Food Oils and Fats: Chemistry & Technology

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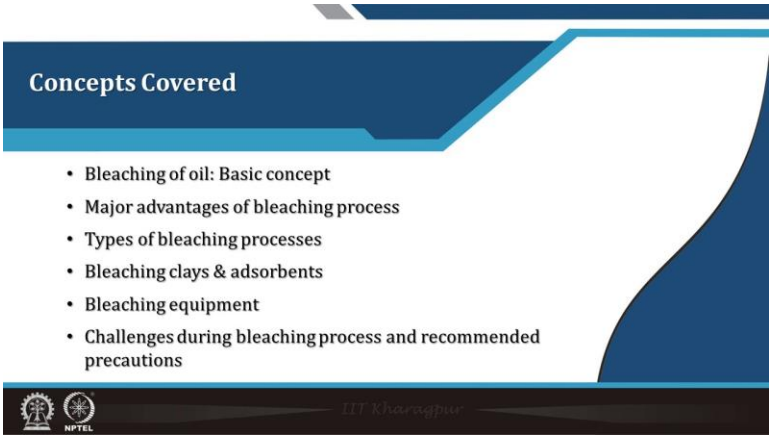
Module 6: Edible Oils Refining

Lecture 29: Bleaching

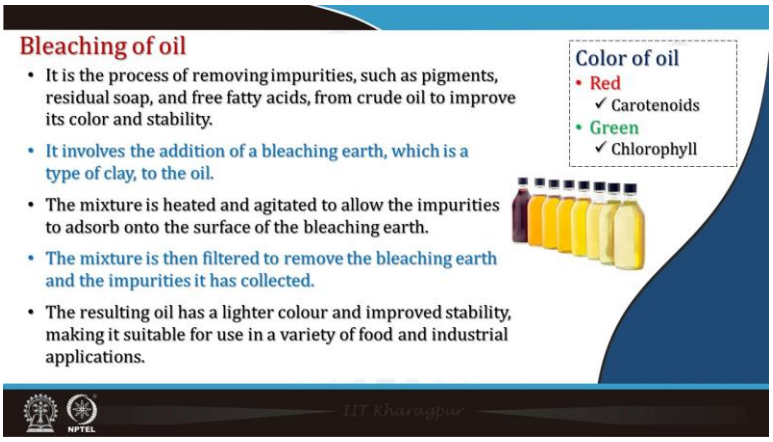
Hello everybody, Namaskar. Let us discuss today another important step of edible oil refining that is bleaching.



The concept which will be covered in this lecture today that is what is bleaching, what is the concept behind this bleaching process, major advantages of the edible oil bleaching, types of bleaching processes, then what are the bleaching materials used that the clay and adsorbents, bleaching equipment and finally, we will also discuss some of the major challenges during bleaching process and recommended precautions.

So, the bleaching of the oil, in the earlier classes also. I think you got some clue what the bleaching is that is the oil which is extracted from the plant materials or from whether it

is seed or leaf or root or whatever from the plant material or from the animal sources etcetera.

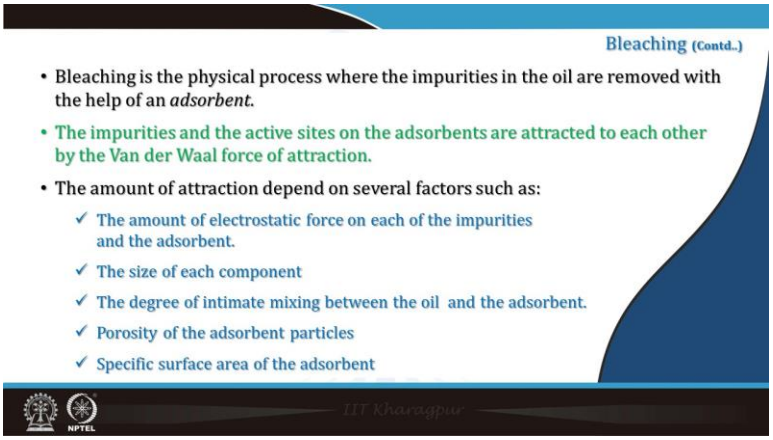


So, depending upon that the process of extraction their source they may contain some natural pigments in this like from the plant material that is the green color chlorophyll which obtained even the red color compound or yellow color compound carotenoids are present. So, all these carotenoids, chlorophylls, and other such pigments etcetera they get extracted into the oil and they are present and there they give some redness to or yellowness or some greenness to the which is which is generally not considered a very good quality.

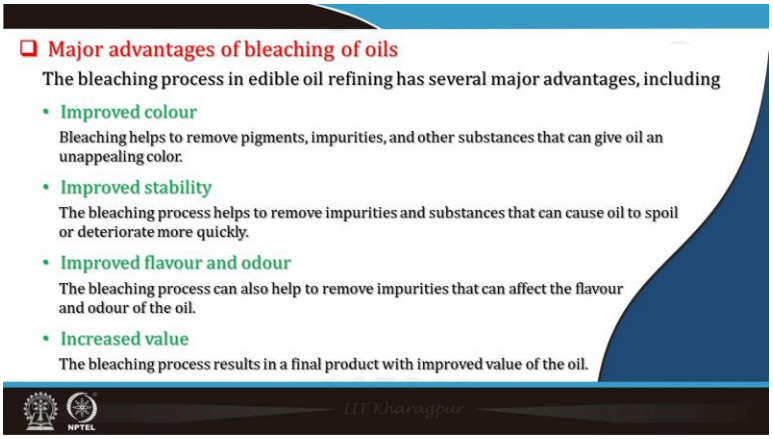
So, it is generally that before the oil is sent to the consumer for its use these pigments etcetera are removed and that is the process of bleaching. In the bleaching process, there is the color that is pigments etcetera or even some of the residual soap that is which was not removed during the neutralization process or some even free fatty acids which were not reduced during neutralization process etcetera all these are removed in this system.

So, bleaching is the basically a collectively mainly it is for the removal of the pigment, but in addition to the pigment it may also remove some residual fatty acids soaps etcetera. So, in this bleaching basically it involves the addition of bleaching earth which is a type of clay and this earth are added to the oil this mixture is heated and agitated to allow the impurities to get adsorbed onto the surface of these bleaching earth.

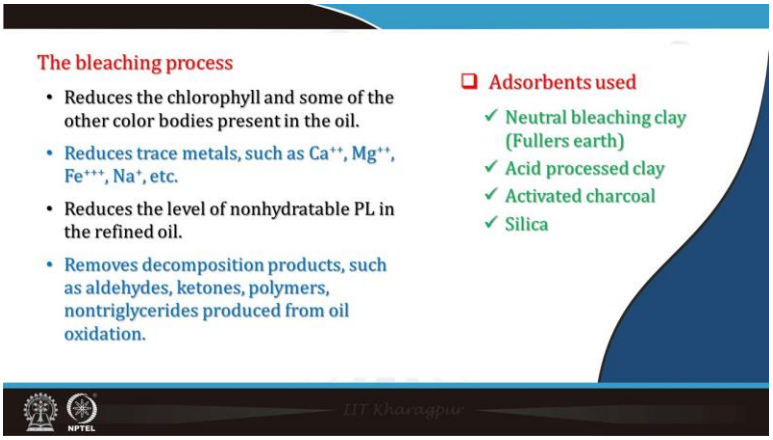
The mixture is then filtered to remove the bleaching earth and the impurities which are collected. The resulting oil has a lighter color and improved stability making it suitable for use in a variety of food and other industrial applications.



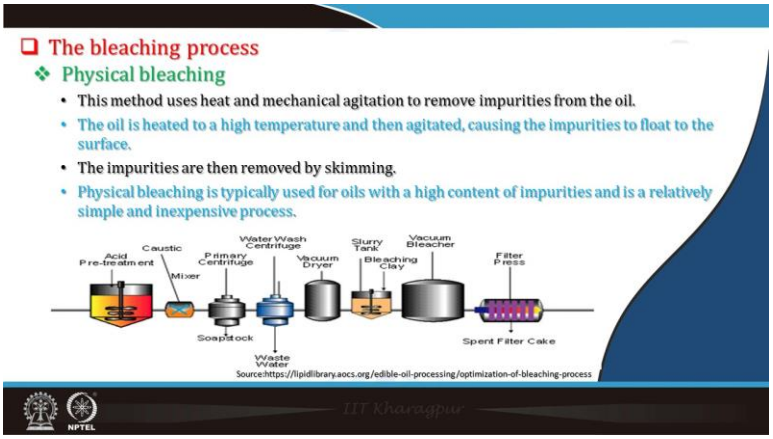
So, as you could see this basically this bleaching is a physical process where the impurities from oil are removed with the help of certain adsorbents. The impurities and the active sites of the adsorbents are attracted to each other by the Van der Waal forces of attraction. The amount of attraction will depend on several factors like amount of electrostatic force on each of the impurities and the adsorbent, the size of each component, the degree of intimate mixing between the oil and the adsorbent, porosity of the adsorbent particles and specific area of the adsorbents. These are the various factors which govern the bond formation.



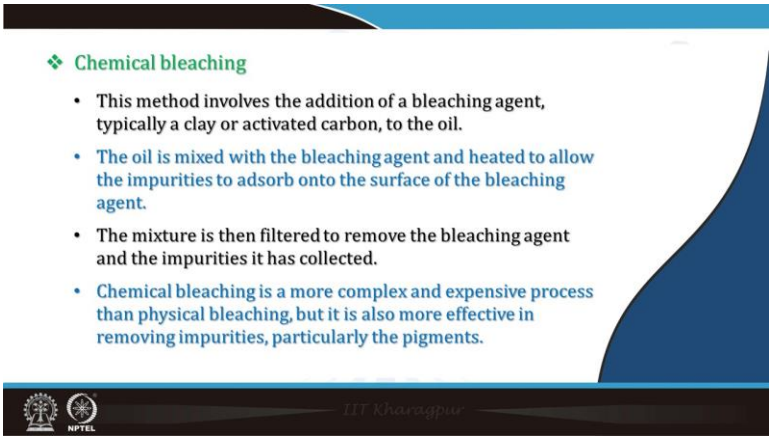
So, the major advantages of the bleaching of the oil obviously, is there is improved color as I told you it helps to remove the pigments, impurities, and other substances and it will improve the appeal of the oil, color of the oil, appearance of the oil. Then it also improves the stability because the impurities are substances that can cause the oil to spoil or deteriorate more quickly they are removed during bleaching process. Also, it improves the flavor and odour of the oil the bleaching process. By removing the impurities that can affect adversely the flavor and aroma of the oil, odour of the oil. Then it adds value to the oil that is the bleaching process results in a final product with improved value to the oil.



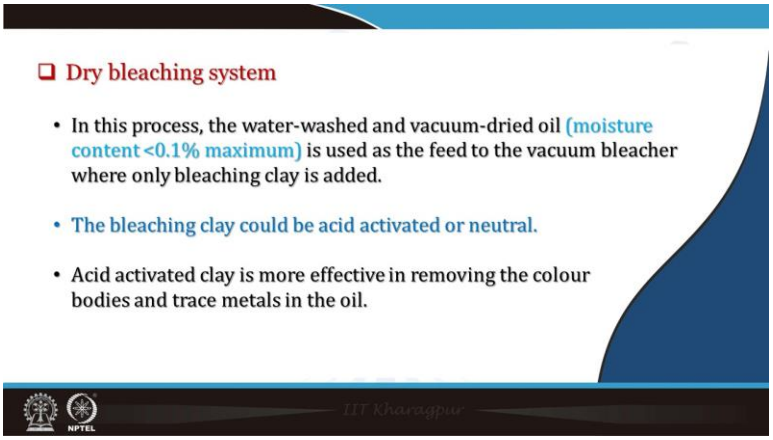
So, what is the bleaching oil as I told you that is the it is physical intimate mixing that is the some of the adsorbents such as neutral bleaching clay that is called commonly fuller earth or acid processed clay, activated charcoal, or silica etcetera. These are the commonly used any of these either a mixture of these depending upon the what type of pigments etcetera that might be present there and so, this bleaching process these are the adsorbent used and the process reduces the chlorophyll and some of the other color bodies present in the oil. It reduces trace metals like calcium, iron, magnesium, iron, ferric, sodium etcetera. It reduces the level of non-hydratable phospholipids in the refined oil and also it removes decomposition products such as aldehydes, ketones, polymers, non-triglycerides which are produced from the oil oxidation. So, these proteins are removed during the bleaching process.



So, the actual what is the bleaching process it may be that is the different methods physical bleaching, chemical bleaching etcetera. So, in the physical bleaching you can see there is a series of the steps that is this method basically uses the heat and mechanical agitation to remove the impurities from the oil. The oil is heated after the adsorbent is added and then it causes the impurities to float on the surface. The impurities are then removed by skimming. The physical bleaching is a typically used for oils which have high content of impurities, pigments etcetera and is a relatively simple and inexpensive process.



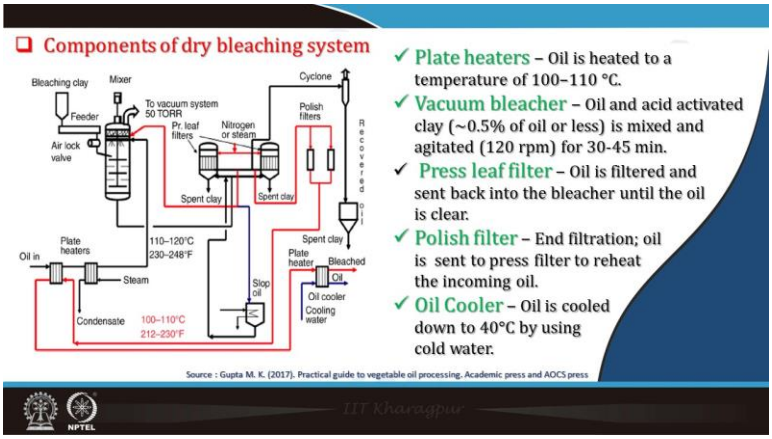
The chemical bleaching, this method involves the addition of bleaching agent typically a clay or activated carbon to the oil. The oil is mixed with the bleaching agent and heated to allow the impurities to adsorb onto the surface of the bleaching agent. The mixture is then filtered to remove the bleaching agent and the impurities it has collected. Chemical bleaching is a more complex and expensive process than physical bleaching, but chemical bleaching is more effective in removing the impurities particularly the pigments etcetera are better adsorbed here in the physical bleaching they may not be removed. So, easily that is the physical bleaching just the oil is heated and mixed and given. So, some of the impurities they come on the top and they are skimmed.



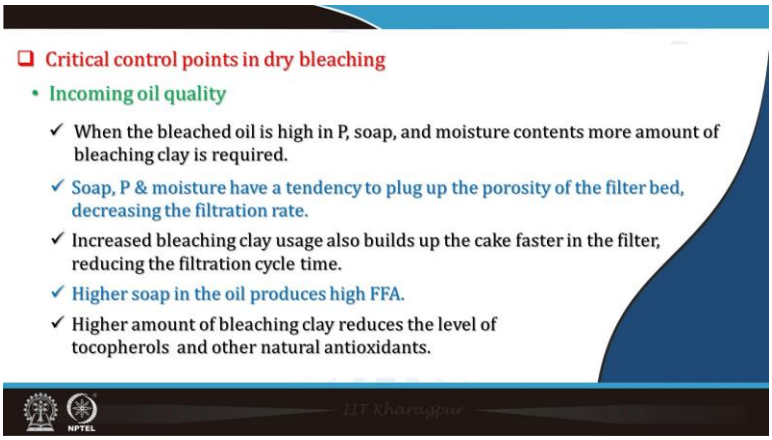
Dry bleaching system. In this process, the water washed and vacuum dried oil that is its moisture content should be less than 0.1 percent that is maximum water should be in the oil may be 0.1 percent. So, less than so, water washed and vacuum dried oil is used here as a feed to the vacuum bleacher where only bleaching clay is added. The bleaching clay could be acid activated charcoal or neutral. Acid activated clay is more effective in removing the color bodies and the trash metals in the oil.

So, the components of the dry bleaching clay you can see here in this figure it has plate heaters. Plate heaters that is oil is heated to a temperature of around 100 to 110 degree Celsius and then hot oil is sent to the vacuum bleacher where this oil and activated

charcoal activated clay, the clay at the rate of 0.5 percent of the oil weight or less is mixed and agitated at 120 rpm for about 30 to 45 minutes. The clay is added here and then it is mixed properly.

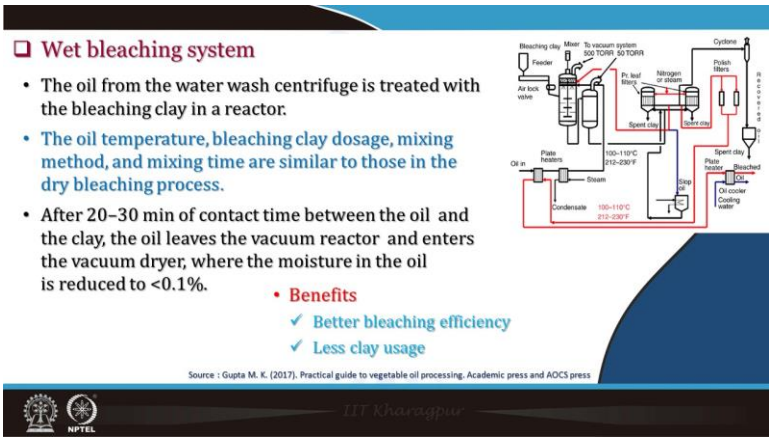


Then it is sent to the press leaf filter. In the press leaf filter there it is where this oil is filtered and sent back to the bleacher until the oil is completely clear and also there is a polish filter. These polish filters this is end of the filtration process that is oil is sent to press filters to reheat the incoming oil and finally, it is sent to the oil cooler where oil is cooled down to around 40 degree Celsius using the cold water. So, these are the different components of the dry bleaching system and obviously, this whole process is provided with all accessories, piping, instrumentation, and other things to measure and indicate the things and flow control valve and all other requirements.

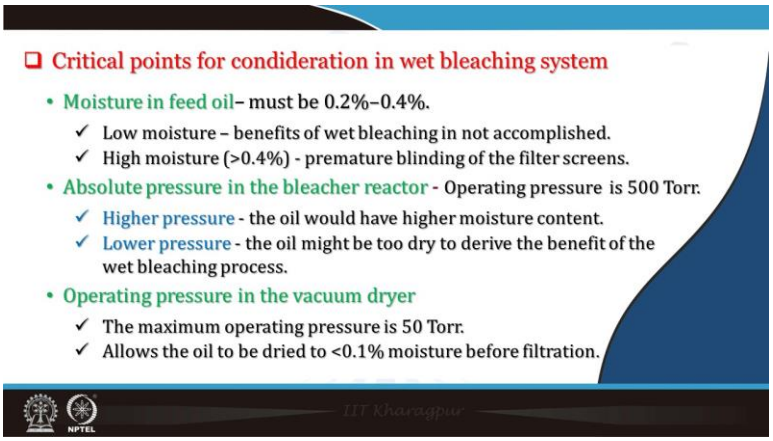


So, the critical control points in the dry bleaching process include number one the incoming oil quality. When the bleaching oil is high in phosphorus, soap, and moisture content, more amount of bleaching clay will be required. Soaps, phosphorus and moisture have a tendency to plug up the porosity of the filter bed, decreasing the filtration rate. Increased bleaching clay usage also builds up the cake faster in the filter, reducing the filtration cycle time. Higher soap in the oil produces high free fatty acids. Higher amount of bleaching clay reduces the level of tocopherols and other natural antioxidants. So, it is

very important that the oil which is sent to the bleacher after the neutralization process it should have a uniform and consistent quality.

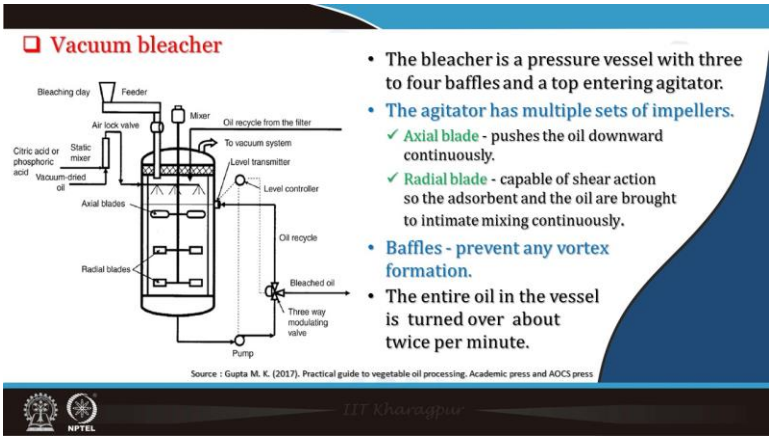


We come to the wet bleaching system. It is also almost similar same type of only thing in the process there are some little additions. The oil from the water wash centrifuge is treated to the bleaching clay in this reactor, but just from the water wash centrifuge itself the oil temperature bleaching clay dosage, mixing method, mixing time etcetera are similar to those in the dry bleaching process. So, after 20 to 30 minutes of contact time between the oil and the clay, the oil leaves the vacuum reactor and enters the vacuum dryer where the moisture content of the oil is reduced to less than 0.1 percent. See after the bleaching. But in the dry bleaching, the moisture content was reduced before it was sent to the clay to less than 0.1 percent. So, the benefits of this process include better bleaching efficiency and less clay usage.

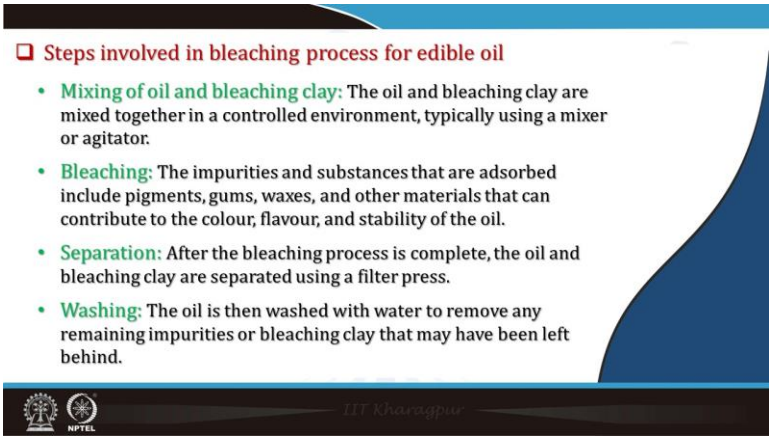


So, critical points for consideration in wet bleaching system includes that is moisture in the free dryer. So, the moisture content it should be in the range of 0.2 to 0.4 percent the dry bleaching system maximum was 0.01 percent. So, the low moisture benefits of water bleaching are not accomplished. If it is high moisture more than 0.4 percent then the premature binding of the filter screens will be there. So, the moisture content should be given in the given range. Then absolute pressure in the bleacher reactor, that is operating

pressure should be around 500 Torr. Then if the more very high pressure is there, the oil would have higher moisture content. Lower pressure, the oil might be too dry to derive the benefit of the wet bleaching system. Operating pressure in the vacuum dryer finally, the vacuum the maximum operating pressure should be 50 Torr and it allows the oil to be dried to less than 0.1 percent moisture before filtration.

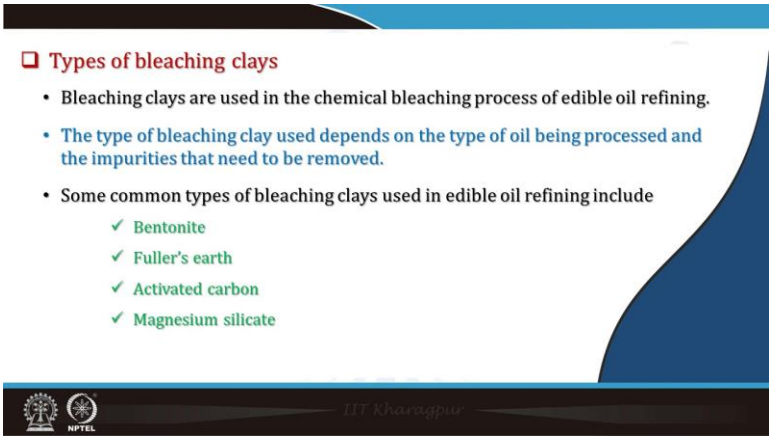


Then next is the vacuum bleacher. Here is an assembly you can see set up it is the again a pressure vessel. The bleacher is a pressure vessel with 3 to 4 baffles and the top entering agitator is provided. The agitator has multiple set of impellers like axial blades which pushes the oil downwards continuously then there are radial blades which are capable of shear action. So, the adsorbent and the oil are brought to intimate mixing continuously. These are provided baffles to prevent any vortex formation and the entire oil in the vessel is turned about over twice per minute by these things. So, the other arrangement like feeder arrangement, feeding bar that oil, bleaching clay and all those arrangements are provided, and vacuum is maintained. So, oil is treated that is the bleaching material is added, adsorbent is added and then under vacuum it is a heated and treated given the proper reaction time for the adsorbent to take place.



So, in this process the steps involved in the bleaching process of the edible oil as you have seen earlier it is clear now that is mixing of oil and the bleaching clay. These are

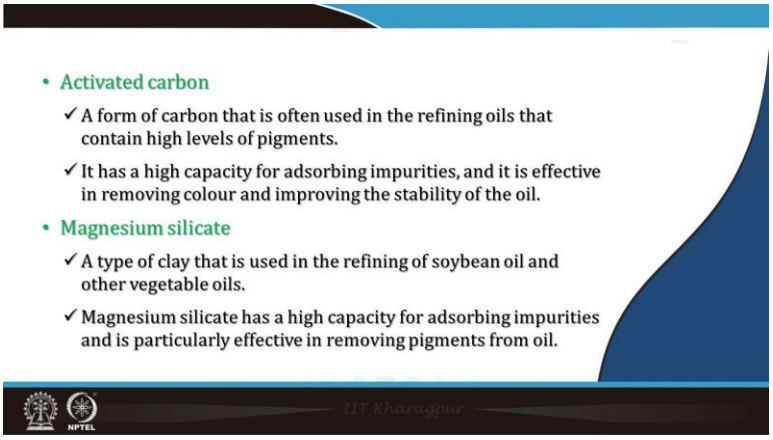
mixed together in a control environment typically using a proper mixture or agitator. Then the bleaching, the impurities and substances that are adsorbed including pigments, gum, waxes, and other material that can contribute to the colour, flavour and stability etcetera of the oil. So, once it is mixed it is given proper bleaching reaction time. So, there bleaching takes place. Then separation, after the bleaching process is complete the oil and the bleaching clay are separated using filter press. And finally, washing, the oil is then washed with water to remove any remaining impurities or bleaching clay that may have been left behind. So, these are the steps involved in the bleaching.



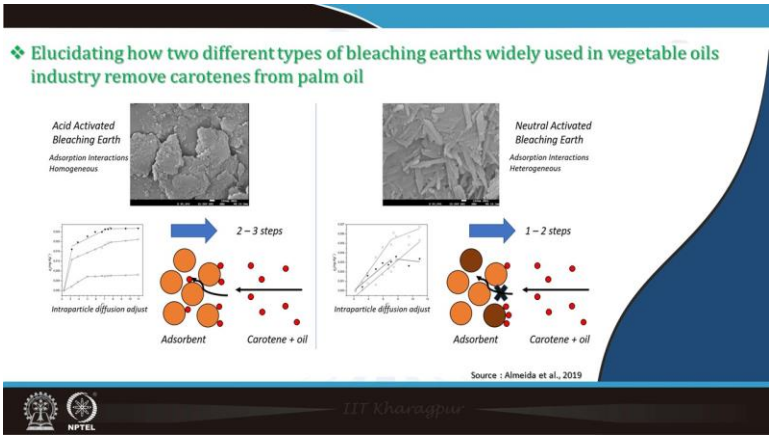
Now, the types of bleaching clay and here also I told it is used bleaching clays are used in the chemical bleaching process of the edible refining. This may be type of the clay used depends upon the type of oil being processed and the impurities that need to be removed. Some common types of bleaching clay used are bentonite, fuller's earth, activated carbon, and magnesium silicate.

Bentonite is often used in a refining of soybean oil, canola oil, and other vegetable oil. It has a high capacity for adsorbing impurities such as which are commonly found in combination with the vegetable oil. So, this bentonite in combination with other materials it can easily that other bleaching agent it can easily adsorb the impurities.

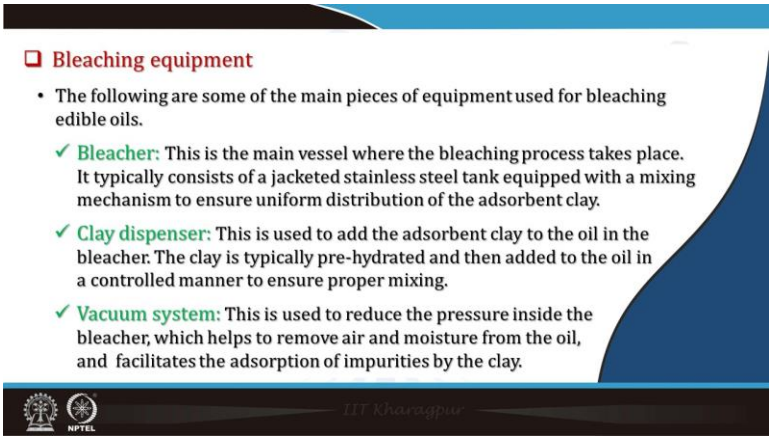
Then fuller earth, it is a type of clay that is used in refining of palm oil and other tropical oils. So, fuller earth has a high capacity for adsorbing impurities and it is also used to remove colour and improve the stability of the oil.



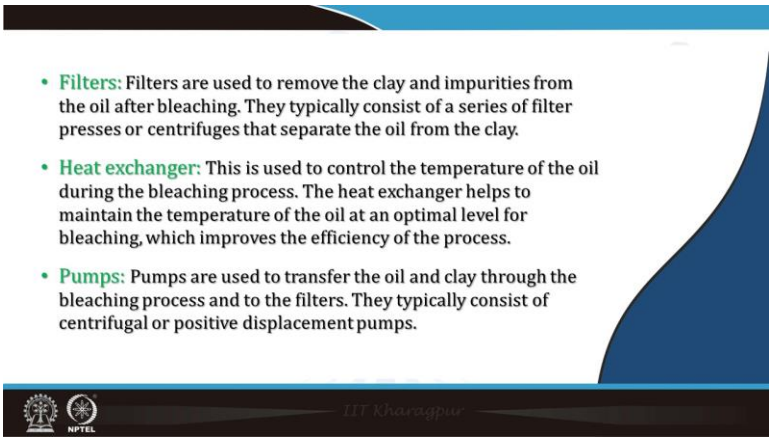
Activated carbon, it is a form of carbon. It has a high capacity for adsorbing the impurities and it is effective in improving the colour and removing the pigments, improving the stability of the oil and this. It may be either acid activated charcoal etcetera can be used as activated carbon. Then magnesium silicate, it has a high capacity and adsorbing impurities and is particularly effective in removing the pigment from the oil. So, depending upon this either individually these are mixture of these things can be used in proper proportion in the oil depending upon the type of the pigments etcetera that are present.



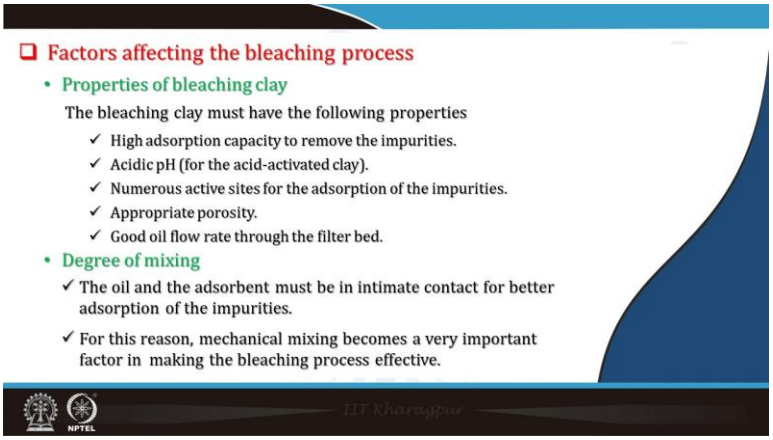
So, here you can see that this is a slide which shows the indicating how two different types of bleaching earth widely used in vegetable oil by the industry remove carotenes from palm oil. This is an acid activated bleaching earth, and this is the neutral activated bleaching earth. In this, it may require two-three steps that is intraparticle diffusion adjust that is the particles etcetera, carotene plus oil etcetera pass through this and the material there. So, in this material, they get adsorbed here on this the acid activated whereas, in the neutral case, you see that it is in this adsorbent it is get adsorbed.



Now, the bleaching equipment. There are some main pieces of the equipment used for bleaching of edible oils or the one in the earlier slide you saw that the bleacher that is the reaction vessel, that is the main vessel where the bleaching process takes place it typically consists of a jacketed stainless-steel tile which are equipped with a mixing mechanism to ensure uniform distribution of the adsorbent clay. So, that is called bleacher. Then clay dispenser, this is used to add the adsorbent clay to the oil in the bleacher. The clay is typically pre-hydrated and then added to the oil in a control manner to ensure proper mixing. A vacuum system is provided, this is used to reduce the pressure inside the bleacher which helps to remove air and moisture from the oil and facilitates the adsorption of impurities by the clay.

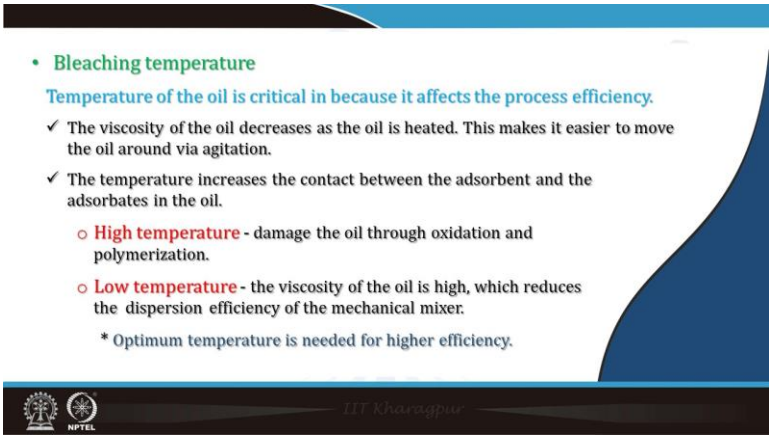


Then filters like press filters and other filters are provided. These are used to remove the clay and impurities from the oil after bleaching. They typically consist of a series of filter presses or centrifuge that separates the oil from the clay. Then heat exchangers, important component, this is used to control the temperature of the oil during the bleaching process. The heat exchanger helps to maintain the temperature of the oil at an optimum level for bleaching, which improves the efficiency of the process and then also vacuum maintaining device also systems also. Then pumps are used to transfer the oil and clay through the bleaching process and to filters. They typically consist of centrifugal pump or positive displacement pumps.



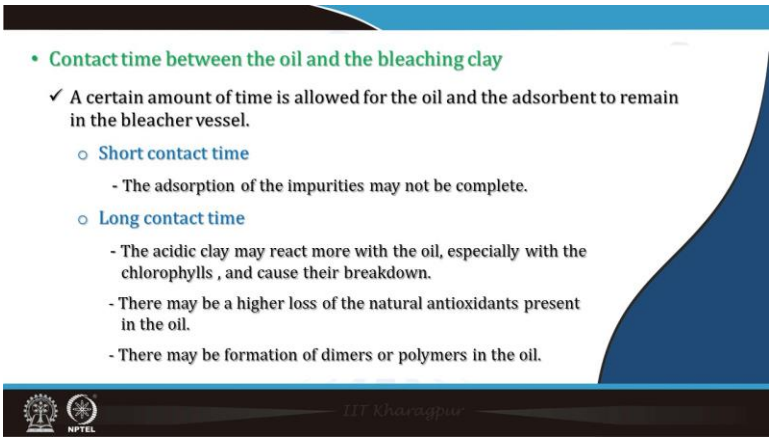
Now, let us see briefly the various factors which influence the bleaching process. So, number one important factor is the properties of the bleaching clay. The bleaching clay must have certain property that is it should have high adsorption capacity to remove the impurities. It should have acidic pH because acid activated clay they have more adsorbent affinity that you could see in the earlier class that is the along with the other than the neutral clay acid activated clay charcoal they can adsorb the material better. It has a that is also the numeral active sites for the adsorption of the impurities that more the active site more will be the adsorption. Of course, it should have appropriate porosity and good oil flow rate through the filter bed. So, these are the type of the properties of the bleaching clay.

Degree of mixing, the oil and the adsorbent must be in intimate contact for better adsorption of the impurity. Proper mixing is a very essential. For this reason, the mechanical mixing becomes a very important factor in making the bleaching process effective.

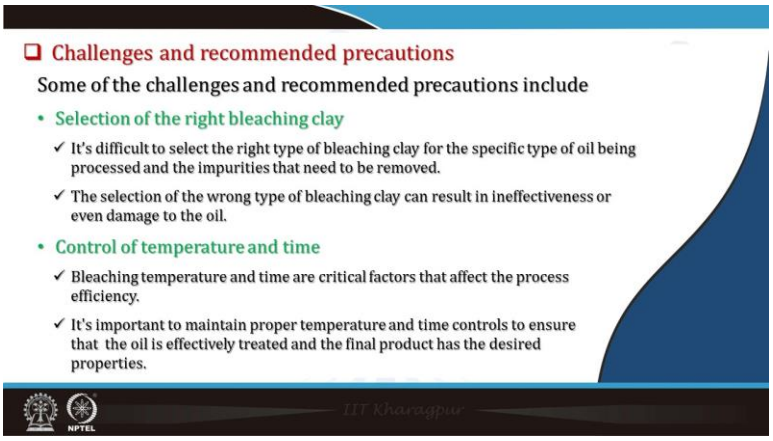


Then bleaching temperature, temperature of the oil is critical in bleaching process because it affects the process efficiency. The viscosity of the oil decreases as the oil is heated. This makes it easier to move the oil around the agitation with agitation. So, the temperature has important role. The temperature increases the contact between the

adsorbent and the adsorbates in the oil. So, high temperature however, it may cause damage to oil through oxidation and polymerization. Low temperature, it may result that the viscosity of the oil may be very high which reduces the dispersion efficiency of the mechanical mixer. So, therefore, optimum temperature is needed for higher efficiency and that will depend upon the type of the oil and other equipment etcetera. So, proper optimum conditions of temperature should be maintained.



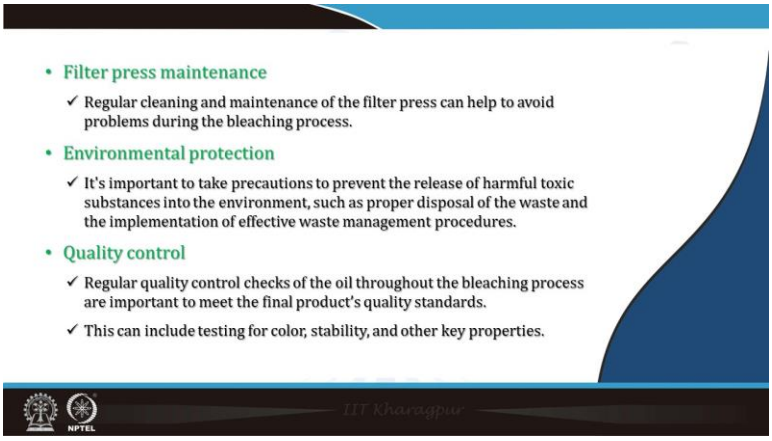
Then another important factor is the contact time between the oil and the bleaching clay. There is a certain amount of time must be given. It is allowed for the oil and the adsorbent to remain in the bleacher vessel. If there is a short contact time, the adsorption of the impurities may not be complete. If it is very long contact time, the acidic clay may react more with the oil especially with the chlorophylls and it cause their breakdown. And there may be a higher loss of the natural antioxidant present in the oil. There may be formation of dimers or polymers in the oil if the contact time is excessively large. So, again the contact time between the oil and the adsorbents should be properly controlled.



Now, the challenges during the oil bleaching process and suggested precautions include number one, there is selection of right bleaching clay. And yes, it is very difficult to select a right type of bleaching clay for the specific type of oil heating process and the impurities that need to be removed because even there may be different depending upon

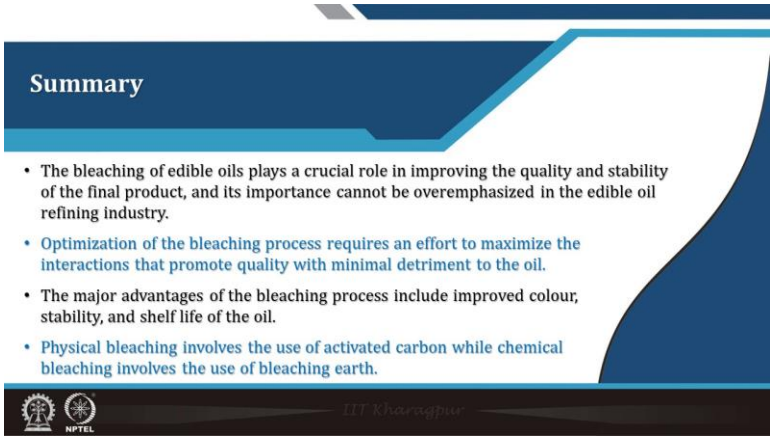
the various source of the oil, even type of pigments, type of the materials etcetera impurities that we are telling which we want to remove during this process may vary. And obviously, the material again that is the interactions between these adsorbents and the adsorbates etcetera that may depend that is what is the properties in the earlier class slide we discussed. So, although it is difficult, but it is very important factor that is the right bleaching clay which has affinity proper environment to be that is a to get adsorbed properly that should be selected. Selection of the wrong type of bleaching clay can result in ineffectiveness or even damage to the oil.

The control of temperature and time as we discussed in earlier slide. The bleaching temperature and time are the critical factors that affect the process efficiency. And it is important to maintain proper temperature and time controls to ensure that the oil is effectively treated and the final product has desired properties. We have discussed that is if the temperature and contact time are more or too less etcetera, high and low temperature then what will be the repercussion. So, it is very essential that the proper control time and temperature it in during the process.



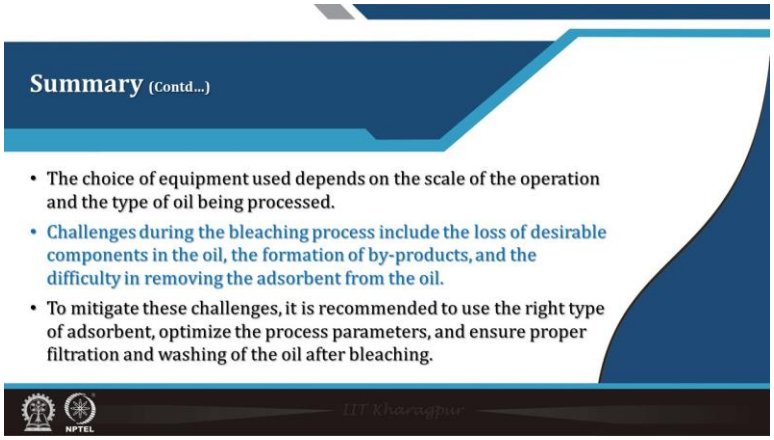
Then filter press maintenance, regular cleaning and maintenance of the filter press will help to avoid problems during the bleaching process. So, proper cleaning and maintenance of the filter press routinely should be done. Then environmental protection, it is important to take precautions to prevent the release of harmful toxic substances into the environment such as proper disposal of the waste and the implementation of effective waste management procedures should be undertaken. Quality control, regular quality control checks of the oil throughout the bleaching process are important to meet the final products quality standards and this can include testing of the oil for its colour, stability and other key properties.

Now, finally, I will like to summarize this lecture saying that the bleaching of the edible oil plays a crucial role in improving the quality and stability of the final product and it is important, its importance cannot be overemphasized in the edible oil refining industry very very important process.



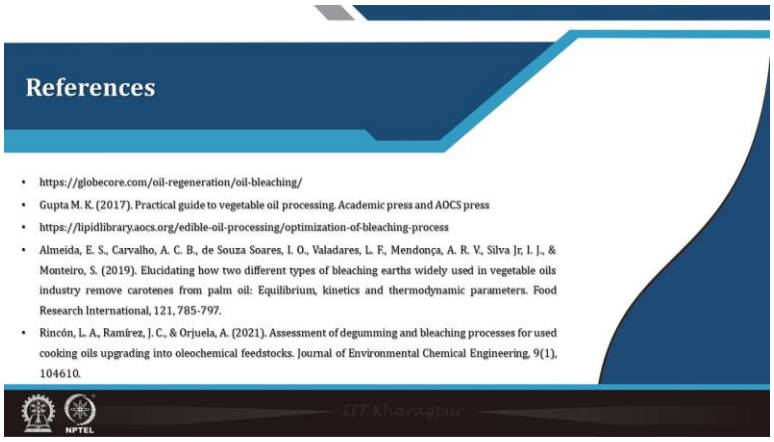
Optimization of the bleaching process requires an effort to maximize the interactions that promote quality and minimum detriment to the oil. With a, there is, whatever bleaching clay because you are adding clay into the also type of the clay and all those things interaction and then these clays should be properly removed effectively all the whatever clay has been added otherwise. So, it should not that the interactions etcetera or this should not lead into the quality deterioration in the oil.

The major advantage of the bleaching process includes improved colour, stability and the shelf life of the oil however, if provided the process is done effectively and properly. Physical bleaching involves the use of activated carbon while chemical bleaching involves the use of bleaching earth and so on among the same silicate etcetera.



The choice of equipment used depends on the scale of the operation and type of the oil being processed. Challenges during the bleaching process include the loss of desirable component in the oil, the formation of byproducts, and the difficulty in removing the adsorbent from the oil. To mitigate these challenges, it is recommended to use the right type of adsorbent, optimize the process parameters, and ensure proper filtration and washing of the oil after bleaching. Because that is very important whatever the adsorbent has been used in bleaching clay earth etcetera that should be even if required two stage

filtration, three stage filtrations should be done to ensure the filtration, removal of all the clay from the oil to as to maintain its proper natural quality.



So, with this these are the references that are used in this lecture.

Thank you for your patience here. Thank you.