Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Week – 05
Lecture – 25

Welcome to the NPTEL online certification course on Modular Food Packaging Technologies Regulatory Aspects and Global Trends. In the last lectures we have seen the plastics as a packaging material. Now, in this lecture we will be seeing metals as a packaging material. The metal packaging plays an important role in the process of food preservation. The common expression used to describe such a process is canning. Can food has become an important part of the human diet in developed countries during the past century.

It is of particular value in those parts of the world where no or limited refrigeration exists for storing food. It is a means of safely preserving food stuffs without microbiological deterioration. Metal packaging has a double function as a protection against any external influence on the food stuffs during heat treatment and storage and as a sales and information pack. The metal packaging market has grown from 2020 to 2030 as the metal packaging market is expected to reach in 2030 to 147.4 billion dollars and at the growing rate of cumulative annual growth rate of 3.1 percent. The global metal packaging market analysis shows that it is growing at a cumulative annual growth rate of 3.8 percent out of which the US market projected US market in 2032 worth rupees 170.5 billion whereas, the dominating region is the North America and fastest growing region is Asia Pacific.

The total world market for metal containers is estimated at 410 billion units per annum. Of this drink cans account for 320 billion and processed food cans account for 75 billion. The remainder are aerosol and general line cans. Drink cans may be divided into those for non carbonated drinks for example, liquid coffee, tea, sport drinks etc and carbonated beverages for example, soft drinks and beer many of which pass through a pasteurization process. Four metals are commonly used for the packaging of foods for example, steel, aluminum, tin and chromium.

Tin and steel and chromium and steel are used as composite materials in the form of tin plate and electrolytically chromium coated steel or ECS. The latter being referred to as tin free steel or TFS. Steel is used primarily to make rigid cans whereas, aluminum is used to make cans as well as thin aluminum foils and coatings. Nearly all steel used for cans was coated with a thin layer of tin to inhibit corrosion and called as tin can. The

reason for using tin was to protect the metal can from corrosion by the food.

Tin is not completely resistant to corrosion, but its rate of reaction with many food materials is considerably slow and then that of steel is evolution of metals as a packaging material. In 1699 the first commercial manufacture of tin plate was in England whereas, in 1720 it was in France. During 1772 to 1777 Dutch government supplied its navy with roast beef covered with hot fat and the lid. In 1797 Dutch had also established a small industry to preserve a salmon in a can whereas, in 1804 French confectioner Nicholas Appart discovered a method of conserving all kinds of food substances in containers. In 1812 first patent was given to Brian Donk of London.

He established the world's first commercial canning factory. In 1820s canned foods were recognized article of commerce in Britain and France. In 1825 first patent of for America by Daggett and Kensett for developing vessels of tin. During 1896-97 Max Amps of New York making it possible to develop high speed equipment for the making, filling and closing of these cans. The container performance requirements metal packages for food products must perform following basic functions if the contents are to be delivered to the ultimate consumer in a safe and wholesome manner.

It should preserve and protect the product, it should resist chemical actions of product, it should withstand the handling and processing conditions, it should also withstand the external environment conditions, it should have the correct dimensions and the ability to be practically interchangeable, it should have the required self display properties at the point of sale and it should give easy opening and simple safe product removal and be constructed from recyclable raw materials. In addition these functions must continue to be performed satisfactorily until well after the end of the stated shelf life period. Most filled food and drink containers for ambient shelf storage are subjected to some form of heat process to prolong the shelf life of the product. For food cans this will normally provide a shelf life of up to 2 to 3 years or more. Heat process cycles used to achieve this are particularly severe and the containers must be specifically designed to withstand these conditions of temperature and pressure cycles in a steam or water atmosphere.

Following heat processing when the can temperature has returned to ambient there will normally be negative pressure in the can that is a vacuum. Under these conditions the food product itself does not provide any strength to the can to resist external loads. Steel and aluminum are used for metal container and closure construction for food and drink products. Both are relatively low cost materials that are non-toxic having adequate strength and are capable of being work hardened. The first is steel, steel is used in the form of a low carbon steel which is initially produced as a black plate.

This is then converted into tin plate or tin free steel for container and closure manufacture. Tin plate is created by electrolytically coating black plate with a thin layer of tin. The tin is coated on both sides of the plate in thickness to suit the internally packed product and the external environment. Different thicknesses of tin may be applied to each side of the plate. Tin plated in sufficient thickness provides good corrosion resisting properties to steel and is suitable for direct contact with many products including specific food stuffs such as white fruits for example, peaches, apricots, pineapple and pears and certain tomato products for example, tomatoes in brine and beans in tomato sauce.

However, for most foods and drinks it is necessary to apply an organic coating to the inside surface of the tin plate container to provide an inert barrier between the metal and the product packed. This barrier acts to prevent chemical action between the product and container and to prevent taint or staining of the product by direct contact with the metal. The tin surface assists in providing good electrical current flow during welding processes. Being a very soft metal it is also act as a solid lubricant during the wall ironing process of forming two piece thin wall cans. TFS also referred to as electrolytic chromium or chrome oxide coated steel or ECCS is created by electrolytically coating black plate with a thin layer of chromium or chromium oxide.

This must then be coated with an organic material to provide a complete corrosion resistant surface. The metallic layer of ECCS provides an excellent key for adhesion of liquid coatings or laminates to the surface and usually marginally less expensive than tin plate. However, being a matte surface after coating with clear lacquer it does not provide a reflective surface like tin plate. ECCS in its standard form is not suitable for welding without prior removal of the chrome or chrome oxide layer. The Japanese steel makers have developed modified tin free metallic coatings for steel that do permits satisfactory welding of this material.

The second metal is aluminum. Aluminum for light metal packaging is used in a relatively pure form with manganese and magnesium added to improve the strength properties. This material cannot be welded by can making systems and can only be used for seamless or two piece containers. The internal surfaces of aluminum containers are always coated with an organic lacquer before the products are filled in. The term tin plate refers to low carbon mild steel sheet varying in thickness from around 0.15 to 0.5 millimeter with the coating of tin between 2.8 and 17 gram per square meter or in terms of thickness 0.4 to 2.5 micrometer on each surface of the material. The combination of tin and steel produces a material that has got the properties of steel provides good strength combined with excellent fabrication qualities such as ductility the capability to undergo extensive deformation without fracture and drawability means these attributes

arise from the grade of steel selected and the processing conditions implied in its manufacture whereas, the tin provides good weldability, non toxicity, lubricity and lacquerability corrosion resistant surface of bright appearance.

Furthermore, the tin coating adheres sufficiently to the steel base so that it will withstand any degree of deformation that the steel is able to withstand without flaking. Some types of tin plate display excellent deep drawing behavior because of a high Lankford coefficient or the coefficient of anisotropy which is a measure of the plastic anisotropy of rolled sheet metal. It is used as an indicator of the formability of recrystallized low carbon steel sheets. It ensures near identical behavior irrespective of the orientation of the deformation in relation to the rolling direction and important consideration in draw and redrawn can manufacture. The uncoated steel sheet is referred to as black plate thus called because some of the early production was covered with black iron oxide.

It is the raw material for electrolytic tin plate and ECCS. The four main grades of steel product that is D, L, MR and N for subsequent use in tin plate production are shown in the following table and all are composed of carbon, manganese, phosphorus, sulphur, silica, copper and aluminium. The D type canes are the steel tin plate stabilized steel and therefore, non-aging less carbon than other tin steels and it is generally used for severe drying operations for example, draw and ironed cans. Whereas, the L type canes has high purity low residual elements and generally used where high internal corrosion resistance is required. And MR grade steels or tin plates are similar to L, but copper and phosphorus maxima are raised and is most widely used tin plate steel and it is used for vegetable and meat packs where internal corrosion resistance is not too critical.

Whereas, N type canes are nitrogenized steel with up to 0.02 percent nitrogen to increase the strength and is generally used where high strength and rigidity is required. For example, can ends and the carbonated beverages where internal pressure is more. That is all for today. Thank you.