Course Name: Canning Technology and Value Addition in Seafood
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Canning Technology and Value Addition Containers and their Properties - Part 2

Hello everybody. Welcome to the third session of Sea Food Canning Technology. Mainly, four metals are commonly used for the packaging of food. That we have already discussed like steel, aluminium, tin and chromium are the different kinds of four major materials that we use for food cans.

Tin and steel and chromium and steel are two combinations. The basic material we use for the steel cans are steel and there are two materials used for coating; one is tin and one is chromium. These are used as composite materials in the form of tin plate. If the tin is used, it is called tin plate or the chromium is used is called chromium plate or tin free steel. Different kinds of terminologies are there either tin plate or electrolytically chromium-coated steel (ECCS). Two different types of steel containers used; one is tin steel and another one is chromium steel. They are used as a composite material in the form of a tin plate or because the steel plate is coated with tin is called tin plate or if it is coated with chromium, it is called chromium plate or it can another name also is referred to as tin free steel. Either tin plating or chromium coating are there are two different methods that is generally used for coating.

Initially, hot dipping method was used but now it is electrolytic deposition is used mostly for coating the steel base with different kinds of metals such as tin or chromium. So that is the case of steel cans. Steel cans can be coated either with tin or chromium. And in the case of aluminium, in the form of purified alloys, mixture of aluminium and other minerals is used. It containing small and carefully controlled amounts of magnesium and manganese. In the case of aluminium sheet or aluminium metal, metallic sheet of aluminium is used for can making. Particular percentage of magnesium and manganese are added to regulate the physical properties of the container.

In the case of cans different terminologies are used. Either tin can or steel can, different kinds of terminologies. Steel can is a general terminology used for both tin coated steel as well as chromium coated steel. Otherwise, it can be called as a tin can or a TFS tin free steel can or a chromium can. The term tin plate refers to low carbon mild steel sheet. It is basically low carbon mild steel sheet varying in thickness. The thickness is around 0.15 to 0.5mm with a coating of tin between 2.8 1nd 17 GSM. So, the thickness is 0.4 to 2.5 micro meter on each surface of the material. That is, basically the material is 98% steel and 2% tin. That is the general composition of a basic tin plate. So, the steel used

basically is low carbon steel, the percentage of carbon is maintained at 0.13% and manganese 0.6%, phosphorus-0.15%, Sulphur 0.05%, silica 0.01% and copper 0.06%. This is an average composition of steel that is used for can making.

The tin plate or tin coated steel was developed in England in 1699 and also in France in 1720. The steel is basically an iron material but the difference is that in the case of carbon and manganese which gives particular properties to the particular iron. It increases the strength, increases the corrosion resistance. So, stainless steel means it is up to 10% carbon.

Stainless steel is another type of steel that is used for cookery purposes in the case of kitchen and other materials, other usage. The stainless steel is up to 10% of carbon. So, why low carbon, why stainless steel is not used in the case of can making is that stainless steel basically the 10% as the carbon percentage increases, the strength of the material, the rigidity of the material increases. So, it is not flexible. So, it is not suitable for can making.

Can making involves different kinds of flexible processes that the can has to be formed into cylinder shape, different kinds of shapes have to be formed from that metallic sheet. So, stainless steel is not an option for that. So, that is why low carbon steel is used. Why low carbon steel is used? It gives more flexibility of the metal sheet. And also, the quality, the grade, there are different grades in the case of it.

MR quality grade is basically one of the steel qualities that is used for can making purposes. Here, what happens is that the phosphorus percentage is kept at a minimum (around 0.02%). Because, as the process increases, the percentage of phosphorus increases, the corrosiveness increase. So, the percentage of the phosphorus has to be kept at a minimum of 0.02%. Why means it increases or reduces the corrosiveness and it also increases the strength. So, that is the ideal phosphorus percentage in the case of MR quality steel that we use. The terminology, the 'base plate or the basic material', metallic sheet that we use for the formation of cans are called as base plate. Base plate is basically a steel plate before tin application. The basic steel or low carbon steel sheet that we use for can making is called the base plate.

There are different types of steel produced for subsequent use in tin plate cans. Before coating the tin, the different qualities of steels are used. D type, L type, MR type and N type. Among this, the carbon is around 0.13% to 1.2%. MR quality is what that is used for the canning purposes. And in the case of MR quality, the carbon percentage is 0.13% and manganese is 0.6%, phosphorus is 0.02%, phosphorus is minimum. In the case of MR grade, sulphur and different kinds of silicon, copper, alumina, different kinds of materials are there. But the presence of manganese, magnesium and phosphorus, these

are the three mineral compositions that determines the different quality of the steel sheet. Preparation of the base plate is one of the important processes. There are basically two methods in which the base steel plate can be used. There is cold reduction method or cold rolled method or hot rolled method.

There are basically two types of sheets, steel sheets. One is cold rolled sheet and one is hot rolled sheet. Cold rolled is considered to be better than hot rolled because hot rolling was the technique that is used in the earlier period because it is basically rolling steel. The molten steel is rolled at high temperature. It is around 926 degrees Celsius.

High temperature is used to roll the sheet because one of the advantages of hot rolled sheet is basically it is cheaper and because of this low cost, it is used majorly. That kind of steel is used in the case of construction and welding industry. But the cold rolled sheets are further processed because cold rolling technique gives high finishing properties and it has also high mechanical strength. So, thinner plates with high mechanical strength can be produced using cold reduced or cold rolled steel sheet. And also, it has uniform thickness compared to hot rolled. These are the advantages of cold rolled sheets compared to hot rolled sheets. So, it has high mechanical strength with thinner plate. Uniform thickness is there. Resistance to corrosion, that is one of the important properties.

It takes uniform tin coating. After the coating of the tin is done, it takes uniform tin coating. Also, the appearance of the cold rolled sheet is much better than the hot rolled sheet. These are the different advantages of cold rolling. And also, after a particular quality MR called T sheet, steel sheet or base plate, low carbon base plate is prepared. MR quality, low carbon base plate is prepared by using cold rolling method.

So, after preparing the sheet or preparing the base plate, the next procedure is basically coating it either by tin or chromium. The tin coating, earlier hot dipping method was used. The sheets, the base plates or basic steel sheets will be dipped in molten tin. But tin eventually started to become expensive. So, the quantity, the amount of tin coating or the thickness of the tin coating was eventually reduced.

So, basically the most economical coating method, it is known as electroplating was developed after that. For basic coating, electroplating method is used. In the case of hot dipping, what happens is that base plate is basically plasted into the molten tin as we discussed before. And the molten tin will be at a constant temperature and then it is passed through a layer of palm oil to lubricate the process and then squeezed through tin coated steel rollers. So, this was the process followed in the case of hot dipping process.

In the case of electroplating, the base plate is first cleaned and it is lightly prickled in

different kinds of acids are used like sulfuric acid or hydrochloric acids. And it is passed through a series of electrolytic cells filled with dilute acid and alkali or Pure tin is used as the anode and the base plate is used as a cathode. So, in this case, what happens is a direct current is passed. So, intermediary what happens is that different kinds of tin deposition are formed from cathode to anode, there is an electrolytic movement of tin ion. So, the tin will get deposited at the anode. So, what happens is a kind of tin-iron alloy is formed, which is higher in porosity resistance, over the base plate. It is chemically passive treatment by dipping either chromium or a chromium oxide coating or other type of coating method. You can dip it in chromic acid or sodium chromate solution, washing, drying then thin coat of oil is applied and these are the different processes in the case of electroplating. So, electroplating is a much easier process. The advantage is that you will get a uniform layer of tin can be applied over the base plate.

In the case of tin plate layers, if you take a cross section of the normal tin plate that is used for preparation of can containers, it will have steel as the basic component. It will determine the strength and formability of the container. The tin-iron alloy is basically formed. The tin-iron alloy that is formed by electroplating, it is an interface of steel and free tin layer act as a band between two layers. The tin-iron alloy is formed between the tin layer and the iron layer and the steel layer.

So, there are basically three layers. The top most will be a normal coating of tin and the bottom under the tin layer, there will be a tin-iron alloy and under the tin-iron alloy, there will be the steel sheet. So, this will be the various the cross-sectional coating that will be happening in the case of a proper tin plate. And also, there will be a chromium oxide layer which is called as oxide passivation layer which prevents oxidation. So, the chromium is also applied.

And also, another layer of oil film. In the case of oil film, normally it is dioctyl sebacate (DOS) or acetyl tributyl citrate (ATC) is used as an oil coating and for easy handling and aberration resistance. For easy handling means, when this tin coated steel sheet is passed through different kinds of rollers and all, while the formation of the can, it should not wear off. So, in the case of aberration resistance this kind of oil film is additionally added as a lubricant. And there are different standard grades and masses or terminologies are used. In the case of tin plate sheets, the basic terminology is used as the base box or BB.

Base box means one base box is basically 112 sheets of 14 * 20-inch size. One pound of base box is basically one pound of tin on both sides. One pound of base box means one pound of tin on both sides. That means 0.5 pound on each side or it is around 11.2 GSR like you know the amount of tin coating. And also, in the case of electrolytically coated tin steel or the grading system uses CETA is called system intentional tin plate area. That is the grading system used in the case of electrolytically coated tin sheet. That means around 100 meters square.

1 SITA is around 4.9426 base box. So different kinds of units are used. GSM is most commonly used in the case of coating to express the coating of tin. And also, there are different kinds of coating. Even coatings and differential coating is there. Even coating means on the both the sides, for example, 11.2 GSM of tin will be coated on both the sides. And differential coating means either the outside will have more tin coating and inside will have a lesser tin coating. In the case of electrolytic chromium, that is, chromium coated steel or tin free steel cans, it is a different terminology. One is electrolytic chromium. It is also known as electrolytic chromium or chromium oxide coated low carbon steel sheet or it is known like ECCS or TFS. These are the two terminologies that we use for chromium coated steel.

In the case of chromium, the base steel will be having around 200 micrometer and we will have a chromium layer. Chromium coating will be there around 0.002 micro meter. And also, at the top of the chromium coating, we will have a chromium oxide layer which is 0.02 micrometer thickness. And finally, we will have a 0.004 micrometer thickness of oil that is used for lubrication and shiny appearance. Now, we can discuss the different kinds of advantages and disadvantages of ECCS over tin plate; normal tin plate compared to TFS or ECCS.

Basically, advantages are that the lacquer addition on this kind of ECCS is superior to tin plate and resistance to under film, that is below the lacquer film corrosion is excellent. So, that corrosion resistance is also good. Lacquer addition is better in the case of TFS cans. And also, TFS cans are resistant to sulphide blackening that is one of the spoilages that is happening in canning. And also, the workability of enameled TFS cans superior to the tin plate and lacquer addition strength remains even after deep drawing. Deep drawing means, the sheet can be drawn into different shapes without compromising the physical strength. And also, TFS can does not contain low melting tin. The tin is not there. Hence, lacquering can be done at high temperature for a shorter period of time because we are using tin cans the high temperature cannot be used. High temperature lacquering procedures cannot be used because it will compromise the tin coating. So, since in the case of TFS can there is no tin coating. High temperature lacquering is possible. And also, it is low cost compared to other plates for can manufacturing, because TFS cans are cheaper than tin plates.

But there are certain disadvantages also in the case of TFS can. So, in the case of TFS surface film does not act as a sacrificial layer and prone to corrosion from outside. For that purpose, an additional layer of plastic layer or polyester layer coating is given in the case of TFS can to this additional corrosion resistance. That is one of the disadvantages. Unlacquered TFS is less resistant to corrosion than tin plates that we already mentioned. The corrosion resistance is a little bit less in the case of TFS can.

So that an additional layer of plastic layer has to be given in the case of TFS cans. Cans cannot be made by side seam soldering because TFS cans are not good for soldered cans especially three-piece cans. Only two-piece cans can be successfully made from TFS steel. These are some of the advantages and disadvantages of TFS compared to traditional tin plates. In the case of aluminium cans, normal aluminium alloy is used and its composition limits like other kinds of additives are used.

So, different purpose of use, different aluminium alloys are there. Different kinds of silicon are used. Silica is used, iron, copper, manganese, magnesium, chromium, zinc and different kinds of such kind of materials are used in the case of aluminium. Why copper is one of the important additives or components in the case of aluminium cans because copper reduces the corrosion resistance of aluminium more than any other alloying element. In the case of aluminium alloy that is used for canning, copper should be minimum. The copper in the case of aluminium cans, the aluminium sheet, aluminium metal that we are going to use for preparation of canning containers.

So, copper should be kept at minimum because copper if it is present at higher concentration, it will reduce corrosion resistance. So, and also, elements reduce high rate of general corrosion. The corrosion is one of the problems created by the higher concentration of copper. And manganese will also slightly increase corrosion. Manganese is tentatively a particular material which slightly increases the corrosion resistance. Manganese needs to be put at a higher concentration in the case of canning can. And magnesium has a beneficial influence and aluminium-magnesium alloys have good corrosion resistance. Both manganese and magnesium give higher corrosion resistance to aluminium. In the case of zinc has only a small influence on corrosion resistance in most environments tending to reduce the resistance of alloys to acid media and increase the resistance to alkali. So basically, the zinc will provide a resistance to acid alkali. So alkaline resistance is given by zinc. So, each of this for example silicon basically slightly decreases corrosion resistance depending on its form and location in the alloy microstructure. So, silicon is there. Titanium increases corrosion resistance as we all know.

Then iron also reduces corrosion resistance. Titanium is there having little influence on corrosion resistance and aluminum also. These kinds of different minerals are there. So according to their property all these like silica, iron, copper, manganese, magnesium, chromium, zinc and titanium these are different kinds of mineral components that is normally found in the case of aluminum sheet aluminum metal sheet which is used for canning. According to their properties those who are those mineral components that will reduce the corrosion resistance has to be kept at minimum and which mineral components that actually increases the corrosion resistance has to be kept at a higher

concentration other than aluminium. That is the basic combination that we use in the case of aluminium containers.

Aluminium, is one of the most abundant metals as we know it contributes around 8.8 % of earth crust rich in aluminium and aluminium ore that we use is bauxite. Bauxites are basically a group of aluminium oxides (alumina) that we use and alumina that we have discussed aluminium with iron and silica impurities. So, aluminium alloy does not have many properties that is why we use an array of mineral components Because aluminium alloy does not have many properties for packaging. So, different kinds of alloying agents are needs to be added that we have discussed.

Analog aluminium, which is called 1050 used for foil and other kinds of containers. Aluminium foil is basically pure aluminium because it is highly fragile. Basically, manganese and magnesium are added for giving strength to the aluminium containers. There are different kinds of advantages for aluminium as a food can like any container material have at both advantage and disadvantage. The advantages of aluminium containers are aluminium does not impart any taste or flavor; it is completely bland.

It is completely neutral towards the food and hence suitable for delicately flavored products such as soft drinks and beer that is why in the case of beverage can beverage containers why aluminum is used. Aluminium does not impart any flavor to the food. That is one of the advantages of aluminium and so aluminium does not contain Sulphur so it does not have any sulphide staining or blackening. The iron is not there. So, iron will not react with the Sulphur containing amino acid. So, there is no Sulphur staining or sulphide blackening is going to happen. Aluminium is soft and workability is very good; highly flexible as we know. The power requirement during drawing and processing is less because of the flexibility of the aluminium and is also it is lightweight. There are certain disadvantages as well. It is poor resistance to acid and chloride containing products and hence highest integrity of lacquer or protective coating is required.

So, aluminium cans do not have any resistance to acid foods or chlorine. A higher coating of lacquer coating is required to protect the aluminium containers. Cost is very high; aluminium containers are very high in cost. So that is why only in the case of beverage cans aluminium is used not in the case of solid food cans because in the case of beverage cans the amount of metal required is very less. So, manufacturers can afford aluminium.

But in the case of solid food cans or seafood cans the amount of metal is more. So, it will eventually increase the cost of the product. So, cost is very high and also aluminium has weak mechanical properties and requires over pressure rate of heat processing. Aluminium containers, even though it is considered as a rigid material but it cannot

withstand the high pressure. So, what happens is that when it is heated it cannot withstand the internal expansion pressure. So, what happens is that while processing aluminum cans unlike either TFS cans or tin plate cans another additional over pressure need to be provided in the retort so that it will not bulge. That kind of physical strength is lacking in the case of aluminium. This is basically the advantage and disadvantage of aluminium containers.