

Food Packaging Technology
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Week – 01
Lecture – 3
Paper as packaging material P1

Welcome again to Food Packaging Technology Course. In today's session, we will be discussing about the different types of packaging materials, and how paper is developed in the industry. So, we will be discussing about these things. So, let's see packaging material. Generally, these need to be non-toxic, they should not react with the food conditions. They should not interact with the contents of the food and should not form any toxic materials.

And also, they should have very good barrier properties. They should not let any moisture to enter from the environment to the food and neither from the food to the environment. And also in the same way, it should not pass any order, light or gas, and even the oil. So, it should have good barrier properties and it should protect the content inside sanitary protection and also during transportation and other handling, it should resist the impact.

It should be transparent, tamper-proof and easy to open and reclose. And it should be easy to dispose and it should come in varying size and shape and weight should not be a limitation. And again, appearance and printability, low cost, and it should have other features which are required for the food product. So according to the requirement of the producer and the consumer, or the requirement of the food product, the packaging material needs to be adopted. So, in nature, we find different types of packaging.

These are some of the examples. And in the food industry, there are different levels of packaging. We have primary level, for example, if it is a canned product, then that can will be the primary packaging material. And if several cans are put in a carton, that will be the secondary material and several cartons they are packed together or they are kept together by a shrink wrap, then it will be a tertiary packaging. And these are helping transportation.

And these are generally placed on the crates and the containers, they are the quaternary packaging system. So, these are generally the different levels of packaging and these are applicable in the food industry also, but you will also find its application in other industries also. Types of packaging materials is based upon the food product. So, what is the kind of food product that needs to be material? Accordingly, the type will change. So, if it is a meat product, then packaging material will be different.

If it is a fried product or it's a dried product, then again, the packaging material will be different. So, we cannot use one single packaging material for all kinds of food products. Again, what is the transportation? How it has to reach to the consumer? What should be

the retail package size or how the retail packaging is done? All this will also decide the type of packaging material. Paper, metal and glass they have been used in as a packaging material for a very long time and now it has been replaced with plastic materials, but in some cases, we still continue with the paper, glass and metal. And wood is also a very common packaging material.

Earlier we were using wood in different forms. In current times also we are using wood as a packaging material in beer industry and these are used for developing casks and casks. And today we use wood for developing crates and pallets. So that is the application where we find wood. The other packaging materials have been replaced.

And the packaging materials that are currently being used are papers, paper boards, fiber boards, regenerated cellulose films, polymer films or plastics and semi-rigid and rigid containers made up of different polymer metals. We also have metal foils, rigid metals, we have flexible materials, then we have glass, wood, textile and earthenwares. Along with the sustainable packaging is also coming up and by sustainable packaging we mean that there should be zero waste and it should be eco-friendly and the packaging material it should be recyclable and reusable and it should be safe to consumer and environment. Now coming to the first packaging material that is paper. Paper is made generally from wood or waste paper.

It is repulped and reutilized. But when we are using repulped waste paper it should not come in direct contact with the food because it has already been used, we cannot use again in food industry. And generally, it starts with pulping of the wood. It can be mechanical grinding or chemical grinding so it is called mechanical pulping or chemical pulping and or else we can have a combination of both mechanical and chemical pulping. But again, this kind of pulping process the paper generated by this method it is not used in the food industry.

So, wood that are used in developing pulps they may be softwood or hardwood and basically, they contain cellulose that is a major ingredient and it also contains lignin. There are some parts of hemicellulose but that is a minor component and other minor components are waxes, resins, pectins and generally the fiber length will be 2 to 3.5 millimeter for softwood whereas for hardwood it is slightly lesser. And diameter of fiber will be much higher in softwood than hardwood. Types of paper that are used in food industry we have kraft paper.

Kraft paper is made from sulphated pulp. It is a chemical pulping method and the kraft paper it can be unbleached or bleached. If it is unbleached it will brown in color and if it is bleached it will have a dull color. And usually, it is used for wrapping individual items or parcelling the items and this can also be fabricated into bags or multi wall sacks. Then we have sulphide paper.

Sulphide paper is again made from chemical pulp. It is an acid digested pulp and it is not strong as kraft paper but it is a general-purpose paper and usually used to develop sacks and bags. Then we have grease proof paper. Grease proof paper is made from

sulphide pulp and subjected to very high mechanical treatment and it is used under dry conditions. Usually, it is a close textured paper.

Next, we have glassine paper. Glassine paper is produced by polishing the surface of grease proof paper and it is resistant to moisture. So, moisture does not pass through it. And next paper is vegetable parchment paper. It is paper developed through chemical pulping method but then it is passed to sulphuric acid and it is washed, neutralized and dry.

And this method it reduces the porosity because the sulphuric acid it interacts or it reacts with the surface of the paper and the porosity is reduced. And because of this, grease proof characteristics are good. For vegetable parchment paper again, the strength is also very high. Even when it is wet with liquid, the strength is retained. Then we have tissue paper which is light and has an open structure but it disintegrates when it comes in contact with water.

Usually, it is used to give a cushioning effect. Then we have wet strength paper. They have strong cross links and which helps in maintaining the strength even when they are wet. But this kind of paper they are not used in food industry. They don't come in direct contact with the food.

Then the final type of paper is wax coated paper. This is heat sealable paper but this heat seal is very weak because the paper is coated with wax and it can be tampered or the seal can be removed. And it is moderately resistant to water and vapor. And also, it can be damaged by creasing and abrasions. Any creases, folding, even any scratches it will remove the wax from the surface of paper.

So, you can find different papers over here. This is a craft paper which is brown in color. And then we have grease proof paper, glass in paper and vegetable parchment paper here. So, this table it shows different types of paper and their sources and what is the grammage and their applications. So grammage it is the grams, the weight of the paper in a meter square.

Craft paper it has a grammage of 70 to 300. Sulfite paper it is 35 to 300. Grease proof 70 to 150. So likewise, you can find grammages for other papers also here. Now coming to the history of paper.

It originated in China. It was new discovery as an alternative to silk because in earlier times people they used to write in silk and since there was a shortage of silk they had to develop a new method. Paper was developed due to that. But in 12th century it was introduced in Europe and for last 200 years paper has been used very widely for various purposes throughout the world. And now coming to the manufacturing of paper. The first step in the manufacturing of paper is to produce the pulp from the wood chip.

In Northern America or the other states of America they use soft woods. We can also go for hard woods and these are subjected to chemical pulping or mechanical pulping. So

that will be the first step in the manufacture of paper. So generally, in the mechanical pulping it is also called ground wood pulping. The wood is subjected to abrasion and it rubs against the grinding stone and it is passed to the chipping action in the mill.

Thereby the fibers are fragmented and separated. They are broken into smaller pieces. So, you can see a figure here. The wood can reach to the mill as logs or it can come as bolts. Bolts are like one and a half meter long and the logs are lengthy pre-barks.

So they need to be cut into smaller pieces and then they are debarked. The bark is removed and then it is subjected to grinding. Usually, the bolts they have 1.2-meter length and or logs. That is the raw material how it is reaching to the industry then it is sawn to shorter length and debarking is done.

For debarking the moisture plays a very important role. It eases the grinding action and the pulping quality is also good. So generally, moisture content should be above 30%. It should not go below 30% and preferably it should be between 45 and 50%. Suppose the moisture content is not 30% it is below 30% then it has to be sprayed with water or it should be pre-soaked in water so that the water content increases.

In earlier times the grinding was done using natural stone which had a diameter of 137 centimeter and 69 centimeter wide. It was connected to water mill and it produced a pulp of 5 to 6 tons per day. But then in this kind of grinders the loading was done manually. Later these grinders were replaced with larger pulp grinders which were powered with electric motors and the grinding speed was increased and the pulp production was much higher and they produced around 130 to 150 tons per day in 24. Horse power of the motor was 10,000 and the pulp stone rotated at an rpm of 360.

The first artificial grinding stone it was discovered in 1924 and it contains abrasives like aluminum oxide and silicon carbide. Initially the material is ground so it is non-uniform in size so it is screened to get the uniform sized material. These are bound using a binder and heated at very high temperature and then these are used to develop the abrasive surface of pulp stone. These materials are used for abrasion. Once the pulping has been done and the stock has been developed it moves to the grinder pulp and from where it screened and it passes through a series of screens and it is filtered in fact and the heavy particles or heavy materials they are removed from the stock.

So heavy foreign materials or unfibered wood or shives or knots, barks etc. which are not wanted which has not been powdered they will be removed during this process. Also ground wood pulp it is converted to sheet on a cylindrical vacuum filter and it is pressed using hydraulic press. The moisture content is brought down below 50% and these are converted to sheets and these sheets many sheets together they form bales so they are usually stored as bales and the quality of wood pulp it is designated by freeness and freeness it means that the readiness with which the water drains from through the pad of pulp. So how easily it goes out the water drains out that indicates the freeness.

Additionally ground wood pulp has low freeness. Ground wood pulp again the fibers

are much fragmented they are fine and it also contains other chemical constants like lignin, cellulose, resins and other things so it is not pure cellulose and since it contains other components it has a yellow color and it also with aging it increases the color increases yellowing and it also increases with exposure to light and heat. And ground wood fibers they have moderate ability to bond with each other and papers containing them do not have high strength but they have good opacity they are bulky and good printing qualities. These can be bleached with peroxides or hydro sulphides to improve whiteness but again the whiteness will not be equivalent to the papers that are developed using pure cellulose. Now mechanical process they are again categorized into four different types that is stone ground wood or ground wood pulp that is SGW it is a natural pressure is applied the stone pressure is applied to pulp the wood and then pressure ground wood it is PGW under pressure it is a mechanical motorized one and refined mechanical pulp it is RMP no heating and the other mechanical pulp is under heating. So these are the different methods by changing pressure and temperature we can do mechanical processing.

In chemical wood pulping the wood chips they are subjected to chemical solutions in the digesters and these are generally operated at very high temperature and pressure and for chemical pulping we use sulphide salts with the excess of sulphur dioxides we can also go for caustic soda and sodium sulphide and generally the alkaline method is used for developing craft papers and these are called craft process and during the chemical wood pulping method the lignin of the wood is solubilized and fibers are separated as whole fibers. This method was first developed by Tiltman a US chemist in 1857 and he studied the effect of sulphurous acid in softening and defibering the wood and in 1867 he patented the methodology and in 1870s this was commercialized and since 1940 it became a leading process and it became very popular in developing the craft papers. The sulphide liquor which contains 4 to 8% free sulphur dioxide in water and together with 2 to 3% bisulphide these are pumped into the digester and this is the initial step of the cooking process and in the pressure vessel it has a steel shell which is coated with ceramic lining this is to protect the steel from corrosion that is acid corrosion to protect the stainless steel and the cement we are giving a tile coating inside the steel and the digester it is a dome shaped on the top and it is tapered or conical at the bottom it has a 5 m in diameter and 15 m in height and usually one digester can pulp around 12 to 15 tons of pulp in one batch we can have a series of digester also depending upon the size of the factory so pulp means they have usually series of digesters and when blue valve is closed at the bottom the wood chips are allowed to flow on the top opening and distributed to fill the digester completely and then hot acid is pumped into the digester and air is replaced with steam so steam also provides heat and after the cooking is over the digester it is blown or the contents are opened and the opening is done at the bottom valve and the force which it is opened it defibers the chips each fibre gets separated out only we get very little unwanted material here that is one to six percent is unwanted which has not been digested compared to the mechanical pulping method it is complete in chemical method whereas in mechanical method we get undesirable residues are much higher and after it has been moved out it is filtered it is passed through series of screen to remove the unwanted particles and this screening is based on the particle size it can be also based on centrifugal action and density and cooking liquor is also separated out and

this cooking liquor it can be re-circulated and this cooking liquor also helps in disintegrating the bark which mainly contains lignin and the conventional sulphide the yield was 44 to 46 percent and lignin content was 2 to 5 percent and presence of lignin it interfered with the colour the papers generated by this method can be bleached or unbleached and again these paper they had very good strength properties so another method was developed which is called alkaline pulping where we go with caustic soda so cooking is done using caustic soda at very high temperature and pressure this is also called soda pulping a soda pulp it has a very low strength compared to the conventional method of chemical processing method it can be mixed with other parts and soda can also be recovered then we have another one sodium sulfate so pulp produced by using sodium sulfate they are very strong and they are stronger than soda pulp and these are used for developing craft pulp and the process is termed as sulfate process because we are using sodium sulfate or salt cake for the chemical processing so the craft paper or the craft pulp it will have a darker colour and it will be difficult to bleach so usually it goes as unbleached paper then we have bleached craft paper which is commercially important and now new bleaching methods are coming up to bleach the craft paper and usually the craft papers are strong and durable and also the chemical processing method can be done in batch process or continuous process also the liquor which is obtained from the cooking method is called black liquor since it is dark in colour and the initial liquor which is added to the digester it is called white liquor and it's a mixture of sodium hydroxide and sodium sulfide steam or cooking liquor it is passed through the heat exchanger and it is used for heating the contents and the liquor can be reused part of liquor it can be recovered and used again to cook the new batch of logs these are economical methods actually and after cooking the pulps are washed thoroughly because it is chemically treated so it need to be washed thoroughly and it is screened and sent for bleaching or it can be used as such without bleaching again chemical wood pulp that is purified both by bleaching and alkaline extraction is also called alpha or dissolving pulp and it is usually used to develop specialty papers or rayons it is also used for the production of cellulose film and other derivatives like nitrate and nitric acetate based papers then there's another method called semi-chemical pulping as the name suggests it is part of chemical method is used it is not as strong as chemical method and in this method the wood chips are treated with sulfide or alkali in amounts and under conditions that will soften the lignin but it is only dissolved it is not as efficient as the chemical method so it is a semi-chemical method and it only softens the chip so semi-chemical pulp it softens the chips and which is then defibered and for semi-chemical pulping wood preparation and chipping is same as the other wood pulping methods the chips are steeped but they are impregnated with inorganic chemicals mainly neutral sodium sulfide solution but the amount is much lesser and it's less severe unlike the chemical pulping method in the chemical pulping method we are using heat and pressure so that is very high temperatures are being used but in this case the conditions are not severe we may also use acid sulfide caustic soda and craft cooking liquor after impregnation these are fed into series of refiners they are softened and pulped and the yield is 66 to 90 percent and again the yield of fiber can be increased by adopting mechanical pulping method so we can combine chemical pulping method and mechanical pulping method this together it is called chemimechanical pulps and they have high fiber yield and semi-chemical pulps they have intermediate properties the chemical and strength properties they are

intermediate and these are used for developing papers and boards these are also used to develop corrugated media which we'll be seeing in the later classes these are used to develop fluids and they have adequate stiffness and strength which is important in corrugated papers and these are used for developing low-cost printing papers this table it shows different types of pulp and the pulp grades and their applications so we had seen the chemical parts it can be developed from both softwood and hardwood and the pulp grades they are sulfide pulp and craft pulp whereas chemically dissolved pulp it is called dissolving pulp and in semi-chemical pulp is cold caustic process and neutral sulfide process in neutral sulfide process we only use hardwood whereas mechanical pulping we have stone ground wood pulp refined mechanical pulp thermo mechanical pulp and chemimechanical pulp and each pulp they are used for developing different kinds of papers printing papers corrugating media newsprint etc let's wind up this session in this session we had discussed about the different types of pulping methods we had seen mechanical and chemical pulping methods and what are the semi-chemical methods also those things we had seen so the remaining part of paper development we'll be discussing in coming sessions and thank you