Food Oils and Fats: Chemistry & Technology

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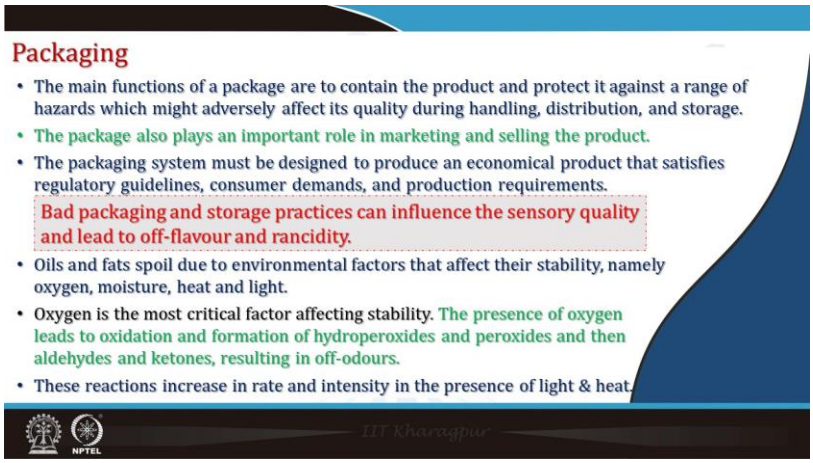
Module 12: Packaging, Storage & QA/QC of Food Oils and Fats

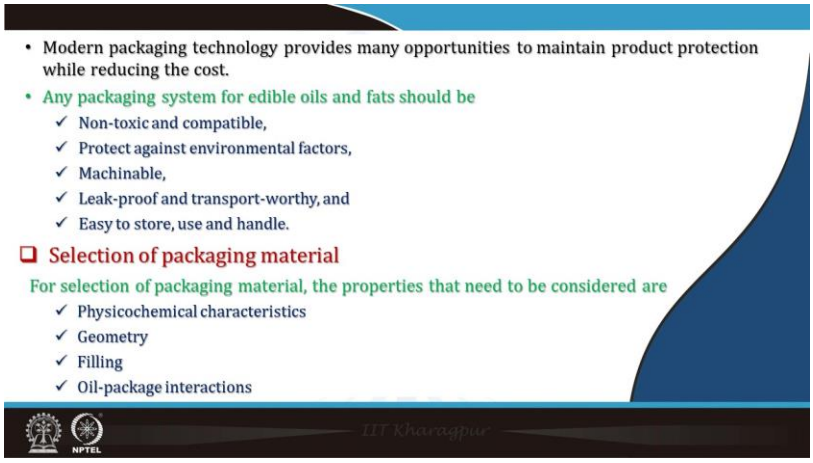
Lecture 57: Packaging Materials & Methods

Hello everybody, namaskar. In the 57th lecture of this course today, we will discuss about Packaging Materials and Methods.

We will talk about packaging, different types of packaging material as well as different types of packages, oxygen removal techniques that is sparging and inert gas blanketing, bottle packaging, pouch packaging and also, we will talk about butter and margarine packaging.



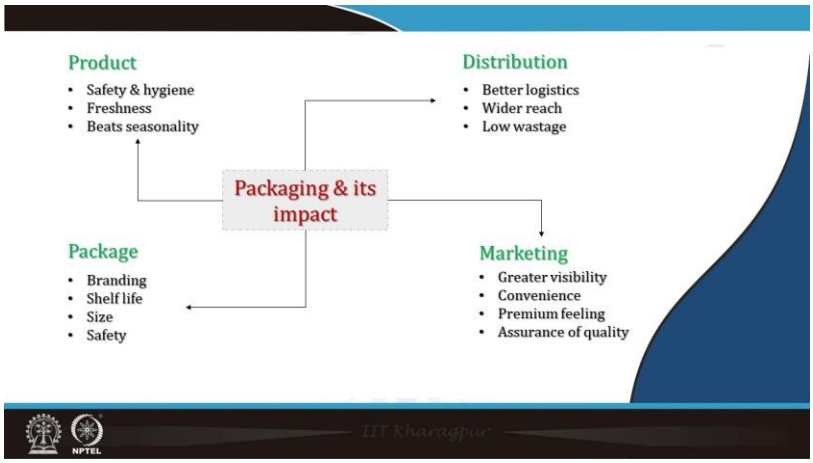
So, let us see what is packaging? The main function of a package is to contain the product and protect it against a range of hazards which might adversely affect its quality during handling, distribution, and storage. This function of a package is true for any food material. In this lecture, we will talk about requirements of the package with specific product related to fats and oil. The package also plays an important role in marketing and selling the product. The packaging system must be designed to produce an economical product that satisfies regulatory guidelines, consumer demands, and production requirements. Bad packaging and storage practices can influence the sensory quality and lead to the development of off-flavor and rancidity in the fats and oil products. Oils and fats are spoiled due to the environmental factors that affect their stability. The environmental factors which mostly influence the stability of fats and oils include oxygen, moisture, heat, and light. Oxygen is the most critical factor. The presence of oxygen leads to oxidation and formation of hydroperoxides and peroxides and then aldehydes and ketones which ultimately gives an off-flavor in the product. These reactions increase the rate of an intensity in presence of light and heat.



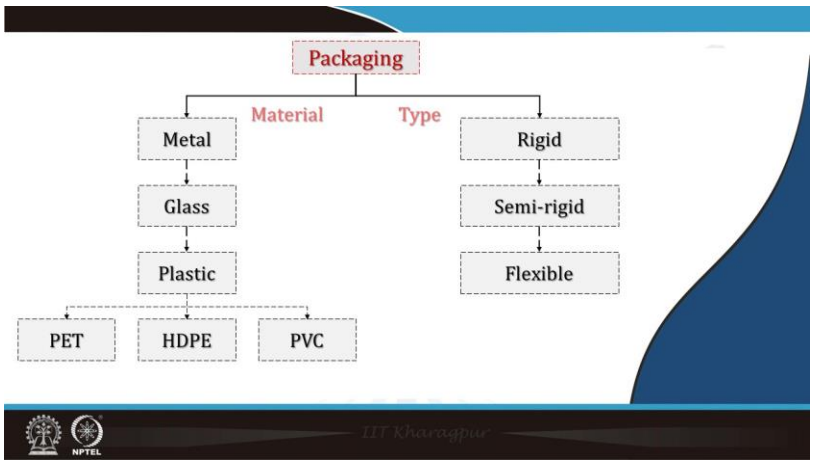
Modern packaging technology provides many opportunities to maintain product protection while reducing the cost. The packaging system for edible fats and oils should be non-toxic and it should be compatible to the product. It should provide protection

against environmental factors. It should be machinable. It should be leak proof and transport worthy and finally, more importantly it should be easy to store, use, and handle.

So, for selection of a packaging material, the properties that need to be considered are physicochemical characteristics of the material as well as the product, geometry of the package, filling methodology, and in this case, oil and package interactions.

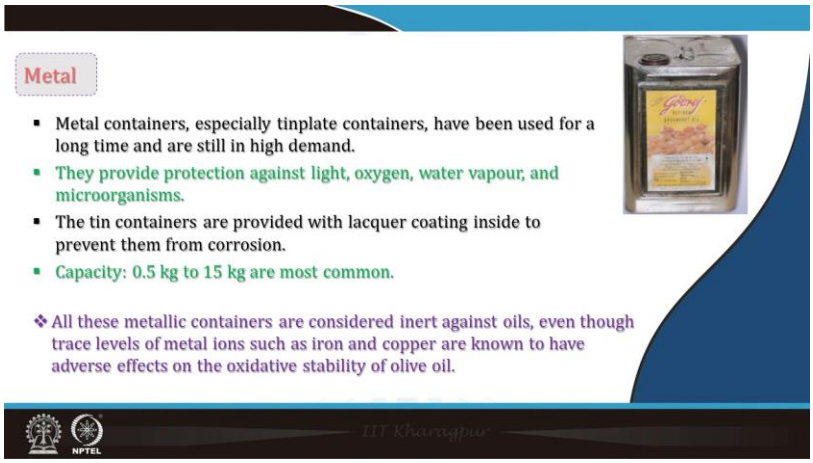


How the packaging material will interact with the oil components? So, the packaging and its impact has a packaging has its impact on different aspects like in the distribution, it leads to better logistic, wider reach, low wastage for the product, it gives safety and hygiene, it protects its freshness, it breeds seasonability. Then package also helps improving the branding of the product, it improves shelf life, it has impact on size of different size of packages etc. and of course, the safety of the product is very important which is protected by the packaging. Then in marketing, the packaging, if it is a good attractive package, it gives greater visibility to the product, even there are various size and shapes of convenient packages, it gives premium feeling, and also a good packaging provides a good assurance to the quality.

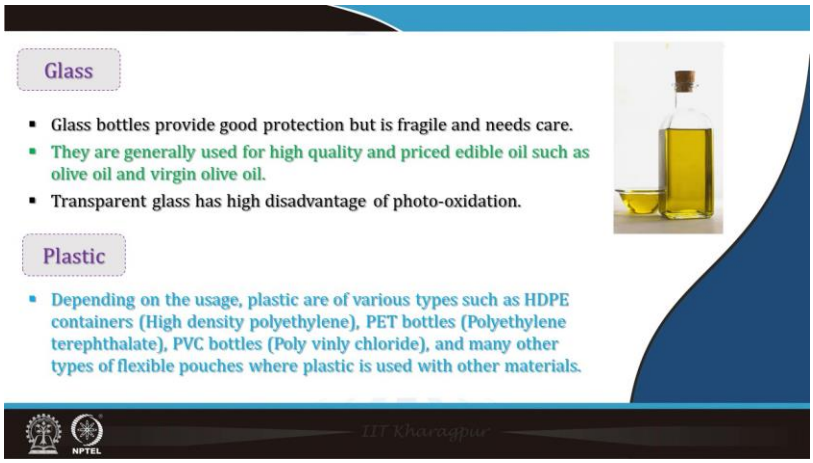


So, packaging it may be that materials and type that different materials which are used for packaging may be metal, glass, plastic, in the plastic it may be PET, HDPE, or PVC and

depending upon the material used for making the package, it may be a rigid package, rigid container, semi-rigid container, or a flexible package.

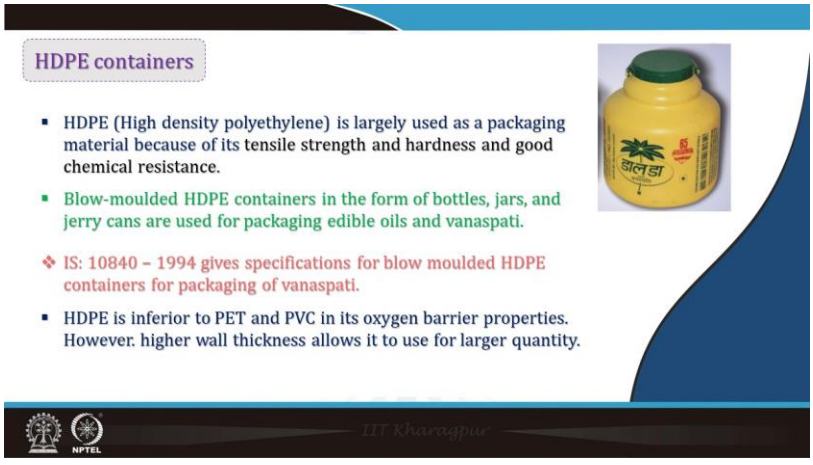


So, let's talk about some materials, important materials like number 1 is the metal. Metal containers especially containers made from tin plate have been used for a long time in the oil and fat milling industry and even they are still high in demand. They provide protection against light, oxygen, water vapour, and microorganisms. The tin containers are provided with lacquer coating inside which prevent them from corrosion and the capacity of the tin container may be from half kg to 5 kg or even to 15 kg and among this half kg, 1 kg and 15 kg are more common. All these metallic containers are considered inert against oil, even though trace levels of metal ions such as iron and copper are known to have adverse effects on the oxidative stability in the natural olive oil or such other oil.



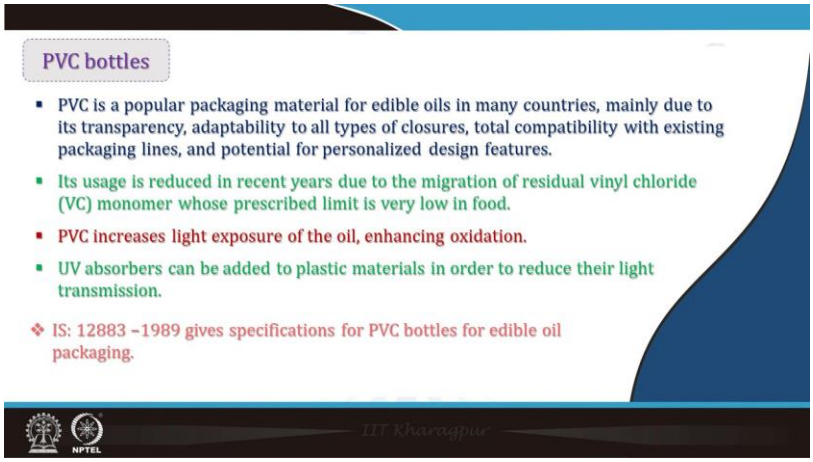
Glass containers, glass bottles provide good protection, but it is fragile and needs care. They are generally used for high quality and priced edible oil such as olive oil, virgin olive oil, and so on. Transparent glass has high disadvantage on the other side because it leads to the photo oxidation.

Plastic depending upon the usage, plastic are of various types such as HDPE that is popularly known as high density polyethylene or PET bottle which are polyethylene tetra-thiolate or PVC bottle like polyvinyl chloride and many other types of flexible pouches which are used where the plastic is used with other materials. PET bottles that is the plastic containers have been used increasingly in the recent year due to their low price, easy handling as well as weight. There are PET bottles in several size types etc. as volume are available which are used by oil milling industry. Here, shelf-life is not high, but they are economical. PET bottles are used for less quantity generally may be 0.5 kg or 1 kg. PET bottles provide good design, better transparency, and can be colored also. They have good mechanical, thermal and chemical resistance, low production cost, they provide good barrier properties against CO_2 and there is a suitability for the storage as well as low weight. So, the weight of the PET bottle is generally very less and which provides convenience. Application of the incorporation of antioxidants and sterilizers in PET bottle is increasing rapidly nowadays because of its convenience.

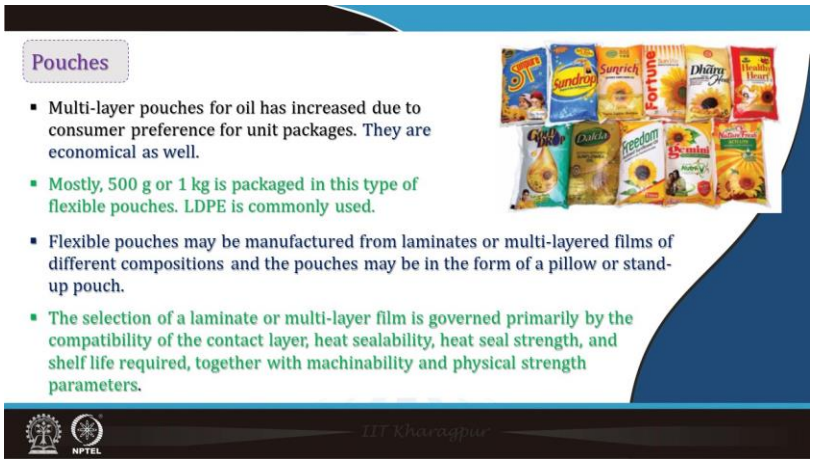


HDPE containers, high density polyethylene containers, you can see that this type of container has been used since several years by now for dalda or vanaspati. HDPE is largely used as a packaging material because of its tensile strength and hardness and good chemical resistance. Blow-molded HDPE containers in the form of bottles, jars, and jerry

cans are used for packaging of edible oil as well as dalda or vanaspati. IS 10840 of 1994 gives specification for blow-molded HDPE container for the packaging of vanaspati. HDPE is inferior to PET and PVC in its oxygen barrier properties. However, higher wall thickness allows it to use for larger quantity.

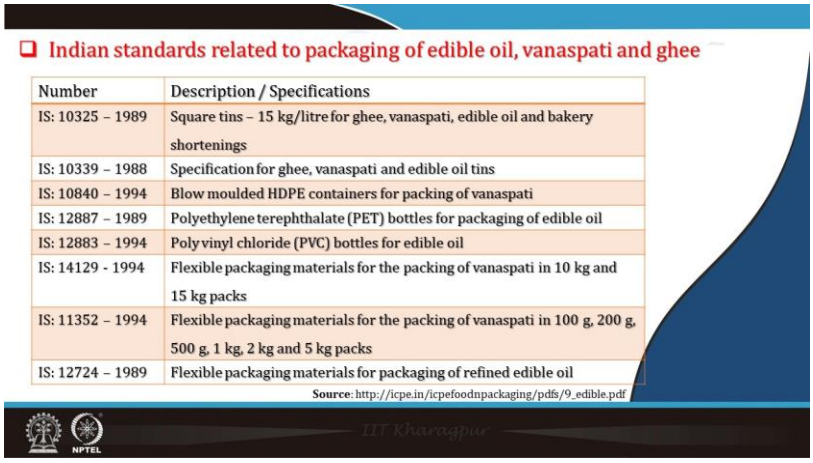


PVC bottles, this is a popular packaging material for edible oils in many countries, due to its transparency, adaptability to all types of closures, total compatibility with the existing packaging lines, and potential for personalized design features. Its usage is reduced in the recent years due to the migration of residual vinyl chloride monomer whose prescribed limit is very low in the food. PVC increases light exposure of the oil, enhancing the oxidation of oil. Ultraviolet absorbers can be added to plastic materials in order to reduce their light transmission. IS 12883 of 1989 gives specifications for PVC bottles for edible oil packaging.

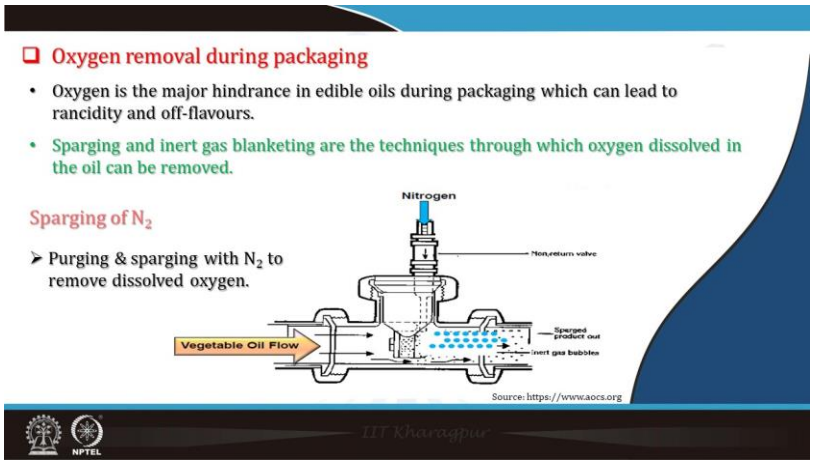


Pouches, multi-layer pouches for oil has increased due to consumer preference for unit packages. They are economical as well. Mostly, 500 gram or 1 kg pack is packaged in this type of the flexible pouches. LDPE is commonly used for packaging of the oils and fats. Flexible pouches may be manufactured from laminates or multi-layered films of different compositions and pouches may be in the form of pillow or stand-up pouches.

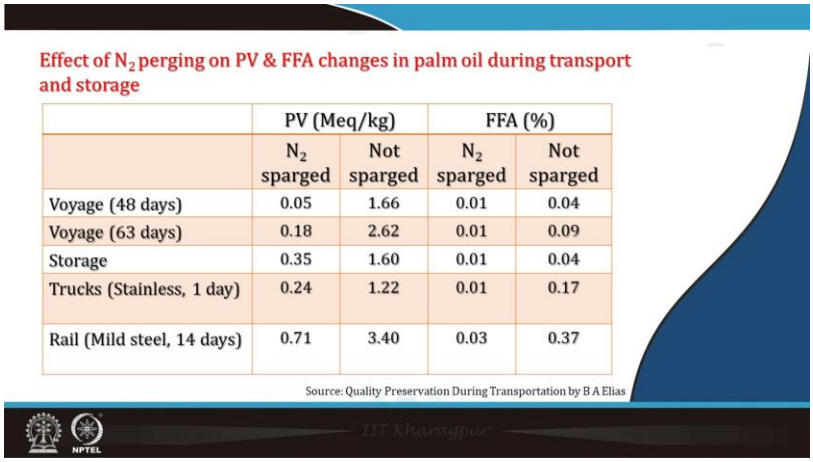
The selection of a laminate or multi-layer film is governed primarily by the compatibility of the contact layer, heat sealability, heat seal strength, and shelf life required, together with machinability and physical strength parameters of the material.



Here in this slide, I have just given you some of the Indian standard BIS specifications of packaging material for different types of products like for example, IS:10325-1989, it provides a specification or description of a square tins of 15 kilogram per liter for ghee, vanaspati, edible oil, and bakery shortenings. IS:10339 of 1988 provides a specification for packaging of ghee, vanaspati, and edible oil tins. IS:10840 of 1994 provides a specification or description of blow-molded HDPE containers for packaging of vanaspati. IS:12887 of 1989 provides a specification for PET bottles for packaging of edible oil. IS:12883 of 1994 provides PVC bottles for packaging of edible oils. IS:14129 of 1994, it provides a specification for flexible packaging material for the packaging of vanaspati in 10 kg and 15 kg packs. IS:11352 of 1994, it provides a specification for flexible packaging material for the packaging of vanaspati in 100 gram, 200 gram, 500 gram, 1 kg, 2 kg and 5 kg packs. IS:12724 of 1989, it provides a specification for flexible packaging material for packaging of refined edible oils. So, one can go into detail as it is available on the BIS websites and other related documents.



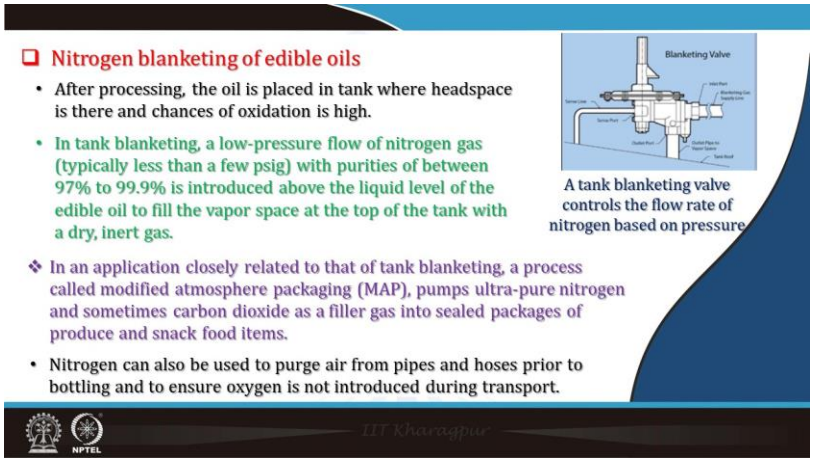
Let's talk about oxygen removal during packaging because oxygen is one major hindrance in edible oils during packaging, which can lead to rancidity and off-flavor or auto-oxidation. Sparging and inert gas blanketing are the techniques through which oxygen dissolved in the oil can be removed. There is particularly sparging of nitrogen that is here oxygen can be removed and nitrogen can be bubbled. Sparging and sparging with nitrogen to remove dissolved oxygen that is one commonly used technique. You can see in the figure here, that is, there is sparging, then nitrogen is sparged here, oil is flowing into this and there is a non-return valve. So, the nitrogen cannot go back. So, it is poured into the oil and then a sparged product where inert gas bubbles can be seen there in the oil and oil containing inert gas nitrogen is there so that oxygen is removed from the oil.



So, here that is in the table, I have given you some data taken from the literature that is effect of nitrogen purging on peroxide value as well as free fatty acid development in the palm oil during transport and storage. So, you can see, peroxide value that is in the voyage up to 48 days where the nitrogen was sparged, the peroxide value was found to be 0.05 Meq per kg of the oil whereas, in the sample where there was no sparging of nitrogen, the peroxide value was much higher that is 1.66 Meq per kg of oil. Similarly, voyage after 63 days, the peroxide value was 0.18 in the nitrogen sparged sample whereas, 2.62 in the non-sparged sample.

Similarly, free fatty acid, if you can see voyage after 63 days, if the nitrogen sparged sample it was very less that is 0.01 whereas, in the sample where the nitrogen was not sparged, free fatty acid was 0.09 percent. During storage, you can see that is peroxide value in the nitrogen sparged sample was 0.35 whereas, in the non-sparged sample was 1.6. The free fatty acid remained at 0.01 in the sparged sample and it rose to 0.04 percent in the samples which were not sparged with the nitrogen. In the trucks, you can see stainless one day or rail made of mild steel after 14 days. So, in the truck, the peroxide value in the sample sparged with nitrogen, the peroxide value was 0.24 Meq per kg whereas, in the truck's samples are not sparged, this peroxide value rose to 1.22.

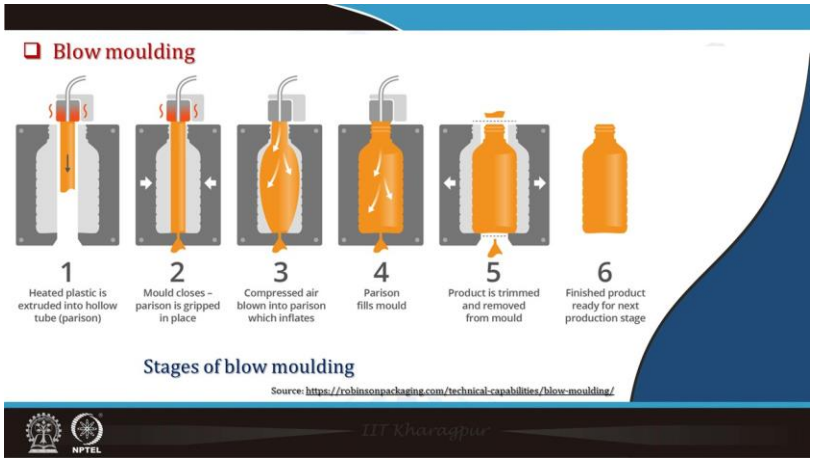
Similarly, for FFA, it was 0.01 in nitrogen sparged and 0.17 percent in the non-sparged sample. So, this data clearly show that is, the nitrogen sparging has benefited, has helped or prevented the peroxidation of the fatty acid, peroxide, hydroperoxide formations as well as free fatty acid formation.



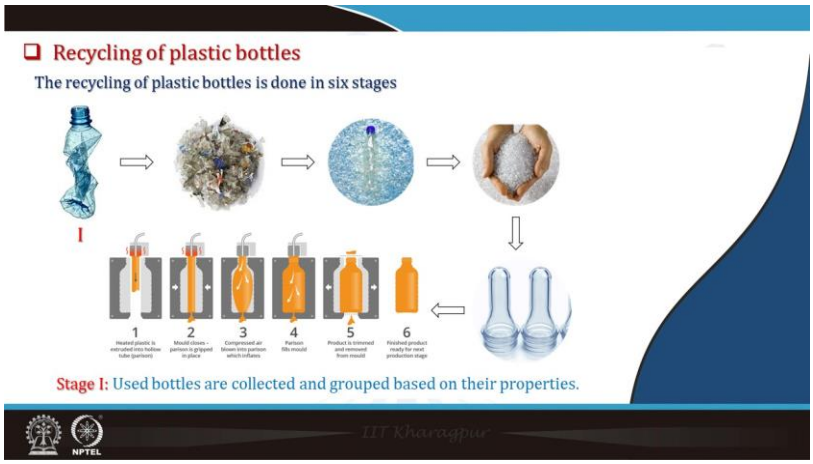
Nitrogen blanketing of edible oil, that is, after processing, the oil is placed in tank where head space is there and chances of oxidation is high because in the head space there may be oxygen gas. In tank blanketing, a low-pressure flow of nitrogen gas (typically less than a few psig) with purities of between 97 percent to 99.9 percent is introduced above the liquid level of the edible oil to fill the vapour space at the top of the tank with a dry, inert gas. So, in the empty space there is this inert gas is filled. So, oxygen is removed. In the application closely related to that of tank blanketing a process called modified atmosphere packaging that is in which the MAP pumps ultra-pure nitrogen and sometimes carbon dioxide as a filler gas into sealed package of the produce and snack food items. Nitrogen can also be used to purge air from pipes and hoses prior to bottling and to ensure oxygen is not introduced during transport.

So, you can see here this short film there is a clear pack and here you can see that bottle packaging process is shown. There is a step by step solution, a complete packaging

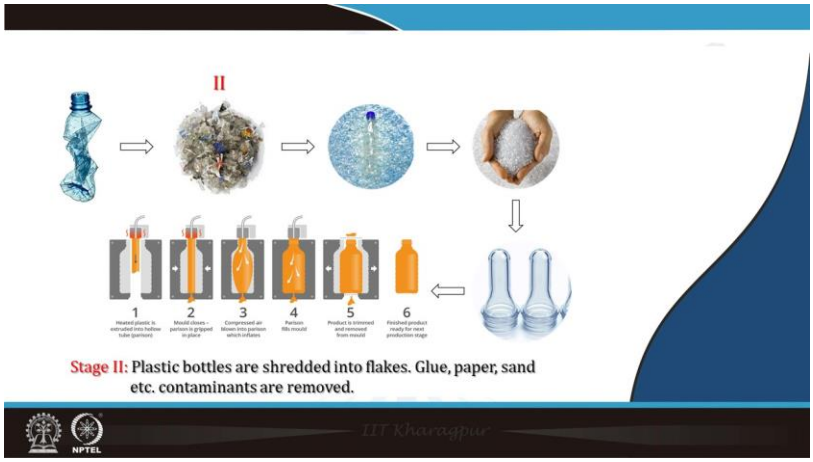
solution for edible oil industry you see that is bottle blow-molding, how it is going after that there is a bottle feeding, bottles are molded then it is fed then filling and capping is done and all these operations are automatic, after that it is labeled. And then, it is shrink bundling, this package there is a shrink bundle and case packing that is these bottles are cased in the cartoons and then finally, these cased are pellet pelletized that is storage. So, and they are sent to the conveyor and turnkey lines. So, this you could see how this packaging is helping.



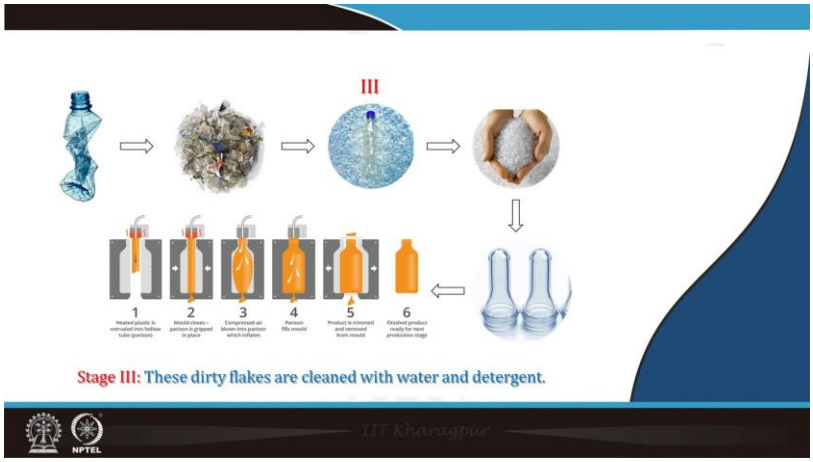
So, this blow molding particularly let's have there are six stages of blow molding alright there is in number one case, there is heated plastic is extruded into hollow tube that is the parison that you see that is heated plastic is coming, it is extruded into the hollow tube alright. Then comes the second stage, where mould closes, you see here the mold closes and parison is gripped in place. Then in third stage, the compressed air is blown into parison and it inflates the parison as you can see here. Then in the fourth stage, there is a parison fills mould, there is a complete mold. In the fifth stage, product is trimmed and removed from mould and finally, the finished product is ready for next production stage for filling and all those things. So, that is how the bottle is made in the blow molding process.



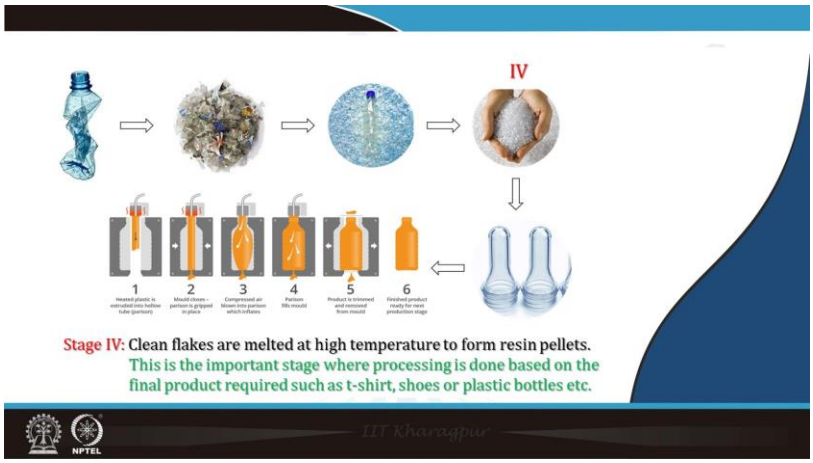
Another very important aspect is the recycling of the packaging bottle which is normally used by the industry. Used bottles are collected. It is the stage one as you can see here that, used bottles are collected and grouped based on their properties etc., different types of bottle what are the materials etcetera.

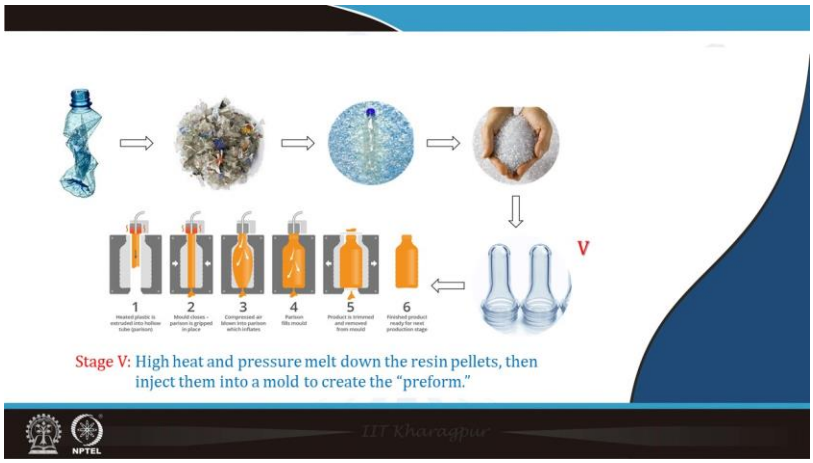


So, they are grouped and then in the next stage there is these second stage, there is these plastic bottles are shredded into flakes, glue paper, sand etc., there are contaminants which are removed from the bottles in the second stage.

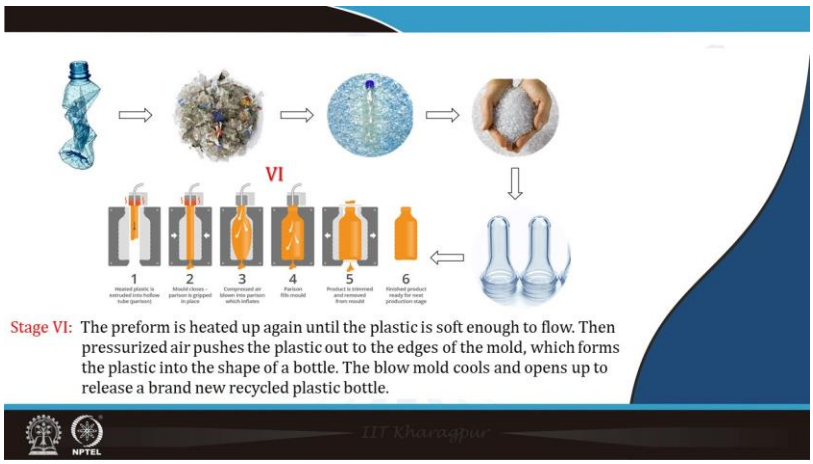


Then comes the third stage, where the dirty flakes are cleaned with water as well as detergent. So, you get the clean material from which the bottles were initially made. Then comes the fourth stage, where the clean flakes are melted at high temperature to form resin pellets. This is the important stage where processing is done based on the final product required such as t-shirt, shoes, or plastic bottles etcetera. So, from this plastic material, anything can be made, in this case, we are discussing about bottles from the reuse plastic.



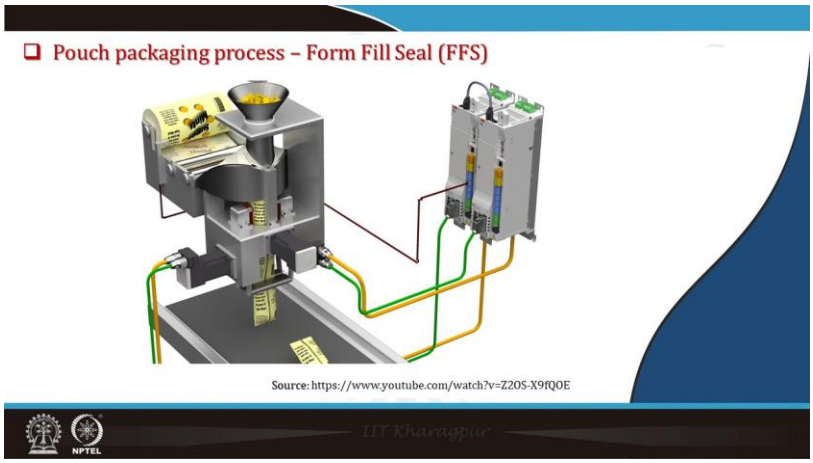


Then comes the final fifth stage, where the heat that high heat and pressure melt down the resin pellets, then inject them into the mould to create the preform.

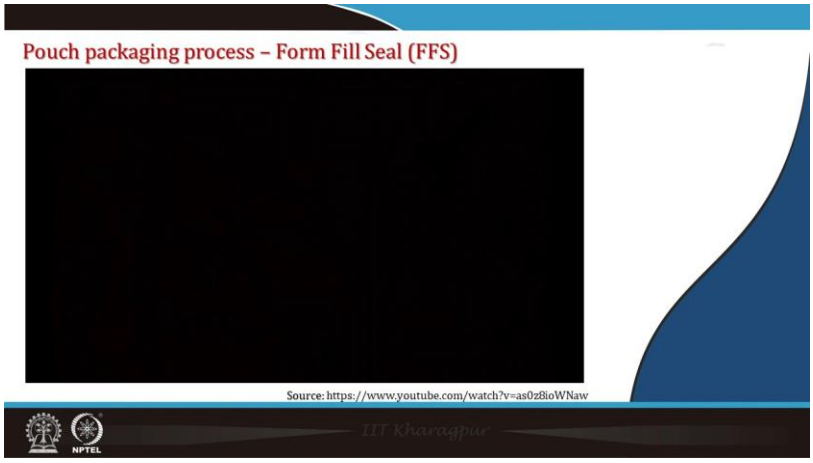


These are the preform and then comes the sixth stage, in the sixth stage, where the preform is heated up again until the plastic is soft enough to blow. Then pressurized air pushes the plastic out to the edge of this mould which forms the plastic into the shape of a

bottle. The blow mould cools and opens up to release a brand new recycled plastic bottle. This is how the plastics are recycled.

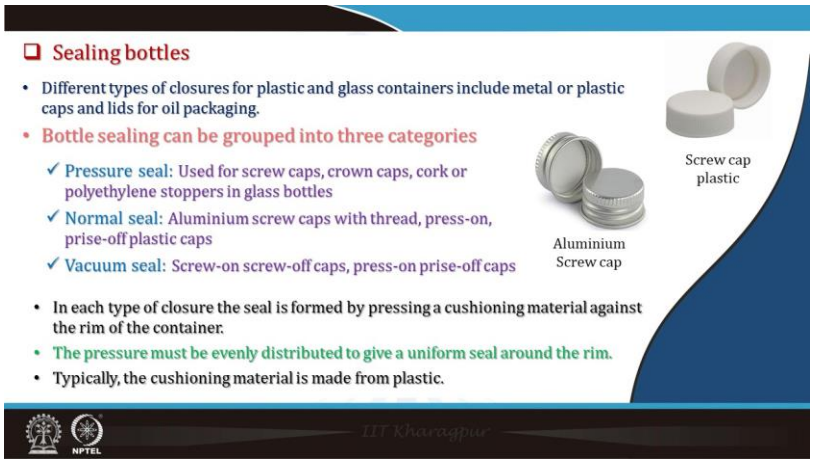


You can see here that is the pouch packaging process in the form fill and seal machine. It is seen in the picture, that is the labelled packaging material is coming, this packaging material whatever it is formed here. Bottom is sealed then the material is filled up and then it is cut on top of that. So, you get the packaging.



This is another automatic liquid filling machine. This is again form you see that is how this packaging material is coming, it is being sealed, it is the similar thing.

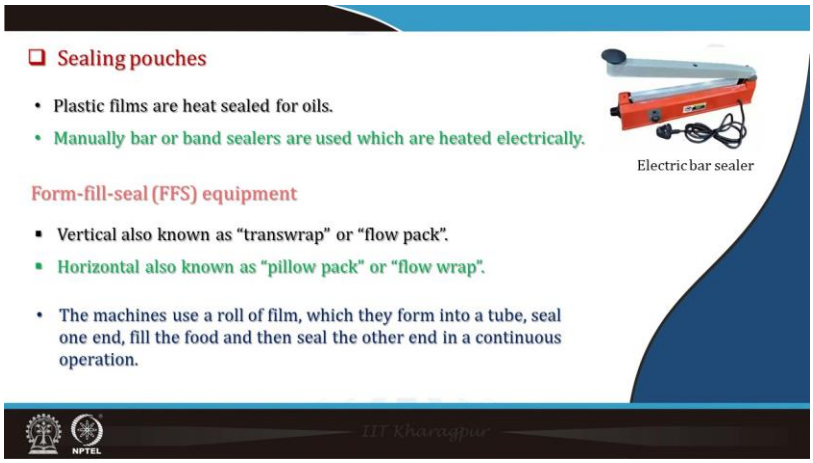
This is another, that is the packaging of the solid fat like butter, margarine etc., how they are packaged you can see here in this figure. There is first is the preform modes and the material of known quantity is filled into this and then the top layer is closed you can see that is this is first preform and then now it is you see that is how the top layer is being closed. Finally, it is removed and pressed.



Now, we will see that is after this that is the sealing of bottles. Sealing of bottle is again very important that is in the bottles one after the material is filled, it should be properly sealed. The different types of closures for plastic and glass containers include metals or plastics caps and lids for oil packaging.

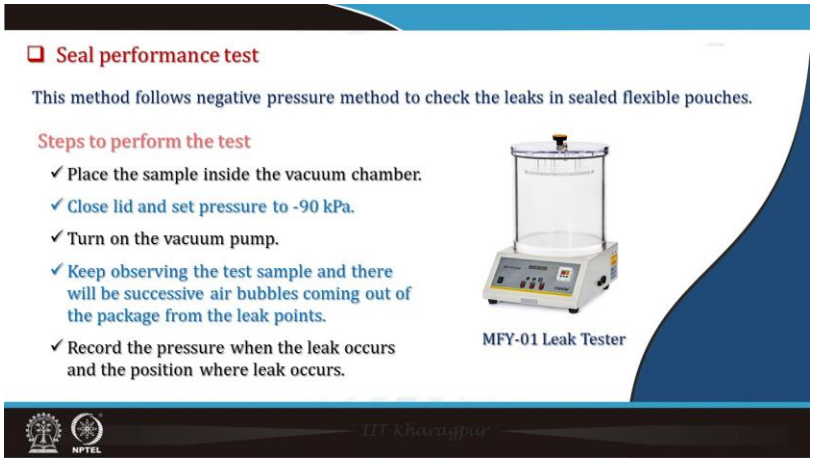
Bottle sealing can be grouped into three categories; number one is the pressure seal, the normal seal or vacuum seal. In pressure seal, it is used for screw cap, crown cap, cork, or polythene stoppers in glass bottles. In normal seal, that is aluminium screw caps with thread press-on plastic caps or prise-off plastic caps are used in the normal seal. In the vacuum seal, it is a screw on screw-off caps, press-on prise-off caps.

So, in this case, type of closure the seal is formed by pressing a cushioning material against the rim of the container. The pressure must be evenly distributed to give a uniform seal around the rim typically the cushioning material is made from plastic.



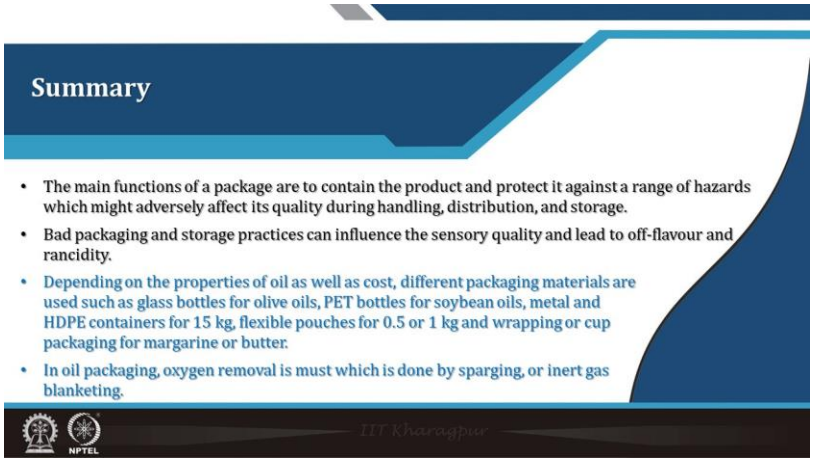
Sealing of the pouches. There are different set up like you can you see there it is inbuilt heating arrangement in the FFS machine, which first seals the bottom and sides. It forms the package; the material is sealed. So, there are manual sealing machines also there, plastic seals are there, heat sealed for oils like that is in the pouches it is kept then the pouch is sealed. Then the electrical bar or band sealers are used which are heated electrically that is electric bar sealer here there is a heating arrangement.

Then FFS equipment, you can see there may be vertical equipment which are known as transwrap or flow pack or horizontal FFS also known as pillow pack or flow wrap. And the machines use a roll of film, which they form into a tube, seal one end, fill the food and then seal the other end in a continuous operation.

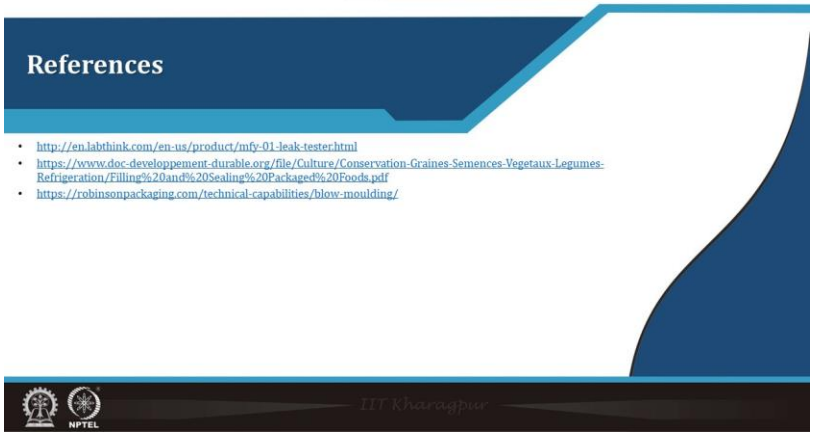


Then seal performance test because that is very important if this after filling the material if seal is not proper there is a leakage etcetera then it may allow even not only the product may come out, but also inside even in a minute leak if it is there it may allow the ingress of oxygen and which will oxidize the oil or autooxidation of the oil or it will spoil the product. So, this seal performance test is a must and it is invariably done without fail. It should be seen that all the sealing is properly intact.

So, steps to perform the test is, place the sample inside a vacuum chamber that is the packed sample placed inside a vacuum chamber, then close the lid and the set the pressure to around 90 kiloPascal or so. And then turn on the vacuum pump keep observing the test sample and there will be successive air bubbles coming out of the package from the leak point if there is a leakage is there then air bubble will come out some of the product will also come out. So, record the pressure where the leak occurs and the position where the leak occurs and that should be ensured that is may be whatever remedial measure in the packaging in the FFS machine is required this should be done. So, that temperature should be regulated, air pressure etcetera should be regulated. So, it must be ensured that the seal is leak proof.



Finally, I will summarize this lecture by saying that the main functions of the packaging are very important and the material particularly in the oil supplied in order to provide them stability against the oxygen, against the environmental pressure. It must be properly packaged. So, the main function of a package is to contain the product and protect it against a range of hazards which might adversely affect its quality during handling, distribution and storage. Bad packaging and storage practices can influence the sensory quality and lead to off-flavor development as well as a rancidity development. So, depending upon the properties of oil as well as its cost, different packaging materials are used such as glass bottles for olive oil, PET bottles for soybean oil, metal and HDPE containers for 15 kg, flexible pouches for 0.5 kg or 1 kg, and wrapping or cup packaging for the margarine or butter etcetera. So, in oil packaging, oxygen removal is must that is very important here in case of oil packaging. So, it is must which is done either by sparging the nitrogen inert gas or inert gas blanketing is used to remove the oxygen from the packet and to ensure more shelf life.



So, these were the references which are used for making this presentation.

Thank you very much for your patience here. Thank you.