Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Week – 03
Lecture – 11

Dear friends, welcome to NPTEL online certification Course on Modern Food Packaging Technologies, Regulatory Aspects and Global Trends. In the last days we have been discussing about the paper and cardboard materials. In that we have discussed how to make the papers and cardboards and the testing procedures for the paper and cardboard materials. Now the another types of packaging material that is most commonly used in the food packaging is glass. So, these are the topic which we will be deliberating in this lecture that is the introduction about the glasses, how evolution of glasses take place and composition and sources of glass, types of glass, properties of glass, physical properties, mechanical properties, thermal properties, optical properties and then how the glass forming takes place and in that various processes we will be discussing about blow and blow process, wide mouth press and blow process for narrow neck press and blow process.

And an annealing, cutting and finishing, glass container design, cleaning operations and environmental profile. About the definition the American Society for Testing Materials defined glass as an amorphous inorganic product of fusion that has been cooled to a rigid condition without crystallizing. Although glass is often regarded as a synthetic material it was formed naturally from common elements in the earth crust long before the world was inhabited. Natural materials such as obsidian that is from magma or molten igneous rock and the tectites that is from the meteors have compositions and properties similar to those of synthetic glass.

Pumice is a naturally occurring form glass. This picture depicts the history of glasses and from here we can see that the glasses have evolved long back that is about 3500 before the Christian era and at various stages it has come to the present days. About 3000 before Christian era the first glass vessels were probably sculpted from solid blocks about 1000 before BC before Christian era the techniques of pouring molten glass or winding glass threads over a sand mold were developed resulting in the formation of crude, but unuseful glass objects. About 200 BC the blowing iron a tube which red hot highly malleable glass adheres was introduced. Blowing through one end of the iron causes the viscous liquid to balloon at the other end leading the production of blow glass objects.

In 18th and 19th century the piece of bottles and jars to a relatively affordable level. In 1920 the Hartford Empire Company developed blow and blow process and developed a machine also. Further developments have occurred resulting in the production of a wide range of glass containers for packing. The two main types of glass container used in food packaging or bottles which have narrow necks and jars which have wide openings. About 75 percent of all glass food containers are bottles and approximately 85 percent of glass container is clear.

The remainder being mainly amber. Currently today's glass containers are lighter, but stronger than their predecessors with the weight of many bottles and jars having been reduced by 25 to 50 percent over the last 50 years. Though developments such as this the glass containers has remained competitive and continues to play a significant, but declining role in the packaging of foods. Now the compositions and structure of glass. The basic raw materials for glass making come from mines or quarries and must be smelted or chemically reduced to their oxides at temperatures exceeding 1500 degree Celsius.

Principal ingredient is silica derived from sand, flint or quartz. Silica can be melted at very high temperature about 1723 degree Celsius to form fused silica glass. Is used for a specialized applications including some laboratory glass because it has a very high melting point. For most glass silica is combined with other raw materials in various proportions. Alkali fluxes commonly sodium and potassium carbonates lower the fusion temperature and viscosity of silica.

Calcium and magnesium carbonates that is limestone and dolomite act as stabilizers preventing the glass from dissolving in water. Other ingredients are added to give glass certain physical properties. For example, lead gives clarity and brilliance although at the expense of softness of the glass. Alumina increases hardness and durability the addition of about 6 percent boron to form a borosilicate glass reduces the leaching of sodium which is loosely combined with the silicon from glass. As a consequence of the sodium in glass being loosely combined in the silica matrix the glass surface is subject to three forms of corrosion that is etching, leaching and withering.

Etching is characterized by alkali attack which slowly destroys the silica network releasing other glass components. Leaching is characterized by acid attack in which hydrogen ions exchange for alkali or other positively charged mobile ions. The remaining glass principle is silica usually retains its normal integrity although not fully understood withering is not a problem in commercial glass packaging applications since it may take centuries to become apparent. However, a mild form of withering is commonly known as surface bloom and may occur under extended storage conditions. The most aggressive solution on glass is double distilled water at neutral pH 7.

The effect of dilute acidic solutions is much less the main action being the extraction of sodium ions which are replaced by hydrogen ions. The result is a surface zone where the glass is depleted of sodium this dealkalized layer forming a barrier to further ionic diffusion. It is worth remembering that the aqueous phase of almost all foods is acidic. In practice however, the quantities varies slightly for example, silica varies from 68 to 73 percent, calcia that is calcium oxide varies from 10 to 13 percent, soda that is sodium oxide varies from 12 to 15 percent, alumina varies from 1.5 to 2 percent and iron oxide varies from 0.05 to 0.25 percent depending upon the glass maker and the raw materials being used. Soda lime glass accounts for nearly 90 percent of all glass produced and is used for the manufacture of containers where exceptional chemical durability and heat resistance are not required. Replacement of alkali by boric oxide leads to the production of borosilicate glass which is used for glass ovenware. This table shows the different composition of different oxides. Now, let us discuss the compositions the glass is neither a solid nor a liquid, but exists in a vitreous or glassy state in which molecular units have a disordered arrangement, but sufficient cohesion to produce mechanical rigidity.

Although glass has many of the properties of a solid, it is really a highly viscous liquid. During cooling glass undergoes a reversible change in viscosity, the final viscosity being so high as to make the glass rigid for all practical purposes. Physically glass has a random atomic structure in that atoms are capable of arranging themselves in different orders. The basic structure unit is the silicon oxygen tetrahedron in which the silicon atom is tetrahedrically coordinated to 4 surrounding oxygen atoms. However, although the silica atoms are always surrounded by 4 oxygen atoms, huge groupings tend to be unordered.

This amorphous structure without slip planes formed by crystal boundaries that might allow deformation is responsible for the stiffness and brittleness of the glass. Now, let us discuss the different types of glasses. The first of this kind is white flint glass that is the clear glass. The colorless glass known as white flint is derived from soda lime and silica. This composition also forms the basis for all other glass colors.

The typical composition would be silica which is of about 72 percent from high purity sand. Lime that is calcium oxide of 12 percent from soda lime that is calcium carbonate and the soda which is sodium oxide that constitute about 12 percent from soda ash and alumina present in some of the other raw materials or in feldspar type aluminous material. Magnesia and potash ingredients not normally added, but present in other materials. Pale green or half white. Here slightly less pure materials are used, the iron content rises and a pale green glass is produced.

Chromium oxide can also be added to produce a slightly denser green color. Dark green this is also obtained by addition of chromium oxide and iron oxide. Amber that is brown in various color densities. Amber is usually obtained by melting a composition containing iron oxide under strongly reduced conditions.

Carbon is also added. Amber glass has UV protection properties and could well be suited for use with light sensitive products. Now, the blue color. Blue glass is usually obtained by addition of cobalt to a low iron glass. Almost any color glass can be produced either by furnace operation or by glass coloring in the conditioning forehearth. The later operation is an expensive way of producing glass and commands a premium product price.

Forehearth colors would generally be outside the target price of most carbonated soft drinks. Now, the properties of glass that is most important properties of glass are transparency, a recycle property, strength, U value that is the rate of heat transfer and transmittance. The physical properties of glass. The glass is a type of solid material. Glass is a solid substance and is solid object the molecule bonds are tighter compared to the liquid materials.

There is a less movement among them in this case. It only means that glass is a type of solid material that will not change its shape unless it being heated to a certain high temperature. Now, durable glass is durable due to strong bonds between the molecules in it. Its strength and its durability mainly depend on its thickness. The thinner the sheets of the glass the easier is to break them.

It is also hard to scratch it since it requires a sharp object in order to do this. It can hold a liquid without breaking. Aesthetic the glass does not react with other materials and will not be reactive to other materials and will not be decomposed by most acids. With this type of property it makes glass appropriate for laboratories use and for storage of acidic food and beverages. Hydrofluoric acid and concentrated acid are the only acids that glass will react with.

It absorbs heat glass absorbs and transmits heat which means that it if you heat a glass then the temperature of the content inside it will react. The heat applied will make the molecules in the glass to vibrate faster that pass through one molecule to another. The energy and friction being applied to the glass will cause the glass of bottles to heat up and this energy is being passed on to the contents of the glass bottle. Thank you very much.