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. Today we will be discussing about different types of packaging materials and in that we will be discussing about the plastics. And the topic of discussion will include the introduction about the plastics, evolution of plastics, use of plastics in food packaging, manufacture of plastic packaging and in that we will be discussing types of plastic manufacturing like thermoplastic, thermoset plastics, biodegradable plastics, elastomers. And in plastic manufacturing processes we will be discussing blow moulding and in the blow moulding we will be discussing extrusion blow moulding, stretch blow moulding, injection blow moulding, form fill seal bottle moulding. And thermo forming methods we will be discussing vacuum forming, pressure forming, matched mould forming, twin sheet forming and at the last compression moulding. Let us define certain things the, the adjective plastic is derived from the Greek plasticos meaning easily shaped or deformed.

From a technical view point plastics is a generic term for macromolecular organic compounds obtained from molecules with a lower molecular weight or by chemical alteration of natural macromolecular compounds. At some stage of their manufacture they can be formed to shape by flow aided in many cases by heat and pressure. These structures are built up by the repeated joining of small basic building blocks called monomers. The resulting compounds being called a polymer derived from the Greek roots meros meaning parts and poly meaning many.

Plastics are widely used for packaging materials and in the construction of food processing plant and equipment, because they are flowable and mouldable under certain conditions to make sheets, shapes and structures. They are generally chemically inert though not necessarily impermeable. They are cost effective in meeting market needs, they are light weight, they provide choices in respect of transparency, color, heat sealing, heat resistance and barriers. Most packaging plastics are thermoplastic which means they can be repeatedly softened and melted when heated. This feature has several important implications for the use and performance of plastics as in the forming of containers, film manufacture and heat sealability.

Thermosetting plastics are material which can be molded once by heat and pressure. They cannot be re-softened as reheating causes the material to degrade. Thermoset plastics such as phenol formaldehyde and urea formaldehyde are used for threaded closures in cosmetics, toiletries and pharmaceutical packaging, but not used to any great extent for food packaging. Plastics are used in the packaging of food because they offer a wide range of appearance and performance properties which are derived from the inherent features of the individual plastic material and how it is processed and used. Plastics are resistant to many types of compound, they are not very reactive with inorganic chemicals including acids, alkalis and organic solvents thus making them suitable that is inert for food packaging.

Plastics do not support the growth of microorganisms. Some plastics may absorb some food constituents such as oils and fats and hence it is important that a thorough testing is conducted to check all food applications for absorption and migration. Let us see the how the evaluation of evolution of plastics takes place. In 1869 the first plastic was invented that was the celluloid. In 1907 Leo Baekeland invented bakelite, the first synthetic thermosetting plastics.

In 30s the creation of phenol formaldehyde used for molded product such as electrical insulations and toys. During the Second World War the research into plastics intensified as scientists shot new materials that could be used in place of scarce resources like rubber and metal. In 50s and 60s plastics became widely available and were used in an ever increasing range of consumer products. In 1971 invention of polyvinyl chloride revolutionized the plastics industry. In 1973 creation of high impact polystyrene.

In 1974 creation of polyurethane which is used in refrigerators afterwards as insulating material. In 1984 creation of polycarbonate which is generally used for feeding bottles. 1987 creation of low density polyethylene actually revolutionized the food packaging industries. In 1988 creation of cross linked polyethylene. In 1989 creation of high density polyethylene.

Let us go into some certain details about the evolution of plastics. In 1907 first commercial plastic that is called bakelite the material of a 1000 uses were invented. In 1988 creation of cellophane is invented by Jax Edwin Bradenberger a Swiss chemist and textile engineer. In 1912 Williams candy company initiated the use of cellophane for their white man sampler making the first use of sellofan by the candy industry. In 1927 DuPont scientist William Hale Church and a team of researchers figured out how to make cellophane moisture proof opening the door for its use in food packaging.

In 1933 polyethylene is invented by ICI a British chemical company. In 1954 zipper

sealed bags invented by Robert W. Wegeby were initially created as pencil pouches, but their convenience soon lent them to food storage including zip lock bags for individual use. In 1956 J. Erskine love jr found print pack with only one piece of equipment a used cellophane bag machine and an abundance of focus.

First customer shipment to Rovio and the company Piana foods is still a customer today. In 70s many new plastics developed for packaging including the pet bottles for carbonated drinks, child proof closures first used bar codes became common on packing. In 80s plastic tubes for such items were used as toothpaste, cosmetics and medicines took over from metal tubes growth of convenience food packaging including special designs for microwave ovens. In 1986 Sergetto shredded cheese became the first consumer product offered in a resellable pouch. Most shredded cheeses-and then deli meats soon followed. In 1988 the society of the plastics industry began a resin identification coding system that provides a way to identify plastic resins used in packaging containers.

In 1996 Salad in a bag packaging that is metallone catalysed polyolefin was developed with the goal of reducing food waste and making it easier for consumers to buy fresh produce. Let us see the different uses of plastics in food packaging. The plastics are used as containers, container components and flexible packaging. In uses by weight they are the second most widely used type of packaging and first in terms of value. Examples are as follows a rigid plastic containers such as bottles, jars, pots, tubs and trays.

Flexible plastic films in the form of bags, sachets, pouches and heat sealable flexible leading materials. Plastics combined with paper board in liquid packaging curtains expanded or foam plastics for uses where some form of insulation, rigidity and the ability to withstand compression is required that is cushioning material. Plastic lids and caps and the wadding used in such closures. Diaphragms on plastic and glass to provide product protection and tamper evidence. Plastic bands to provide external tamper evidence.

Packaging and dispensing devices to collate and group individual packs in multi packs for example, high cone drinks for cans of beers, trays for jars of sugar preserves etc. Plastic films used in cling, stretch and shrink wrapping. Films used as labels for bottles and jars as flat glued labels or heat shrinkable sleeves. Components of coatings, adhesives and inks. Now, the plastic manufacturing is the process of creating plastic products by transforming raw plastic materials into finished products.

It involves several stages of production from designing and engineering the product to molding, shaping and assembling it. The raw materials used in plastic manufacturing

typically include polymers, resins and additives. The process of plastic manufacturing varies depending on the type of plastic being used and the intended product. The most common types of plastic used in manufacturing include thermoplastics, thermoset plastics, elastomers and biodegradable plastics. Each type of plastic has its own unique properties and requires specific manufacturing processes to achieve the desired product.

Plastics manufacturing also involves a variety of manufacturing processes including injection molding, blow molding, extrusion and thermo forming. These processes vary in complexity and are chosen based on the type of plastic being used and the desired product specifications. The use of plastics in manufacturing has become increasingly important in modern society due to its versatility, durability and cost effectiveness. The plastics can be used in wide range of products from packaging materials to medical devices to automotive components. However, plastic manufacturing also poses significant environmental challenges such as plastic waste and pollution.

To address these challenges, the industry is working on a new technology working to develop more sustainable and eco-friendly manufacturing practices such as recycling and up-cycling and the use of biodegradable plastics. Different types of plastics, plastic manufacturing. There are four main types of plastics used in manufacturing, each with its own unique properties and manufacturing processes. These types of plastics are the first of its kind is thermoplastics. Thermoplastics are type of plastic that can be melted and remolded repeatedly without undergoing significant chemical changes.

Examples of thermoplastics include polyethylene, polypropylene, polystyrene and polyvinyl chloride. The manufacturing process for thermoplastics involves melting the plastic material and injecting it into a mold which is then cooled to solidify the product. The second types of plastics are thermoset plastics. Thermoset plastics are type of plastic that undergoes a chemical change when heated and cannot be remelted or remolded. Examples of thermosetting plastics include epoxy, phenolic and melamine.

Further, the manufacturing process for thermoset plastics involves heating the plastic material in a mold until it undergoes a chemical reaction and hardens. The third of its kind is biodegradable plastics. Biodegradable plastics are a type of plastic that can be broken down by natural processes over time. Examples of biodegradable plastics include polylactic acid and polyhydroxyalkanodes. The manufacturing process for biodegradable plastics is similar to that of traditional plastics, but the materials used are biodegradable biodegradable and compostable.

The last one is elastomers. Elastomers are a type of plastic that can stretch and return to their original shape. Examples of elastomers include rubber, silicon and polyurethane.

The manufacturing process for elastomers involves mixing the plastic material with a curing agent and then heating and molding the mixture into the desired shape. Now, the manufacturing processes, the blow molding. Blow molding is a type of plastic and molding is a process to produce hollow objects.

It was practiced with glass from ancient times and the basic techniques used by the plastics. The basic techniques used by the plastics industry have been derived from those developed by the glass industry. Currently, a wide range of blow molded bottles and containers are produced for use in food packaging. In blow molding, molten tubes of thermoplastic known as a parison is surrounded by a cooled mold having the desired shape. The gas usually air, but occasionally nitrogen is introduced into the tube causing the molten mass to expand against the walls of the mold where it solidifies on cooling.

The mold is then opened and the bottle or jar ejected. Generally, the process for manufacturing plastic bottles and jars consists of two types of three stages. Melting the resin, forming the parison and blowing the parison to produce the final shape. The blow step may take from a few seconds to more than a minute. For large shapes, the rate limiting step is the cooling of the molded shapes.

There are five techniques of plasticizing resin that is making the material flow and forming the parison. The extrusion blow molding, stretch blow molding, injection blow molding, form fill seal bottle blowing, blowing of wide mouth containers. Thank you very much. This is all for today and the next lecture we will go into details of these processes.