Dairy and Food Process & Products Technology
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Lecture - 54
Process of Ice Cream Preparation

So, in the previous class we had said the ice cream, what it is made of and what the constituents do? What is the role of the constituents? So, in this Dairy and Food Process and Products Technology, lecture number 54 let us look into how it is made right. What is the process by which ice cream is manufactured? You see I have given a flow chart in that way that the solid raw material whatever it comes right.

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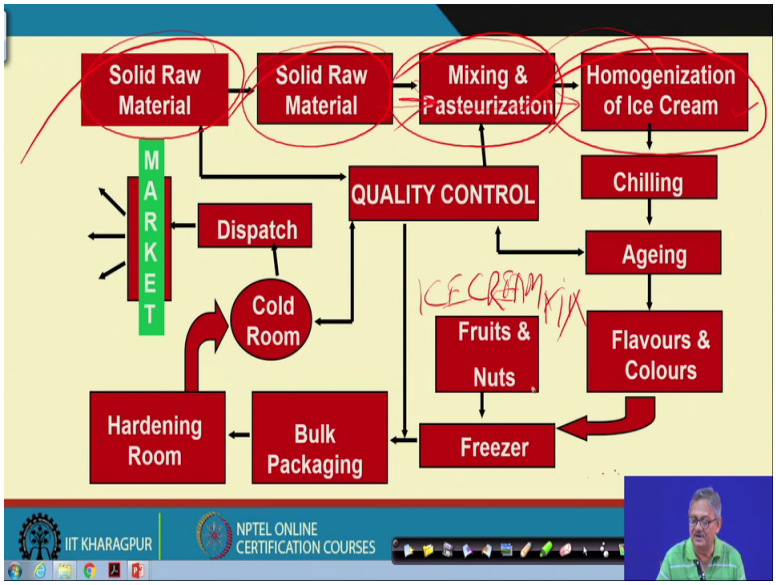

We have said in the constituents that you have sugar, you have butter, you have stabilizer emulsifier, then solid not fat. So, all these solids are there, all the materials are coming and then milk, in many cases people do directly use milk or that depends on the manufacturer where whether they will l substitute water with milk. Or they will take water from the milk or they will add externally water and make the composition that is entirely the manufacturers right or they select, but whatever it comes their solid raw materials, it comes right.

So; this solid raw material comes and then they are mixed with the liquid and solid. So, this is mixed and pasteurized. So, after mixing and pasteurization, it goes to

homogenization that is the process flowchart, it goes to homogenization of the ice cream mix, this is called ice cream mix. Here, whatever is being going is called ice cream mix right. So, this ice cream mix is then homogenized and, then it from homogenization goes to chilling. After chilling it is aged or called ageing, then it goes to flavor and color addition it, then it is taken to the freezer.

So, when it is been getting freeze frozen say, at the before it is coming out, these fruits and nuts are added in that, that softy or soft ice cream and then it is going to for bulk packaging. So, maybe small cups like that if this is a 50 ml cup like that say 12 or 24 50 ml cup, 24 numbers are packed in a container and in a paper pack and then it goes for hardening right.

So, bulk packaging, it is there and it then it goes for hardening and after hardening it goes to the cold room, from the cold room goes to dispatch and to the market right, but in all the cases there is a quality control, which controls all the quality at every stage right. From the raw material or milk then mixing and pasteurization, when it is over or not then, homogenization that is proper or not then chill for definite period that is done or not then ageing. So, ageing is there for a definite period chilling at a definite temperature, ageing for a definite period, whether that is done then flavors and colors are added.

Then fruits and nuts come into the freezer and and before it is exiting, then packaging it should be; so, every stage quality control is being considered and this quality control is controlling the quality of the product right. Now, how then, what are the parameters which is involved in this process flowchart?

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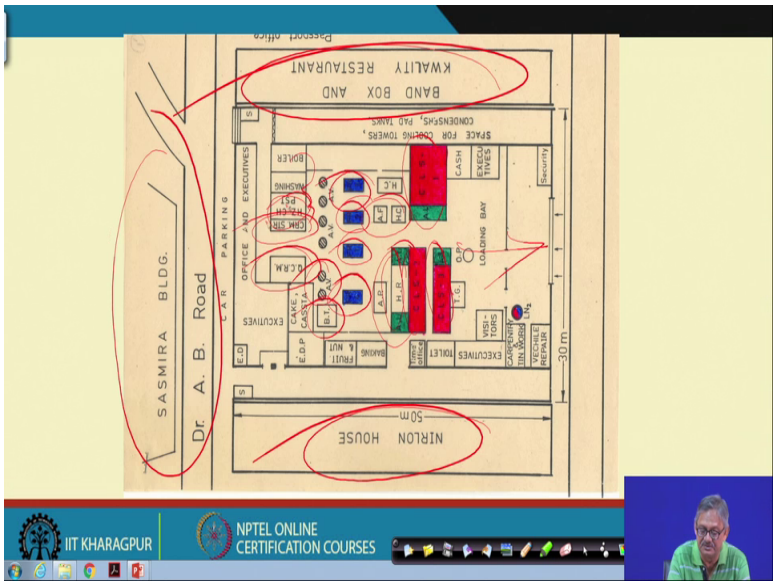

This is a typical ice cream making industry, where a layout I have given right. So, do not look at these, because these are some, but this was, it is no longer there, I used to work there that is why I could make it right.

So, here you see the primary things are that, your product is coming right, your product is coming. Yeah, it is coming and then it is going for here right. It is going for your mixing and mixing and after mixing it is going for your pasteurization and then homogenization. And, everywhere there is a quality control, which is coming in and, this is a ice cream lollies are being made, the freezers are there right and, cold storage hardening room. This is the hardening room cold storage they are side by side right.

And, and this is the outlet bay, where the loading unloading are being done right. So, this is the quality QC or room quality control room, where it is being then this is the edging vats right and this is a brand tank where your, ice cream lollies are being made right. This is the cream, then pasteurization homogenization, they are being done then, could be, whatever heating boiler is coming true and, these are the different freezers which are used ok. So, these are layout for the entire thing. Then, how it looks like under microscope, in under microscope it looks like this; where a is the ice crystals.

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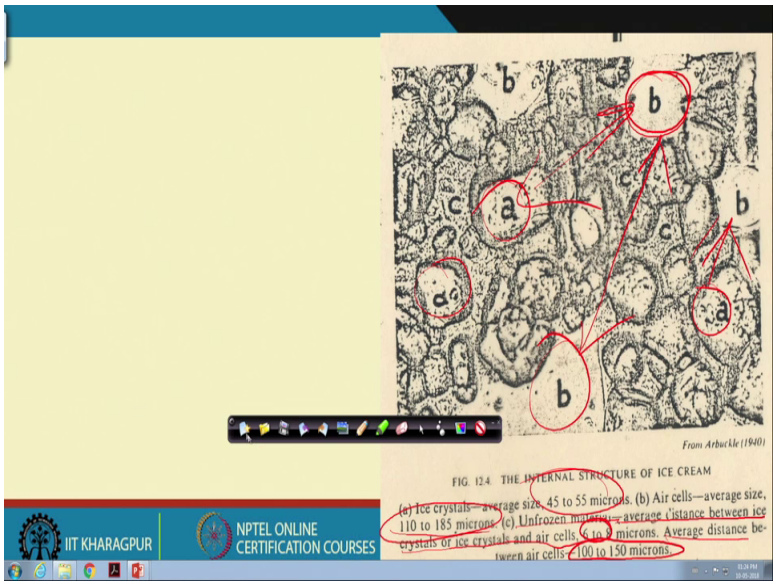

These are ice crystals right, a like this, these are ice crystals right then b is air cells, these are air cells right. These are air cells and, then c is unfrozen material, whatever is not frozen that part is c. This is that c is the unfrozen material right and another thing which you need to know is that let me take it temporarily to this side, because, temporarily I am taking it ok.

So, here you see that the unfrozen material is c and average distance between ice crystals or ice crystals and air cells is around 6 to 8 microns between ice crystals and ice crystals and air cells right, ice crystals is a. So, that is this one and the this one or this one, the average distance is be around 6 to 8 microns and also between this a to b or say a to b right. They are 6 to 8 microns.

Average distance between air cells is around 100 to 150 microns between air cells, air cells where, average size is around 110 to 185 microns. This air size whereas, a ice crystal size is around 45 to 55 microns right. So, air cells distance, there is b to b, this is around 150 to 108, 100 to 150 micron size. So, this is under microscope, if you look at, it looks like that right. So, let us put back it to its original place.

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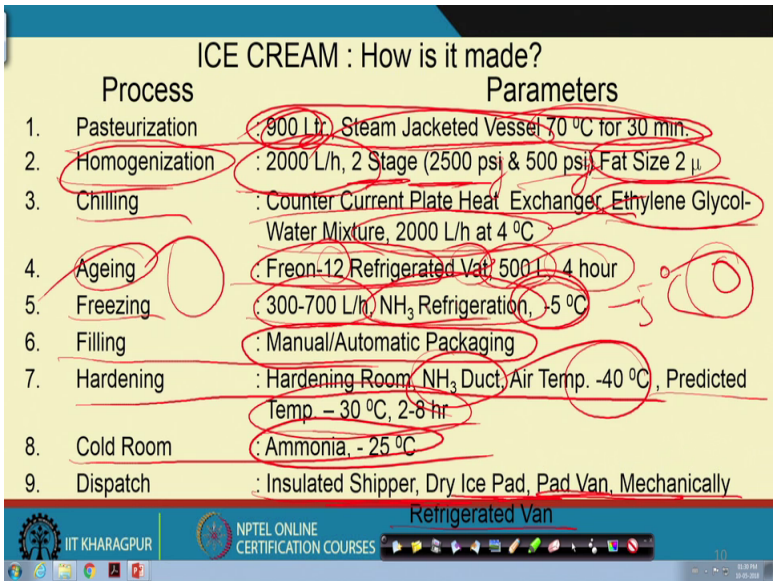

So, if we look at this yeah. So, if we look at this then ice cream how it is made of that, the process is like this that you are pasteurizing, whatever be the, whatever be the container size 900 litre typically in steam jacketed vessels, 70 degree centigrade for 30 minutes. Then homogenization is done around 2000 liters per hour in 2 stage; 1 stage is 2500 psig and the second stage is, 500 psig and fat size level is around 2 micron. then chilling. This is done by counter current plate heat exchanger, through ethylene glycol as the refrigerant and ethylene glycol water mixture and, the capacity could be 2000 liters per hour and it is 10 to 4 degree centigrade.

Then ageing is done with, Freon 12 refrigeration in Vat big, big containers with 500 liters and this is done for 4 hours. Then freezing is done, usually the commercial freezer sizes are between 300 to 700 litres per hour and the refrigeration could be ammonia or could be Freon 12, depending on what you have and the outlet temperature of an ice cream is minus 5. So, at minus 5 degree centigrade this becomes soft, which you buy from the market as softy that is temperature is around minus 4 minus 4 5 like that right, it becomes soft, it is softy and flowable.

Unless it is, it has flowability, it will not go to the out, other side of the freezer right. So, you just imagine that in your household, deep freezer you have kept water, it got ice. So, you cannot take it unless you force it right, in this case ice cream is coming out from the freezer continuously, because as you see it is around 300 to 700 liters per hour capacity.

So, that mean it is continuously flowing right. So, it should have flowability that is possible if the temperature is not lower than minus 5.

So, coming out at minus 5 and a initial freezing point of ice cream generally is around minus 2.5. So, minus 2.5 it is started freezing and maybe some portion has frozen 5 percent, minus 5 degree centigrade, you have taken out the ice cream. And, this soft ice cream is then packed and then kept in hardening room for solidifying and then to the cold room, that is what it is done. So, filling that can be done manually or automatically, those cups which you get, they are automatically filled in the containers or the big, big packets like from where scoops are being made in some functions or in some gatherings.

So, ice cream scoop is being made, that is from the gallon packs or 4 litre packs, from there it is coming right, then hardening. This hardening is done in a hardening room with either ammonia or Freon and the temperature is around minus 40 degrees centigrade right. And, the product temperature could be somewhere around minus 30 degree centigrade and it takes around 2 to 8 hours; obviously, a cup of 50 ml will take less time than a than a packet of 4 liters right, 4 litre takes around 8 to 10 hours for hardening.

Whereas, a small cup 50 ml may take, half an hour, 1 hour, 2 hour at the most depending on the environment temperature. This will come also in detail, because not only this will help, to a know about the ice cream manufacturing, but also with the associated refrigeration that also will be a little bit covered. Then the cold room is at minus 25 with a ammonia and then it is going to dispatch for in with insulated shipper dry pad, pad van, mechanical refrigerated or refrigerated van or polar stream.

All these are used for dispatching the product from the production point to different places or agencies or storages right. In big-big cities your production could be at a one place and manufacture could be at one place and consumption could be at another place.

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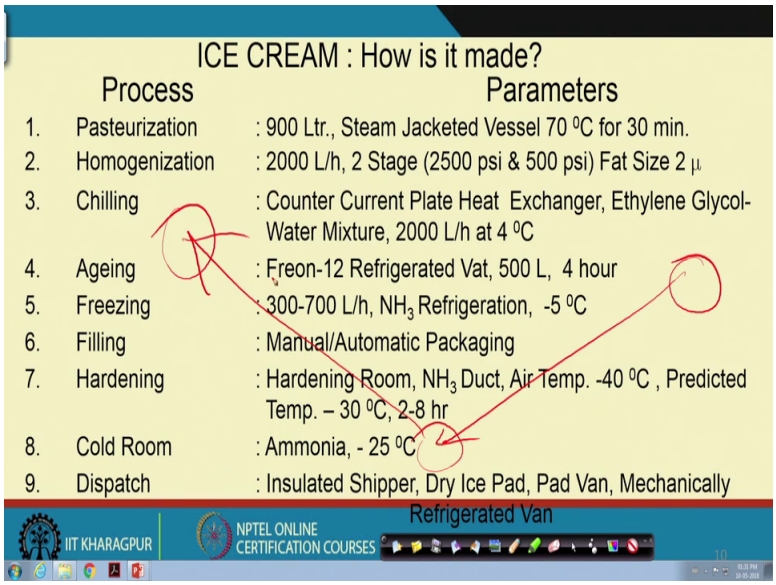

It is so big a distance that here, if it is produced here, if it is to be consumed may be in between one cold room is there. So, it comes here stays there for days together and maybe depending on requirement is goes to there right. So, this way the ice cream is manufactured in the, this is the process flowchart and the parameters, which are involved in the production right.

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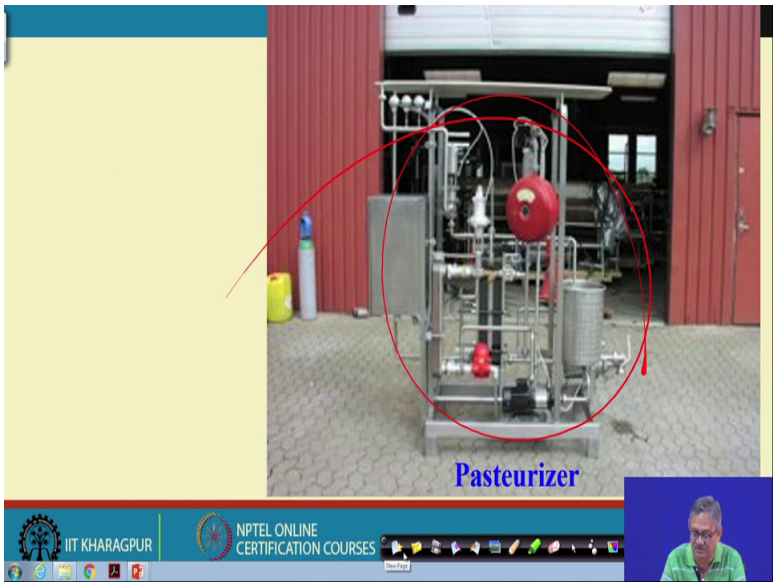

Now, let us look into how the ice cream industry they are using. This is a, this is of course, small typical.

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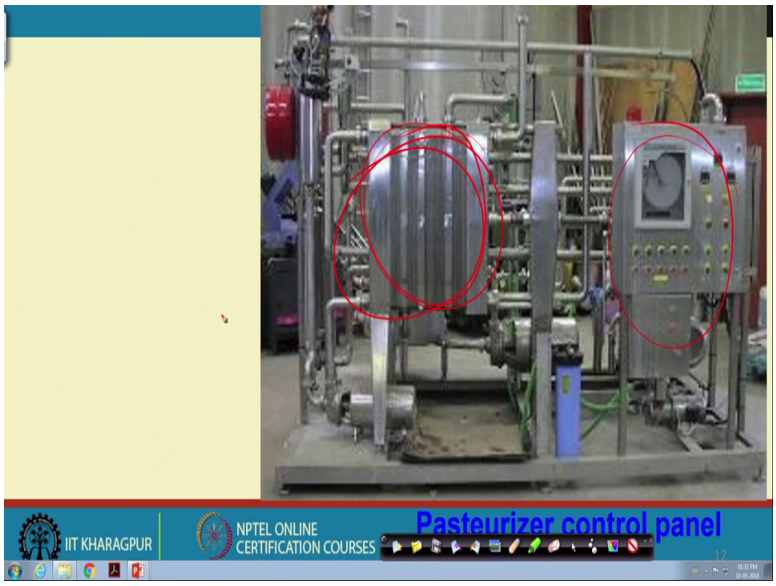

This is for the a of, laboratory use our thing. So, this is the pasteurizer right and then it goes to homogenizer. So, this is a pasteurizer with these. These are the plate; this is the plate heat exchanger. So, with the controls and other things, all pipelines, this is the commercial one. So, pasteurizer are using for pasteurizations plate, plate heat exchanges. Then it goes to, then it goes to homogenizer.

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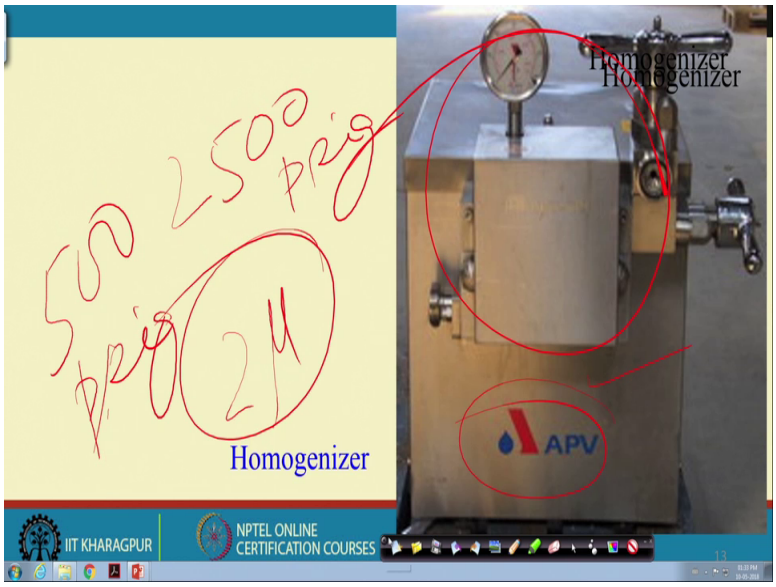

So, this is the typical homogenizer right, APV make, so that homogenizer is homogenizer, the fat to around say 2 micron and this is a 2 stage. So, 1 stage is around

2500 psig and the second stage is around 500 psig right. Then from there it goes to the freezer.

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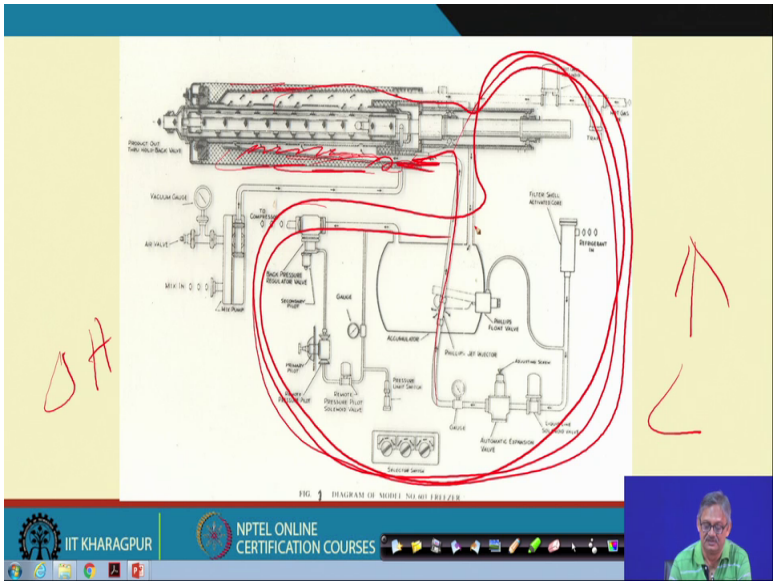

This is a typical view for ice cream freezer right and till this typical view is that, it includes everything. Number 1, this is the part where the refrigeration takes place right, that the refrigeration part is all along like this and this is the part where the feed of the ice cream mix is happening as well. The air is being fed and this is the ice cream freezer.

The heart of the ice cream in the street ice cream freezer right; what it is doing? So, if it is the ammonia or Freon 12, whatever that is, under this section right. So, the liquid either ammonia or Freon, that is then coming to the ice cream freezer right. This is at the outlet; you see it is insulated right like this. This is insulated and the liquid is coming here and this is called boil of technology right. Liquid ammonia or Freon that is coming here and getting boiled up right, giving the latent heat right; delta H giving the latent heat to the product right.

Sensibility it is not so much available, because the moment this liquid is vaporized that vapor comes out and comes back and again put back into the cycle right. So, that is the vapor which is coming in out.

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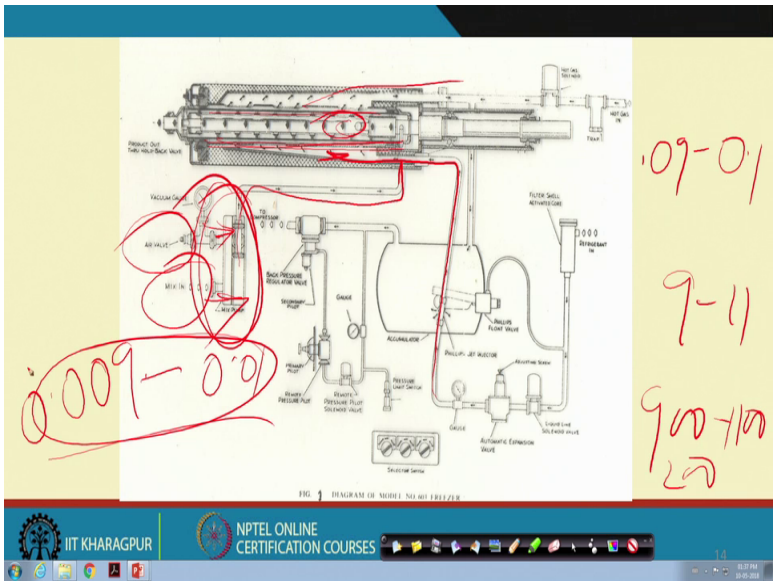

So, this refrigerant is coming here, the refrigerant is going out from there. Then the other two thing is the mix and the pump mix and the air. Now both mix and air, this is the dual pump right. In one case this is mixing is getting in, in another case that air; that is getting in right.

So, both air and the ice cream mix, they are going in and put into the system right and this system is this. So, this is the 12 inner wall of the ice cream and ice cream wall. If you have seen it, it is like a mirror or more than a mirror right. So, here you need to know a little about the freezing right, because freezing if you see that, the faster the freezing the quicker the freezing. The ice crystal sizes are smaller. The smaller the ice crystal sizes less is the space required for the volume expanded. We know that 9 cc of water, when it is getting converted into ice 11 cc of the ice is formed. So, that is called 9 11; this 9-11 conversion; that is less water volume with more ice volume.

So, that ice volume has to be, has to be accommodated. Now this 9 to 11, if it is 9 to 11, then only two if it is 900 to 1100, then it is 200 right, but if it is 0.09 to 0.1, then it is very small, even if it is even smaller 0.0009 to 0.01, then it is even smaller. So; that means, the quicker the freezing, the smaller will be the ice crystal size and the smaller the ice crystal size, the better for the quality of the product right. And if that is there, that is being done in this section; that is the ice cream manufacturing section right.

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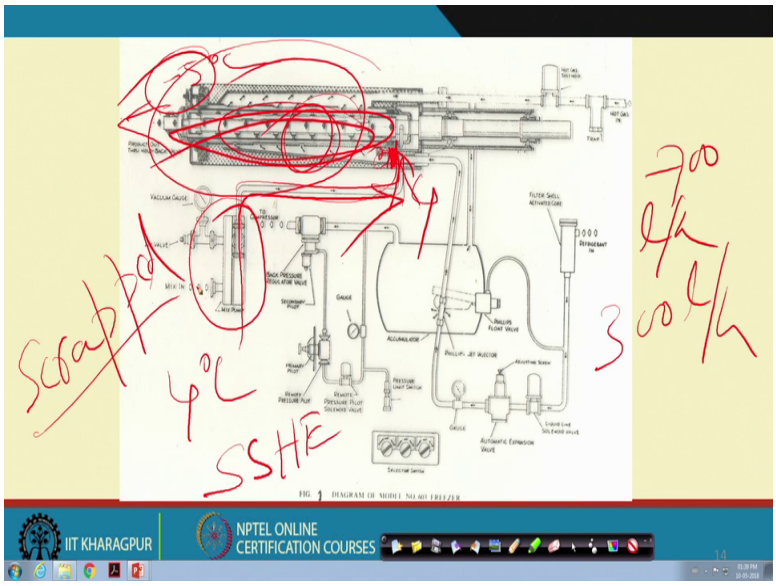

So, the product or this, this mix along with the air is going in. So, here this mix was at 4 degree centigrade after ageing. So, at 4 degree centigrade, this makes is getting pumped, entering into the inlet of the ice cream freezer. Now this 4 degree centigrade, when it is coming out of this. This is at minus 5 degree centigrade right, and it is a continuous, as we said 300 liters per hour, say or 700 liters per hour. That means, at every hour 700 liters ice cream is being formed.

So, when it is entering here at 4 degree, by the time it comes out from the exit, it is at minus 5, a semi solid or flowable composition, flowable composition. So, that minus 5 degree, this is being done. This is called the scrap surface heat exchanger or SS HE scrap surface heat exchanger. So, this is generally written as scrapped, scrapped surface heat exchanger right, what actually is happening?

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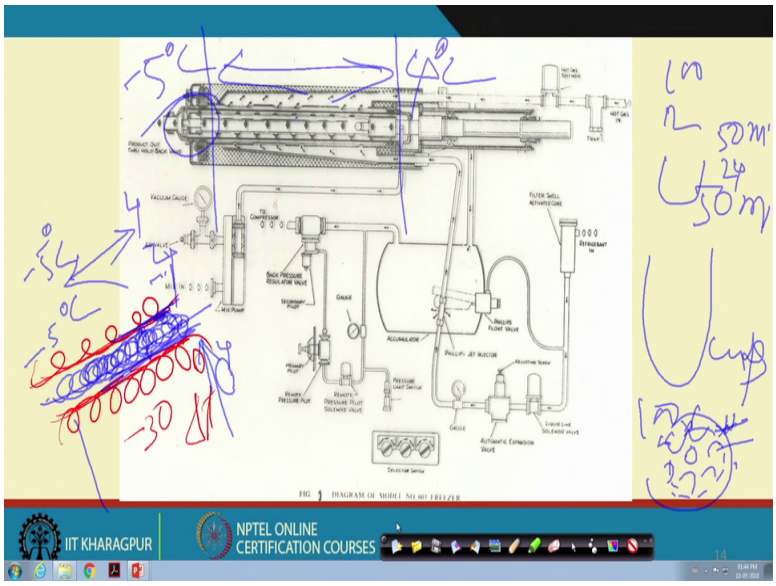

If this is the wall of the ice cream barrel; that is called barrel, this is called barrel. So, in this barrel this outer side is with the refrigerant right. This outer side is with the refrigerant which is at say minus 30 minus 28, depending on what refrigerant you are using. It is giving at is latent heat delta H to this wall right, and this wall. This ice cream, say we talk about 1 molecule. I cannot make the color another, let me, let me try whether it is making, yeah, so if this is a ice cream mix molecule.

So, then that comes here at the entry, then it is make going here to the wall getting is solidified, because the then it will be solidified, then the scrapper blade which is this one. There is the blade here, the scrapper blade; that is scrapping off, that is scrapping it off like this right. If this is the blade, so it is going like this and scrapping it up like that right. This scrapping is done by the scrapper blade, the moment inside ice cream is formed so that getting then mixed with the interior and from this 4 degree here, it has become say minus 0.1 degree and then gradually it is mixing, mixing and getting frozen like that and moving, and at the end when it is coming here, it is at minus 5 degree centigrade right.

So, minus 5 degree centigrade, it is coming the way it is mixing with the inside of the of the blade, inside of the barrel where it is getting frozen, getting a scrapped of it mixed with the remaining ice cream liquid, whose temperature is gradually going down from plus 4 degree to minus 5 degree. So, plus 4 to minus 5, this entire length of the ice cream

freezer is taking place. So, this is what that ice cream, this length within this length. This is 4 degree centigrade and this is at minus 5 degree centigrade; that is coming out right.

Now, what is happening after that? this ice cream now here which is flowable at minus 5 degree centigrade, this is kept, this is being hold in containers like cups, maybe 50 ml or maybe 100 ml bigger cups right. 100 ml they are, they are filled in say in circular. These kind of your things are there where cups are being made and some mechanism by which, when it is coming here; that is getting shifted to the next and this way it is moving right.

And when all are, it is in a line and maybe from here it goes to a chain sprocket line, where your ice cream. This cup leads are being put right and then maybe if it is 100 ml, then 12 bit numbers. It is packed in a in a paper container or if it is 50 ml then it is packed in a in a 24 numbers container, a paper packet right and that is kept in the hardening room for hardening or may be from here that entire thing comes into your container, which is 1 litre pack called party pack.

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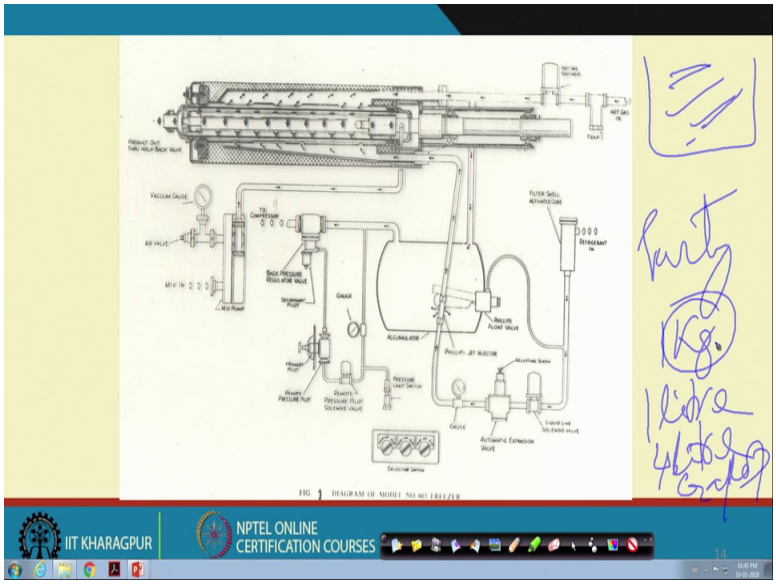

1 litre pack, that is called party pack or generally not in kg, but liter, 1 litre party pack or maybe 4 litre called gallon pack right. 4 litre called gallon pack, because one gallon typically is 3.75 or something like that.

But since in our country it is not gallon, it is litre. So, it is 4 litre packs where big packets of 4 litres are filled automatically and then these all are taken to that hardening room,

which we had said the hardening room is say minus 35 to minus 40 degree centigrade right.

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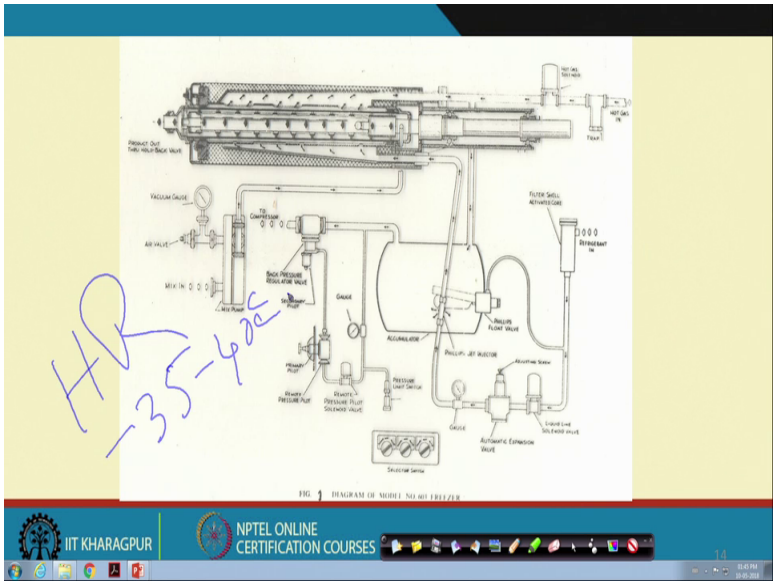

So, minus 35 to minus 40 degree centigrade, these are kept for 2 to 10 hours, depending on size shape etcetera right.

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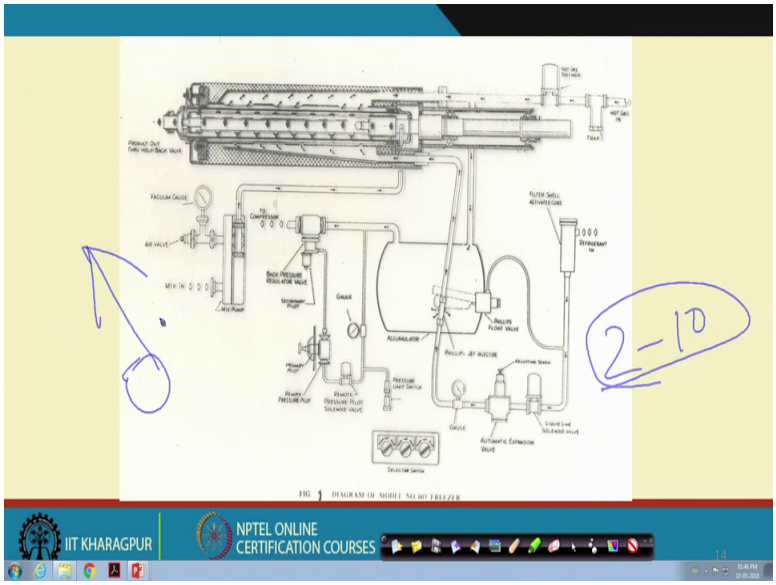

So, after this is hardened, then it goes to the cold room and this cold room it is kept maybe for 1 day, maybe for 10 days, maybe for depending on the sale of the product right. And, then this is dispersed through different medium. So, that we will discuss in

the next class that how the frozen foods are being distributed; in what way they are getting distributed.

What is the mechanism? How they are surviving? These things we will discuss in the next class, because today we are running out of time. Hopefully you have understood the manufacturing process and why all the steps are required, what is their purpose, these we have tried to give you in detail ok.

Thank you.