Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Welcome to the NPTEL online certification course on modern food packaging technologies regulatory aspects and global trends. We were discussing different types of food packaging materials in that we have covered paper and glass so far and we were discussing plastic material. In continuation to that different types of plastic materials which are used in food packaging materials are polyethylene, polypropylene, polyesters, inomers, ethylene vinyl acetate, polyamides, polyvinyl chloride, polyvinylidene chloride, polystyrene, styrene butadiene, acrylonitrile butadiene styrene, ethylene vinyl alcohol, poly methyl pentene, high nitrile polymers, flouropolymers, cellulose based materials and polyvinyl acetate. These are the different materials which are recycled and they are like polyethylene terephthalate which are come common products which are packed in that is soda and water cups, jars, trays, clamshells and this can be recycled and make into different products like clothings, carpet, clamshells, soda water bottles. The next material is high density polyethylene which are generally used for making products like milk jugs, detergent and shampoo bottles, flower pots, grocery bags and after recycling it can be used for the detergent bottles, flower pots, crats, pipes and decking.

The next material is polyvinyl chloride, the primary product which is made for from this material is cleaning supply jugs, pool liners, twins, sheeting, automotive products, bottles and sheeting and after recycling this can be used for making products like pipe, wall siding, binders, carpet, backing, flooring etc. The another material that is low density polyethylene, the primary products made from this is bread bags, paper towels and tissues, over wraps, squeeze bottles, trash bags, six pack drinks and after recycling the products which can be made is trash bags, plastic hangers, furniture, shipping envelops and compost bins. The polypropylene, the primary materials can be made is yogurt tubes, cups, juice bottles, straws, hangers, sand and shipping bags and after recycling this can be used for making paint cans, speed bumps, auto parts, food containers, hangers, plant pots and razor handles. The polystyrene, primarily it can be used for making flatware, hot cups, razors, CD cases, shipping cushions, curtains, trays etc and after recycling it can be used for the making picture frames, crown molding, rulers, flower pots, hangers, toys, tape dispensers etcetera.

The other products which are generally used is the polycarbonate, polycarbonate

plastic, other products which are used are polycarbonate, nylon, ABS, acrylic, PLA, bottles, safety glasses, CDs, headlight lenses and after recycling it can be used for the electronic housings, auto parts etce. Now, let us go into detail one by one in all that polymers used in the food industry that one is polyethylene. Polyethylene is structurally the simplest plastic and is made by addition to the food industry polymerization of ethylene gas in a high temperature and pressure reactor. A range of low medium and high density resins are produced depending on the conditions that is temperature, pressure and catalyst of polymerization. The processing conditions control the degree of branching in the polymer chain and therefore, the density and other properties of films and other types of packaging materials.

Polyethylene are readily heat sealable they can be made into strong tough films with a barrier to moisture and water vapor. They are not a particular high barrier to oils and fats or gases such as carbon dioxide and oxygen compared with other plastics although barrier properties increase with density. The heat resistance is lower than that of other plastics used in packaging with the melting point of around 120 degree Celsius which increases as the density increases. Polyethylene is the most widely used in tonnage terms and is cost effective for many applications. It is the work house of the flexible film industry.

Polymer plants can be found in all countries around the world supplying a specialist film making polymers. The LDP that is low density polyethylene, low density polyethylene is easily extruded as a tube or blown to stretch it by a factor of 3 times the original area. It is commonly manufactured around 30 micron with newer polymers allowing down gazing to 20 to 25 micrometer within a density range of 0.910 to 0.925 grams per centimeter cube.

It is possible to color the films by blending pigments with the polymer prior to extrusion where extruders have more than one dye it is possible to form films with two or more layers of the same material or to produce co-extruded films comprised of layers of different plastic materials. With three extruders it is possible to produce a film where for example, a moisture sensitive polymer EVOH that is ethylene vinyl alcohol is sandwiched between two protective layers of polyethylene. EVOH provides a gas and odor barrier and the polyethylene offers good heat sealing properties and a substrate for printing. Polyethylene film melts at relatively low temperatures and melts to itself when cut into a śhot wire or blade to form effective seals. For packaging it is possible to use either pre made bags or form filled seal machines using flat film or reel form.

A major use of white pigmented low density polyethylene film is for making bags for holding frozen bed stables. By laminating to other substrates with adhesives or extruding

the polyethylene polymer on to another material or web it is possible to make strong sachets, pouches and bags with good seal integrity. As the polyethylene flows to fill holes in the sealing area or around contaminants in the seal. Polyethylene and other plastics are used in combination with paper board to make the base material for liquid packaging cartons. Major uses of polyethylene film are in shrink and stretch wrapping for collating groves of packs and for securing pallets size loads.

The another type of polyethylene is L L D P E that is linear low density polyethylene film has a density range similar to that of low density polyethylene. It has short side chain branching and is superior to L D P E in most properties such as tensile and impact strength and also in puncture resistance. A major use has been the pillow pack for liquid milk and other liquid foods. L D P E and L L D P E can be used for making in blends with E V A to improve strength and heat sealing. There is a degree of overlap in application between L D P E and L L D P E due to the fact that there are differences in both.

As a result of conditions of polymer manufacture and ongoing product development. The thickness used for specific applications can vary and this can also have commercial implications. Now, M D P E that is medium density polyethylene film is mechanically stronger than low density polyethylene and therefore, use in more demanding situations. L D P E is a co extruded with M D P E to combine the good sealability of L D P E with the toughness and puncture resistance of M D P E. For example, for the inner extrusion coating of sachet for dehydrated soup mixes.

H D P E that is high density polyethylene is the toughest and is extruded in the thinnest gauges. The film is used for boil in the bag applications to improve heat sealability. H D P E can be co extruded with L D P E to achieve fillable seals where the polymer layers can be made to separate easily at the interface of the co extrusion. A grade of H D P E film is available with either transverse direction, mono axial orientation or biaxial orientation. This film is used for twist wrapping sugar confectionery and for lamination to oriented polypropylene.

The transverse direction oriented grade easily tears across the web, but is more difficult to tear along the web. Being co extruded a heat sealable layer is applied to enable the film to run on the conventional form fill seal machines. The biaxial oriented film has properties similar to that of O P P, but has a higher moisture vapor barrier. It may be coated in the same way as O P P including metalizing to give a high barrier performance film with the good sealing integrity associated with the P E. High density polyethylene is injection molded for closures, crates, pallets and drums and rotationally molded for intermediate bulk containers.

A major application of H D P E is for blow molded milk containers with the capacity of half liter to 3 liters. The another important plastic material is polypropylene. Polypropylene is an addition polymer of propylene formed under heat and pressure using zieger natta type catalyst to produce a linear polymer with protruding methyl groups. The resultant polymer is a harder and denser resin than polyethylene and more transparent in its natural form.

P P has the lowest density and highest melting point of all the high volume uses thermoplastics and has a relatively low cost. This versatile plastic can be processed in many ways and has many food packaging applications in both flexible and rigid forms. The high melting point of polypropylene that is 160 degree Celsius makes it suitable for applications where thermal resistance is needed. For example, in hot filling and microwave packaging P P may be extrusion laminated to PET that is polyethylene terephthalate or other high temperature resistant films to produce heat sealable waves which can withstand temperatures of up to 115 to 130 degree Celsius for sterilizing and use in retort pouches. The surfaces of polypropylene film are smooth and have good melting characteristics.

P P films are relatively stiff when cast the film is gloss clear and heat sealable. It is used for presentation applications to enhance the appearance of the packed products. Unlike polyethylene the cast film becomes brittle just below 0 degree Celsius and exhibits stress cracking below minus 5 degree Celsius and hence has to be used in a laminate if the application requires deep freeze storage. P P is chemically inert and resistant to most commonly found chemicals both inorganic and organic.

It is a barrier to water vapor and has oil and fat resistance. Aromatic and aliphatic hydrocarbons are however, able to dissolve in films and cause swelling and distortion. P P is not subject to environmental stress cracking. Environmental stress cracking is a surface phenomena whereby cracks can appear in molded plastic as a result of contact with materials which affect the surface structure in critical parts of the design. This can lead to cracking without actually degrading the surface.

There are specific tests to check the environmental stress cracking and shelf life tests with the actual product to be packed should also be carried out. Oriented polypropylene films was the first plastic film to successfully replace regenerated cellulose films in major packaging applications such as biscuit packing. O P P films do not weld or heat seal together easily and as the melting temperature is close to the shrinkage temperature of the film and the structure spring apart when being sealed. However, acrylic coated O P P has good runnability including heat sealing on packing machines designed for

regenerated cellulose films though improved temperature control of the heat sealing equipment is required.

Many of the polypropylene films are used in the form of laminations with other P P and P E films. This allows for the reverse slide printing of one surface which is then buried inside the subsequent laminate. Oriented polypropylene film was the first plastic film to successfully replace cellulose film in other packing applications such as biscuit manufacturing. The range of food products packed in P P films include biscuits, crisps and snack foods, chocolate and sugar confectionery, ice cream and frozen food, tea and coffee. Metalized polypropylene film can be used for snacks and creeps where either a high barrier or longer shelf life is required.

P P white opaque polypropylene films and films with twist wrapping properties are available. There are several types of heat sealing that are required for heat seal coating and in addition it is possible for converters to apply cold seal coating on the non-printing side in resistor with the print for wrapping heat sensitive food products such as those involving chocolate. Paper board can be extrusion coated with polypropylene for using a plastic film. The polypropylene film can be used as frozen chilled food trays which can be heated by the consumers in microwave or steam heated opens. Major food applications of polypropylene are for injection molded pots and tubes for yogurt, ice cream, butter and margarine.

It is also blow molded for bottles and wide mouth jars. Polypropylene is widely used for the injection molding of closures for bottles and jars. Polypropylene can provide a durable living hinge which is used for flip top injection molded lids which remain attached to the container when opened for example, sauce dispensing closure and lead. It is used in thermo forming from P P sheet as a monolayer for many food products such as snacks, biscuits, cheese and sauces.

In coextrusions with polystyrene, ethylene, vinyl alcohol and polyethylene it is used for the packaging of several types of food products including those packed aseptically by hot filling and in microwavable and retordable packs. Thank you very much.