

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

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Module No 12

Lecture 58 **Cold Storage**

Good afternoon my dear boys and girls and friends. In this course we are on the verge of completion of the course, we have 3 more lectures left, and as I said earlier that, my last lectures will be on ice cream, but as you know that, ice cream is a very cold product and definitely cold is associated with that. So, our purpose of the course will also be justified. Now, we were in the previous class with cold chain and cold storage, right, and let us complete the cold storage today and to do that. I had shown you condenser and also said that what exactly is happening in the cold storages right. I had shown you exactly one, from one of the cold storages, but I have visited tens of cold storages, but I did not find any, anything, which is beyond, what I said right. Because, most of the cold storages are very very old, and not only old, they are designed, on the basis of thumb rule, no detailed calculations are made.

Fortunately, we had done lot of calculations with the help of CFD computational fluid dynamics, so, there we have shown also what are the real problems associated, and with that let me show you that, in this cold storage, in this cold storage, yeah, this I have, I will come back again, but what exactly this heat of respiration? Earlier also, I have shown and told you during our load calculations, how the heat of respirations are calculated right. Some of the heat of respirations at different temperatures are given here. Now this I would like to discuss in detail that, why the situation of the cold stores is like that. From here, what we observe that, while we are considering refrigeration load, that depends on primarily heat of respiration, that is one part, second part, heat in leak through the insulation, and third part is the handling by the compressor.

So, these three parts if we look at separately then heat of respiration that depends on the quantity of if it is potato as one of the storage material, its maturity whether it is early or matured that depend that will depend the heat of respiration. So, some question rather the quality of the potato that is also important right. Then heat in leak through the insulation that depends on insulation quantity and quality right. So, insulation technique is also important how it is being insulated I said one of the other day that if a pipe you have to insulate with a 6 inch. So, this is 6 inch insulation and this is the pipe right.

So, if you have to do 6 inch insulation what you will do what is your reply will you buy

one and if it is a cylindrical one definitely that also will be a cylindrical one. So, are you going to buy a 6 inch half of it. So, 6 inch half this side 6 inch half that side are you going to buy an insulating? If the answer is yes then it is no you should not because yes if you buy in one shot 6 inch insulation then your cost will be less, but you see your pipe is this and your insulation whatever be the insulating material whether it is polyurethane foam of course, polyurethane foam is not insulated like that mostly it is insulated in situ and it can be thermo cold right. So, if it is thermo cold then if you buy a 6 inch like this then there is can be some cases where your insulation is almost thorough. That means, the density depending on the density how much compact it is air can be going in and out easily.

So, to avoid that it is advisable that such a pipe you insulate with number of say 2 inch then another 2 inch then another 2 inch. So, that this 6 inch there will be lot of resistances. That is how here we said that insulation technique how it is being insulated. If we talk about insulation quality then what is the type of insulation you are using and then it is degradation by vapour permeation whether it is degradable or not that also has to be looked into, but as I said in most of the cases things are not like that. If it is from the handling of the compressor then for the compressor nature of cooling what how you are cooling the compressor then how it is associated with the condenser and also with evaporator and what are the compressor types you are using.

Now, nature of cooling it could be again by convection by either natural convection or forced convection. So, this are you have the possibilities you have to of course, select the best then over when you are talking about condenser whether it is air cooled condenser or water cooled condenser. If it is water cooled condenser whether it is a bare tube or fin tube and the other type of condenser could be it is evaporative type of condenser. Again you have to select the best for evaporator again whether it is a bare tube evaporator or a fin tube evaporator. If it is for the compressor then whether it is ammonia or Freon obviously, depending on ammonia or Freon it will be quite different.

So, you have to select out of these the best one best combination you have to find out that is technical. Now what actually happens is that the this is the actual vis-a-vis the owner of the store. So, owner thinks that more capacity of the cold material must be kept. Yes that is giving him a positive gain because more money can earn from the storage and as the rent for the material right. So, this could be a plus for the owner right.

So, for that what he needs to do he has to store it with more compactness right very tightly like one here next one is adjacent to and one above it one below it like that more compact he has to do. Then if it is done that more compactness as he will get positive result out of that the more rent he can gain, but what he has to forgo for that. This will

lead to higher temperature at the centre and this higher temperature at the centre means more rotting at the centre this is a negative rotting means you have to throw out. So, this is negative which they do not consider or it can be low temperature at the surface. I will just show you again that how it is compact and how the evaporator coils are there.

So, he has to bring down the temperature to make it more compact. So, that assuming he will supply properly the cold air for that temperature has to be lowered and the moment he does it is low temperature at the surface resulting to more cold injury at the surface. So, that is also negative for the owner. Now, the moment the temperature is lowered how it can be done by lowering temperature of the evaporator. So, when he is doing lowering of the temperature of the evaporator this will lead to more moisture on the evaporator because the more difference of temperature moisture will migrate from the potato to the evaporator.

So, this will lead to more frost on the evaporator which is also a negative part because the moment frosting is there other, day I said that, that will act as insulation. So, this is not absolutely desirable. Then this lowering of temperature in the evaporator means more compressor work is required because we have seen that if you lower down the evaporator temperature then compressor power requirement is more. So, more work for the compressor again more energy consumption which is also negative right. So, that means, you see, for a gain of some rent from the material, so many negative things he has to undergo, which he is just forgetting or overlooking whereas, if he does the reverse, that less quantity of material for stacking with air flow space in between bags if he has that.

So, it will affect less compact of the cold room. So, less quantity of material so less rent obtained so it is a negative on the owner side, but what will be positive? So, this will not result to high temperature at the centre. So, not too high temperature, or it is reasonable a temperature at the centre. So, this will minimize the rotting. So, that is a positive he does not have to throw out to the material.

So, that is positive. So, that means, he does not have to low temperature at the surface or surface temperature will not be low on the top. So, that will result to less cold injury which is also positive he does not have to throw that cold injured product out because neither the person who kept it nor the consumer will accept it right. So, he has to throw. So, this means that higher temperature of the evaporator the moment temperature is higher we have seen earlier compressor has to work low.

So, less compressor work so which is also positive power consumption is less. So, less energy consumption that is also positive and the higher the temperature of the evaporator less is the moisture migration because temperature difference will be less moisture

migration also will be less deposition of the moisture on the on the evaporator will be less. So, there will be less frosting. So, the heat transfer will be better. So, less frost on the evaporator so that is also positive.

So, with all these negative and positive part putting together what gain one cold room owner cold storage owner is gaining he is if he is keeping more quantity of material thereby he is earning more rent, but further he has to have all negatives right. And if he does keep reasonable quantity, a little less than compact, then his earning will be less in rent, but all others will be positive no loss due to frosting no loss due to cold injury no loss due to again rotting everything is not there and power consumption in the compressor is also not the high as well the evaporator will have no such frosting by which the heat transfer will be minimized right. This is the real picture reality, but nobody listens to it. So, if we go back as we were starting with we have shown with the condenser now we show the evaporator. So, this is the evaporator coil ok.

This is one, which is just after running the compressors. These are the holder of the refrigerant, from where it is getting distributed. These are the pipelines as you see some frosting has started right because these people they do not believe if there is no frosting that means, the system is not working, that is what they feel not only they feel it has been told that you see that, there is frosting, then only you can confirm that your system is working. They never go and check, there is a ghory (dial), that what they call that, there is a dial, that dial they will never see that, what is the pressure, what is the temperature. So, these things are not taken care of.

So, this is one which has just started the frosting. Now, next if you look at you will be surprised if you look at the next you will be surprised. We said now, just now, that the more quantity they can put more is the rent. So, more is the profit it is not at all because at the centre of this at the centre of this, this is, there are, as you know there are 6 feet by 6 feet by 6 feet cubicles right and as you know, I will show some that the floor is like that. So, there is some gap by through which the air can go in and come down it is all in all floors except the top and bottom, bottom means ground.

So, they do load it in such a compact way that there is no chance of flow of air inside. So, the one which we said rotting will be there and this is true. It has been seen that many bags they are rotten simply rotten right. Rotten means, burnt out black along with the material, because, this heat of respiration is also high, and if they are not eliminated and that too there will be carbon dioxide production inside, because, it will not be going out, it is respiration, the same respiration you are having. So, more compact is injurious right.

Then another one, which you can show is this. I said that there are fans, which are axial fans, like at your home, and imagine that this is on the top floor, 54 feet height of the cold room, 54 feet height of the cold room at the top it is there. So, we can reduce 5 feet. So, around say 50 feet roughly, the air has to travel. For that what are the resistances? First resistance is that, these are all evaporator coils, I said that evaporator coils are roughly around 30 to 35 kilometer in length, for evaporator and condenser. So, around 30 to 35 such kilometer coils are there, and here you see the previous one, I showed, which was just starting the frosting, and here it is, a thick ice is there. So, that means, if the refrigerant inside is at minus 2 degree say, then because this is ice, it is not getting minus 2, the rest is only getting 0 degree, right.

So, ice is acting as the resistance for flow of heat, and where from this ice is coming? This ice is coming from the packets, which I had shown you, from the packets which I had shown you just now. So, these packets' moisture will come out from them right and will accumulate into the evaporator coil. This we have discussed beforehand, right. So, this is the actual condition, and nobody looks at, nobody in anywhere of India takes care of this, unless and at least, not less than 25 to 30 interactions with the farmers, and the cold store owners, tried to convince, but they understand, but the moment they leave the place, forget everything. So, it is exactly happening like that which is absolutely not desirable.

So, the desirable one is one, which just we showed that, you should have, you should have, I am not going back to this, you should have, this action should be followed, that less quantity put, you have all positive, except the rent is less, except that you have everything positive, and you have really a positive gain, your profit will be much more, because, nowadays, that energy is becoming day by day increasingly high, and the power consumption, if it is more, then the electric bill will be very very high. It is several lakhs they do pay, because of miss handling. So, my request to my students that, if you really come across with the cold store people, try to make them understand, only this page is good enough, for rectification of the cold store. I have shown you the reality in terms of condenser, in terms of compressor, in terms of evaporator coils, but and also the fans, but, I could not show you the expansion device, right because, those are very very close to the evaporator. So, could not find, it is, and please convey that it is a loss for them.

So, with this, I complete the cold store part, and next we will go for the last two classes, in both manufacturing ice cream, and preserving or storing it and transporting it. So, thank you all for carefully listening. Thank you.