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

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Lecture 41

Selection of Condenser

Good afternoon my dear boys and girls and friends. One thing I would like to share with you at this moment that, we have crossed 40 lectures, we have only 20 more. A lot of things are there to cover for which, it may not be possible to go in depth in every cases, because, we have to, in any case, complete within 60 classes. So, we have only 20 more, still we have the parts like compressor, condenser, expansion device, then, evaporator, all these things are remaining and then the application. So, as far as practicable, I will try my best to cover most of the things, so that it becomes your total package. And in today's class, we will start with selection of condensers right.

In the earlier class, we have done with compressors, and its effect, multiple effects on the condenser evaporator, expansion device. So, today we are doing on selection of condensers, right. So, to do that you have the choices that you can do or select condensers either air cooled condensers or air cooled with water spray condensers or maybe shell and tube condensers with water cooling. If it is water cooled shell and tube condenser then it could be either lower discharge pressure or higher tonnage of refrigeration TR or lower power consumption.

Obviously all these selections you are making according to your suitability whatever is best suited for you will select out of them. The choice of condensers is normally practiced between air cooled and air cooled with water spray. Why? Because air cooled means you have you do not have to pay for the condensing fluid that is what exactly in our household refrigerator you have seen on the back there is some coil kind of thing not coil that is a net kind of thing. So, that is the condenser and that is cooled by air and that to room air right. So, that could be one or it could be condenser with water cooling.

In almost all the cold storages and other places it is done with condensers with water air cooled condensers with water cooling supporting. We will also come when we are in condensers design of condenser or different aspects right. So, for large shell and tube heat exchangers where it is 0.65 meters per tonnage of refrigeration and those are used as condensers and those are equipped with good cooling tower operations allowing operation at low discharge pressure values and improve the tonnage of refrigeration capacity of the refrigeration plant and this is how it reduces the power consumption right. So, we are not going again with the example right.

Let us go to the next that is maintenance of heat exchanger surfaces this I told earlier also that poor maintenance that is increased power consumption. So, if you are not able to maintain the surface then you are inviting to increase the power consumption. Maintain condensers and evaporators correctly by which you can separate the lubricating oil from the refrigerant timely you can defrost the coils that is evaporator coils. You can increase the velocity of secondary coolant if you are using and cooling towers you can maintain where 0.55 degree centigrade reduction in returning water means in cooling tower some sprays are being given and air is coming from bottom of it and going at outlet.

So, the bottom where from the water is pumped and supplied to the condenser that only 0.55 degree centigrade reduction can lower the cooling tower power consumption by 3 percent. So, this is another very important information. So, once compressors have been purchased effective maintenance is the key to optimize the power consumption right. So, a maintenance checklist for condenser and evaporator could be like that ensuring proper separation of the lubricating oil and the refrigerant.

Very defrosting of coils increasing the velocity of the secondary coolant, that is, air or water etc. right. So, equally, you have to give importance to the proper selection of the compressor condenser evaporator its sizing and maintenance of the cooling towers right. So, if we look at effect of poor maintenance on compressor power consumption obviously, you see that it is specific power consumption from 0.69, that is, normal the temperature is 7.

2 degree centigrade, right, that is, condenser temperature, no,that is, evaporator temperature, and condenser temperature is 40.5, right. In that case, normal if it is 0.69, specific power consumption per kilowatt, rather kilowatt per tonnage of refrigeration, then, if it is dirty condenser, and evaporator, where, evaporator temperature is 1.7 and condenser temperature is 46.

1, and specific power consumption is increasing to 0.96, earlier it was 0.69, now it is 0.96. So, it is increasing almost 40 percent of the power consumption.

So, you have to be very careful in selection of that. So, this shows that the effect of poor maintenance of compressor, power consumption and for example, a dirty condenser, and evaporator can increase, as we said, around 38 to 40 percent. Then, you can have multi stage systems, multi stage in the sense, this is, suitable for low temperature applications with high compression ratio, wide temperature range and there are two types of compressors, two types of compressors, and they are compound and cascade right. Obviously, the compound is really compound, and cascading is more important. I do not know, how many of you have seen that, how many of you have seen that.

In the laboratory, there are typically for biological material storage, there are deep freezers, which can go even up to minus 80, minus 90 minus 100 degree centigrade, with only

vapour compression refrigeration system, with a single system. It is not possible to reach, arrive, at that temperature. So, there, either compounding, or cascading is very much required. So, what is compounding? Two low compressor ratios, that is, one high and one low, first stage compressor meets cooling load and second stage compressor meets load of the evaporator and flash gases. Single refrigerant can be used so, that is, compound type, whereas, cascading type it is preferred for minus 46 to minus 101 degree centigrade, right.

Two systems with different refrigerants in the compound system, it is single refrigerant can be used, but the systems are two low compressors with compression ratios one with high one with low. Whereas cascading, you are doing with two systems with different refrigerants, right. So, for cascading, we can say that, it is very good between minus 46 to minus 101 degree centigrade, and cascaded systems are normally used. In this system, two separate systems, using different refrigerants, are connected to that one rejects heat to the other, right. So, one system is rejecting heat to other and that it is taking.

The main advantage of this system is that, a low temperature refrigerant, which has a high suction temperature, and low specific volume, can be selected for the low stage to meet very low temperature requirements. Otherwise, minus 100 degree, it is very difficult to achieve, ok. Now, you have to also look at matching capacity, to load system. Obviously, matching capacity in the sense, say, you have taken 100 tons of, or 100, I told you earlier also, that, the compressors are still expressed with hp, right. So, if you have taken 180 hp, 3 or 4 compressors, already, maybe 80 only, 80 hp, 3 or 4 compressors, but your evaporator or condenser are not matching, either over or under size.

In either case, your COP will be going down, right. So, you have to look into the matching of the, load matching capacity of the individual components so that compressor, condenser, expansion device, and evaporator, they are well matched, right. So, if the ambient variation is there, then, also it will not affect that much, that you have to look into right. So, you can skip, and then, capacity control of compressors, what is that the cylinder unloading vanes valves all these are associated with the compressor. Reciprocating type of compressors, where, step by step, through cylindrical, or cylinder, unloading, it can be controlled.

If it is centrifugal compressor, then, continuous modulation through vane control is required. Then, screw compressors, if it is used, then it needs, sliding valves. So, unloading of the vanes, or valves, for different types of compressors, in different ways, that, is one, you have to do it. Then, how to control the speed? If it is reciprocating compressor, then, ensure that the lubrication system is not affected. The other day, when we were talking about Carnot, and it afterwards, we said that, the lubricant is carried away by the liquid refrigerants, which is not desirable, right.

If it is centrifugal compressor, then, more than 50 percent of the capacity is used only. Then, we skip. This temperature monitoring. This is one vital thing, because, ultimately, it is the temperature, which is giving you the COP, right. So, if it is reciprocating compressors,

then return water, that is, varying with the local conditions of water leaving chiller, that is also, can be a constant load, but you have to look into the temperature correctly.

In centrifugal compressors, outgoing water temperatures must be correctly monitored. In screw compressors, outgoing water temperature, that is also required to be controlled. If it is a part load application, then, screw compressors, are more efficient. The other day, we were talking about part load, but part load normally, we do not come across so much unless your system is divided in different segments, right. You have one storage with one capacity, one temperature, another storage with another capacity with another temperature, like that, if it is there, and out of that, if one is not, say, working, or is not used, then, why you will do all the segments or cabin or whatever you call cooling? So, that is why, the part loading is coming in.

So, that has to be correctly done. Then, multilevel refrigeration, like bank of compressors at central plant, even many buildings, many houses, many places, you will see that multilevel refrigeration are done. In some rooms, you have computers, and many other, very very sophisticated instruments. Here, the temperature requirement is very very low, and at that low temperature, people may not be able to feel comfort. So, you need multilevel refrigeration.

There, you are monitoring cooling, and chiller load. One chiller full load is more efficient than two chillers at part load. Isolation systems are also to be monitored. Individual chillers feed all branch lines. Isolation valves, valves to isolate sections, that is, how they could be isolated.

Now, load individual compressors to full capacity before operating second compressor, if you have multi compressors. So, one used fully, and then, use the second, that use fully, then, use the third one, and provide smaller capacity chiller to meet peak demands. And these chillers are, of course, usually used for local cooling, right. So, we skip this. Then, packaged unit, that is instead of central plant.

In many cases, central plant may be advantageous, and some cases, it may be disadvantageous, right. As, I just gave you the example that, if you have this one, this one, this one, all connected to one unit. Then, what will happen, if this is not working? Then, unnecessarily, the system will run, right, or if both are not working, only this is to be required, to cool. Then, these two are definitely not required to cool, and in that case, you have to do this package units. Package units means, for one unit, sorry, for one unit, you have a full system, that is compressor, condenser, expansion device, and evaporator, right.

So, all are in one unit right. So, that is more useful. If the system is of very very low capacity. Then, chilled water storage, in many cases, where, unlike our country, which is warm country. In moderately warm country, there, in many cases, chilled water is used as the circulating, or cooling medium. Obviously, chilling is also to be done by the compressor,

condensers.

So, chilled water, that is to be stored, and you should have storage facility, and that should have insulation. Similarly, if you see in your household refrigerator, you will see that, a part, which is going from the compressor and then, from the condenser, then, going into the expansion device, from expansion device, it is going to the evaporator. So, a part is always insulated, right. Typically, where it is from the expansion device to the evaporator.

So, that you have to take care of, right. Then, let us skip this, the system design features, what are the features, for designing the system. Number 1 that, FRP, this is a part of civil impellers film fields, PVC drift eliminators they are used. Softened water for condenser. Now, soften in the sense, you know that, hard water and soft water. So, that with respect to that hard water, it is said to be softened water, right.

So, that the dissolved, which, may cause, which may cause deposition in the pipeline. So, those are to be removed beforehand, and that should be used in the condensers, but unfortunately, in most of the refrigeration units, you will see that, this softening may not be properly done. Then, insulation must be economically thickened. It's thickness should be given as economically possible. So, that your loss of cold, or gain of heat, is minimum.

Roof coatings, and false ceiling in almost all the cases, you have seen that, where things are big, they are using either roof coating, or false ceiling because, this minimizes the heat load. Then, energy efficient heat recovery devices. If there be, it can be used, variable air volume systems, that also can be used and some film application, for heat reflector, that is also used. In cases, if you have a coating, that will reflect the heat.

So, that will be also very much useful. So, you are also supposed to optimize the lighting facility or load from the light because, if load from the light is also very high, then unnecessarily you will go on increasing it. So, we can skip this, and we can now say, that hurriedly, we have come across with the different situations. Like, first thing is that, matching of the capacity, which is very much fundamental, that matching of the capacity is absolutely required, like your compressor, your whatever is capacity, your condenser, whatever is capacity, your expansion device, whatever is capacity, and evaporator. These four must be aligned, aligned in the sense, in terms of capacity. So, if it is very high capacity, and others are low, then, unnecessarily, you will be spending money on the compressor.

Similarly, if compressor is reasonable, but you have chosen a very big condenser, right. Someday, I will show you, how the commercial condensers are there. In the course, during the course. So, there you will see that, if the condensers are very very big, more than required, then, that is also costing you/ Expansion device, normally, it is having a parity with the compressor, and condenser, but evaporator may be either high or big or low. So, that you have to take care, that the matching of the components are very well done ok.

Our time is over. So, thank you for listening. Thank you very much.