

Food Packaging Technology
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Week – 01
Lecture – 5
Paper as packaging material P3

Welcome again to the NPTEL course, Food Packaging Technology. So, we had been discussing about the food packaging with a brief introduction. We have also discussed about the need for packaging and role of packaging in food industry. We have also seen what are the different types of packaging materials. We were discussing about paper as a packaging material and what are the different processes that are involved in the development of paper. And now we are going to discuss about paper boards. The raw material for paper boards is same as papers. So, it is the wood which is used for preparing the paper boards and instead of using the Fourdrinier and the cylinder machine, which we had seen in the paper making. Here only cylinder machine is used for making paper boards and the thickness of the paper boards ranges between 300 to 1100 microns. Paper boards contain 2 or more layers of papers. These are of different quality; it need not be of the same quality and there are different types of paper board.

First one is chip board. It is prepared or it is developed from repulp waste with the chemical and mechanical pulp. They have a dull grey color. They are relatively weak and these are mainly used for lining. It is lined on one side with unbleached semi or fully bleached chemical pulp, but these are not used in food industry. They are used for developing outer cartons.

The duplex board it is made up of a mixture of chemical and mechanical pulp and they are lined on both sides with chemical pulp and these are applicable in food industry. They are used to pack frozen foods, biscuits and other products. Then we have solid white board. It's all plies are made from fully bleached chemical pulp. These are used for frozen foods, liquids and other special products which needs protection. Paper boards can be coated with wax or polymers like polyethylene, polyvinylidene chloride and polyamide. These coatings enhance the functional property of the paper boards and it makes them water resistant. These are generally used to pack wet and fatty foods. Paper boards they are expressed in grammage and that is the basis weight for paper board.

So, this in terms of grammage they are denoted and the basis weight is greater than 224 grams per meter square. These can be used for developing folding cartons. However,

the cartons are not hermetically sealed packages. They are not airtight, so air can enter easily into the package. Again, folding cartons are important in consumer packages because it will inefficiently fill corrugating shipping cartons. These are the paper board and the card board so you can see the paper board does not have any fluids in between and card board is a 3ply cardboard. Corrugated box it has two structural elements facings it is also called liner boards and flutings the corrugating medium. So now let's look into the structure here. We have a board over here and it has two liners that is on the top and at the bottom there is a liner and in between, the flute. That is also called corrugating medium.

These are called liner boards or facings. Now liner board they can be of two types. Fourdrinier craft liner which are made of pine craft pulp. They are mainly unbleached and then cylinder liner which are made from reprocessed fibers. The general protocol for the preparation of corrugated box involves unwinding the single face liner and corrugating medium from holders. Threading the media into the fluting rolls and applying adhesive to the tips and bringing the medium in contact with the liner and this forms single face web and again glue is applied onto the fluting tips. Second face liner is pasted with the single face web. So, combining the boards these boards are passed through the hot plate section and then it is cooled and it is passed through slater or scorer.

So, this is the mechanism so here you can see. This is a three-ply paper board Fourdrinier table. So, the first ply and the flute, they are combined together and then only after that this forms a single face web. The second liner is attached and then it is passed through the hot plate. It is dried and cooled and this is that cylinder paper board method and again this is the slurry is injected between the two forming wires. This is also another method for producing the paper board. Here you can see the different types of food products and their requirements. What are the different types of paper boards that can be used for these foods. Packaging material which comes in direct contact with the food. They need to be high purity. They should be clean and runnability and for these reasons folding box boards are used and for frozen food which needs strength, barrier, purity, cleanliness and runnability we go for sulphate bleached boards. We can also use sulphate unbleached solids.

Similarly for indirect contact foods where the food is separated and they do not have any contact with the packaging material only runnability is required we do not have to worry about the purity or the cleanliness. In these cases, we can go for white lined chip boards. So similarly for other food products you can see what is their requirement. For example, the confectionery it again requires purity, cleanliness and odour/paint free and printability. So, similarly based on the requirements, packaging material need to be selected. So, sulphated bleached board, the bleached chemical pulp is there. It is coated on either side and that forms the sulphated bleached board and for the fibre folding box board.

The bleached chemical pulp or virgin mechanical pulp is added which is unbleached form and it is a sandwich actually of which the coating is added.

So, this is how the folding box board is developed. Now, both types are defined according to the standard. It is a combination of two letters and one figure. So, the first letter it describes the type of board surface treatment. So, what kind of treatment has been given to the board.

So, A refers to cast coated, B refers to the pigment coated, U refers to the uncoated. It is referred in the standard it will be written as AZ1 or AZ3 the A; it will stand for cast coated. Similarly, the second letter it will give an information about the origin of the pulp from where it has been used. So, what kind of treatment has been given. So, if it is said it means that it is bleached chemical pulp and it is identified as unbleached chemical pulp, C as mechanical pulp, T stands for secondary or recycled pulp.

These are fibre pulp with white cream or brown reverses. So, these such kind of packaging materials they will not have any contact with the food and D to secondary fibre pulp with grey reverse and for D grades density of the bulk of the paper will be more than 1.45-centimetre cube per gram. They are generally considered as D1 and it ranges between 1.45 that is more than 1.45 and around 1.3. Now, we also have moulded pulp. Moulded pulp are containers made from waterborne suspension of mechanical chemical pulps or we can also go for waste pulps or mixtures. So, a recycled can be used to develop the moulded pulps.

These are suspensions, they are moulded into shape either by applying pressure. So, pressure injection moulding or by applying vacuum. So that is suction moulding. And these moulds are then dried. These act as cushions; they have a very good cushioning property and it limits the movement of package during transportation. So, and therefore, it gives a good mechanical protection.

Generally, these kinds of moulds are used in trays for eggs, fruits, etc. Then corrugated fibre boards, they are also called fibre boards. In some literature you will find it as corrugated boards or in some other literature you will find it as fibre board or sometimes it is combined together. So, fibre board it is a solid or corrugated form. It contains more than one layers.

If it is three ply then it will be two liners and one medium. These are kept in place using the adhesive. So, in the corrugated fibre board, the medium may be chipboard, straw board, boards made which are the mixtures of chemical and mechanical pulp. And these can be a single vault or double vault or triple vault and including the liner board and the

media. This figure it shows the development of corrugating board.

So, here you can see there is a liner board and this is another liner board. So, the first liner board will have the adhesive to it and the flute will be attached to it. And when it comes out next liner board will be attached and again the adhesive will be applied to the flute and next liner will be attached to it. So, at the end of the process, we will get a three ply with two liner and one flute. There are four different types of flutes.

This is based on sizes. These are classified as A, B, C and E. A has around 104 to 125 flutes per meter and these are described as coarse and they have good cushioning effect and they are also rigid. Whereas B has flute numbers it varies between 150 to 184 in a meter and it is designated as fine and it has good crush resistance. Then C has the number of flutes it will range between 120 to 145 per meter and usually it compromises between these properties and E has higher flute number that is between 275 and 310 in a meter and these are very fine. These are used for making small boxes and it has some cushioning effect.

So, if you look at the cardboard over here, these are the flutes. So, you have to count the flutes and see how many flutes are there in one meter and accordingly it will be categorized as A, B, C and E. Now this table also summarizes the flute type that is A, C, B, E, F. So, the height is also given as the flute number increases the height of the flute also comes down. So, you can see F has the height is very small, but the flute number per meter is very high and it has poor stacking property.

Puncture resistance is also poor, cushioning effect is poor and flat crush is poor and but it is good for printing and other properties. Similarly, we have A, C, B, E. Here also in the figure you can see A has the height of the flute is very high and as it reaches to F the height is very less. So, cartons they are composite structures consisting of fluted paper laminated on one side or both sides. This helps in resisting the puncture or resisting the compression from forces perpendicular to the fluted dimension.

Microfluted corrugated materials often substitute for paperboard in cartons. They require high strength for compression resistance and holding strength. So, again here in this we can see the flutes this one is 5 ply you can see 2 flutes and 3 liners are there. So this is a 5 ply board and again in this little more zoomed picture you have flutes like this and this is a 3 ply 1, 2 and 3 and this lower cardboard it is the flute height is lesser.

So it is F type or E type. Cartboards they are cost effective, lightweight and easily recyclable and they are usually used for secondary packaging during the transit. Since they can be stacked and palleted 6 to 8 boxes they can be put one over another then can be

stretch wrap and this together they can be used as a secondary packaging material. Primary packages they contain only microfluted cartons. Paper which is made up of plant fiber they can absorb moisture or they can desorb moisture. This depends upon the relative humidity that is the humidity in the environment it very much affects the nature of the carton and also the strength properties of the carton.

Now additives are added during the paper making and coatings can increase the hydrophobic nature of the paper fiber. It decreases the absorption of moisture by the cartons. Usually, the wax can be applied we can also apply plastic coating to make it waterproof. It can be applied on paper as well as paper boards. Usually, they absorb oil and grease but we can add some additives to remove this property or to mitigate this property so that it will not absorb oil or grease.

Fluoro chemicals these are manmade chemicals these are added to the paper boards to improve such kind of functionalities but in some ratios. It has been reported that these are carcinogens and they may pollute the environment. Moreover, attention is being paid to recycling of fibers and reusing the boards. Now lot of studies are also going on reported by the European Food Safety Authorities that mineral oil saturated hydrocarbons and mineral oil aromatic hydrocarbons were detected in the consumer diet. So, the consumer diets were contaminated they contain this kind of hydrocarbons which came from the recycled fiber. So if we are going to use the recycled fiber or recycled package material, these should not come in direct contact with the food they can be used as the tertiary packing material and this contaminants they generally come through the inks and the adhesive that has been used during the processing of the paper development.

Now properties of the packaging material paper boards, substance and quantity measurement, the weight of substance per unit area this is called basis weight and this is how this designator of paper boards are denoted. The sample under the equilibrium that is 24-degree centigrade 50 percent relative humidity, minimum 10 sheets are taken and the total area should not be less than 600-centimeter square. So, weight of this is taken and on this basis the property is denoted for the paper boards. Similarly, the thickness of paper boards also important and another property this is a physical property again, just a gravity or density it indicates the weight and thickness of the paper board. Then strength and durability are very important in the packaging material during transportation strength and durability is very important for the paper boards it affected by the strength of individual fibers of the stock and average length of the fiber and it is also affected by the kind of bonding that is present among the fibers and the structure and formation of the sheets.

So, these four parameters they are important and they determine the strength and durability of the paper board. And then we also need to check the resistance to rupture and

tensile strength, the greatest longitudinal stress a paper can bear without tearing apart. So that is another tensile strength and elongation inversely related and these are important parameters of packaging material and wettability how much it can absorb water that will also affect the strength of the paper then resistance to bending and degree of porosity. Degree of porosity if the pore size is more can be reduced by sizing as we had seen during paper manufacture it because porosity it affects the barrier properties. Third property is optical properties and in the optical properties we check brightness, color, opacity and gloss.

Then brightness is the degree to which white or near white papers or paper board reflect the blue light of the spectrum. Generally, it is measured at an angle of 45 degree using a wavelength of light at 457 microns. Opacity it requires the white mineral pigment to be incorporated with the paper stock or applied as coating. Opacity helps in making the printing more legible. So, it is also very important then gloss indicates glare or final finish and smoothness.

It is the surface characteristic of the paper. Calendaring and coating these are paper treatment methods for glossiness. Glossiness is determined by measuring the percentage reflectance at a very low angle that is 15 degrees. Now there is another group of papers or the packaging material that is called regenerated cellulose. These are again made from wood pulp and these are of very good quality. These are bleached sulphide pulp which are treated with sodium hydroxide and carbon disulphide and this produces sodium cellulose xanthate and sodium cellulose xanthate is again dispersed in sodium hydroxide which becomes viscose and viscose is passed through acid salt bath and it forms salts which is neutralized using alkali and this is desulphured, bleached and softened for flexibility and dried.

This is called plain regenerated cellulose. The regenerated cellulose needs a step-by-step process. The pulp needs to be converted to viscose and the viscose is desulphured to give regenerated cellulose and regenerated cellulose it is denoted as P, plain regenerated cellulose. It is clear, transparent, not heat sealable, transparent paper. It protects against dust and dirt. It has only few mechanical protection or less mechanical protection, but it is grease proof, good gas barrier and it becomes wet.

It permits moisture to pass through it and plain cellulose is generally not used in the Food packaging, but its functionality can be improved by adding additives like nitrocellulose, waxes, resins, plasticizers, etc. and thereby we produce nitrocellulose papers and these are recorded as using by coded letters. So following code letters are used to reflect the properties of coated regenerated cellulose films. For example, A, it indicates lacquer coating, D indicates coated on one side, M stands for moisture proof, P means uncoated

that is plain regenerated cellulose, Q means semi-moisture proof, S heat sealable and P stands for transparent, XT copolymer coated on one side, XX copolymer but coated on both sides.

So, this is how it is denoted. And there are different types of film that are used. In food packaging, we have MSAT which is nitrocellulose that is plain regenerated cellulose. It has been treated with cellulose and coated on both sides. So, it gives a good barrier property to water vapour, gases and volatiles and it is heat sealable. Similarly, we have QSAT which is nitrocellulose coated on both sides and since it is so heat sealable and it has more water permeability than MSAT. DMS, it is nitrocellulose coated only on one side, MXXT, it stands for copolymer coated on both sides.

It has very good barrier properties and it is strong, it can be heat sealed strongly and MXDT stands for copolymer coated on one side. And sometimes we can also use mixtures of polyvinyl chloride and PVDC, polyvinylidene chloride and if it is coated or mixed with these kinds of polymers, then such regenerated celluloses are used for developing laminates, bags and pouches. Now we also have another kind of packaging material called cellulose acetate. These are generally used for developing window packing materials. If you can look at the figure here down, you can see this are sandwiches where we are using this kind of window packaging system.

Cellulose acetate is used made from waste cotton fibres which are acetylated and partially hydrolyzed and these are developed using extrusion method or solvent casting method. Such films are transparent, clear, sparkling and these are permeable to water vapour gases and volatiles. And they can also be thermoformed into semi-rigid containers or blister packing as in tablets. So, this is here also we find the application of cellulose acetate. Now composite cans, containers, composite containers, the cylindrical body will be made of paper board or fibre board, but the ends will be made of plastic or metals.

These have good barrier properties and it can be improved with coating and laminations on the body using aluminium foil or aluminium foil can be incorporated into it. Small containers less than 200 mm in diameter are referred to as tubes or cans and these are good for salt, pepper, spices, custard powder, chocolate beverages, frozen fruit juices etc. Whereas large containers they are called fibre board drums, they are used for storage and other purposes, usually for storing. They are also called paper or plastic sacks or metal drums and these are used to store milk powder, emulsifying agent and cooking fats.

These are also called fibre board drums. Now, wooden containers, these have been in use early period, but later these were replaced by other kinds of packaging material and still we continue using wood for some other packaging material or it forms a part of

packaging material. Usually, the outer wooden containers where high degree of mechanical protection is required, we go for wooden containers and they also form part of crates or cases and in case of wine industry, these are used as casks, kegs and barrels. So, you can see the picture of barrel here which is used to store the wine or liquid products and oak casks are used for storing high quality wine and spirits whereas low quality wines they are stored in chestnut casks and this is a crate or pallet. These are some other types of pallet box and crates which are tertiary packaging materials and which can be used for transportation. And textiles, these are again like jute or cotton-wound materials which are used for packing large quantity of materials.

Sacks made of jute were used for packing fresh fruits and vegetables, grains, dried legumes and multi-walled paper sacks and plastic sacks were also used. Cotton sacks are in use for storing flour, sugar, salt, similar products. Even fresh meat was also packed in textile or cotton scrim. So, we have seen different types of packaging materials. We started with paper board here in this session and we have seen what are the different paper boards and how it can be developed and what is the importance of having flute and liner, how the different types of paper boards are developed, that is three ply, five ply, etc.

And we had also discussed about corrugated fiber board and then textile sacks or the wooden packaging, regenerated cellulose, etc. So, we will wind up this session and we will meet in the next session. Thank you.