Dairy and Food Process & Products Technology

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Lecture - 42
Thermal Death Time

So, now we come to the 42nd class that is in Dairy and Food Process and Products Technology lector number 42. So, we said that we will discuss on Thermal Death Time right.

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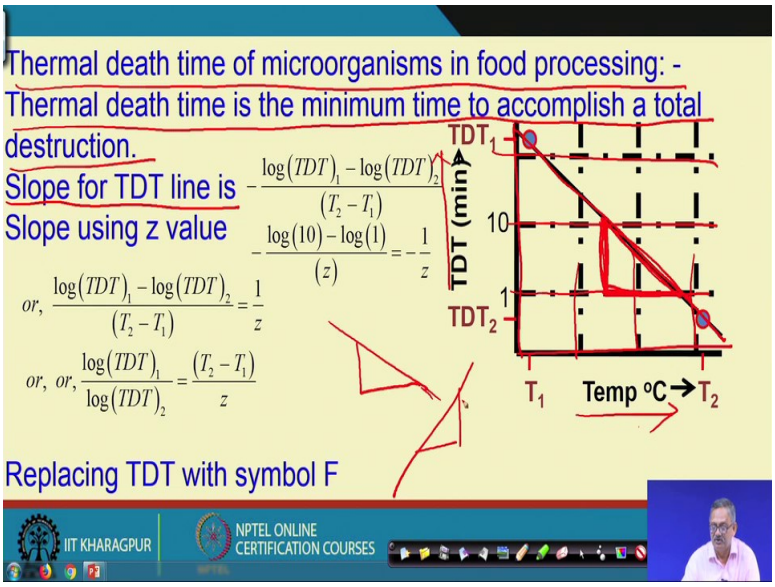

So, if we want to look at the thermal death and curve then first here we have drawn it like that ok. So, the thermal death time of microorganisms in food processing is like this thermal death time is the minimum time to accomplish a total destruction like.

So, if that be then we are plotting x-y plot right where temperature in degree centigrade in x axis and TDT that is thermal death time in minute in y axis, we are potting right and this is the plot which we have come across right. So, there these are the log 1, log 2 log like that similarly in the this is in the log paper right.

So, that be true then this is that to bring down 1 1 log cycle this is the temperature which we are this is that and this and this temperature 1 log cycle is being reduced and this is the slope of that cure right. So, we come to that slope of the line TDT this is the thermal death time line right.

1So, if we see that then it is negative slope right. So, because if it is like this then it is a 2positive slope if it is like this then it becomes a negative slope, I hope this we know right.

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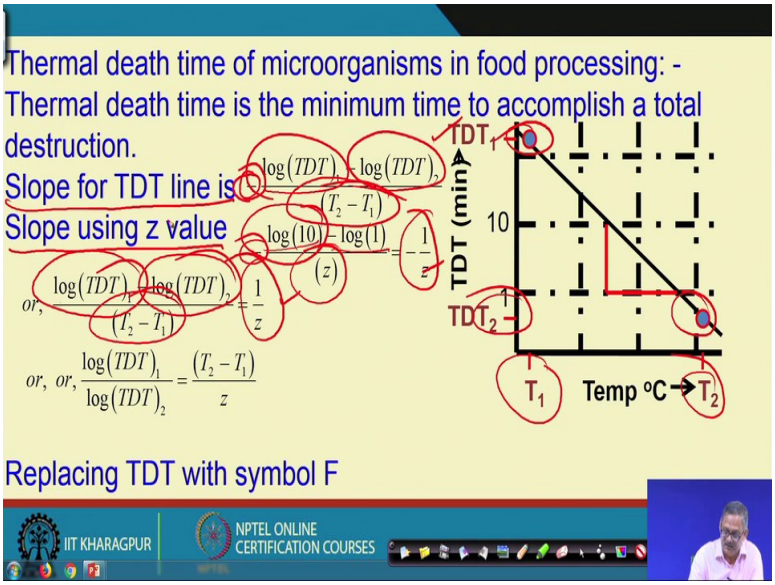

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5So, if we look at the then this slope for TDT line is $\frac{-\log(TDT)_1-\log(TDT)_2}{(T_2-T_1)}$. From 6figure, TDT_2=1 and TDT_1=10 so, corresponding temperature T_1 and T_2. So, by using so, slope 7using z value which we have said 1D so; that means, we have negative of that we are taken 81D that is 1 log cycle that is

9 $$\frac{-\log(10)-\log(1)}{z}=\frac{-1}{z}$$

10 that is the z value which we have defined right. So, this is nothing but is equals to that

11 $$\frac{\log(TDT)_1-\log(TDT)_2}{(T_2-T_1)}=\frac{1}{z}$$

12because here we have one negative, here we have had a negative here also we have a 13negative. So, that is canceling out.

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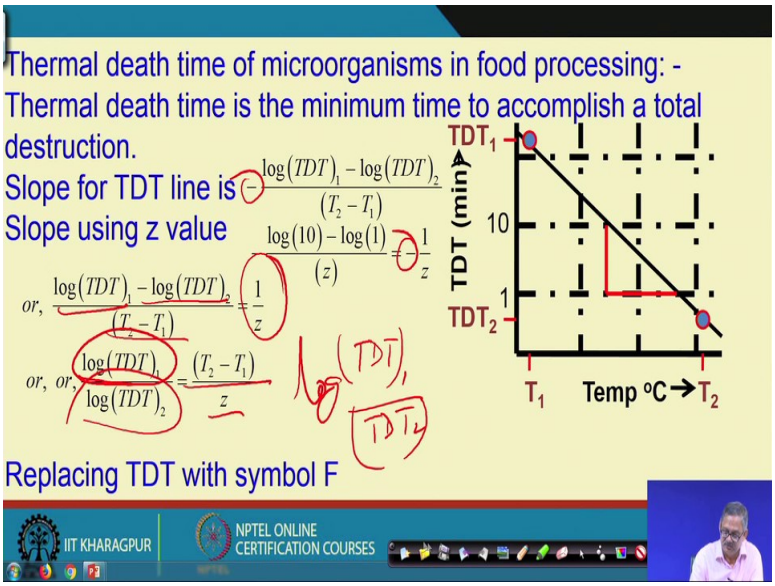

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3So, $\frac{\log(TDT)_1}{\log(TDT)_2} = \frac{T_2 - T_1}{z}$. This can be may be in the next slide we have written.

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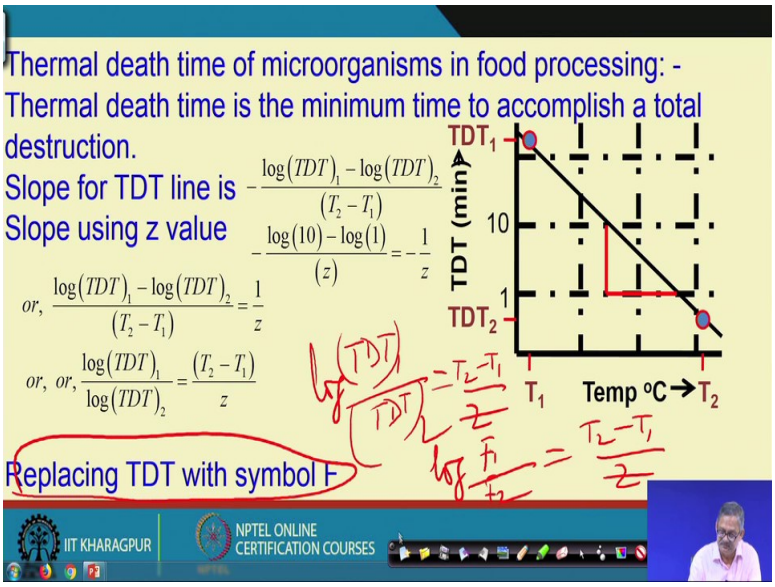

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6So, replacing TDT with the symbol F now, if we replace this with F then we get

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1 $\frac{T_{2-¿T_1}}{z}$

$\frac{logF_1}{logF_2}=¿$

2or $\log\frac{F_1}{F_2}=\frac{(T_2-T_1)}{z};\vee¿$ $\frac{F_1}{F_2}=10^{\frac{T_2-T_1}{z}};\vee¿$ $F_1=F_2 10^{\frac{T_2-T_1}{z}}$

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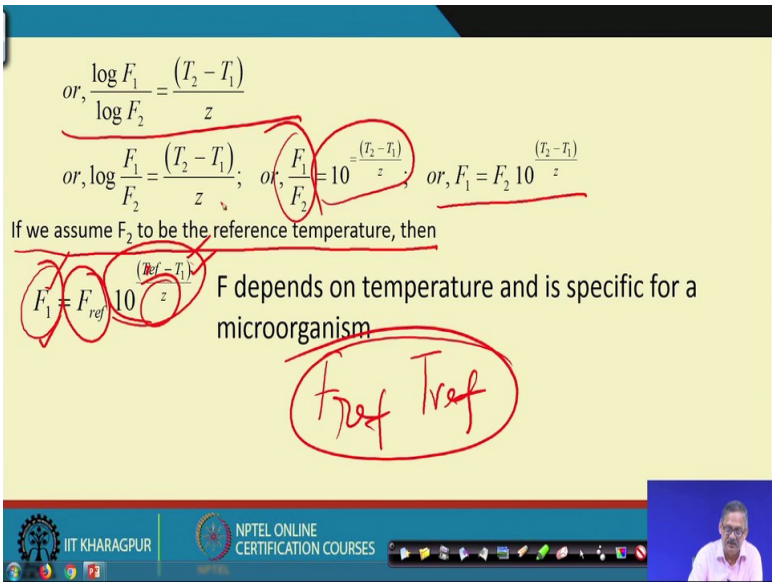
4 

5If we now assume that F_2 to be reference temperature then

6 $F_1=F_2 10^{\frac{T_2-T_1}{z}}$.

7So, $\frac{T_{reference}-T_1}{z}$. So, value of F at reference with the reference temperature is known if

8that be known. If the z value of that is known then what is the F value or if for a given T_1

9what is the F value or if F_1 is known what is the T value that we can find out right.

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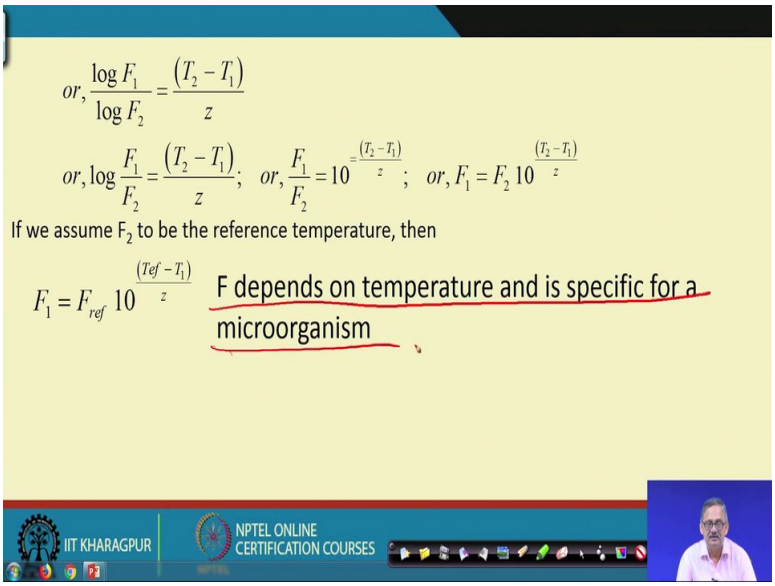

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3This is how TDT progresses that F depends on this says that F depends on temperature and is 4specific for microorganism. So, for a given microorganism that F is a function of temperature 5right that is what we have seen F is $F_1 = F_2 10^{\frac{T_2 - T_1}{z}}$ which says that F is a function of 6temperature right.

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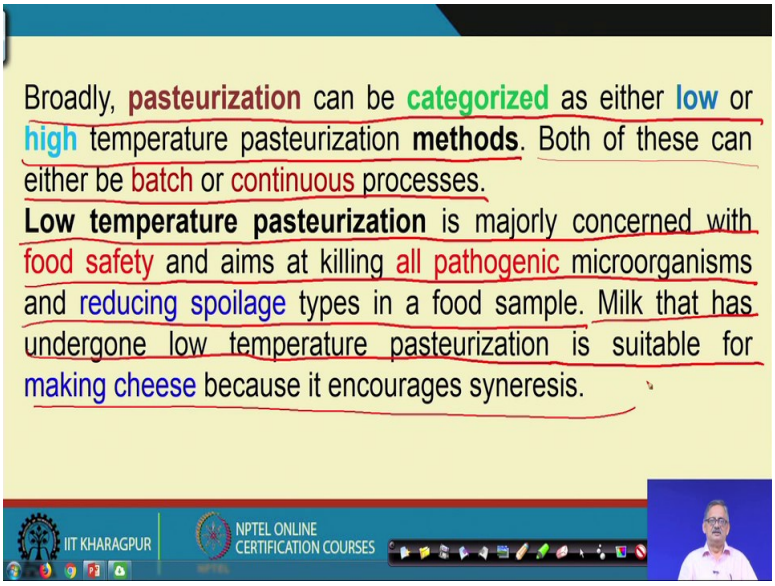

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9So, if that be true then broadly we can say that pasteurization can be categorized as either low 10or high temperature pasteurization methods. Both of these can be either batch or continues

process for low temperature pasteurization is simply is majorly concerned with food safety and aims at killing all pathogenic microorganisms and reducing spoilage types in a food sample.

Milk that has undergone low temperature pasteurization is suitable for making cheese because it encourages syneresis right. Syneresis that day that time I have I hope we have said that the best example is that for syneresis to understand that when you are making jam/jelly, so, that time if there is an jam/jelly marmalade they are physical.

They are there is a physical mixture there right, there is no chemical bonding in that it is a physical jell and in that jell formation. If there is any of the constituents like may be pectin, may be acid anything if they are not in the right promotion then the jell does not set and water comes out from the jell and this exudation of water is known as wiping of jelly or in other words in scientific term it is called syneresis. Here also that exudation right in cheese exudation is required so, there it is helpful right.

So, that low temperature pasteurized milk is helpful for making cheese product widely all over world is liked by people right.

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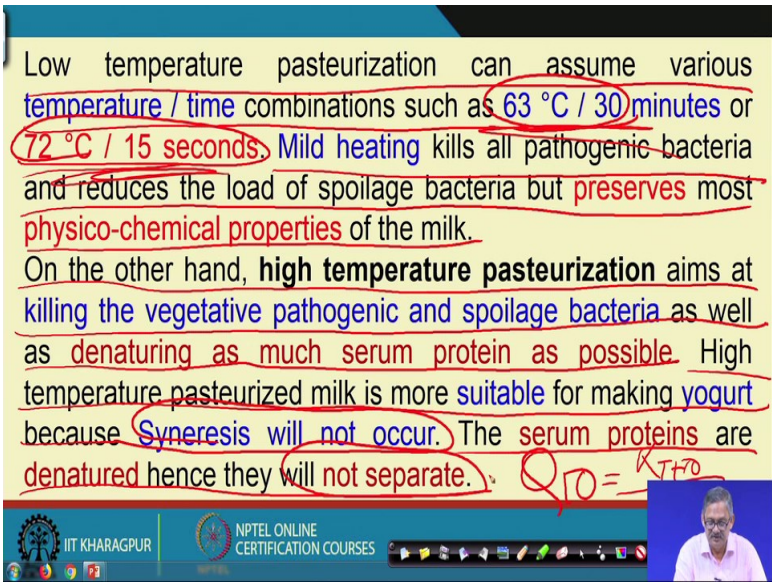

So, if that be true then let us look into that low temperature pasteurization can assume, low temperature pasteurization can assume various temperature time combinations such as 63 degree centigrade for 30 minutes or 72°C for 15 seconds.

Mild heating kills all pathogenic bacteria and reduces the load of spoilage bacteria but preserves most physico chemical properties of the milk that is an advantage.

That again this Q_{10} is coming into picture; if you remember Q_{10} we had said that is the temperature quotient right, you remember we had said that these is nothing but $\frac{K_{T+10}}{K_T}$ right these we have said earlier. So, here also that this all the changes which are occurring; which will occur they are function of the temperature.

So, if the temperature is high then the reactions whatever it be good or bad so, they are also increasing; the rest of the reactions are also increasing. So, the lower the temperature better for the product there is no ambiguity as for as its quality is concerned. But quality that is big term which we had defined earlier and said in detail, but here one thing we have to keep in mind our target, our objective is to kill all the pathogenic organisms minimum and then if possible many spoiling organisms or all spoiling organisms.

Generally, these spoiling organisms their temperature is also not very high right that is why if it is pasteurized at a right temperature and time combination then not only the pathogen, but also many spoiling organisms are also destroyed right. So, this is for low temperature low time that is what we call 63°C for 30 minute or 72°C for 15 seconds.

On the other hand, high temperature pasteurization aims at killing the vegetative pathogenic and spoilage bacteria as well as denaturing as much serum protein as possible right. High temperature pasteurized milk is more suitable for making yogurt because syneresis will not occur there or not repaired. So, high temperature pasteurization is they are required because yogurt does not need or it does not syneresis does not happen there. So, there high temperature pasteurization is very very helpful. The serum proteins are denatured hence they will not separate out right

So, it is denatured so, it will not also separate out. Otherwise at that high temperature you remember we said that when you are making that protein casein separation then you have the soluble protein.

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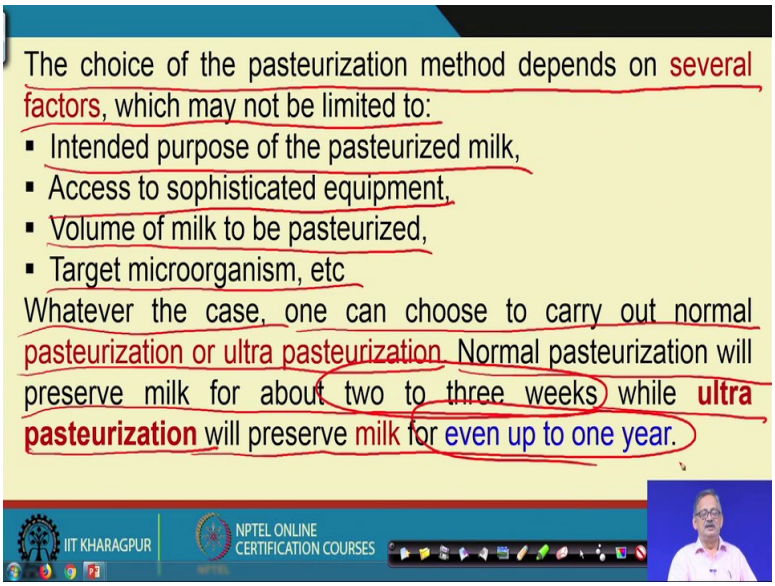

So, those soluble proteins if they are heated so, they become insolvable. But when you are making denatured then the properties all together are changed. So, that is that is what is happening and high temperature pasteurization is also killing the spore formers. The choice of pasteurization whether it is high temperature or low temperature.

So, pasteurization methods depends on several factors which may not be limited to right which may or may not be limited to intended purpose of the pasteurized milk; what is the purpose which you are using. Whether you are making cheese from the pasteurized milk, whether you are making any other product like your yogurt or you are making the whole milk; I mean liquid milk for drinking like that.

So, that what is your end product activity what you will do with that. So, that we will dictate that will tell you what should be the pasteurization temperature and how should you pasteurized method. Access to sophisticated equipment that is another thing you may need to do pasteurization, but you do not have the sophistication or the instruments which are sophisticated.

So, your access if it is not there in spite of your need you cannot do that so, that is another aspect. Volume of milk to be pasteurized that is another aspect, how much volume you have to pasteurized; whether it is 100 litre or 1 lakh litres or 10 lakh litres that will dictate of course, the availability of the recent or improved pasteurizers or methods or instruments.

Then target microorganism, what is your target microorganism because from the target microorganisms from its TDT curve, you can know what is the time and what is the temperature required to inactivate that typical target organism and you can work on your pasteurization time and temperature right. So, whenever be the case one can choose to carry out normal pasteurization or ultra pasteurization right.

Now, what is normal pasteurization will preserve milk for about two to three weeks while ultra high temperature or ultra pasteurization will preserve milk for even up to one year. The other day when packaging I was showing I hope you have seen that there are some packets tetra pack things were like that.

Now, if you go to the market and ask that I want sterilized milk they will give you similar like that; that depends on the company how they are making the packet whether it is pyra pyramidal shape or whether it is rectangular shape that having some handling facilities or things like that.

So, that will depend on the processer how they will make, how will they make the packaging. But definitely that the high temperature were ultra high temperature pasteurized that milk may survive or may sustain even up to one year or more whereas, normal pasteurization the milk will survive no around one to two weeks not more than that right. So, this we have to keep in mind and depending on that you have to select the method pasteurization right. Then different types of thermal processing method.

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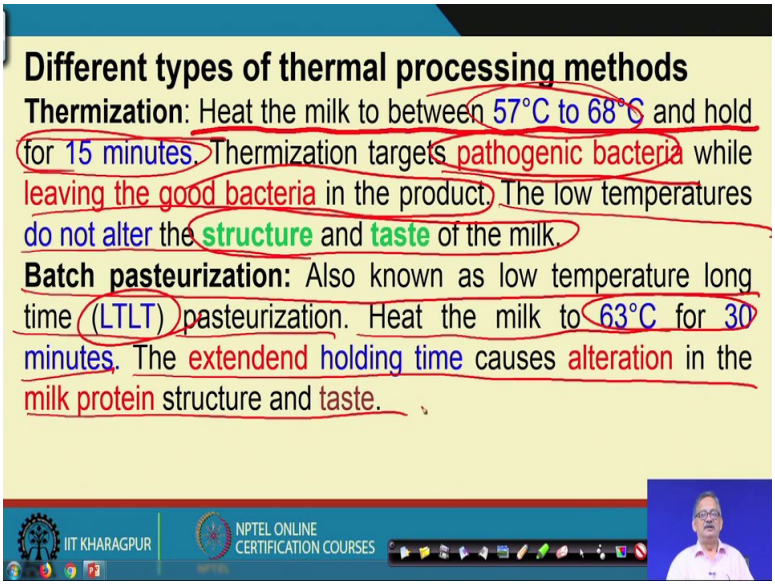

Different types of thermal processing methods are that thermi that this is thermization. Thermization is a process or it process where the milk to be heated between 57 to 68°C and holding period is around 15 minutes. So, temperature is around 57 to 68°C and time is around 15 minutes.

So, low time low temperature high time it is being heated for pasteurization right. In normally we had given that earlier time temperature combination one was 63°C for 30 minutes and the other was 72°C for 15 seconds. But in this the thermization we are calling it is between 57 to 68°C temperature whereas the time requirements is 15 minutes right. So, this is targeting the pathogenic bacteria while leaving the good bacteria in the product. So, only this will kill the pathogenic microorganisms, but the good bacteria which because you are heating when the temperature is high.

So, temperature does not know who is good and who is bad right. So, depending on the temperature the corresponding organisms also will get killed; so, along with bad organisms if you are also killing some good organisms that is not desirable right; because nature has produced in such a way. So, if you are killing the pathogenic organisms, but restoring that good organism/beneficial organisms then the that process where the temperature zone is 57 to 68°C and time requirement is 15 minutes is called thermization or thermalization. Then there the low temperatures do not alter the structure and taste of milk because again Q_{10} so, the lower the temperature better of it.

So, in this case better than 72°C, 72 is much higher may be for 15 seconds, but much higher temperature here you have 63°C 30 minutes. So, here you are making 63, 57 to 68°C within this zone, but it is 15 minutes that is what you are heating right. So, you are killing all pathogen, but not the desirable or favorable or helpful bacteria right.

Now, batch pasteurization is such that no which is also known as low temperature long time LTLT; Low temperature long time pasteurization where milk is heated to 63°C for 30 minutes. The extended holding time causes alternation in the milk protein structure and also the taste because at 63 though the temperature is low but time is more right though the temperature is low, but time is more.

So, 30 minutes you are heating at 63. So, lot of alterations may takes place in the milk protein and its structure as well the taste. So, that you have to keep in mind.

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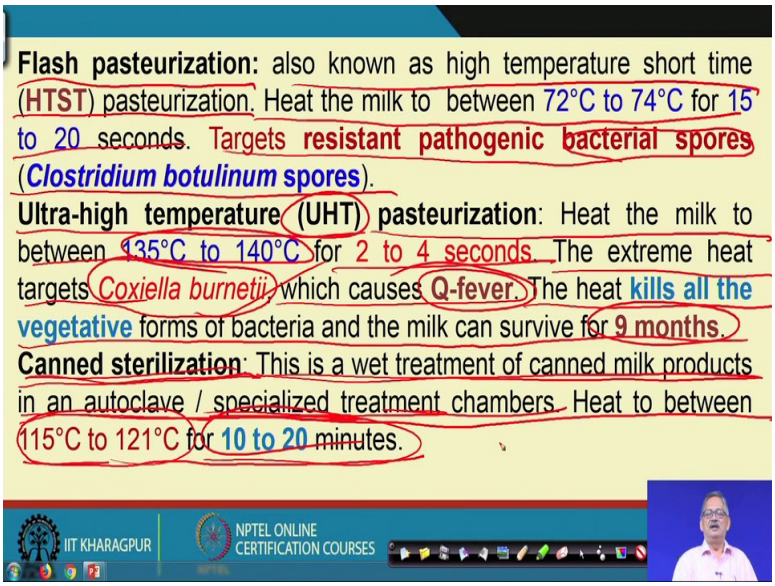

Then flash pasteurization, that is another pasteurization process were you are doing flash pasteurization also known as high temperature short time HTST pasteurization; where milk is heated between 72 to 74°C for 15 to 20 seconds. And the targets are resistant pathogenic bacterial spores like *Clostridium botulinum* spores. So, another techniques of pasteurization is ultra high temperature or UHT pasteurization. There you are heating milk between 135 to 140°C for 2 to 4 seconds. And in this case the extreme heat targets the *Couxiella burnetii, Coxiella burnetii* which causes Q fever.

So, Q-fever is caused by *Coxiella burnetii* right and you are doing ultra high temperature pasteurization. The heat kills all the vegetative forms of bacteria and the milk can survive for 9 months around; then another one is canned sterilization. This is a wet treatment of canned milk products in an autoclave or specialized treatment chambers. Autoclave is what, autoclave they are I hope you have seen you know that you have some lid and you have some water some heating elements there so, you are heating and locking that lid tightening it so, that it becomes leakproof and then heating this that pressure is increasing.

So, when the temperature comes to 121°C you are keeping for 15 minutes and that is called high temperature sterilization or canned sterilization. So, this wet treatment of canned products in an autoclave specialized treatment chambers; Heat to be between 115 to 121°C between 10 to 20 minutes right.

So, here again you are seen that range right 115 to 120°C and time is 10 to 20 minutes right. This all depend of course, in this case our product is milk, but this all depends on the many factors right. What is the pH? What are the types of food? So, depending on them the heat treatment may vary right.

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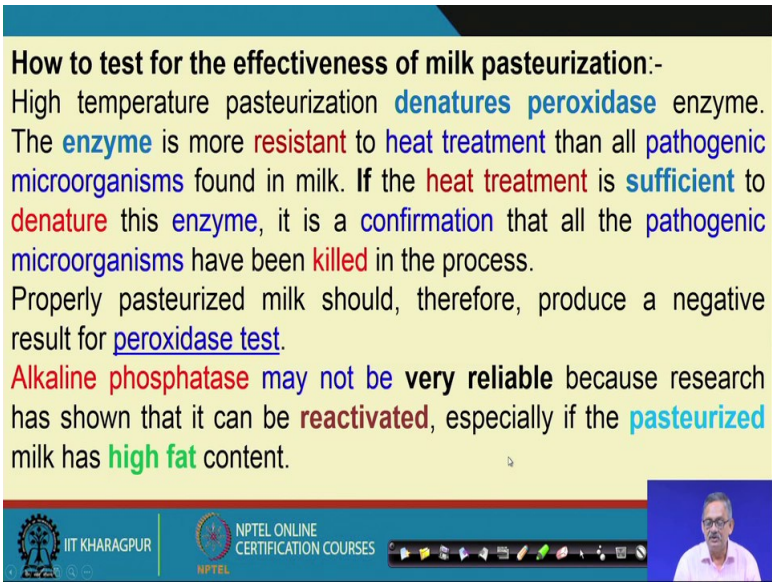

So, if we look at that so, the next our today's time is almost over so, we will come to this next. But today we have come how different is pasteurization are performed right, including flash, canned, ultra high temperature pasteurization everything we have come across and this we should keep in mind.

So, that subsequently when we are also doing not only pasteurization, but standardization and then homogenization all this process will be covering subsequently ok. Today time is up. So, let us stop it today now.

Thank you.