

**Course Name: Canning Technology and Value Addition in Seafood**

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**Canning Technology and Value Addition Containers and their Properties - Part 4**

Hello everybody! Welcome to the third session of Seafood Canning Technology. After coating, the metal sheet is prepared and coated with internal or external protective or decorative lacquer. The next step is the can making process. In the case of cans, there are two basic classifications: three-piece cans and two-piece cans. Three-piece cans, when initially developed, have three basic parts. It has a body, a cylindrical can body, a top lid, and a bottom lid. These are the parts of a three-piece can. In the case of a two-piece can, the body is drawn using different kinds of dies. It has only a cylindrical body and a top lid. That's why there is a classification like two-piece cans and three-piece cans. Initially, there were only three-piece cans available. Later, when this drawing technology developed, we could make two-piece cans as well. So, based on the number of components, the metal can be divided into two: three-piece cans and two-piece cans.

Three-piece cans can be prepared in two ways: welded side seam or soldered side seam. These are the two methodologies available at that particular period to make these cans. Additionally, double seaming is required for both ends. So, both ends need the double seaming technique since it is a three-piece can. In a can body, there is a cylindrical can body made either by using a welded side seam or a soldered side seam. Finally, it has to be welded because it has top and bottom lids. Both the top and bottom lids have to be double seamed to the can body. In the case of two-piece cans, either the drawn and redrawn method or the drawn and wall iron method is used. Either the DRD or DWI method is used for making that container.

And finally, it is double seaming of the can lid. Only one double seaming is required for a two-piece can. These are the methodologies available for can making. In the case of three-piece cans, the cylindrical body is soldered or welded. Basically, it starts with a basic metal sheet which has to be converted into a cylinder can body. So, the basic metallic sheet is called a body blank. It is cut according to the size of the container. So, all corners are exact right angles. That is the peculiarity of this body blank. The body blank is converted into a cylinder using a flexing machine. The flexing machine is used to remove the irregularities and flatten it perfectly. The next step after flexing is the notching procedure. When locking the side seams, the side seam has to be locked together in the mid-region. When the two metals are overlapping, additional bulging may occur. In order to prevent that additional bulging in the side seam when overlapping two metal layers, this particular notching is done. Basically, there we will have only two layers of metal to reduce the thickness. That is why this notching is done.

Notching is cutting the container so a perfect interlocking can be made on the side seam. If notching is not done, the side seam will have three metal layers, increasing the

thickness of the can seam. To reduce that, notching is done. If notching is done perfectly, the side seam will have only two layers of metal, significantly reducing its thickness. After notching, edging is done. Edging forms a hook by the body edges, creating a perfect hook at both ends of the cylinder. These hooks overlap each other and are coated with a flux for soldering or welding. The cylinder is formed by locking the hooks and soldering or welding. After this, the locked hook is hammered, and a second coat of flux is applied and soldered in a solder mill or welded. Then, it is polished to remove excess solder because the soldering component is made with lead and tin. This soldering or welding can seep into the food, resulting in lead poisoning. That's why two-piece cans are preferred for food, as soldering and welding can spoil the food containers. Initially, the process required either soldering or welding.

Initially, that was the process, but in those cans, this kind of lead poisoning and risk was associated with it. After soldering, it needs to be polished to remove the excess mold, as we discussed earlier. Also, these cans were given circumferential beads for larger strength. To increase the strength of the container, circumferential beading was given surrounding the can. Lastly, there is flanging. The flanging machine is there. Flanging is done on both ends of the container in the case of a three-piece can. A particular neck, a can neck, is created so that the lids can be properly attached or properly double seamed into the can. That is the final process. After flanging, the soldering of the side seam has to be done because, as we mentioned, tin-lead solder is used. It is in a ratio of 2 to 98. But there is a risk of migration to food from those components. So, USFDA 1995 prohibited soldering on food cans, and on food cans, soldering is now again used. Also, there is a welded side seam because welding is basically the overlap hook is formed and requires less metal than soldering. Soldering needs more metal, but in the case of welding, less metal can be used. It is stronger, and its finish is also very good. Basically, for welding, a highly thermosetting metal has to be used. Normally, a copper wire welding where copper is basically an intermediate electrode is used. So, it has a higher temperature of 900 degrees Celsius. Copper is the metal that is going to fuse both the metal layers together. Either a welded side seam can be used or a soldered side seam can be used.

In the case of two-piece cans, there are two main methods used commercially. The first one is the drawn and iron method or DI process, which can be adapted to produce a can for pressure packs, including carbonated beverages, and for food containers. The DRD process, drawn and redrawn process, is a multi-stage operation and produces a can mainly suitable for food products. So, DRD is there. DI or DWI, drawn and wall ironed cans are there, or drawn and ironed is also known as drawn and wall ironed, either DI or DWI. Another one is DRD, drawn and redrawn process. So, drawn and redrawn processes are there. It forms in a five-stage process. A body blank is there initially, a drawing cup is there, to convert this into a drawn cup. Then also, the drawing process proceeds into the third and fourth stage. What happens is the diameter decreases as the cup is redrawn, but the thickness will not change. The finished trimmed can with a profile base can be after finishing. So, the fifth stage will be the finishing process, where the profiling will be given to the base so that it can be properly stacked and the proper pressure resistance will be achieved by the container. Both the drawn and redrawn technique and drawn and wall iron technique were developed for aluminum cans in the 1950s and for the tinplate cans in the 1970s.

The main advantage is that either the two-piece cans made using DRD or DWI method do not have a side or bottom seam, which provides more structural integrity because the weakest point in any container is where it joins. So, only one joint is there, which is the lint. It also has higher advantages compared to soldered or welded cans; it requires 35% less metal, making it lightweight. The weight is significantly reduced, which is one advantage, and the absence of a side seam provides a better printing area, enhancing the container's appearance compared to other three-piece cans. In the case of the DRD process, the thickness and surface area of the metal do not change; only the diameter changes, always equal to the body blank. Around 2 mm thickness sheets are used in DRD containers. The basic difference is that only the diameter changes, equal to the body blank, so the thickness and surface area of the metal do not change. In the case of the drawn and wall iron method or DWI method, it is basically an extension of DRD, so additional steps are added after drawing. In DWI, the diameter does not change; instead, the wall thickness decreases from 0.3 mm to 0.1 mm. The body height usually increases, and the bottom remains the same thickness. That's why it's called wall ironing; the wall thickness reduces from 0.3 mm to 0.1 mm, but the bottom thickness remains the same as the base plate. The diameter does not change, but the height of the container or wall thickness changes. In DRD, the thickness of the wall does not change; only the diameter changes, so there is a difference between drawn and redrawn and drawn and wall iron.

In the case of wall ironing, a synthetic lubricant is applied, which is later washed off. This ensures that the ironing process is smooth and flawless. For example, metals are pressed through rollers or certain dyes to reduce metal thickness. Metal friction can occur, potentially damaging the metal surface area. To prevent this, a synthetic resin or lubricant is added during wall ironing. Mostly, beverage cans are prepared using the drawn and wall ironing process or DWI process, while food cans typically use the DRD process. Another important component besides the body of the container is the lid, also known as the can end or can lid. In the case of the can end, you can observe different consecutive ring-like structures, known as expansion rings.

Expansion rings are added to counteract deformation of the container during heating and cooling. They deform according to internal and external pressure, allowing the container to withstand pressure. The sealing area of the container, the cover, is double seamed with the can body. A sealing rubber base is used, and a sealing compound is added. The compound composition includes around 20-25% rubber, 50-75% filler and pigment, 10-25% resin, and less than 1% each of plasticizer and antioxidants. This sealing compound is generally applied on the exterior of the lid so that during double seaming and heat application, the resin fills gaps between the double seam, forming a perfect seal around the container.

The success of the process depends on using certain quality metals, applying specific lacquer coatings, and following precise manufacturing methods to achieve the desired container shape. However, the key determinant of success is how the food is enclosed within the container and how it's hermetically sealed or filled in an airtight manner. The container must withstand expansion pressures during the process and avoid leakage. Any faulty sealing methodology can lead to post-process leakage and eventual spoilage.

To prevent this, proper seaming techniques must be used. Previously, soldering and welding were used, but they are no longer employed. The process used to connect the lid with the can body is called double seaming. Double seaming machines have various parts, including a chuck, which rotates, and a base plate or turntable where the container is placed. A rotating chuck holds the container and lid together, consisting two seaming heads, with a blunt first roller and a sharper second roller, perform the sealing process.

Initially, the blunt roller rolls up the layers of the can lid and body, and then detaches. Subsequently, the sharper second roller flattens the curved rolls to create a perfect seam.

First roller will curve the metal layers, and the second roller is going to flatten it up. So, that is why there are two steps in the seaming, that is why it is called a double seam. The first roller seaming, and there is also a second roller seam. In this, you can watch that like the double seaming happens in different stages. Basically, they can end and the body are brought together including the lining compound is there, and first it will rotate that and second seaming operation that it forms a curve nature, then there is going to be a first seaming operation, and going to be second or final seaming operation.

So, this kind of two seaming operations is going to happen, and a perfectly formed seal will have five layers of metal that is going to be three layers; lid metal and two layers of can body. That is why a perfect seam will have five layers of metal is going to be there. If you take a cross-section of a perfect double seam can, you can see different parameters such as seam thickness is there; seam gap has to be measured. The overlap is one of the most important parameters in the case of a double seam. If you measure the overlap; it should be more than 40%.

It should not be less than 40%. So, overlap is there and hook length is there, depth is called as a counter sink depth. So, these kinds of different parameters can be measured from the cross-section of a double seam. The lid of the container has gone through different kinds of modifications because the main issue with the lid once it is double seamed is that; it is impossible to open. So, we need to use special kinds of tools basically to open the lid. Earlier, it was like using a hammer or a chisel, we need to try the cans open.

Still, such kinds of can containers are there. Different kinds of tools and can openers are available, which will cut through the lid so that we can open the container. But it was basically to carry an article or a can opener; eventually, people find it difficult to carry an additional article to open the container. They were interested just to open that.

The opening process was very difficult. So, what happens is that the initial invention was made by Ermal Cleon Frazee (1962); he invented the pull tab. That was the first attempt made by Ermal Cleon Frazee in 1962. It was known as a pull tab. But the issue with the pull tab is that once you pull, the tab loosens and its metal end was separated from the lid. So, what happens is that this kind of pull tabs created a wastage problem because wherever the people go, once the container was opened, this tab was very difficult to dispose and it caused different kinds of hazards especially in the beaches and all these

tabs started to corrode, and people got damaged with different kinds of wounds by stepping on such tabs.

Such issues were created, and finally, a solution was proposed by Daniel F. Cudzick in 1975. He invented the stay-on tab, so still now we use a stay-on tab for opening the containers. The stay-on tab is like the basic physical civet methodology that uses if you pull the container in a particular direction and particular pressure is created in the opposite direction and due to that extra opposite to that pressure that it will basically break the surface of the previously grooved can lid. The advantage is that the stay-on tab will stay on the container and it was easier to dispose that way.

Now, we have easy-open ends; it is called easy-open ends or EOES cans. Initially, it has a pull tab and finally in 1975 the stay-on tab was invented. After sealing the cans, the next important component in the case of industrial aspects it is called the metal can dimensions. So, the dimensions of the container have to be standardized depending upon the type of food.

We need to put based on consumer preferences as well. So, metal can dimension like earlier it was only round cans were there and also belonging cans were there also known as F style cans so in the case of round cans they are shown as two sets of numbers. The round can dimensions were shown as two sets of numbers; the first set of number is the can's diameter, and the second set is its height. So that is the basic dimension that was used for round cans. In the case of belong cans, they are shown as three sets of numbers; the first set of numbers is the can's slang, the second will be the width, and the third set is the height. So, the expression of these groups of three-digit numbers are unique to metal cans in the case of the United States. This kind of dimension is used. This number is the dimensions in whole and sixteenth of an inch. So, now the industry standard is that use it as a whole number and a sixteenth of an inch of that number.

The first digit indicates the number of whole inches, and the second and third digits indicate the fractional inches as sixteenth of an inch. To demonstrate how this looks for example, a round can with the size listed as 307 x 512 would be 3 and seven by 7/16" in diameter and by 5 and 3/4" in height. So, in the case of can dimensions, we use this kind of methodologies. For example, if we can discuss that is the 303 x 406 containers are there.

So, what do you mean by 303x406 is that, 3 inches and three by sixteen that is 303, into four and six by sixteenth inches that is 406. This is the dimension methodology; dimension of the can containers is expressed in one whole inch number followed by a particular number that number divided by 16th ratio. It is expressed in such a manner and there are different kinds of popular seafood can size which is widely used throughout the industry. The most common type of can is that normal the standard size is called 307 can. Why it's called 307 can means it is the dimensions 307 x 109 and it is the capacity around 170 grams.

That is a standard can used throughout the world and also different kinds of other shaped cans are there. For example, one by four club cans are there. So, approximate dimension

of a club can is around 104 mm length x 59 mm width x 28 mm height. Different heights will be there. So, these kinds of club cans are basically used for sardine, mackerel etc.

It has a particular shape but also another common name Dingley can is there. So, approximate dimension of a dingley can is 105 mm length, 73 mm width and 24 mm height. It is also used for this kind of cans sprats, herrings, etc. depending upon the can size and also there are oval cans. An approximate dimension of 105 mm length, 64 mm width and 30 mm height and also used in different kinds of seafood preparation.

There is also another kind of can called hansa; this is a trade name. So, hansa has an approximate dimension of 148 mm length. It has 81 mm width and also 22 mm height and it is used for sprats, herring fillets, mackerel, etc. All these kinds of different cans like you know standard 307 can, it can be a standard club can, standard Dingley, standard oval or standard hansa. These are all trade names that is used.

These cans have different kinds of dimension, different shape and that according to the consumer preference, according to the seafood material that we are going to fill in the containers, according to the label design that we are going to use. Any industry can choose from different can dimensions. Other than can dimensions, there are certain improvements to the structure of the containers that has been made to improve the physical properties of the containers like high tin fillet cans are there, light in coated cans, grade-K tin plates are there, litewel-N (LTW-N) cans are there. So, different kinds of modifications, for eg: -, in the case of beaded cans, beading is done to reduce the cost. Metal has to be used but the strength has to be increased and beading in different kinds of higher size cans can be prepared with a lower amount of metal.

So that is why this like beaded cans are there. Side beadings are given in order to increase the physical strength of the container. Compared to other containers, less metal can be used. That is called beaded cans and also there are cemented side seam cans where polyamide adhesive is used for sealing. Instead of double seaming a particular polyamide adhesive is used.

In this case, it is normally used tin free steel cans (TFS). It has better printability because we are not using any sealing agent. So, there is no double seaming or metal overlapping or metal binding is used. Only a polyamide adhesive is used so that it has a better printability and better look to the container. There are also high tin fillet cans or (HTF) cans which is widely used in the canning of spinach and tomato, basically high acid foods. So, what happens is that high acid foods which have additives such as oxalates and nitrates they have a detinning effect detinning effect means the the tin coating is removed because of this component.

This is going to affect the product color, etc. So, an extra tin fillet is added. Extra tin fillet is provided which acts as a sacrificial anode. Detinning effect will be from the fillet other than the can. So, it is called a high tin fillet cans and there are also light tin coated steel (LTS) cans. Basically, a very thin layer of tin is used; one GSM tins are used. The lowest is around 5.6 gsm, is further protected with chromium coating and chromium oxide. Light weight tin is used. It is not tin free steel, but a small quantity of tin is still used.

That is why it is called light tin coated steel. It is still a TFS can with chromium coating is there with an additional small amount of tin but lesser than other normal tin cans. That is why it is called a light tin coated steel. Grade-K tin plate is the tin coating of 0.75 pounds that is 16.8 GSM of tin coating is used, instead of normal one pound, which is 22.4 GSM. Normal can, you will find a one-pound coating that is 22.4 gsm coating; in the case of Grade-K tin plate, we will have a 0.75-pound coating or 16.8 gsm coating and there is also litewel-N n or (LTW-N) containers are there. It's a less tin container which is having a nickel alloy layer between tin coating and steel which gives additional corrosion resistance, weldability and lacquer addition than tin plates.

So, it is an enhanced property than normal tin plate and also there is another kind of containers like aluminoid steel. It is basically steel only; which is hot dipped or coated with aluminium and aluminium and silicon base are used. Additional coating with aluminium silicon alloy is used for protect the steel. So, it is called aluminoid steel the advantage is that it will be having both the properties of steel as well as aluminium. The next important packing material is basically the flexible packing material which is called the retort pouch; either it is known as retort pouch or retortable pouch.

The retort pouch was invented by the United States Army Natick R&D Command, combination with Reynolds metals company and the Continental Flexible Packaging; who jointly received the Food Technology industrial achievement award for his invention in 1978. So, the retortable pouches or retort pouches are extensively used by the US military for field rations also known as meals or ready to eat or MREs. This pouch was developed by the US army, now mostly all the military are using this kind of retortable pouches for carrying their military ration. Even though it is initially used by the military and slowly now, we can see many consumer products are also using the same technology for ready to eat products using this flexible packaging called retort pouches. Because, it is flexible material, the heat transfer ratio is comparatively faster compared to the rigid metal containers, where it has to go through cycles of conduction convection processes. But conduction in the case of flexible pouches is faster because of the reduced thickness and the material. So, the processing time is reduced to 60% than metal cans. It has a better quality of the food. Rapid heating by consumer before eating; it can be easily heated by the consumer before eating and weight and space is also saving compared to metal containers. These are the major advantage of using a retort pouch.

In normal retort pouch, different layers are there; two ply, three ply, four ply layers are there. Normally, an inner polypropylene layer will be there, either a top nylon layer, an aluminium foil and external polyester layer. So, this is the normal layers of a standard retort pouch. In the case of two ply, there may be a 12-micron nylon or polypropylene and 70-micron polyolefin. In three ply, 12 micron polyethylene, 9 to 12 micron aluminium foil and 70 micron polyolefin and the face of four ply it is going to be 12 micron polyethylene and 9 to 12 micron aluminium foil then 12 micron polyethylene and around 70 microns polyolefin. This is dependent upon whether it's a two ply, three ply or four ply.

Different kinds of materials will be added but any cases the inner most material is going to be polypropylene because polypropylene is the food safe material food contact surface it's a neutral plastic so it is always the innermost layer with where the food contact

comes and then aluminium layer is used nylon sometimes used nylon without nylon also pouches are there nylon gives the mechanical properties and aluminium foil gives the barrier properties and also external polyester layer will give the abrasion resistance and printability, etc. So, these are the functions and there are also two types of retort pouches; transparent retort pouches are there and there are also opaque retort pouches. Opaque retort pouches will be usually made with aluminium foil inside. Then transparent can be produced by replacing the aluminium foil layer with a silicon dioxide or some like a transparent material which will have same barrier property as aluminium. In the case of opaque retort pouches, where aluminium is there, the consumer cannot directly put the pouches inside a microwave oven for heating but in the case of see-through pouches, since it is without aluminium foil instead of aluminium foil we use silicone dioxide and other kind of similar materials, it can be directly heated after opening, in a standard microwave.

If you see the advantages and disadvantages of retort pouches; first if you see the advantages, because of the thin cross-section profile, heat transfer is rapid there will be 30 to 40 percent saving in processing time. No overheating of the product takes place near the package walls because in the case of metal cans since it is a conduction because the metal walls will heat more than the inside container. So, the food which is in contact with the exterior of the can which is in contact with the can wall can subject to overheating or over cooking in the case of metal containers. So, that risk is not there in the case of retort pouches and because of the reduced exposure to heat, loss of color, flavor or nutrients is minimum and shelf life is equal to or better than that of foods in metal cans. The empty pouches require only very little storage space compared to empty cans and also pouches are easy to open as well.

There are also certain disadvantages to the retort pouches. The main disadvantages are the pouch seals are more vulnerable to damage than the metal containers and hence require individual over wrap. The packaging cost is going to be more in the case of retort pouches because they require an additional cardboard or paper covering for protection and with an over wrap the cost of the pouches may become higher than that of metal cans. It also has a slow rate of production in the place of handling. 300 to 400 cans can be produced per minute. The pouches line can handle only 30 pouches per minute. So, the rate of production is very less. It also needs special retorts for thermal processing because the pouches cannot withstand the internal expansion like metal can. They will need an additional over pressure of 5 psi so that total pressure needs to be applied is 20 psi when the metal cans need only 15 psi to operate. So, we need additional over pressure retorts for preparing retort pouches. In a retort pouch, a thermosetting adhesive is used to band the layers the different kinds of layers have to be bonded together, there is a thermosetting adhesive is used.

It is like polyethylene isocyanate is the normal thermosetting adhesive has used. The seal is made by thermal fusion of polypropylene layers. It is basically a thermal seal using a thermo sealing machine, the edges of the pouches are fused together when there is a thermosetting adhesive like polyethylene isocyanate is also added. Different terminologies are used for pouch bodies; basically, the area of the pouch located within the sealed area. The outer border of the retort pouch totally will be sealed and inner body

it's called the body's area within the sealed area and also side seals are there like or manufacturer seal it's called manufacturer seal or side seals so basically three numbers of side seals with the three mm width is normally there and top will be open to add the food and after food adding food only the main seal is applied there is also a cosmetic seal a seal applied by the processor called a buffer zone outer side the main seal or the hermetic seal is the cosmetic seal is also there there is a hermetic seal it is like a seal to prevent post-process spoilage or process seals also known as a processor seal and also tear notches are given on the sides for easy opening of the container there are different kinds of tear notches depending on the thickness of the material there is v-notches u-notches and c-notches are given according to the the type of the container and pouch sealing machine is used to usually a thermosealing machine is used and there are different dimensions there is around different types of a grade dimensions a sizes b sizes and c sizes are there so different kinds of length into breadth is the only dimension that matters in the case of the retort pouch. Naturally it is at 130 into 160 pouches are there, 130 into 200 like that or 150 or 170 different dimensions are there.

One of the most important packaging materials that is used along with the flexible retort pouch is called a tetra pack. Tetra pack was invented by Anders Ruben Rausing who lived in 1895 to 1983 and the co-inventor was Eric Wallenberg. So, these two were responsible for the development of tetra pack. So, tetra pack is basically a multinational company based in Sweden. It was found by these two gentlemen in 1944 before the company was known as Akerlund and rausing and after the invention of tetra pack, the package name was taken by the company as a company name.

It is the tetrahedron packaging that was initially developed. It is basically like four sides packaging; is aseptic packaging technology and is also known as ultra-high temperature short time processing. The process we will discuss in the later sessions but the technology is used mostly for preparing the liquid foods like fruit juices are there, milk products are there. Mostly such kind of liquid materials are used. It is also known as ultra-high temperature short time processing or aseptic packaging technology. Even though the initial container was tetrahedron with four sides, but eventually the tetra pack company evolved and they developed different kinds of packaging materials.

Now the most popular one is tetra brick aseptic packaging components or TBA. It is like different six layers of materials are there. Two layers of polyethylene is there. Then this aluminium layer is there and again polyethylene, then paper and finally polyethylene. These are the six layers of a tetra packing material. Next comes the semi-rigid container; thermoform trays. Thermoform trays are also known as semi-rigid containers and different kinds of plastics are used like high impact polypropylene or plastic is used which is having high barrier polypropylene is used. High impact polypropylene is having a high physical strength but for increasing barrier properties we can use high barrier polypropylene, different levels of polypropylene and also there is multi laminate traces are there like a polypropylene/ethylene vinyl alcohol (EVOH)/ polypropylene, polypropylene/EVOH/polyphenyl, polypropylene/EVOH/polyamide; like different kinds of materials can be used for preparing the thermoform trays. It could withstand temperature up to -40 degree to 125 degree Celsius. So, this is the extreme temperature

range -40 degree Celsius to plus 125 degrees Celsius that is the temperature range of this kind of thermoformed trays so thermoforming materials can withstand. Thank you.