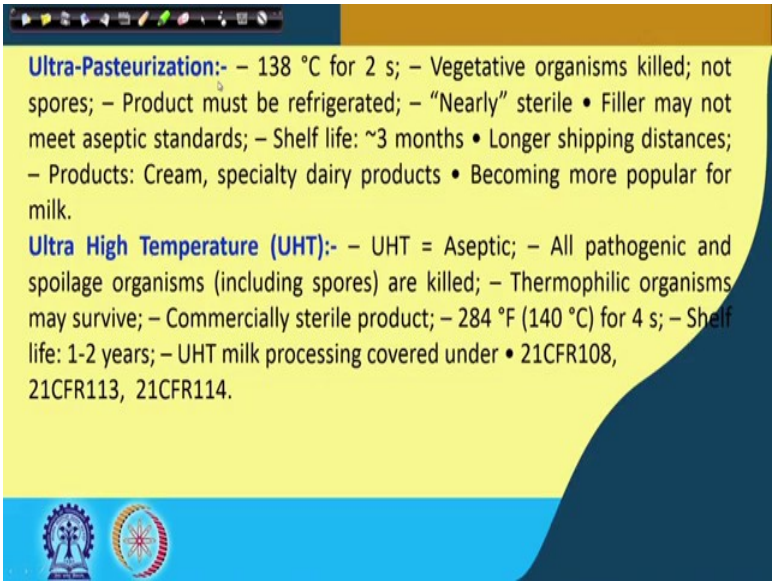
Thermal Operations In Food Process Engineering: Theory And Applications

Prof. Tridib Kumar Goswami
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 56
Preservation by High Temperature Processing (Contd.)

So, we had in we had been doing of course, let me wish a good morning to all of you that we had been doing that how the Preservation can be made with the help of High Temperature Processing right. So, we come to lecture number 56 and this is the continuation of the previous class right.

(Refer Slide Time: 01:01)



So, earlier we have seen even pasteurization, but there are also some methods like ultra high temperature pasteurization or called ultra pasteurization where the temperature is made or brought to 138 °C for 2 s right, where all the vegetative organisms are killed and, but the spore formers are not being able to killed and product must be refrigerated after the pasteurization process and it is said that it is nearly sterile, but not.

Filler may not mean aseptic standards and shelf life could be around 3 months. You will see that in the market earlier it was much more visible but because of the sale etcetera it might have been withdrawn or, but a nowadays I also see very less in number but still available that triangular shaped like tetra pack similar kind of pack milk products used to

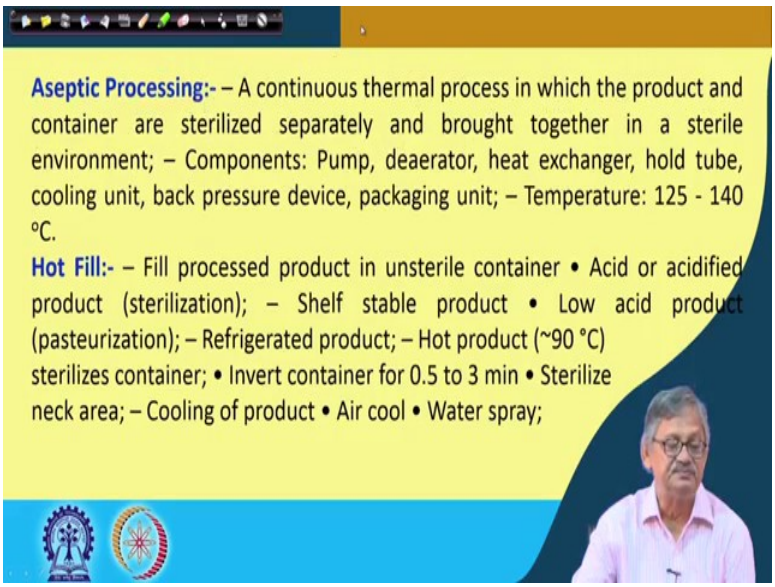
be in the market and that they are normally the milk which you buy in polythene packs or pouches their life is for 48 h around maximum if it is kept all time at 4 °C.

If in the summer if it goes up then there is all likelihood that it may go wrong or it may curdle during heating. But, this type of ultra high temperature treated milk they are for 3 months easily they can be kept. Longer shipping distance if it is then it is very useful and products like cream special speciality dairy products here depending on your requirement different dairy products are formed becoming more popular for milk nowadays.

Ultra high temperature that was ultra pasteurization; ultra high temperature in that UHT aseptic fair process is being followed and all pathogenic and spoiler organisms including spore formers are killed. Thermophilic organisms may survive there is a chance; commercially sterile product – these are called commercial sterilization or commercial sterile product and the temperature range is 140 °C roughly around 284 °F right 140 °C for 4 s right where the shelf life could be between 1 to 2 years or even more.

So, when you are using UHT milk processing that covered under some rules and regulations. For example, we had given some example of 2 and 21CFR108, 21CFR113 – 114 etcetera.

(Refer Slide Time: 04:48)



Aseptic processing – obviously, from the word aseptic it appears that you are keeping the surrounding also organism free right. So, a continuous thermal process in which the

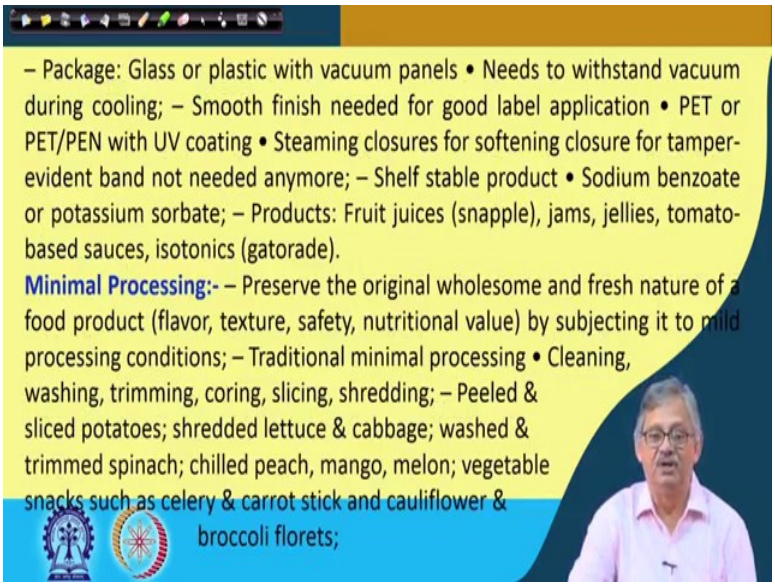
product and container are sterilized separately and brought together in a sterile environment and components required for this could be from deaerator, heat exchanger, hold tube, cooling unit, back pressure device, packaging unit etcetera. Temperature which could be utilized is in the in the temperature range of 125 to 140 °C.

In many cases hot fill that also extends the life. Perhaps I gave this example also that when this jam, jelly, marmalades are being prepared their temperature at almost at the endpoint is around 100 – 304 °C and the container where it is kept say this is the container for keeping that and this is not sterilized; cleaned perfectly, but not sterilized why because you are putting that jam, jelly, marmalade at the hot condition.

Because if jam, jelly, marmalade they are they are forming gel before putting or before transferring to the container then it cannot be it has become almost a semi-solid or a solid almost. So, it cannot be transferred and like that. So, the flowability will be lost. So, it is transferred at this hot condition and since it has maybe from the thermal point of view very high specific heat so, or heat capacity. So, it can withstand or it can hold that temperature or that heat rather for a longer period and by which the container gets more or less sterilized. So, that is what is hot fill.

Fill processed on product in unsterile container acid or acidified product where sterilization is done. Shelf stable product – it is a shelf table product; low acid product such as pasteurization; refrigerated product – for example, hot product around 90 °C sterilizes container. Invert container for 0.5 to 3 min; sterilized neck area; cooling of the product is also done simultaneously. So, that cools by air or could be by spray of water.

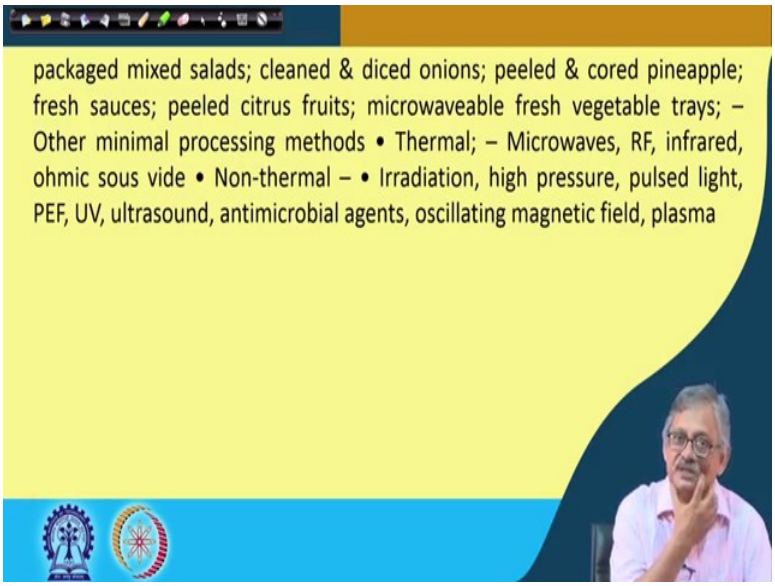
(Refer Slide Time: 08:12)



Packaging could be done in glass or plastic with vacuum panels. Needs to withstand vacuum during cooling; a smooth finish needed for good level applications PET or PET PEN with UV coating; steaming closures for softening closure for temperature evident band not needed anymore. Shelf stable product – these products are self stable; sodium benzoate or potassium sorbate may be used as the preservatives for the products like fruit juices right say snapple or jam, jelly, tomato based sauces, isotonic some say gatorade etcetera are some of the examples of the products.

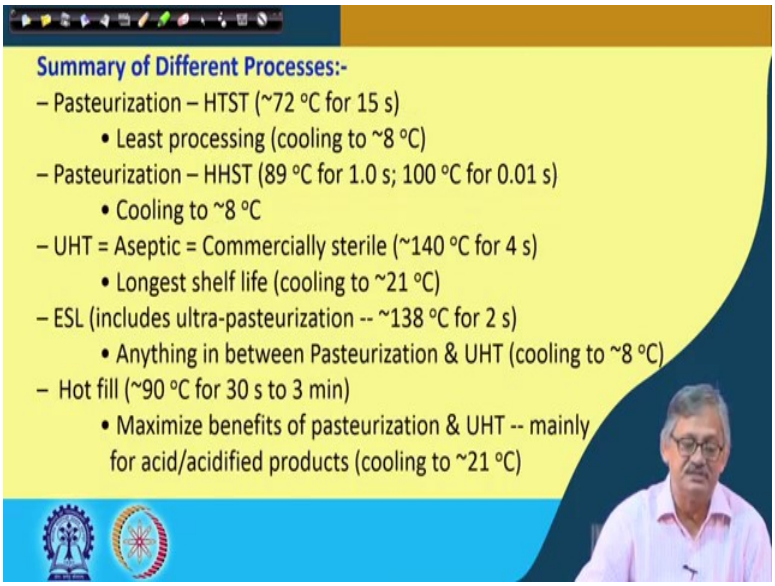
Then under minimal processing or minimal processed food we can say preserve the original wholesome and fresh nature of food product where whose flavour, texture, safety, nutritional value having or other flavour texture etcetera and safety nutritional value all are well protected. But, by subjecting it to mild processing conditions where traditional minimal processing also can be done, but for which the basic things like cleaning, washing, trimming, coring, slicing, shredding etcetera and then peeling are required then peeling and sliced potatoes peeled and sliced potatoes are also used for this minimal process food; shredded lettuce and cabbage, washed and trimmed spinach, chilled peach, mango, melon, vegetables, snacks such as celery and carrot stick and cauliflower and broccoli flowers are or broccoli florets are some of the examples of the products.

(Refer Slide Time: 10:59)



Packaged mixed salads also under minimal processed food where minimally really it is processed. So, that the both the quality and the flavor excel everything are retained. Cleaned and diced or onions, peeled and cored pineapple, fresh sauce, peeled citrus fruits, microwavable fresh vegetable trays. Other minimal processing methods could be thermal where microwaves RF – RF we have already said, infrared, ohmic sous vide. Non-thermal; irradiation, high pressure, pulsed light, PEF that is pulsed light, UV, right then ultrasound, antimicrobial agents, oscillating magnetic fields, plasma. So, all these methods either singly or in combination can be used for this type of minimal processed food right. So, where processing is done minimal.

(Refer Slide Time: 12:30)

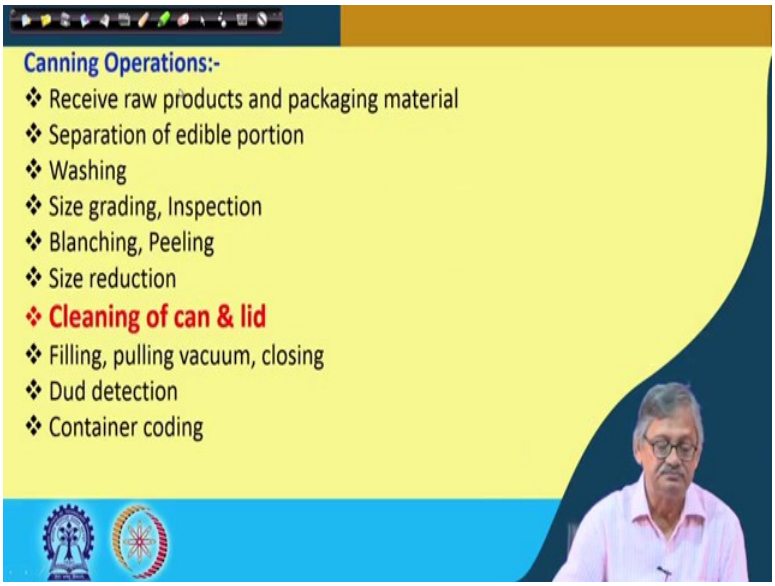


So, if we then summarize that whatever we have said here that pasteurization where HTST is done 72 °C for 15 s, least processing is required where cooling it is done to 8 °C. Then pasteurization at high temperature short time right HTST not HH it is HTST not HH that was by mistake. So, HTST where 89 °C for 1 s and 100 °C for 0.1 s in cases just earlier we has said where again cooling is done to 8 °C.

UHT – ultra high temperature pasteurization or that can be associated with aseptic packaging also commercial those could be said commercially sterile right around 140 °C for 4 s heating is done. Then longest shelf life we have where cooling to 21 °C. ESL or in that we said extended shelf life that is includes ultra-pasteurization around 138 degree Centigrade for 2 s. Anything in between pasteurization and UHT, where cooling to 8 °C is required.

And, hot fill we said 90 °C for 30 s to 3 min hot filled. Examples we gave that jam, jelly when it is hot is being filled. It maximizes benefits of pasteurization and UHT mainly for acid or acidified food. Jam, jelly are also in the bracket up acidified or acid food right. That is why little less temperature around 90° we said right it could be good enough and for acid or acidified products we need to cool it back to 21 °C right.

(Refer Slide Time: 15:22)



Then we come to canning operations. So, in the canning let me since we have a little time not here I do not say that we have little time means for this class yet some more time we have. Since I am not teaching caning separately except some fundamental things in related to heat transfer that if you look at any can that can cans are made like from a sheet; this is a sheet, this is another sheet right.

So, you assume that a part of that sheet you have taken and according to your size of the can right and in the cans there is no heat seal, there is no welding or brazing things like that. So, then how they become leak proof? Absolutely because can stay for maybe after the canning process it stays for 1 – 2 years. So, how could that be because yes there is no such heat treatment as such for making the container. So, for the container there is a sheet. So, this is also that sheet the end of the one where you are making that can. So, you fold it like this right.

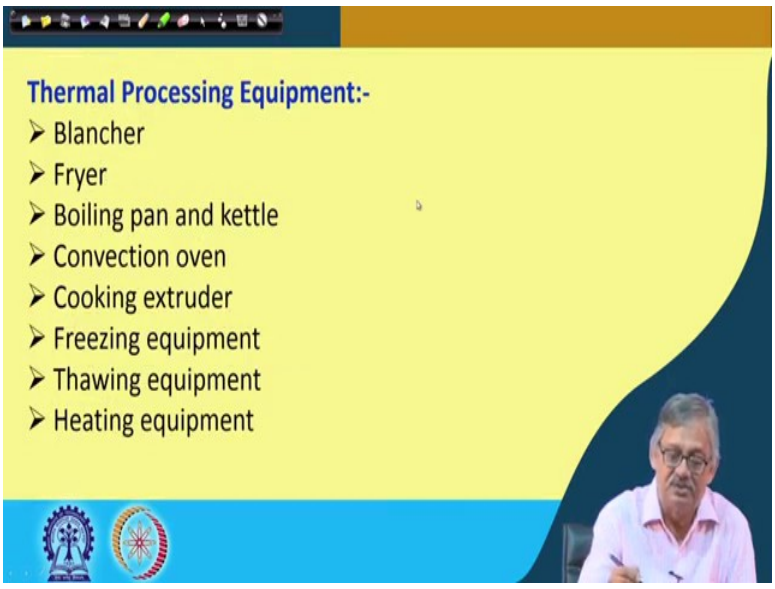
So, you have met one sheet at one end at this fold another sheet also right another sheet also. Oh sorry, another sheet also. So, you have this sheet and now from their you have made it that this sheet and from here you have bent it like this. Another one which you took like this, and again you have made that bend, right. So, when you have made these two bends then you make like this. This is one fold one this is another not fold this is one one side or one one unit. This is another unit second, this is the third unit and this is the fourth.

So, whole layers are there right 1 layer, 2 layer, 3 layer, 4 layer. These four layers are made like this and once they are like that then it is highly pressed right. So, this one, it is like this, and the next one that is like that, they are highly pressed right. So, that I mean the pressure by that this two come very close and the this is called seaming s e a m i n g seaming of the cans are done right.

So, if somebody teaches you caning that time you will also come to know. However, for the caning operations normally done receiving the raw products and packaging materials; then separation of the edible portion; then washing; then size grading, inspection etcetera; then blanching and peeling are done; then it is again size reduced – size reduced means cut into pieces etcetera etcetera depending on what you are canning right.

Then cleaning of can and the lid very basic, after that it is filled, filling; then pulling, vacuum and then closing. When the entire can is closed like this end like this end and you have the materials inside. So, this is called dud detection means which you cannot see with your naked eyes maybe there is a there is there is a process by which this duds are detected right. And, then container coding after of course, before that you have already canned and this cans can is made to code, so that you know which can is utilized or which can is still staying back. So, that is the companies code and that is being used and this process then done for thermal right.

(Refer Slide Time: 20:47)



This process is then done that for this canning what you do you know the pressure cooker right. So, similarity autoclave also you know right, similarly the big big or units of those kind of thing, these small cans duly sealed they are put there then under this high pressure may be 1 atmosphere or 2 atmosphere depending on the time temperature requirement of the product etcetera this is done right.

And, at this high temperature of 121 are the yesterday in the last class last last class we had said 121.11 °C right that is used for this is called 15 psi right gauge corresponding pressure; actually it is 14.7 psig, but we offer all practical purposes we tell to be 15 because 14.7 is very difficult to gauge it from the dial right. So, it is made 15° 15 psig which corresponds to 121 °C and at that temperature 15 min is kept and that those cans are kept at 15° min at 121 °C then the cans becomes sterilized right.

Now, these sterilized cans are then cooled and then it is absolutely no organisms officially; officially means what you what I should say theoretically there is no organism or rather other we can say not theoretically sorry, practically there is no organism because you have made maybe 12D 12 log cycles or maybe 15D or that depends on your system and what are the contents right whatever you make 1D is 1 log cycle right. So, 12D 12 log cycles 15D 15 log cycles you have come down. In none of the things as I said earlier there is no number ln of that number will become equals to 0.

So, theoretically we cannot bring it that the all organisms are killed and there is no organism or zero organism, but we can come close to the 0 like maybe 10^{-5}, 10^{-6} that is out of one 10^5 right out of 10^5 number of cans one can probably could be there is a chance of not being sterilized right. So, that is why we use higher D may be 12 may be 14 or 15 things like that D right so much so much heat treatment is done.

Now, to do all these type of whatever thermal thermally rather processed food for extending the life, we have discussed. There are many equipments to do that right. Normally, blanching is done with steam jacketed kettle right. You remember, we had done with that problem of boiling we had done it. So, in steam jacketed kettle steam is introduced, material is inside for 2 to 5 minutes, for 2 to 10 min obviously, and 75 to 95 °C this is done right.

Then, we have then we have fryer – the frying is done. Generally, maybe in this shaped containers you can have your oil, oil is then boiled around 150 to 160 °C and your things

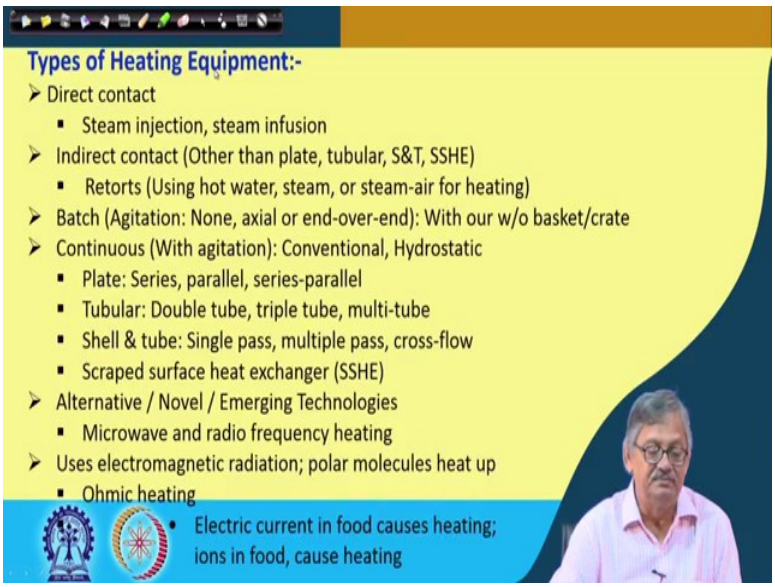
can be fried, right that is called fryer. Then boiling pan and kettle, kettle is just said like that right; boiling pan you also have seen many pans are being used for heating that is the boiling pan.

Then convection oven yeah that there are many ovens nowadays available including microwave oven right, in that microwave there is also some provision of convection right. So, convection oven or some heaters are used, some pans are being used rather some fans are being used and then that whole thing can be used for heating right that is called convection.

Freezing equipment – yes, there are many freezers right; primary, secondary, tertiary freezers are there, they are utilized. Then thawing equipments – once the material is frozen right. So, this frozen material can stay for a long period, but before consumption it has to be thawed. So, for the thawing commercial thing there are some thawing equipments available.

Then of course, the fundamental is the heating and equipment. Of course, in all of them in side by side we have said that the requirement of the heating equipment right. We have said heating and those heating equipments are utilized right.

(Refer Slide Time: 27:55)



So, we come types of heating equipment are direct contact. There are direct contact where steam injection or steam infusions are done indirect contact other than plate or

tabular or S and T or SSHE that is scraped surface heat exchanger etcetera. Retorts which you have just said about canning using hot water or steam or steam air or for heating rather. Batch if it is through agitation none or axial or end-over-end, with or without right with or without baskets or crate. Then continuous with agitation maybe conventional hydrostatic units are used.

Plate series parallel or series plate series separately or parallel separately a combination of series parallels are used; tubular double tube or triple tube or multi tube tubular heat exchangers is used; shell and tube single pass or multiple pass cross flow etcetera are used. Scraped surface heat exchanger SSHE in many cases are also used. Alternative, novel, energy emerging technologies may be used and microwave, radio frequency heating are some cases used. Uses electromagnetic radiation; polar molecules heat up – ohmic heating. Electric current in food causes heating ions in food that causes also heating right.

So, with all these now let us come to the end of this class and perhaps the different ways of extending the life with the help of thermal processing we have tried to explain and you also studied thoroughly.

Thank you.