

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

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Lecture 01

Introduction to Cooling

Good morning my dear students. At the outset let me wish all of you Shubho Bijaya. Just now DP has been over, i.e., Durga Puja, and as you know that in Bengal it is a big ceremony and we obviously, go to the full extent of our enjoyment and also Puja. However, we are now in a new course and this is under NPTEL and the name of the course is Cooling Technology Why and How it is utilized in food, right.

And it is a cooling technology and its application, because as the name suggests that why and how it is used in food that needs to tell that how the cooling is produced and why it is produced, right. You do not go to the market and buy anything which is not required. So, you must know that why it is used or required and how it can be produced, so that we will do obviously, while doing it many ancillary things may come up, it may be beyond the scope of the course curriculum, but even then, I feel, any new thing, which will come, I will try to touch upon or brush it up, so, that your old memory can be utilized successfully, right. So, whenever we are talking about cooling, let me tell you some preliminary things, which you also perhaps know, but even as a recapitulation for you, or you may not be knowing because you do not know.

Now, the thing is that, I hope in everybody's house, at this present time, in everybody's house, there is a refrigerator, right and this refrigerator is nothing, but a cooling unit. Those, who are in very very cold area like at very high altitude like Darjeeling or Kashmir or Ladakh or things like that, for them, already nature has produced cold, but those who are say in Delhi, Delhi of course, during this November December January February, this 3 4 months, is very cold, but say some part of Rajasthan, some part of Maharashtra, some part of Bangalore, Mysore, Karnataka, Chennai, Bengal, some part of northern places, Bhopal, MP. Similarly, many other places round the year it is hot except for 1 - 2 months during winter season and that also does not go in most of the cases less than around 10 degree of course, in centigrade. Now, in this 10 degree centigrade many food materials are not supposed to be kept for a long period. It can be for 1 - 2 days, fine no problem, but if you have to keep it for a longer period, then, it is not, and that is why the refrigerator has come in your house.

Now, the question comes from the knowledge point of view. Afterwards you will see

when we are proceeding towards the right class or right period, there you will be talking about how the cold is produced and mostly it is vapor compression refrigeration system or VCRS or VCRC whatever you call. In this vapor compression refrigeration system if I ask you, whether you have seen your refrigerator every day or not? Your parents have used your elder sisters brothers they have used, but have you ever asked them that which one is compressor, which one is condenser, which one is evaporator and which one is expansion device? These are the 4 components of vapor compression refrigeration system. So, if you have not asked, if you know, obviously, you will not ask if you know, but if you do not know, if you have not asked then, ask today because when you will be marrying and you will have your children, it may so happen at some point of time. Nowadays, schools are starting right at 1 and half year to 2 year of the child that is pre-school etc, etc.

So, lot of information, they gather and they may ask you papa, mammi, who so ever, what is this fellow which is on the one side of the room or kitchen wherever. Then you have to answer and you know for the child, the best teacher is the parents, best teacher is the parents not the schools not the other places because they learn mostly from the parents and environment. So, if you are asked what is this and if you are not able to answer, it is not that every part in the world you are supposed to know, and you will be able to answer, that is also true. But this is so common and so obvious that they will think that my parents do not know this is what is the bad part because as I said, to the child, the most, what should I say, the most lovable person or respectable person is the parents and if parents are not able to answer to their queries then obviously, that is against the confidence of the child. However, you can look at the refrigerator.

Now, now-a-days there are 2 types of refrigerators. which is totally a box from outside you do not understand anything just a box. It can be single door, double door, triple door depending on the type of freezer or a refrigerator, rather. So, if it is a single door or double door whatever, but you do not understand from the outside, but if you can come across with the old ones where there is a compressor down below the box, there is an expansion device again that is down below the box, there is a coil inside the box, on the top of the box, there are some coils right and on the back side of the box, there is a, what we call usually, that is a net, there is a net kind of thing made of, of course, pipes small small very small pipes, but it is appearing like a net. So these parts if we identify then if we tell our children they will be very happy and their confidence on the parents will also go up.

Why I am starting with this because this is the beginning which is at home and you should know and you should learn. If you know, I am sorry, for repetition, but if you do not know and there will be many who do not know, of course, there will be few who also

know, right. So, as I told, the modern refrigerators, which are in the market, they do not have anything which is visible from outside, it is just like a box one as I told one or two or three depending on the freezer you are buying. Then there also if you watch that one side of the refrigerator is warm right and if you have watched, even smaller kids those who are crawling or walking, starting walking etc. If you have the older ones even the new one by chance if they have touched upon the hot side they will never go to that place again and touch it otherwise most of the child they play with the things available in the house apart from their own toys. So if they touch the hot side that will be a lesson to them that this is hot do not come and touch it again.

It is from the beginning of the childhood where the age could be around plus minus 6 months they are crawling or walking and if you have or they have the old version models they are also on the backside that net which I said if they touch once they will never again go to the place of the refrigerator which is kept right. This is the tendency or nature of the children or everybody even we, when we were also young, of course, I do not remember during my old those days whether there was any refrigerator in our house or not, most likely not. However, we have seen our children, we have seen other children the similar things are happening. Now, let us come to that, which one is what? As far as the first one I said, the box, which is not visible, the entire thing, because it has to have a compressor a condenser an expansion device and an evaporator. So, there also nothing is visible you cannot see from outside or from inside also, but you know that there is some deep frosting, and this deep frosting is automatically done in those cases.

But, if you as I said, if you touch one side you will see, it is hotter and the condenser unit is there, right, whatever heat is being transferred to the ambient that is condensing the compressed gas, right. Compressor, that is black, will come in detail when we will be coming into the appropriate place. So, that is the compressor, by the side and compressor is also hot. So, the child, who is crawling or walking at that stage, if they have the tendency to know the unknown, both by either touching or putting into mouth if whatever is possible. So, if they have ever touched that compressor in absence of you of course, in presence of you will not allow in absence of you if they have ever touched they will not again go back to that place because they have gotten a shock this is thermal shock as well as mental shock.

So the compressor by the side of that there is an expansion device generally this household refrigerator they have the expansion device through capillary tubes. So we identify two other two one is the condenser which is behind there or on the back side of the refrigerator. So on the back side of the refrigerator which is there that is the condenser and that also is hot. So the child, if he goes there, touches will never again go there. Now, why there are many types of condensers, many types will come during the

course of the classes many types are there and this one is typically called air cooled because surrounding air cools, and that is why you will see, you will observe at home the refrigerator is kept at a little away from the wall it is never placed one to one against the wall.

There is a gap between the wall and the refrigerator why because air from the surrounding has to blow or flow. So that the condenser is condensing and it is being transferred from the condenser to the surrounding. Then next one is the evaporator, now which one shall you call evaporator? I told that in the old models there are some coils down below in side the top that is called freezer cabinet. So in that freezer cabinet down below you might have seen some coils which are there and as I told that in the present ones that is the modern ones they do not have any such evaporator, right. Then the old ones, as I said, there is some, shall we call that to be evaporator, the question comes what is the function of the evaporator? Compressor compresses the gas then condenser condenses the gas to liquid, fine, expansion device throttles the liquid to low temperature you desire, evaporator what it does, it accumulates heat from the material from the surrounding from everywhere and give it to the evaporator and thereby the coil or thereby the liquid, liquefied gas get expanded or gasified and that again goes to the compressor right.

So, if we know this function of the evaporator then shall we call only the freezer cabinet down below where the coils are there shall we call that to be only evaporator since you are not able to reply. So let me tell you on your behalf no it is not that because apart from the freezer cabinet where you are keeping fish meat other things which are stored for number of days, right. So apart from that, there are trays down below that freezer cabinet and in that trays you are keeping either leftover food material or freshly prepared food material for future use. There is also absolutely down below, there is also a cabinet and there you are keeping the fruits vegetables everything on the door you are keeping lot of things for cooling, maybe water maybe some other things and maybe some valuable like egg also there is a place where you are keeping eggs. So, are they not contributing to the heat to the evaporator? Obviously, because if you even touch the egg it is cold if you touch the water which you have kept that is cold.

There is water ice tray forming ice, right from water to ice that is also getting cold. So, all these are contributing heat to the evaporator, then outside temperature, which is depending on time, of course, time of the year it is, maybe 30, maybe 40 maybe 50 degree centigrade whereas, inside is 4 5 6 8 10 degree centigrade or in the freezer cabinet it is minus 10 degree centigrade. So, out of this in whole delta T is a lot, delta T is 50, if you take plus 40 ambient and freezer cabinet is minus 10. So, 50 degree centigrade delta T so, lot of heat will be infiltrating. So that is taken care of by the

evaporator, right, then whom we can call the evaporator in that refrigerator system, it is the entire box, right.

Let me draw a little if you will understand that it is the entire box. So you have this freezer right and you have trays like this like this like this, you have one freezer cabinet like this, right, it may have one holding system, right and we said compressor is down below we said expansion device is down below which on the back side of it. if we look from the back side then it will look like this that there are like this some thing so, this is the condenser right. So, if that be our question was which one is the evaporator out of this entire box, sorry for redoing redrawing because then we had the cabinet. So, cabinet is c a b cabinet we had the compressor here we had that expansion device here and we have different shelf to keep many things and down below there is one again fruits and vegetables holding things and this side, this side, this side, this side, that side, and below all are insulated.

In the earlier stages, it was with glass wool, but nowadays it is with puff PUF polyurethane foam which is expanded in situ, right. So, this puff or insulation is protecting inside here, say, 4 degree centigrade, inside here, say minus 10 degree centigrade, right. So, this insulation, this puff is protecting the entire freezer from outside 40 degree centigrade, right. Whereas, these people are around 4 degree centigrade. So, total heat is coming from the cabinet, where you have put legs of, maybe chicken, or parts of fish etc or meat, here you have kept some dishes which are already prepared or maybe the leftover from the previous lunch or dinner or breakfast whatever.

So, everybody is contributing to the total heat required for evaporator right total heat available from the evaporator. So, we can say that the entire body, the entire body of the refrigerator is acting as evaporator it is not the coil down below here, right. Whereas, it is through which the liquefied gas is moving and that is cooling the cabinet and that is in turn, because it is hot, it is cold, you know cold air will be thicker it will come down and hot air will be lighter it will go up. So, this way, there is a convection current inside the freezer and it is keeping the temperature low right. So, this is the way how we say that the entire body is the freezer entire body of the freezer is or refrigerator is evaporator ok.

So, thank you for this class this is the preamble or very preliminary of the cooling ok. Thank you, so nice.