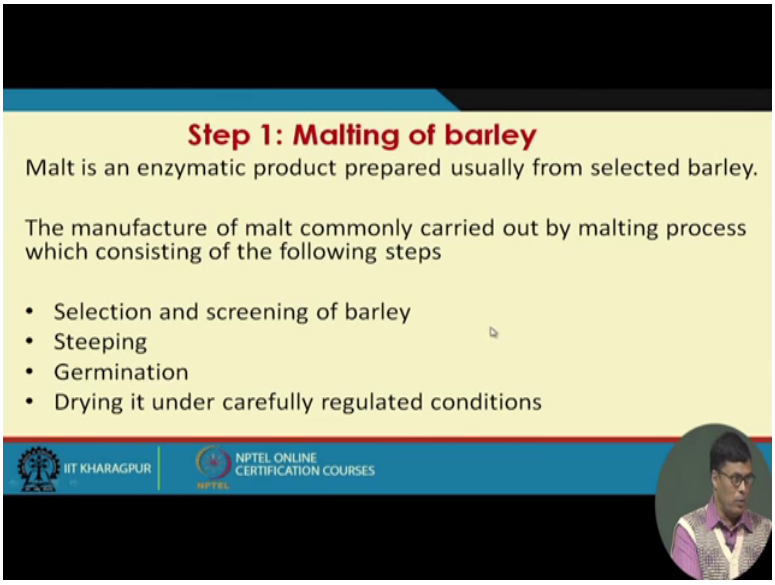
Course on Industrial Biotechnology
By Professor Debabrata Das
Department of Biotechnology
Indian Institute of Technology, Kharagpur
Lecture 30
Module 6
Brewing Industry (Continued)

Welcome back to my Industrial Biotechnology course, now I was discussing about the brewing industry then and in the last class I try to share with you that what are the different types of beers are easily available in the market and how the what are the major steps are involved in the beer making industry and how the that hops plays important role to give the specific taste and flavour to the beer and also we try to discuss I try to discuss the process flow diagram of the whole process due to the overall idea on the beer making industry.

Now in this lecture I shall continue this beer and go in details that what are the how this individual steps of operation how they operated and also we will give the detailing of the process that also we will walkout.

(Refer Slide Time: 1:32)

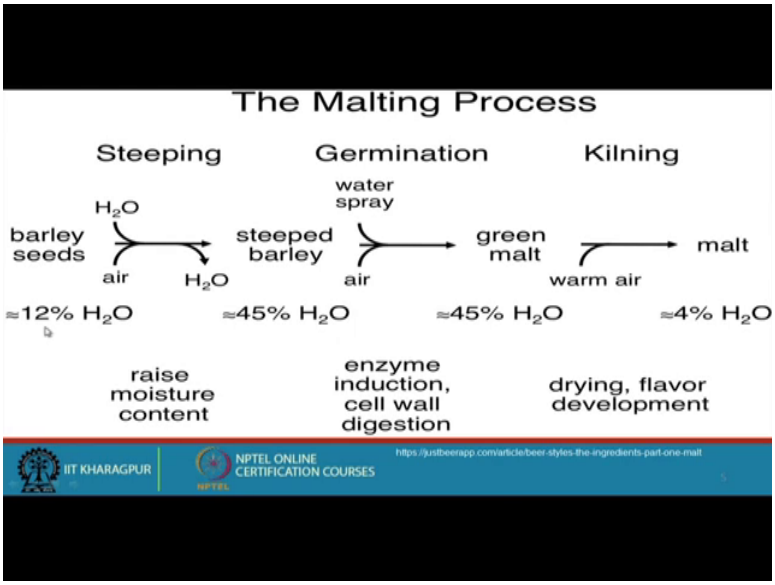


So we start with malting process because this is the first step of this process and I told you this is produced from the barley grains and barley grains looks like this you can you can I told you this is something similar to the wheat grains, so it looks like that.

The quality of the barley grains that plays very important for the that influence the quality of the beer, so the in India that we are Kingfisher beer largely marketed not only India but also in the foreign countries. Now malting of barley grains is malt is a enzymatic products prepared usually from the selected barley. The manufacture of malt commonly carried out by malting process which is consists of the following step.

Selection or screening of the barleys barley grains and then steeping process what you call soaking process, germination process what you call sprouting process and drying under the careful regulation condition. So the four measure steps are involved in the malting process.

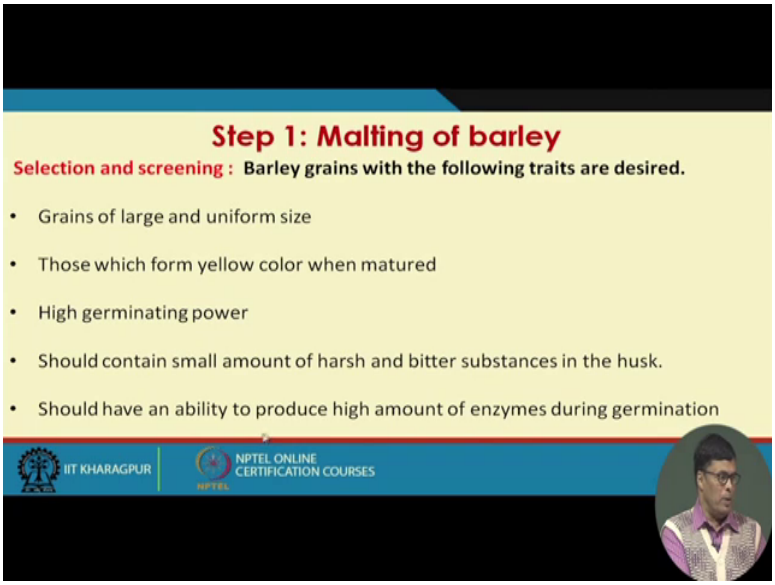
(Refer Slide Time: 2:42)



Now it can be explained like this the steeping process barley grains in presence of water. This initially the water contents the barley grains is 12 per cent then when you soak in the water the this barley grains water then it increase to about 45 per cent and then this barley grains we keep it I told you that we keep it under aerobic conditions and under humidified condition so that the germination takes place.

So what we call the enzyme induction and cell wall digestion that will take place and we get the green malt and then this is we dry this and then we have the so that the moisture content come back comes to 4 per cent. This we make it powder and use as a malted food or this is used as a raw materials for the beer making industries.

(Refer Slide Time: 3:45)

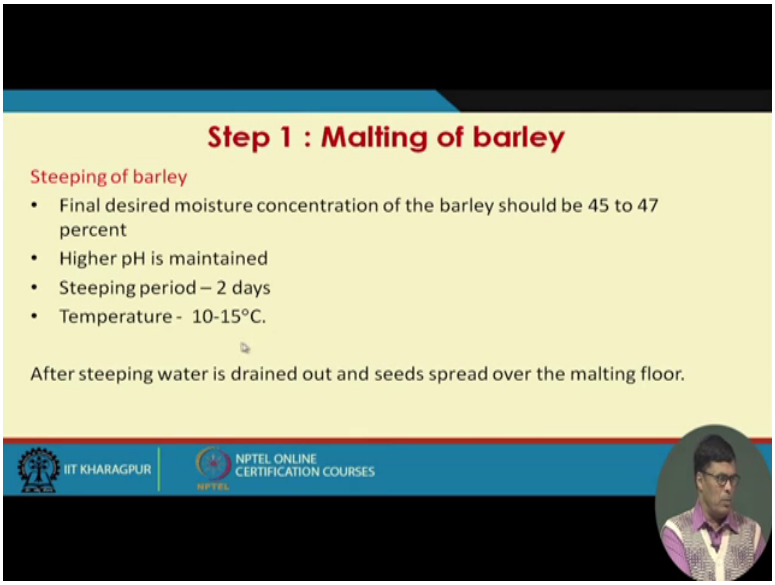


Now selection of barley grains that we have this grains are large or uniform size this is very important and those which has yellow colour and when matured and high germination power should content small amount of harsh and bitter substances in the husk and should have the ability to produce high amount of enzymes during the germination process.

(Refer Slide Time: 4:15)

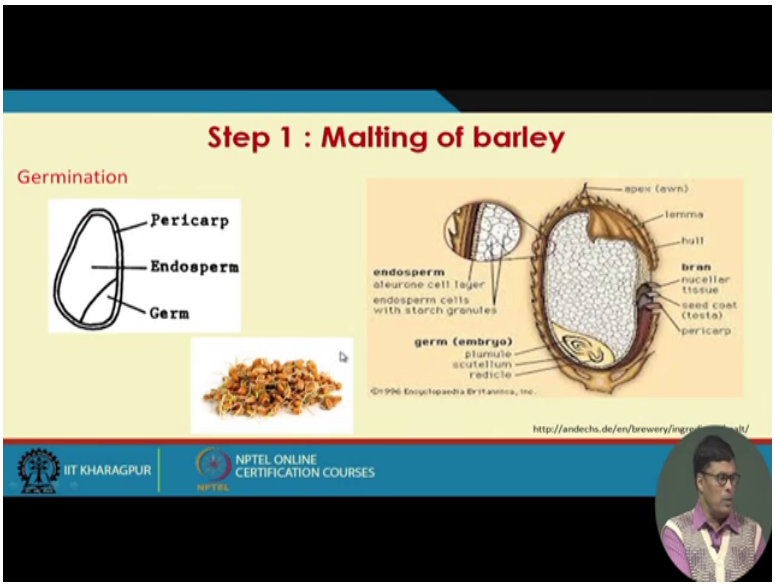
Now steeping process is looks like this soak in the water you can see how it is there, it is a process of soaking barley grains so that it may take up sufficient moisture to quicken the living cells of the embryo and start the process of enzyme production and germination of the which precede the breakdown of the cell wall and the hydrolysis of the stored food. This is undone in the aerobic conditions.

(Refer Slide Time: 4:46)



After the steeping process the final desire is the moisture concentration of the barley grains should be 45 to 47 per cent, pH higher pH is maintained and steeping period usually for two days and temperature we maintain 10 to 15 degree centigrade.

(Refer Slide Time: 5:05)

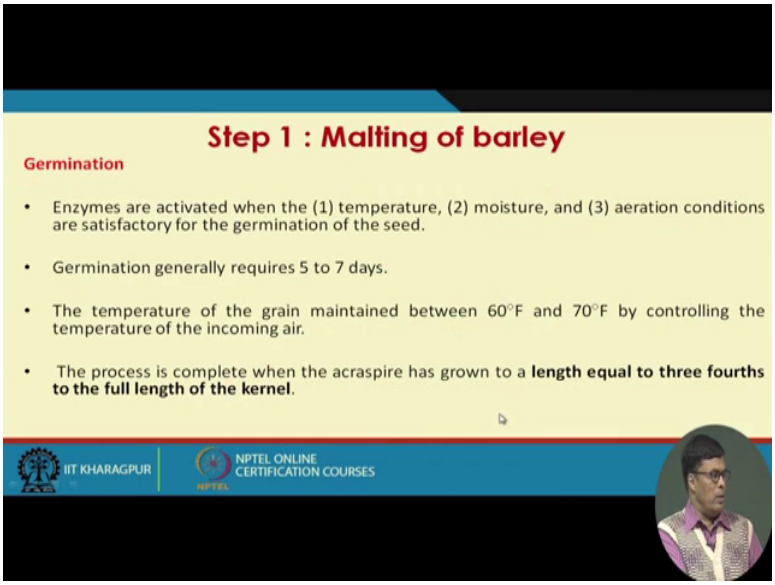


Now this is the barley grains how it looks you can see that how this we have pericarp then endosperm then germs that we have. I hear the germination takes place you can see that here the in this germination your endosperm formation is there.

When this is germination take place three fourth as length of the kernel then and only then you stop the germination process. How you stop the germination process? You just dry it so

the germination will be stopped. Now this is the sprouted barley grains you can see the how the suit formation takes place in the barley grain during the germination process.

(Refer Slide Time: 5:50)

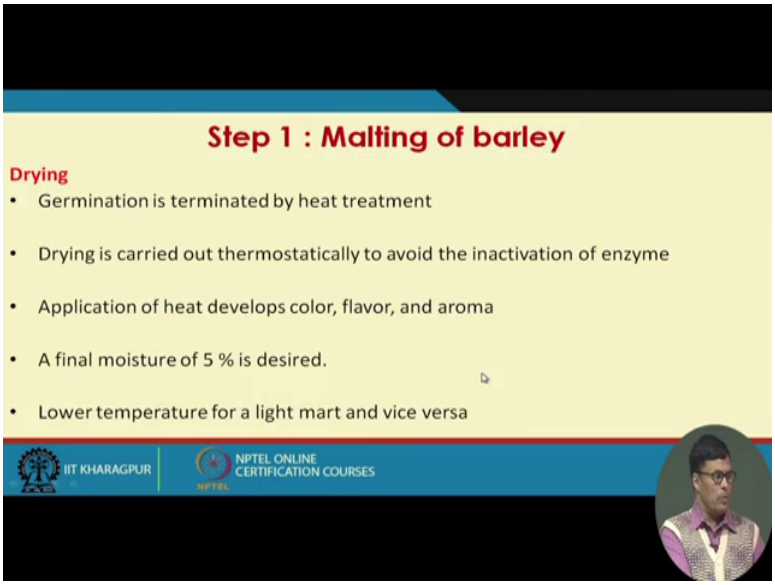


The germination enzymes are activated when the temperature moisture and aerobic conditions are satisfactory for the germination of the seed. Germination generally require 5 to 7 days, the temperature of the grain maintained 60 degree Fahrenheit to 70 degree Fahrenheit by controlling the temperature of the incoming air. The process is complete when the acraspire has grown to the length equal to three fourth of the length of the kernel that I told you this is the asperspores this this should be three fourth the length of the kernel then and only then we stop this germination then the we consider the germination is over.

(Refer Slide Time: 6:30)

Now how will you how the morphologically it looks like this the dry barley grains looks like this and then after the steeping process that wetted barley grains looks like this and after the germination of the barley grains it looks like this. This is the physical change how take place during the malting process.

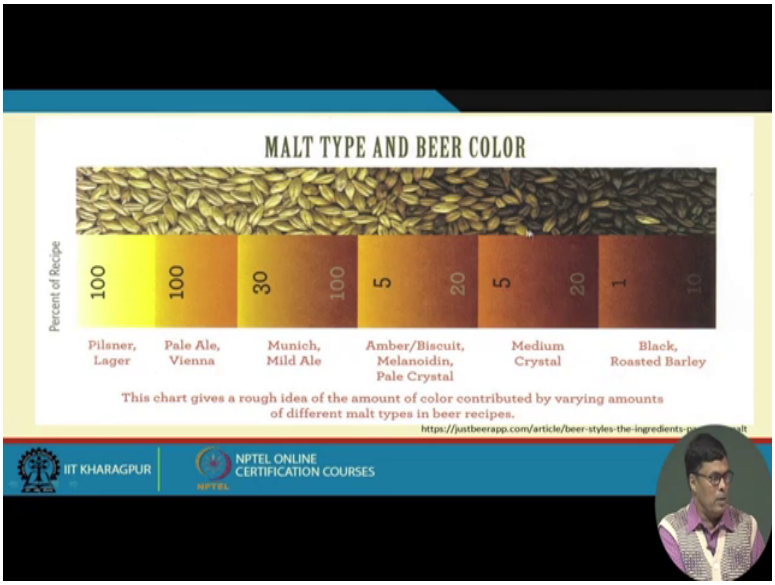
(Refer Slide Time: 6:55)



Now during drying the germination is terminated by heat treatment drying is carried out thermostatically to avoid the inactivation of enzyme. We maintain the temperature in such a way the inactivation of enzyme does not take place and application of the heat develops a colour flavour and aroma and final moisture content is I told you 4 to 5 per cent is desired

then lower temperature for a light mart or vice versa. So if you increase the high temperature then colour will be little bit darker, low temperature colour will be little bit lighter.

(Refer Slide Time: 7:33)



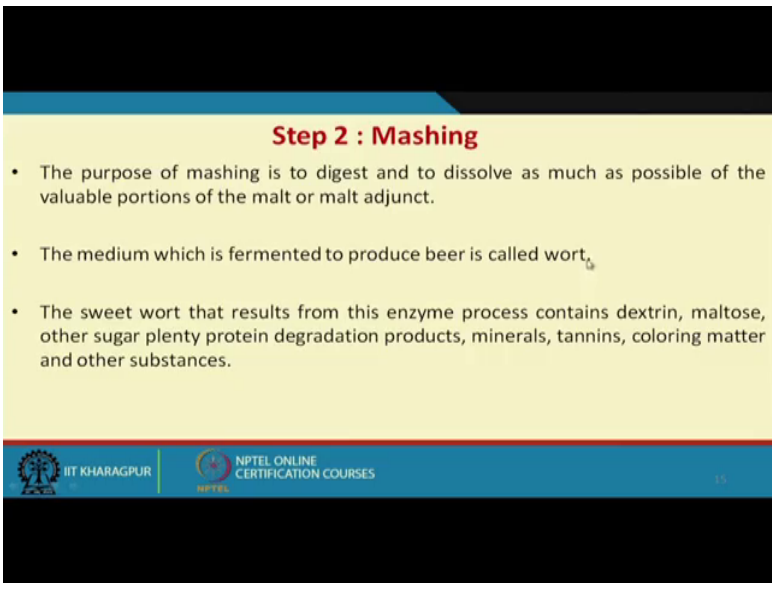
Now this is the colour that different coloured that malt that we have with lager beer this is the kind of pilsners that peel early like this the demand you can see the we can see the colour of the barley grain also varies with as per our as we as we change the characteristics of the barley grains that colour changes. So we have different grades we have this chart gives the rough idea about the colour contribution of varying amount of different malt type in beer recipe.

(Refer Slide Time: 8:13)

So use of malt has different use brewing industry has the cheap raw materials then it is used as a saccharifying agent in the manufacturing of industrial alcohol because I told you that whisky is produced from the starchy raw materials wheat starch and rice starch.

So there we can use this hydrolytic enzymes for the for the hydrolysis of the starchy materials so saccharifying agent in the manufacture of the industrial alcohol it is largely used malt is used in the manufacture of malted milk I told you that the malted food is recommended for the school children and for the patients the candy cereals then food colouring it is largely used.

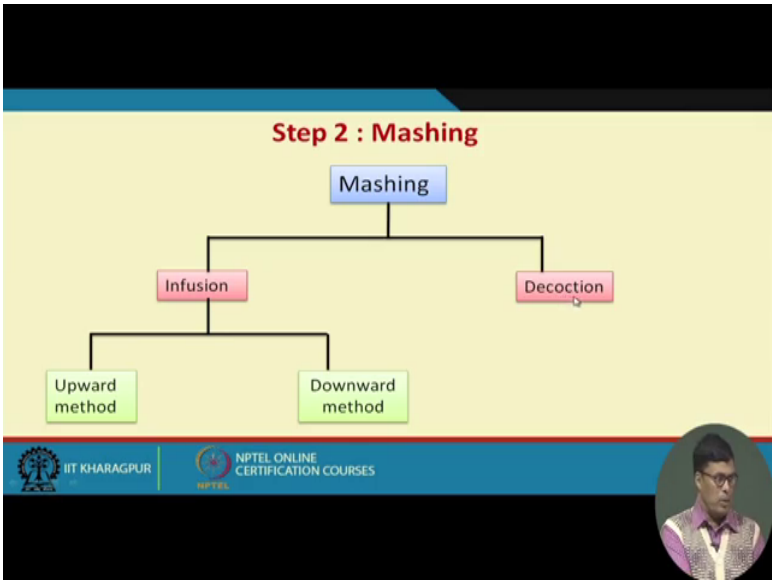
(Refer Slide Time: 8:58)



Then we next step is the mashing process the purpose of mashing is to digest or to dissolve as much as much as possible of the valuable portion of the malt and malt adjunct. The I told you that here the insoluble material will be solubilised the media which is fermented to produce beer is called the wort, wort this is very important the wort tank if you go to the industry we will find the wort tank, wort tank is nothing but the after the saccharification whatever soluble material comes out that is wort because their media that is suitable for the fermentation purpose that is called wort.

The sweet worts that results from the enzymes process containing the dextrin, maltose and other sugar plenty protein degraded products, minerals, tannins and colouring matter and other substances.

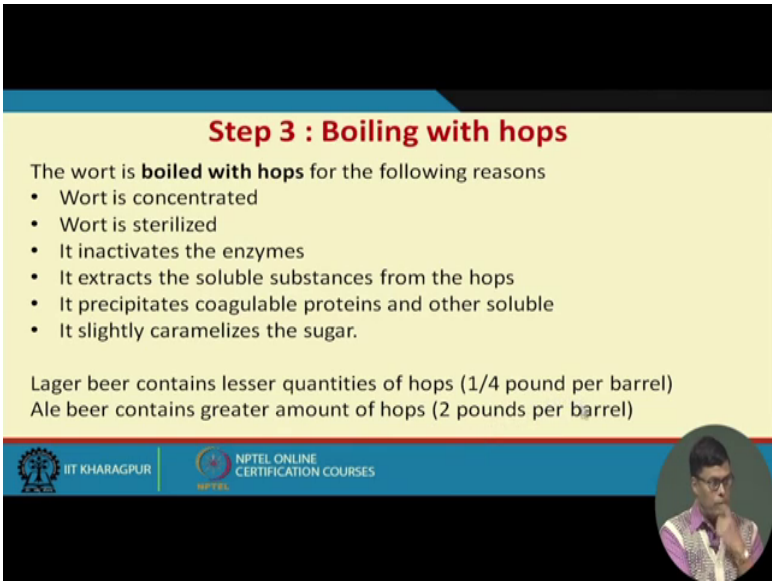
(Refer Slide Time: 9:55)



The mashing process as I mentioned before also it can be divided it can be divided in a two types one is called infusion another is called decoction. Now infusion process we have upward method and downward method basically upward method means we increase the temperature gradually that initially proteolytic enzyme they will be activated they will degrade the protein molecules then finally high temperature 60 about 60 degree centigrade temperature that saccharification takes place where alpha amylase they degrade the starchy molecules to glucose and downward method is start from the high temperature to low temperature.

Decoction process basically the proteolysis takes place in two different temperatures and saccharification take place in two different temperature that is called the decoction process.

(Refer Slide Time: 10:48)

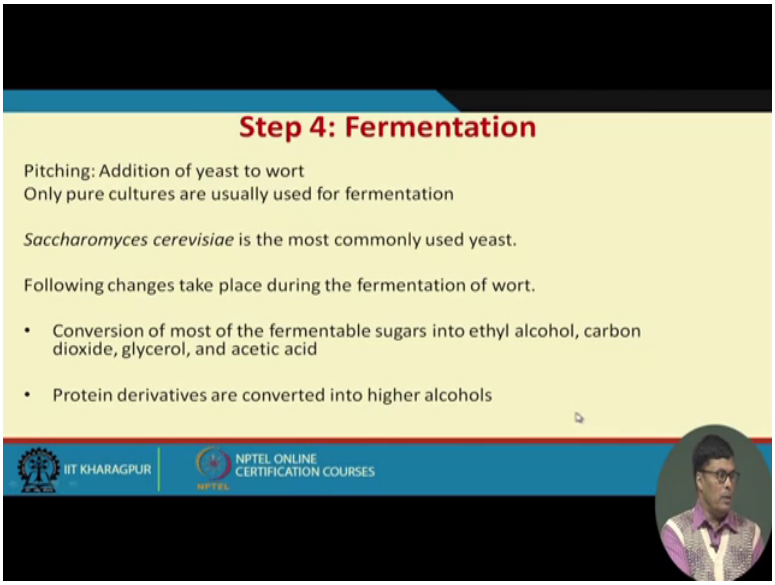


Now boiling of hops that I mentioned in the last lecture this is very important step as per beer making industry is concerned so it is a main purpose of boiling of hops is that wort is concentrated that when you boil it then the water evaporation will take place that causes the things concentrated.

And also it the wort will be sterilized that if there is any kind of contaminant present that will be killed then it inactivates the enzymes because with the enzymes is produced during this germination process or used in the during the mashing process that will be inactivated then it extracts the soluble substances from the hops because I told you hops contain the resin, tannin and the essential oils that will be solubilised and during this process, then it precipitates the coagulable proteins because I told you the tannin and protein higher protein molecule particularly that precipitated out and other solubles is slightly caramelized the sugar.

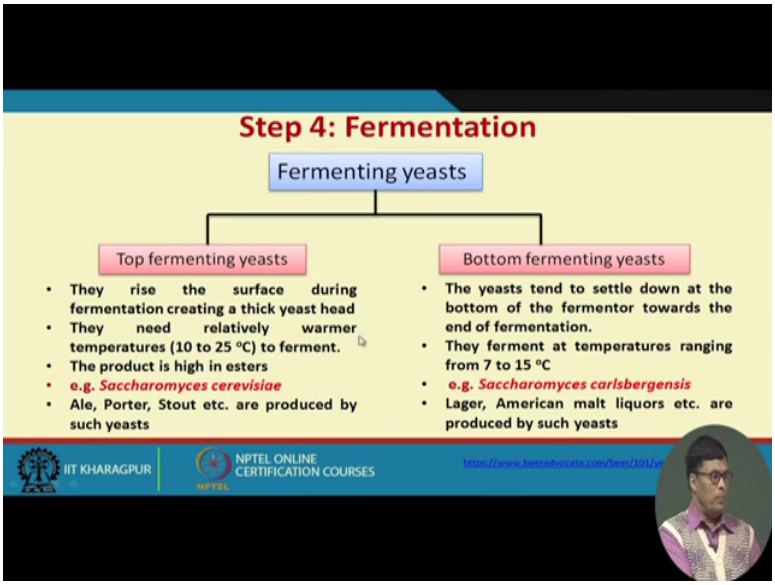
I mentioned during the alcohol fermentation process how the caramelization takes place when we heat the sugar dehydration of the sugar take place and due to dehydration the colour of the sugar changes to black, so slight caramelization means the black colour development will take place and then lager beer contains lesser quantities of hops because water found hopes is liquid per barrels. And in case of ale beer it contains higher amount of hops about 2 pounds beer per barrel of beer formation.

(Refer Slide Time: 12:37)



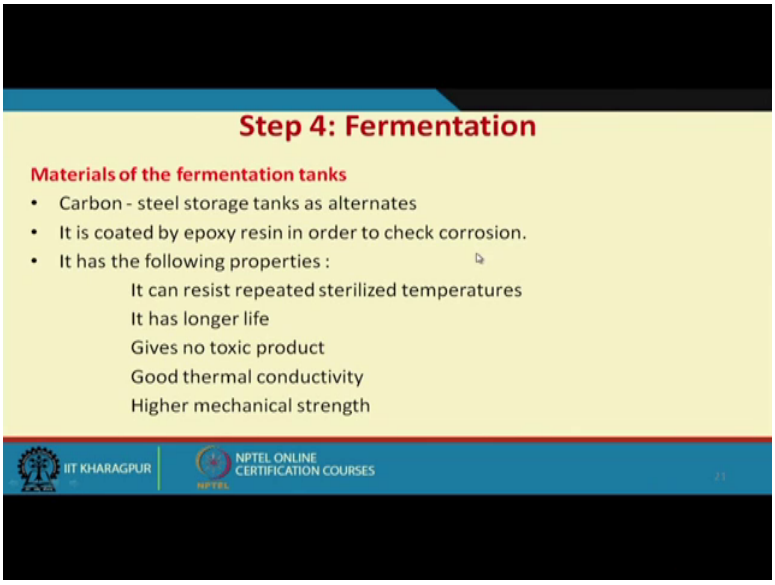
Now in the fermentation the addition of yeast to the wort you have to yeast for the carrying out the fermentation only pure culture is usually used in the fermentation saccharomyces cerevisiae commonly used in case of lager, ale beer we use saccharomyces cerevisiae this is the top fermenting yeast and saccharomyces carlsbergensis is usually important fermenting yeast. Following changes takes place during the fermentation of wort conversion of most of the fermentable sugar to ethanol and carbon-di-oxide and glycerol and the acetic acid. Protein derivatives are converted to the also converted into the higher alcohols.

(Refer Slide Time: 13:18)



So this is the difference we have between the top fermentation, fermenting yeast and the bottom fermenting yeast I told you the top fermenting yeast saccharomyces cerevisiae bottom fermenting yeast the saccharomyces carlsbergensis and they rises the this is usually take place at the higher temperature and time of fermentation will be less as compared to this saccharomyces carlsbergensis which usually takes place at the lower temperature.

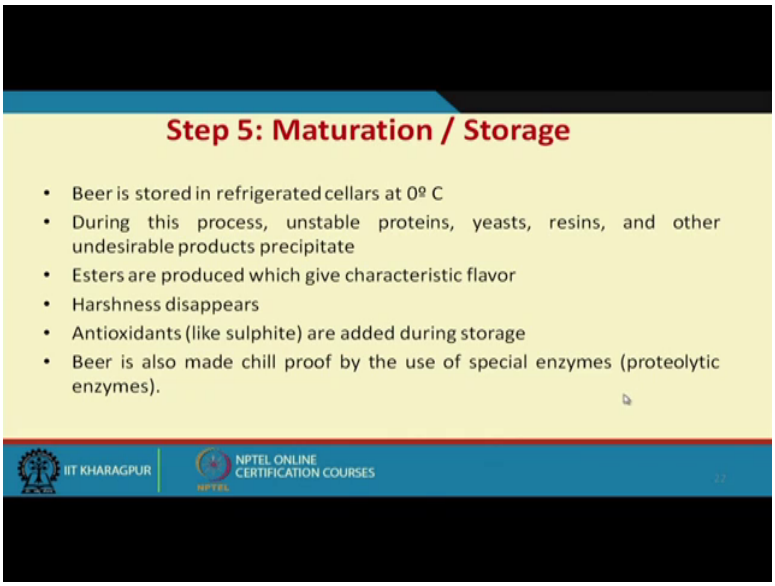
(Refer Slide Time: 13:50)



Now the material of the that is the materials of the fermentation tank in ancient age, wood or concrete tanks are used and short life and contamination rigs that, so now it is we use some in that carbon steel storage tank as alternative. It coated with epoxy resin in order to check the corrosion epoxy resin largely used in the fermentation industry. It protects the acid attack to the material of construction, it has the following properties.

It can resist the repeated sterilizing temperature, it has a longer life, give no toxic product and good thermal conductivity and higher mechanical strength. These are the different properties that we have the material of construction that we have with the fermentation broth this is to be maintained.

(Refer Slide Time: 14:53)

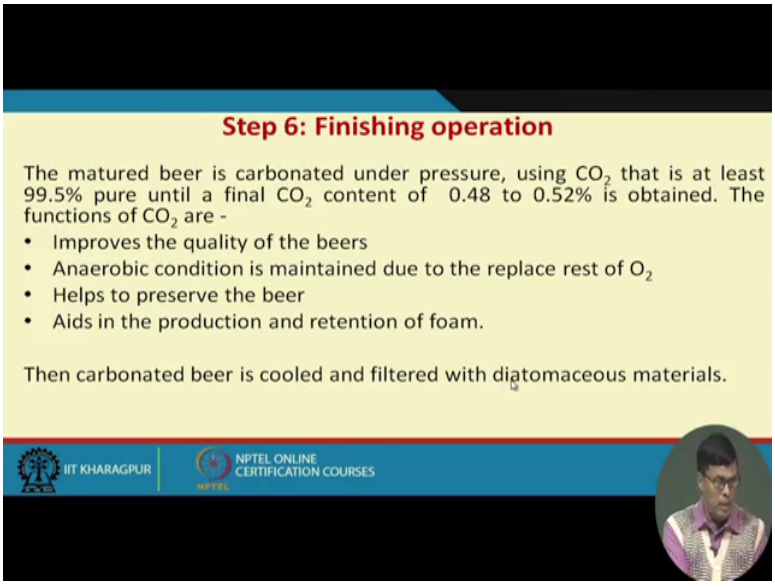


Now maturation process I told you I mentioned before the beer is stored at the refrigerated cellars at 0 degree centigrade and during this process unstable protein yeast and resins and other undesirable proteins are precipitated out which is very important.

Esters are produced to give the characteristic flavour I told you the ethanol and organic acid they form the esters so the harshness of the beer will go and then then harshness disappeared what I mentioned then antioxidants like sulphide are added during the storage because that the increase the storability of the particular beer. Beer also made chill proof by using special enzyme I told you during this maturation process we add some kind of proteolytic enzyme.

Main purpose of adding proteolytic enzyme is to degrade the higher protein molecules into the smaller protein molecule. So that even in low temperature the protein will not be precipitated out.

(Refer Slide Time: 15:57)



Now finishing operation the matured beer is carbonated under pressure using the carbon-di-oxide that is at least 99.5 per cent pure until final carbon-di-oxide content is 0.48 to 0.52 per cent is obtained. The function of carbon-di-oxide is several it improves the quality of the beer because beer is a carbonated drinks and I told you this this this protein helps for maintaining the foam in the beer.

Anaerobic condition is maintain due to the replacement of oxygen so is the anaerobic condition a few organism can grow the contamination problem will drastically reduce then hence in the preservation of beer because this anaerobic condition that preserve the preservation of beer because less number of organism can aids in the production and retention

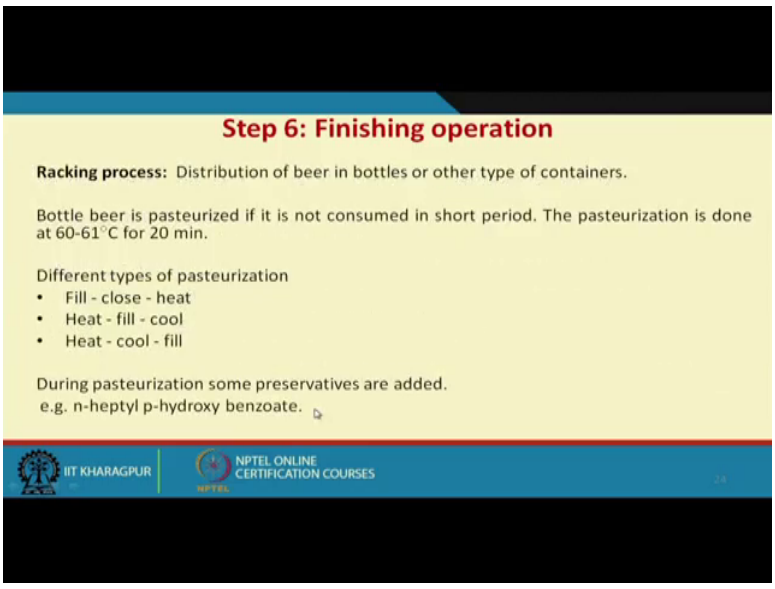
of foam, retention of foam is very important I told you that carbon-di-oxide in presence of protein is form the foam which is quite stable.

So you can remain for some time. Then carbonated beverage is cooled and filtered with diatomaceous because here let me point out sometimes the find sometimes we find some kind of fine particles present in the beer and this is removed by using some filtered aid. The filtered aid means I mentioned before also this is largely used in the different chemical and biochemical industry particularly I tried to mentioned that in case of chemical and biochemical industry we use the activated charcoal which is very fine particles when we use that and then after the this is this has the bleaching powder this is the bleaching property.

This bleaching property helps to remove the colour from the product so but after use of activated charcoal it is very difficult to remove the activated charcoal because size is very small so what we use some kind of filtered aid so that we can that bigger particle can this the activated charcoal can absorb on the surface of the bigger particle and that bigger particle we can separate it out very easily.

So that is the here diatomaceous how this kind of filtered aid that is used in the beer making industry to separate the fine particles.

(Refer Slide Time: 18:33)

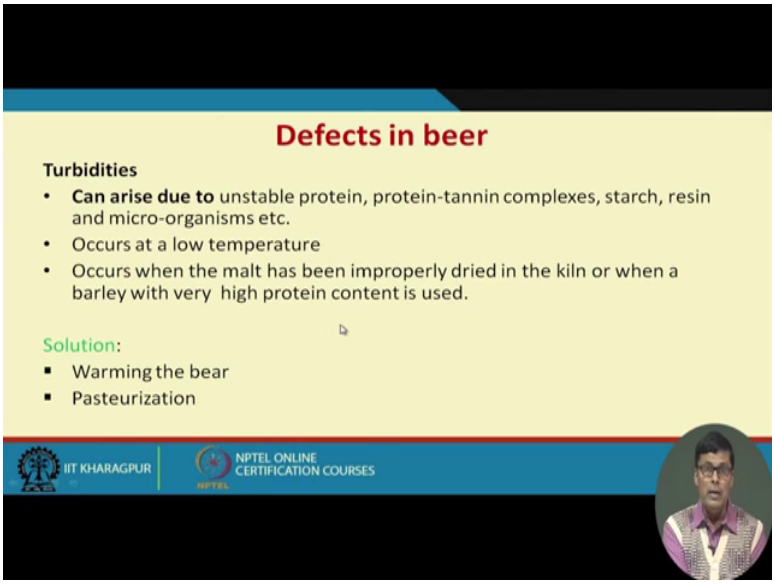


Now I told you that racking process that is another process that is this is also kind of through this kind of clarification process clarification I mentioned that it is kind of separation of solid from the liquid if you want to separate the finer particles you have to pass through the racking process so that fine particles can be separated out.

The beer bottle is pasteurised if it is not consumed for the short period I told you the beer can be marketed in two different forms one is short time market another long time market if you have short time market you do not have to pasteurize, you use the preservative like normal heptyl parahydroxy benzoate you add that increase the storability of the beer so you can have a short time market this can be used.

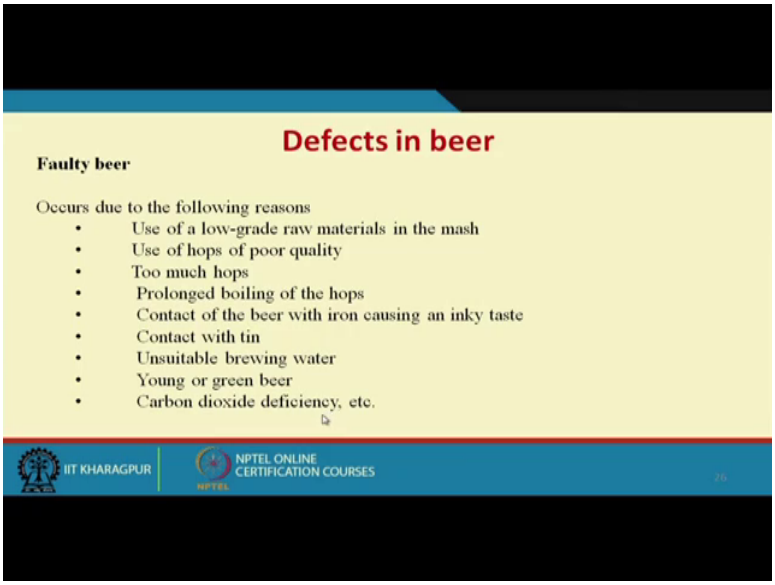
For long time market we do the pasteurization 60 to 61 degree centigrade for 20 minutes and three type of pasteurization we have, Fill, Cool and Heat. Fill, Closed and Heat. Heat, Fill and Close. Heat, Cool and Fill. So you know first you fill then close then heat this is this is that and first you heat then fill then cool then heat, cool, fill. So there are three different that mode of operation we have for the pasteurization of the beer.

(Refer Slide Time: 20:00)



Now beer has several defects that we have how defects of beer and defects of beer is arises due to mainly due to the precipitation of the proteins or remaining some suspended particles. So this is can arise due to the unstable protein protein-tannin complex, starch, resin and the microorganism etcetera occurs at low temperature, occurs when malts has been improperly dried or in the kiln and when a barley with very high protein contain is used. That this this can be removed by solution is warming the beer and the pasteurization process. So this can be removed to some extent that you know the turbidity of the beer can be you know removed.

(Refer Slide Time: 20:54)

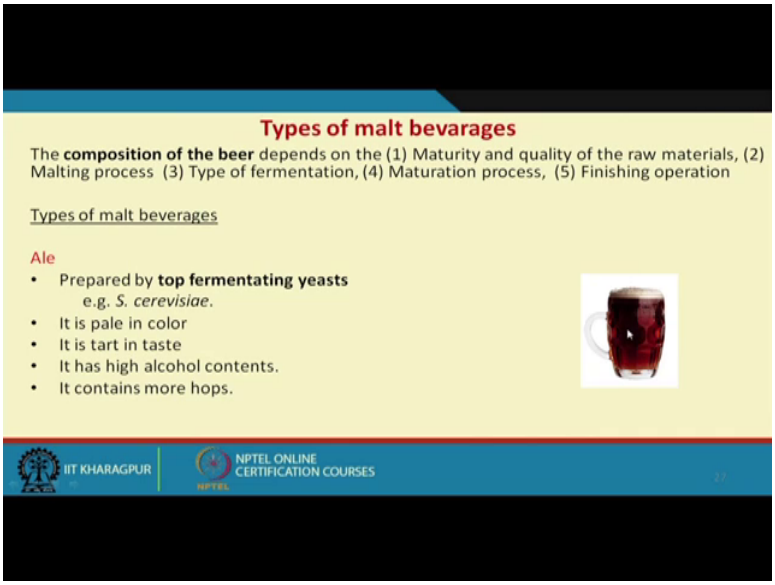


But another very important defect of the beer is the is the faulty beer this is due to the following reason, due to the use of low grade raw materials in the mash. If the quality of the raw materials is very less very low grade that particularly quality of the barley grains is the poor quality then there is the possibility of this defects in beer then we have hops of poor quality if the hops have very poor quality that also give some poor quality, poor defects in beer then too much of hops.

If you use too much of hop it gives too much of bitterness in the beer and prolong boiling with hop if you if you heat the beer for longer period of time then also it causes some kind of defects in the beer, contact the beer with iron causes the inky taste because the iron if it contains iron contains in the beer that causes the inky taste because the ink has some kind of taste particularly in the early days we use the fountain pen and in the fountain pen we use the ink and that ink if you touch if you taste in the tongue we will have typical taste and that is called the inky taste and this inky taste is occurred due to the presence of iron in the beer.

Then contact with tin then also it is there, it is a problem then unsuitable for the bring water if is used that causes if the quality of the water is poor then also causes the faulty in beer. Young and green beer that is also due to the formation of that carbon-di-oxide deficiency also causes the defects in beer.

(Refer Slide Time: 22:50)



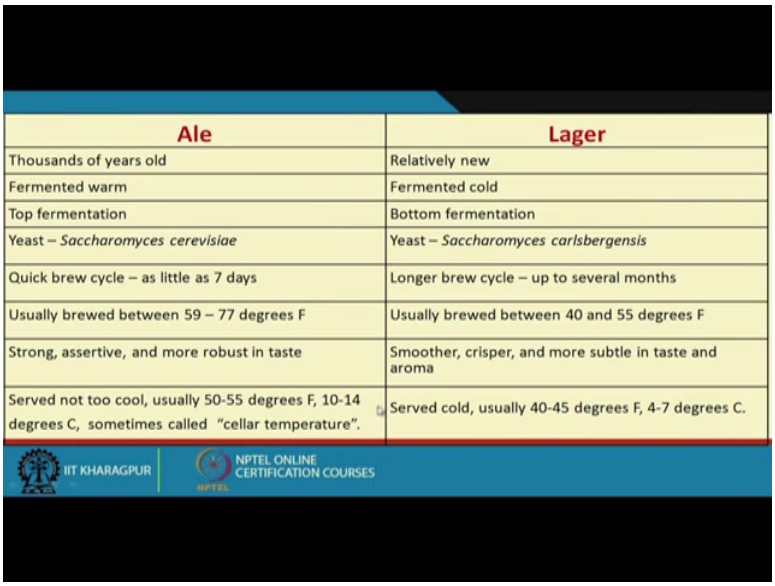
So there are there are different defects in beer that we have so and then composition of beer depends on the different different parameters, one is the maturity and quality of the raw materials. Malting process, types of fermentation, maturation process and finishing operation. The types of beverages we have ale beer prepared by the top fermenting is saccharomyces cerevisiae, it is pale in colour and it is tart in taste and it has high alcohol contents and it has good hops and it has more hops. So you know that this is ale beer that is that is that looks like darker in colour that is not in practise in India but some places in the world they use this dark colour beer.

(Refer Slide Time: 23:44)

But in India we mostly use the lager beer. Lager beer is little bit yellowish in colour you can see how it looks, stored beer and it is prepared by bottom fermenting saccharomyces carlsbergensis it contains the high alcohol and low proportion of hop because I mentioned that water formed hops is required per barrel of the beer and then we have the porter. Porter is further if you consider that that dark colour beer because is very very dark if you if you consider that ale beer it is much darker than ale beer you can you can see it, it is much darker. What we call stronger than ale and the and lager beer that porter is stronger actually and high high in extract alcohol sweet in taste this is porter has sweet in taste.

It is prepared from the dark malt that is why it is dark colour and I mentioned that how the dark malt is taking place if you if you barley grains if you if you heat it if you (())(24:59) if you heat it for quite some time then it colour will be little bit darker. So we can easily make the colour darker is usually produced from dark malt. It has less distinct flavour than the ale it is less distinct flavour than the ale.

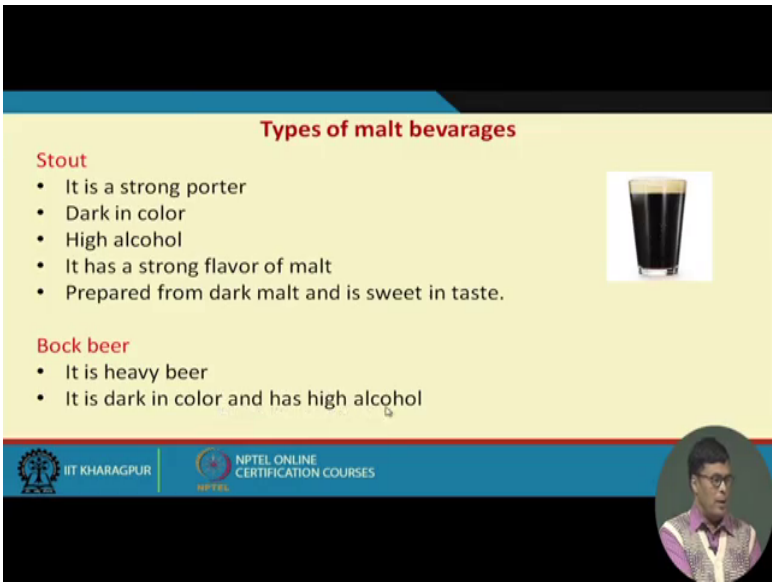
(Refer Slide Time: 25:17)



Now we have we have this is the difference between the ale and lager beer, a thousand years old relatively lager beer is little bit new and I told you that ale beer is fermentation take place little higher temperature as compared to the lager beer. It is ale is formed by the using top fermenting yeast the bottom fermenting yeast. Ale is produced by using saccharomyces cerevisiae and lager is produced by using saccharomyces carlsbergensis. Quick brew cycle this is seven days, it is longer cycle that is several months. And usually the brewed between 59 to 77 degree Fahrenheit usually brewed between 40 to 45 degree Fahrenheit.

Strong assertive and most robust in taste, the smoother, crisper and most subtle in taste and aroma. Served not too cold usually 50 to 55 degree, 10 to 14 degree centigrade sometimes called cellar temperature. Cellar I want to tell cellar is nothing but the underground tank that is used for storing the this for the maturation of the of the alcoholic beverages and that lager is a served cold usually 40 to 45 degree Fahrenheit and that is equivalent to 4 to 7 degree centigrade.

(Refer Slide Time: 26:54)



Now malt beverage we have another we have Stout it is very stronger than porter we have we have seen the porter is quite dark it is more darker than that and dark in colour high alcohol.

It has strong flavour of malt and prepared from dark malt and in sweet in taste this is called stout and this is Bock beer it is very heavy heavy beer it is dark in colour and high alcohol. So in conclusion let me tell you that brewing industry that that is largely used throughout the world and we have we have two different type of beer largely used throughout the world one is lager another is ale beer and barley grains is mostly used as a basic raw materials for the production of beer but with barley grains we use some kind of malting agent also that and four steps are major steps are involved for the beer making industry one is malting another is mashing then and there is hoping then you have fermentation.

I told you the maturation process also very important as well beer making industry, long time and short time marketing on the basis of that we have to find out that whether beer should be pasteurized or not and you know your your malting process depends on different steps we have steeping process where here the your barley grains is wetted then you have to do the

germination on the wet and aerobic conditions and in case of this then mashing process you solubilize the insoluble material and in the then hopping you boil with the hops to get the desirable ingredients from the hops desirable taste and flavour to the beer.

And finally that we there we passes through the fermentation process, two types of yeast is used one is saccharomyces cerevisiae and saccharomyces carlsbergensis and after that it bypasses through the maturation process and we do the carbonization and do the bottling or put in the can on the barrels and send it in the market. So this is gives a some kind of idea how the brewing industry looks I think in the next class we will be discussing some other fermentation process. Thank you