

Food Packaging Technology
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Week – 02
Lecture – 08
Plastic as packaging material – P2

Welcome back to another session of NPTEL course Food Packaging Technology. So, in the previous session we had discussed about different plastic films and we will be continuing again with the plastic films and other flexible packaging materials and the molding parameters and other things. In the last class we had discussed about polystyrene and other polymers. I think we had stopped at polystyrene. So, we will discuss about polycarbonate. Polycarbonate PC it is again a polymer which is developed using phosgene and biphenyl carbonate with bisphenol A and this produced by extrusion or casting method.

It is mechanically strong and crease resistant and it has very high permeability to water vapor and gases. However, it is very stable arranged over a range of temperature it can be stable from minus 70 to 130 degrees centigrade. However, it is not very widely used in food packaging, but it can be used as boiling bag packages for food, ritored pouches and frozen foods. So, this is phosgene which has two chlorine molecules and this is a biphenyl A monomer.

They react together to give polycarbonate and on polymerization monomers will react together or they will join together to give a polymer of polycarbonate. Polytetrafluoroethylene otherwise called PTFE. It is formed by the reaction between hydrofluoric acid with chloroform which is subjected to pyrolysis and then it is polymerized and films are developed using extrusion method. These are very strong and they have low permeability vapor and gases. These are crease resistant. It is stable over a range of temperature of minus 190 to 190 degrees centigrade that is on the lower side it will go up till minus 190 and it has very low coefficient of friction.

Generally, these are not used in food packaging, but it can be used to develop ritored food packages and for freeze dried products. Polytetrafluoroethylene has a very good nonstick property and for this reason it is used as heat sealer and as a coating on the cooking utensils. So nonstick pans which we find as a coating on the cooking utensils. So nonstick pans which we find it in our kitchen it contains polytetrafluoroethylene and this is the Teflon. This is how the chemical structure is.

Ionomers it is another polymer it is formed by introducing ionic bonds and covalent bonds in the polymers such as polyethylene. This is achieved by reacting them with metal ions and such Ionomers they are stiff and resistant to puncture. They have high permeability to water vapor and good grease resistance and these are mostly used as laminates with other films like polycarbonate or PET. These are used in packing cheese and meat products. Ionomers they are not chemically bonded cross-linked polymers, but they are type of thermoplastics that have reversible cross-linking. So, in the figure down you can see in the PET. It is in stable form the ions are attracted to each other, but when it is heated the ionic groups. They lose their attraction and chains move apart and the valencies are satisfied by with the help of metal ions and polymers. They do not bind together so it is in the loose form, but then again, the valencies are satisfied. And these Ionomers they are also used for developing thermoplastic elastomers.

Next polymer is ethylene vinyl acetate copolymer then ethylene vinyl acetate copolymers it is another group of polymers which are used again for packaging. This is a copolymer which is developed by the polymerization of polyethylene with vinyl acetate and since it is a copolymer it has high impact strength, high permeability to water vapor and gases and heat sealability and the sealability ranges for a wide range of temperature. EVA can also be used along with other polymers like ethyl acrylic then acrylic acid and these will improve the functional properties of the polymer. Generally, these are used as laminates with polyethylene, polypropylene and other filaments in food packaging. EVA also has very good stretch and clinging properties. So, it can be used as secondary packaging material also. Now this is the structure of EVA we have ethylene and vinyl acetate which polymerize together to give EVA or ethylene vinyl acetate. Now coming to the general properties of plastics, the first most important property is optical property it is also called as gloss property. It affects the appearance of the packaging material. Optical property defines the consumer preferences so if it is good in appearance then it will also attract more and more consumers and transparency is great when the degree of crystallinity is lower so less the crystalline it will be more transparent. Again, the second property is tensile strength and elongation. This is very important for a packaging material and there is an inverse relationship between tensile strength and elongation but in some cases, we do see direct relationship between tensile strength and elongation. For example, in polylactic acid and tensile strength and elongation, it is significant during filling and seal packaging. Films that can withstand the tension of passing through the molding machine without breaking or stretching while the formed shape should withstand the force, it takes to put the weight of the product in place without resulting in deformation. So, this indicates while we are packaging the food package should not undergo any deformation it can be during filling or sealing or it can be during molding also. So tensile strength and elongation they are directly related to the deformations in the packaging that may happen during the processes and the third most important property is

impact strength and this indicates the material's resistance to break during sudden impacts like transportations and handling. When it is transported, the vehicle may face some impact during movement. Over the road or during a flight or again during handling if the shock it should be able to bear the shock and it should not break down during these processes. So that is impact strength is also important then another property is tear strength. It is a tear resistance during molding and handling. So, it should not tear off easily when a person is handling or consume only when a person wants to tear off. He should be able to tear off. But on the other hand, while traveling or molding or in transit, it should not be toned. So that is also important next property surface friction so surface friction it affects the ease with which packaging materials go through the packaging line so it should have a smooth flow during the production. So, for that surface friction is very important and it also has an impact on the stability of palletized cargo and a surface friction it can be enhanced by adding additives. Density is another parameter and its density changes with the crystallinity. So, they are correlated and it is related to solvent absorption and loss of plasticizer and it varies with the temperature discolasticity it indicates the degree of permanent deformation during filling and stacking. The last property of packaging material is the heat sealability. It is a very important property of plastic materials and it is dependent on temperature pressure and time. So, it should stand withstand a wide range of temperature pressure the internal pressure and the external pressure and the time it spends on the jaws of packaging machine. Also heat sealability is also important in the case of hermetically sealed packages the airtight packages there also heat celebrity plays a very important role now this table it shows different polymers or different packaging materials they have a uniform thickness of 0.025 millimeter and then in that condition what are the different barrier properties of this polymers so pvc we can see the water vapor barrier property is 1.525 and 5 gram per meter square in 24 hours whereas an oxygen barrier property is 8 to 25. It has a light barrier property of 90 that means it reflects 90 of the light only 10 can be transmitted. Similarly, it is for polystyrene but EVAC, it can transmit 55 to 75 percent of the light. Similarly, you can also see the barrier properties of other polymers here and according to the requirement of the product the polymers can be selected for packaging now. We have another packaging film that is called metalized film and metalized films. They are packaged flexible films which has a thin metal coating. Generally, this metal the thickness of metal is less than one microns and by giving a metalized coating it improves the resistance to water vapor and gases. It is also used to pack snack foods. Generally, it involves heating the metal at very high temperature of 1500 to 1800 degrees centigrade in a vacuum chamber. Then maintaining it at very low pressure and this metal it evaporates it vaporizes and it gets deposited on the film and we can deposit this on pet polypropylene, polystyrene, polyvinyl chloride, polyvinyl chloride, regenerated cellulose. So, all these com films they can be metalized and they can be used in various forms. Then we have flexible laminates. Flexible laminates are comprising of a paper or a film

not which doesn't have enough protection or it cannot give protection to product and for that reason we combine two or more flexible materials together to give a laminate or to develop a laminate. This also improves the functional property and both the components will be giving the functional properties. They will be complementary to each other. So, we'll be utilizing the properties of both the films and in flexible laminates we can include papers, paper boards, films and aluminium foils. Paper and paper board, generally, they are stiff and they protect the foil against mechanical damage. They have a good surface for printing and the film can be coated or it can be co-extruded with it it will give the property of barrier properties against water vapor and gas. It has good sealability and it strengthens the laminate. So, these two properties we both the properties of paper and paper board as well as the film it can be utilized and it can be explored and also the foil it acts as a barrier material. It will have a good attraction and laminates can be of paper film. It can be in any combination. It can be more than one or two. We can have paper film and foil combinations. These are generally bonded using an adhesive it can be aqueous adhesive or non-aqueous adhesive. It is an acid, it is water soluble and non-aqueous adhesive. They are not water soluble. These can be developed into thermoplastic layers by the laminates through heated rollers. These are extruded into thermoplastic materials they can be molded to different forms. They can also be co-extruded and some of the examples are vegetable parchment paper and foil which is used for wrapping butter and margarine. We also have PET and PE laminates for coffee paper board foil polythene for polyethylene for milk and fruit juice carton. This table, it shows the different types of plastic materials, their properties and usages which we had already discussed. It's just a compiled table. These are different types of containers that we use in food packaging industry or as in a food processing industry, whatever plastic materials we had seen earlier. They can be molded into different forms. Nowadays, the biodegradable packaging materials are also coming up. This is because of their environment friendliness and sustainability. So most of the the food processing industries they have to ensure that their packaging materials can be either recycled or reused. Therefore government are also encouraging the utilization of biodegradable packaging materials. Now containers when we use them they should exhibit many functions so till now we had seen what are the different types of packaging materials and what are the different packages that can be developed using this films or materials. Now when we develop a package, it needs to exhibit some properties. These properties can be containment. It should contain the product and it should protect the content inside. It should communicate with the consumer, pass the information to the consumer. It should be convenient to handle that means it should easy to operate, easy to close. It should have a good presentation. It should be able to attract the consumer. Then it should improve the shelf life of the product and it should be eco-friendly. Basically we are using glass, plastic and metal containers. These are readily available plastic containers. These were commercially used in 1875 and they were very expensive in 1960s and after 1960

HDPE was developed and it was introduced into the market. It became very popular because the effects properties like lightweight cheap. That it is cost effective, low production charges and transportation charges were low and also it can it was easy to replace the glass. Though we are still using glass for wine and beer, HDPE has become very popular and it has replaced almost all other plastics. These plastic containers they are available in different forms like barrier bottles, boston round bottles, jars ,storage containers, packer containers or packer bottles, media bottle, cylinder bottles. These are different types or different shapes of bottles. These are some of the example. This is a barrier bottle and a boston round bottle. How to mold a bottle we have films and sheets which are converted to pellets. These pellets they are melted to form liquid this is done under very high pressure and there's an internal friction while melting, heat will be supplied as well as internal friction will also generate heat. So under high pressure and high heat, this gets melted up and becomes liquid and it is blown. It is just like, how we saw in the glass molding. It here also we use blow molding and we develop a hollow tube or the parison. This is used for extrusion and the mold encloses the parison and pinches of the end so which is a protruded which is a deformed structure attached to the parison so that will be cut. In the second figure you can see here the parison is inserted into the mold and the irregular shape attached to the parison. It will be cut off. It is tightened and then compressed air is blown into the parison. It inflates and it fills the mold and this how it takes the shape of the mold and then it the unwanted parts or the extended parts are trimmed off. It is removed from the mold and this way the bottles are ready and they can be utilized and generally the plastic containers. They are lighter they are inert and non-corrosive and versatile to use cheap. They can also cube microbes away and also we can keep it airtight under by using heat or pressure. The disadvantage of many plastic bottles are that they are permeable to gas and vapor. They interact with the contents and they are not as strong as glass and time. So we have come to the end of this session. In this session we had discussed about different types of polymers we continued in the previous session also. It was a continuation in this session and we also saw what are the different methods by which the plastics or the containers can be developed. Thank you for today!