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. In the last lecture, we were discussing about the blow molding technique for the manufacturing of plastic containers and in this lecture, we will go into details of individual molding methods. The first of its kind is extrusion blow molding. The extrusion blow molding uses many arrangements for making and forming the parison. In the simplest method, the mold is mounted under an annular die and the parison extruded between the open halves of the mold.

When the parison reaches the proper length, the extruder is strobed. The mold is closed around the parison and the bottom of the parison is pinched together in by the mold. A blow pin mounted inside the die head allows the air to enter and blow the parison, which expands to fill the mold. The shape of the bottle or jar is defined, but the distribution of material and thus the wall thickness is less well controlled.

The cycle results after the part has cooled and the mold opened as shown in the figure. This is the extrusion and the molten plastic is flown over the dry to form a parison. Parison when it takes the desired length, then the mold is closed and the through the blow pin air is passed. Air causes the parison to expand and touches the walls of the cooled mold, where it get hardened and after it gets hardened, the mold is opened and the bottle is ejected. The since the extrusion of the parison is a continuous process, numerous systems have been developed to use the full capacity of the extruder.

One uses more than one mold moving the filled mold away to cool, while another is moved into parison to receive the next section of extruded tube. The molds can be reciprocating once or can be mounted on a rotary table. In some cases, multiple layers of plastic may be extruded simultaneously using a co extrusion process. This allows for the creation of products with different properties or colors. In several food packaging applications, for example, pasteurized milk, the bottles are blow molded and filled online in a continuous operation.

Exclusion blow molding is widely used with the following resins that is HDPE, PPE, PVC and AN copolymers. The most common blow molding resin is HDPE used to produce containers ranging in size from 30 ml to 200 ml. Sorry,HDPE used to produce

containers ranging from 30 ml in size from 30 ml to 200 liters. The common grades of PET cannot be extrusion blown. There are certain advantages of this method that it is of its versatility.

Extrusion can be used to produce a wide range of plastic products with a consistent cross section. The efficiency, the process can be automated making it highly efficient for producing large quantities of identical parts. Strength and durability, extruded products are generally strong, durable and resistant to impact and environmental factors. Cost effectiveness, the extrusion can be a cost effective manufacturing process especially for high volume production runs, but at the same time there are certain disadvantages which include that it limited design capabilities. Extrusion is best suited for producing products with a constant cross section limiting the ability to create complex geometries or shapes with varying wall thicknesses.

High set of costs, designing and creating extrusion dies can be a costly process resulting in higher set of costs compared to other manufacturing processes. Limited material selection, extrusion is best suited for producing products from certain types of plastic materials limiting the choice of materials that can be used. Poor surface finish, extruded products may have a rough or uneven surface finish which may require additional finishing processes. The next process is stretch blow molding. Stretch blow molding is a process where bottles with appreciable orientation with both longitudinal and transfer directions are produced.

The extrusion, it is sometimes known as biaxial orientation blow molding. Orientation in the transverse direction only is produced in normal extrusion blow molding while appreciable transverse and some longitudinal orientation are placed are produced in individual blow molding. Injection blow molding, true biaxial orientation produces bottles with improved properties including increased tensile and impact strength, improved surface gloss, reduced creep, improved gas and water vapor barrier properties, and a reduction in haze in transparent bottles. As a result lighter weight lower cost bottles can be produced. This figure shows the stretch blow molding method in which the parison is stretched in both direction that is the horizontal direction and transverse direction and which produces the bottles of improved qualities that reduces the haze, the crease and improved water vapor barrier properties and the bottles produced in such fashion are more transparent.

To produce a biaxial molded bottle a preform parison produced either by injection molding or extrusion of a continuous tube or parison which is then cut to the required length and closed at one end. This is stretched longitudinally under heat and blown into a bottle with consequent transverse orientation. A metal stretch rod enters the bottle to

assist in the stretching process. The process of SVM is particularly important in the field of carbonated beverage packing using PET. The best results the resin molecules must be conditioned, stretched and oriented at just above the glass transition temperature where the resin can be moved without the risk of crystallization.

Although PET is the major stretch blown resin PVC, PP and acrylonitrile coal polymer resins are also stretch blow molded. The advantages of this method is that it is very versatile. This molding can be used to produce a wide range of shapes and sizes of hollow plastic parts. The efficiency the process can be automated making it highly efficient for producing large quantities of identical parts. Strength and durability molded parts are generally strong, durable and resistant to impact and environmental factors.

Cost effectiveness It can be a cost effective manufacturing process especially for high volume production runs, but at the same time there are certain disadvantages associated with this method or limited material selection. It is best suited for producing parts from certain types of plastic materials limiting the choice of materials that can be used. Limited part design the process may not be suitable for producing parts with complex geometries or thick walls. Long lead times designing and creating molds for blow molding can be a time consuming process resulting in longer lead times for product development and production.

Additional post processing molded products may require additional post processing such as trimming and finishing which can add to the overall cost of production. The another blowing method is injection blow molding. The injection blow molding is a non continuous cyclic process shown in figure the most closely resembles the blowing of glass bottles. The parison is formed in one mold and then while still molten is transferred to a second mold where blowing with compressed air is forms the final shape. The after cooling the mold is opened and the bottle ejected several modes must be available if the injection molding machine is to operate near full efficiency.

The major advantage of injection blow molding over extrusion blow molding is that the process is virtually scrap free the finish parts usually requiring no further trimming, reaming or other finishing steps. What happens in the injection blow molding the parison is formed around a blowing pin and this black part is the parison which is after making the parison it is transferred to a another mold where and the mold is closed and then the air is passed to blow the parison to take the shape of the mold and where it get cooled and then it is mold is opened and the bottle is ejected. In addition the dimensions of the bottle including the neck finish show very little variation from bottle to bottle and with some materials improved strength and clarity are obtained due to the effect of a limited degree of biaxial orientation. The resins most commonly used for injection blow molding

are high density polyethylene, polypropylene, polystyrene, polyvinyl alcohol and polyethylene terephthalate. The polyethylene terephthalate has replaced polyvinyl chloride in many countries especially in Europe where PVC has a poor image among many consumers.

Co injection blow molding has been developed using 2 or 3 injection units working with 1 mold to produce a perform that is later blow form using compressed air inside the mold to make a bottle or jar. The various components materials are metered into cavities in such an order that the barrier material flows through the main structural material to create a multilayer structure. This process is used to produce 5 layer retortable containers from 3 materials typically Polypropylene as a structural layer and ethyl vinyl alcohol copolymer as a barrier layer with tie layers in between. The advantages associated with this are the high precision and consistency.

Injection molding can produce highly precise and consistent parts of the process with minimal variation between individual parts. Efficiency the process can be automated making it highly efficient for producing large quantities of identical parts. Versatility injection molding can be used to produce a wide range of shapes and geometries from a small intricate parts to larger where more complex parts. Cost effective injection molding can be a cast effective manufacturing process especially for high volume production runs. There are certain disadvantages also which include the high initial cost.

The initial cost of tooling and equipment for injection molding can be high making it less feasible for a small scale production runs. Limited material selection injection molding is best suited for producing parts from thermoplastics and thermoset plastics limiting the choice of materials that can be used. Long lead times designing and creating modes for injection molding can be a time consuming process. Resulting in longer lead times for product development and production. Limited part size injection molding may not be suitable for producing large bulky parts due to limitations in mold size and machine capacity.

Now, the fourth one is the firm filled shield blowing methods. It is an automated computer operated technology to produce sterile products like intravenous infusions bottle. In this process all steps are performed sequentially, consistently and automatically in a closed sterile chamber of machines such as form that is formation of container fill, filling of container with content and seal, sealing of container. The reason behind FFS technology is to reduce the contamination by forming the container, filling the content and sealing in a closed sterile chamber of a machine. There is no personal intervention to reduce the chances of contamination during the manufacturing of sterile products.

Again it gives more production in very low operational cost with high assurance of sterility. It involves three sections. The first section is formation of container. In this process polypropylene granules are heated at 200 plus minus 30 degree Celsius to form parison a tube like structure. The parison reaches the mold forming the container.

The parison reaches the mold forming container by the pressure 350 bar of a sterile compressed air and temperature 170 to 230 degree Celsius. Here two halves of the mold close around the parison to seal that base simultaneously the top of the parison is cut free by hot knife edges. The second part is filling of container with content. The bulk solution prepared under a septic condition is delivered to the machine through a bacteria retaining filter before entering the container. Fill nozzle fills the liquid into container with the metered volume of solution, displacing the sterile air.

The pipe filter housing and machine parts that are coming in contact with the product are steam sterilized. Again system uses nylon filter media to remove colloidal silica, pyrogens, micro plasma, viruses and other contaminants. The next part is sealing of container. The after filling the container the filling unit is raised above the containers are sealed automatically then the mold is opened. This picture denotes the step by step processes of the filling to sealing.

The first the extruding the polymer parison is extruded from resin pallets and positioned inside the open mold then blowing. The mold closes and the welds the base. Sterile air is blown into the parison to create the polymer desired shape. Now, filling the exact amount of filling as measured by the dosing system is fed into the container via the mandrel.

And next comes sealing once the material is removed once the mandrel is removed the head mold comes together to form the desired closure type and then demolding. Opening the mold releases the container from the system and the next cycle begins. Advantages of form filled sealing machines entire operation takes place in aseptic chamber it reduces personnel contamination a very low manual labor is required for the operation. It gives high production efficiency means about 40000 I V bottles are prepared per day. It is cost effective technology for producing I V fluid bottles single machine operates all processes such as formation of container filling and sealing. Thank you very much.