sorry, not volume, sorry, I am sorry, weight of 1 gallon of ice cream mix minus weight of 1 gallon of ice cream over weight of 1 gallon of ice cream into 100 is the percent overrun by weight right. As I said, by volume is the most popular, by weight normally, it is not used again to show that let me say that 8.85 is the weight of ice cream mix, 5.06 is the weight of ice cream, for the same volume and 5.06 is the weight of ice cream into 100, that becomes 74.9. So, in whatever combination permutation you do, it will be very difficult to get the whole number of 80 or 60 or things like that.

For that reason, the overrun is not expressed in terms of weight. It is always in terms of volume, ok. Then, let us go to this is a real problem ok. Let me say another thing very important here, this one this is a called Pearson square method. In earlier days, I hope you have now, you are using all calculators. Now, a days of course, your this thing what this fellow, smart mobile, is also with you.

So, that is also having calculator, but if we go back to days, back to decades back, when there was no calculator and I still remember, my brother in law who was also a faculty here, he used to, they used to use slide rule. I have seen that, but I did not use, because our time, calculator was also available. So, they used to use slide rules before that right, this Pearson square, he felt that the people who are working, they are under very much stress why? That they have to give the detail of the sheet like, perhaps, and there it is, it is used like this, 35 percent of say fat source is mixed with 4 percent of another fat source. Then, you have to get 20 percent, which is at the centre, now the question comes how much? Right, see it can be said 16 parts of 35 percent of 1 fat source if it is mixed with 15 parts of 4 percent of another fat source, they do make 35 parts of the fat, which is having 20 percent fat right. So, 35 parts you are getting by mixing, 16 parts of 35 percent, 15 parts of 4 percent, and getting 31 parts of 20 percent, this we have already shown you earlier. So, I am not going to again spend time on it right.

So, let us keep some and this is a typical ice cream scoop, right you are given ice cream scoop this, and you have seen that this is dipped in water, right, it is not for cleaning, because when it is dipped in water, this temperature is slightly increased. So, scooping becomes easy that is why it is dipped into water so that the temperature is increased. Then this is a, as we have shown in the freezing, ice cream not, ice cream generally, that freezing, with the mechanical or vapour compression refrigeration system, you see, how much time it takes, it is around couple of hours, whereas, with the help of liquid nitrogen it could be almost instantaneously, right maybe no time, or few seconds, or minutes,

right. Then this is the cold chain, ok. Now we come to the distribution. There are, as we have said, it is stored in cold room at minus 18 or below, and that is done by again vapour compression refrigeration system, and you might have seen, if you have any ice cream, further, nearby your place, that there is some ice cream coming through this type of mechanically refrigerated van.

What is there that machine that is cooling machine that is placed over the head of the driver cabin and inside there is an evaporator, and a fan and this distributes the cold air, but still it takes couple of hours time to cool right. Then, we go to another this is called polar stream, where liquid nitrogen is spread as and when required, right there is this liquid nitrogen cylinders, there is a three-way valve, and as and when, there is a sensor, this sensor tells that temperature has gone up. So, some liquid is spread and you know as earlier also I said, 1 litre is converted to 800 litre right by volume, 1 litre liquid nitrogen is converted to 800 litres of vapour nitrogen. So, this way, it can be used, this is called polar stream, and done by British oxygen, ok. Then we come to, and these are the how all cylinders are interconnected right.

Then, maybe there was no fan. So, some fans are used, right and this is the last one where this is called dump charging method, that means, you have already calculated all the heat required to tackle and then dumped air, we have done with liquid nitrogen, dumped all the refrigeration and temperature maybe from minus 18 brought down to minus 35, right. And this again, when come back, comes back to minus 18, it can be transported from one place to other place, right. So, this is how the transportation of liquid nitrogen transportation of ice cream can be done. Now, our time is over I am really thankful to all of you that you have patiently you have heard my lectures and I wish that you have learnt something and that is where is my success. If you have learnt something and one more request from my side that those who have registered please and again please appear in the exam it is only a 1000 rupees for examination fee perhaps.

So, far I know that you will get a certificate and this certificate you can utilize anywhere in your college because it is under the ministry. So, your equivalent this thing credit course can be taken out from the normal your courses. So, this is very very helpful and obviously, challenging you have to appear in exam as well as every week you have to appear or not appear you have to give some exam or assignment right. So, everything put together when you are taking so much trouble by completing why you do not appear in the exam. In the previous one just completed I think around 5000 students they attended the whole classes registered and attended, but only around 1500 students appeared right.

I do not know whether everybody passed or not obviously, as usual in the colleges and

everywhere some people get EX, some people get moderate, some people get even lower and some people also fail. So, here also it will be a similar distribution depending on your performance. So, it is a challenge. So, please do appear in the exam. Thank you so nice of you I am so happy. Thank you all.