

Food Packaging Technology
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Week – 08
Lecture – 39
Bottling machine – Part 1

Hello everyone. Welcome to another session in the module 5 of Food Packaging Technology course. Over the few weeks, we have been discussing on packaging equipment and machinery and this week we already discussed on retort pouches. We're going into another important topic which is bottling machines. This will be discussed in two videos and this will be the Part 1 of that. When you see bottles, bottles are usually the first thing that comes in our mind earlier used to be glass bottles.

Milk used to be in glass bottles and many of the drinks would be in glass bottles. Glass is one of the most non-reactive materials that you can think of. But it has got a very big disadvantage that it can easily be broken and the weight. That adds into the transportation cost.

And today you have replaced that glass with a variety of plastics. And this comes in different shapes and different stabilities. So, when you have a bottling machine or a bottling machine that has a line, this has to handle the different shapes and sizes of these plastic bottles and glass bottles. That is what exactly we're going to deal with in this session. What is a bottling line? A bottling line is actually a collection of automatic machines which are connected by a conveyor belt or sophisticated automatic units.

And the whole thing is integrated by synchronized drive arrangement. That is the bottles are usually, unpacked in one set and then it has to be filled with the material. Then it goes into the final sealing, goes into the corrugated box. The whole thing is going to be the bottling line. So, this can be either semi-automatic bottling line or it can be fully automatic.

When it's semi-automatic, it's a slower speed where you have automatic as well as manual handling of these bottles. And that is usually you have a speed of 30 to 60 units per minute. But if the speed is greater than 30 to 60, it is usually a fully automatic machine bottling line. Now, this picture here shows a typical bottling line that you have. This you can see is marked as A, B, C, D, E, F, G and H.

So, let's look at these points in a bottling line. First one, A is a depalletizer. You

recount that pallets are usually tertiary containers and they actually collate different secondary containers together. So, first thing you do is to take it out of the pallet. That is what is done in A section, depalletizer, taking it out of the pallets.

In B, you'll empty the crates. The crates will be empty. Then you wash the crates (C). And in D, you fill the crates with the material. Now, where this happens, simultaneously in section E, there is washing of bottles which is done.

Once the bottles are washed, they're taken into section F where the bottles are inspected for cracks and other things. This can either be done with machineries also which can detect small cracks. And then it goes into the section G which is just next to F for filling and closing the bottle. Once bottles are filled with the product closed, it's taken to pasteurization in section G. H will be your pasteurization and then I will be the bottling of the bottles.

You can see they're done step by step. This is stock of these pallets taken and finally at L, palletization where these bottles in the carton boxes are again palletized and taken out. This is a typical bottling line that you'll see in a production line. Before we go into other details, let's talk about a very simple concept which is the bottle shape and size and automatic bottling lines. Now, the best thing that you have a design for a container is one it should have sales appeal means the consumer should be tempted to buy it.

And if we see a design. A second important factor for container design is stability. See, you have stability both in the vertical and horizontal plane. I think it'll be more clear if you see this picture here. Here it's very clear that such a design of bottle makes it more stable.

While such a design with sharp ends at the sides will make it topple in the production line. So, it's important that you see that your packaging material has got good stability as well as sales appeal. So, when a container has to have good stability, the three basic things that you need to remember. One is relatively large base area, which is a concept of physics when your base area is large enough, it's more stable. You have a pointed portion at the bottom, it's more likely to topple.

The second one is low centre of gravity. So, when the product is not very high, the center of gravity will not be very high also. It'll be towards the ground. So, that makes it more stable. See, that it is not a very long and cylindrical one, where it can easily topple but short one, with strong base with a larger base.

And third one, it's important to see that they have parallel contact point and that is

exactly on each side, what you see in the picture here. When you have contacts point which is a good straight line, it is most suitable for automatic handling. But at the same time, you need to avoid such pointed points at the sides so that it don't spill together, they don't hit each other, and they will be otherwise very unstable. Another thing is here, if you look at this, if there are ovals which are too pointed at this end, this pointed ovals; it's very difficult for it to be stable while it is moving on the automatic bottle line. You see that you flatten these oval lines a little so that they stable contact with each other.

They are very simple but very important things that need to be remembered while you're allowing the bottles to move through a bottling line. The cross section also should be such that you avoid possibility of any jams. You see that these bottles don't, you know, when you go through the bottle lines, there are also these conveyor belts. It doesn't jam into the different conveyor belts or any part of the roll that is there. All these things are very important when you design a bottle.

So, there are different steps in a bottling process. They are simple when you think about it. First thing is bottle feeding. Bottle feeding is when you introduce the bottle into your conveyor belts. Once it's introduced into the conveyor belts, like that was in section A that we saw, depalletizing and then conveying it to the conveyor belts.

Then we go for bottle cleaning. After the bottle is cleaned, it goes for filling with the product, closing it or sealing it, labelling it and finally collating it, bringing it together for packaging and transportation. Let's look at this one by one. First one is bottle feeding. This picture here shows you an automatic glass bottle and scrambler machine.

So in specialized operators like dairies and breweries and even in soft drink machine manufacturers, what they have is they have something called a decrating machine. That is to remove the bottles from the crates. These bottles are removed from the crates into the conveyor belts. But, most of the other manufacturers generally use new glass wares or new plastic bottles. These are taken directly from the annealing section or manufacturing section.

Directly it can go into the conveyor belts and that will go to the conveyor belts, goes into the crates and shift to the manufacturer of the products. Now there again, it has to be removed from these crates and there you use something called a rotary unscrambling table, which is the simplest or a container feeder. So, this here is a scrambler line, which will actually remove your bottles and take it into the conveyor belts. So once the filled cases, you know, these cases which are filled, they will be inverted, the bottles will be pushed into the conveyor belts, then these crates are conveyed back again to another section where they are washed and reused again. So the first step is bottle feeding.

The second step is bottle cleaning. Now these bottles have to be cleaned. Sometimes they are reused, but most of the time they are new bottles. But whatever it is, it has to be cleaned.

There are two types of cleaning. One of it is water cleaner and the other is air cleaner. In the water cleaner itself, you can either have hydro cleaners which are using water jets. Second one is a soaker hydro where you completely immerse the bottles into the water bath and you'll even have a rotary blade of brushes which can remove any dirt from these bottles. And you use a rotary brush which is automatically done. The operating speeds are usually 20 to 600 bottles per minute.

In the air cleaner, as the name suggests, you're going to use your air under high pressure into these bottles. So, you invert the container and you insert the air nozzle into the bottle and this blast of air is given into it for 2 to 3 seconds. It's something different from a vacuum where you suck it, you actually push in the air and allow the dust and dirt to come out of it. So, minimum air pressure that you require is 60 psi for efficient cleaning. So, all the dust is actually blown out and that is taken into a trap and it's removed.

And some cleaners, they will also incorporate a vacuum system and compressed air. So, you've got a combination of vacuum and compressed air which can be used and the operating speed is usually 60 to 600 per minute. First part is the bottle feeding, where the bottles are de-crated into the conveyor belt. Second part is the cleaning. You can either use water or you can use air for the cleaning.

This is a bottle cleaner that is usually used where you have these nozzles where the bottle is inserted in the nozzle. You can either have air pushed in or water jets. Third step, very easy, filling. Now this filling, you can either have fillers for liquids or for solids. Your product can either be a solid or a liquid.

If it's a liquid, there are four main methods of filling it. Either vacuum filling, gravity filling, measured dosing filling or pressure filling. Now, most of these are stand alone or sometimes they use a combination of these for filling. Now, this diagram here clearly shows you a classification of the different liquid fillers that are there. The two types, like I said, you can either fill it to a given level.

You're predetermined. You want to say it's a one-liter bottle. You want to fill it up to one liter or a volume of say 500 ml. The other one, there is something called a measured dosing where displaced volume, they just replace the air with the product. Now, when you're doing the first one, filling in at a predetermined, there are four types, vacuum,

gravity, pressure, level sensing. Vacuum itself, you've got three different classification and gravity, two different classification which we'll see in detail now.

We'll first go in for vacuum filling. As the name suggests, this is the most cleanest and most economical way of filling liquids into your bottles. What happens is this will avoid defective bottles with cracks. Why? Because if you have a crack, a vacuum is never created. It comes into the nozzle and it is sealed and if you have a crack anywhere, you'll never be able to create a vacuum.

The bottle will just move out. This is one of the methods in which you can avoid many defective bottles in this with any cracks or chips. There'll be no drips, there's little loss of product and it's unnecessary to wipe the product. So, everything is going right into the bottle itself. Now, in the vacuum itself, there are three different types of vacuum fillers; rotary, tray and auto-fill. In the rotary machine, every bottle is handled individually.

There is a centre filling system that is where you raise the bottle into the filling system. It is then filled, it travels around the machine independently. This is a picture of a rotary filling machine under vacuum. Now, there's a tray type machine. Here, the bottles are placed in trays and they are rolled in the conveyors and then each of these nozzles again, the head filling heads will go into the bottles and fill it up to the desired level.

So, this is all predetermined levels under vacuum in a tray. The third one is automatic feeder type. That will operate using a lever and the whole group, here you fill a group. The other two were individually filled. In automatic feed type, you'll have a group which is filled together.

It's got into the nozzle. Again vacuum is created and you'll keep the bottle in position. Vacuum is created and it is filled to the predetermined position. So, this vacuum system that's actually there, it requires supply tank below the level at which the bottle is filled. Now, the supply tank connected to the filling nozzle using a supply pipe.

You have the product which has to be filled. That supply tank is going to be connected to the filling nozzle using supply pipes. There is also something called an overflow or an overflow receptacle, which is connected to the supply tank. So, once you start the machine, vacuum is created. The overflow receptacle will become airtight. Vacuum is created on the lower end and it sucks out and the liquid fills into the bottles.

Now, around the nozzle, there is a gasket once as you see. You must have noticed in your pressure cookers also, you have these gaskets which makes it very airtight. Around

these suction nozzles, you have something called a gasket and this bottle is pushed in to and that gasket helps in making it airtight. That is again when I said if the bottle has any cracks or chips, this will never form. Because, air will get in and you will never be able to form the vacuum.

Such defective bottles can be easily eliminated. Once you have made it airtight, vacuum can be created and it draws the liquid from the supply tank through the tube into the bottle. When the liquid reaches the end of the air lines, it breaks the vacuum and moves on. Among the systems, vacuum is one of the most efficient methods of filling liquid into the bottles. The second one is measured dosing. In measured dosing, the height of the filling is not constant.

You don't have a predetermined level. Each filling unit consists of a calibrated cylinder and a piston. So, when the piston is pushed down, there is a downstroke, what happens is the valve opens, it allows passage of liquid into the cylinder, then whatever is filled in the cylinder goes into the bottle in the measured quantity. Immediately, once the piston discharge the liquid, it returns to the whole sequence repeats for the next bottle. So, what we discussed now is the vacuum fillers which were rotary, tray, auto feed and the measured dosing. Coming to the second type of liquid fillers, which is the gravity fillers.

The name itself suggests that you are going to allow the liquid to flow down under gravity. So, that itself you have two types of gravity fillers. One is using a measuring chamber and one is a time cycle. In the measuring chamber, just like you have medicines like 5 ml or 10 ml, you will pour it and then you will drink it. Same thing, you will have a supply valve which will open to admit the liquid.

But that will only open up or that will only fill up to a calibrated level in the chamber. When the product reaches the predetermined level, the valve closes, the delivery valve opens and that is filled into the bottle. But here like I said, it is all under gravity, there is no vacuum or no pressure. It all comes down under gravity.

This is using a measuring chamber. The second one is using a controlled time cycle. Here they don't measure the volume, it is under time. Say it is 2 secs, how much it fills or 3 secs or 5 minutes or whatever. So, depending on the time, the liquid flows in a predetermined time.

The valve closes and the container is taken away. So, the open time depends on the viscosity of the product and the control may be mechanical by time clock or by electronics. So, basically in the measured volume, you will put a predetermined volume while in the time cycle one, you will under predetermined time, you will fill it up to that

particular level. Now, this is an automatic gravity filler that you see in this picture here. No pressure, no vacuum, the liquid flows under gravity and is filled into the different bottles. So, we discussed vacuum fillers, gravity fillers, two types of gravity fillers.

Third one is pressure. So, naturally you would know what is a pressure liquid filler. Here, the pressure is applied so that the liquid flows into the bottles. It is very similar to the gravity filling, it is all vertical. There is an artificial head pressure given.

So, gravity you don't have a pressure from above. But, here you have a head pressure which is induced to the liquids by a pump and this is suited usually for fast filling or low viscosity liquids like juices. This usually is done by using a pressure filling in it. Here, you can handle 1 to 8 bottles at rates up to 35 bottles per minute. So, we have come to the end of that. So, we have got different kinds of liquid fillers, dosing one, vacuum, gravity and pressure.

This shows you the comparison of the different fillers. For example, what is it suitable for? The dosing one is suitable mainly for thin and for thick. For most of the things dosing can be used. For vacuum, usually they use it for thin or low viscos products. In gravity or vacuum low one, they use only for thin liquids.

And in pressure, you can have both thin and thick. For thicker one you can have pressure applied. Gravity you should understand, it is only gravity is the force that is pulling. So it is usually used for thin liquids. In the industry, dosing is used for soups, sauces and flavourings.

And juices, they usually use the gravity filling. Pressure level system is also used for the juices. Limitations, usually none here. Here, in vacuum, it is stable between 100 to 650 millibar vacuum. And the vacuum should be accurate.

So in all these, there are limitations and there are advantages. But, they are used for different purposes in the food industry. So, we have gone through the different fillers for liquids. Coming to solid fillers.

These are powders. You don't have these solids that are in bottles. You wouldn't have any thicker solids. But you will have usually in powder form. Okay, either granules or in powder form. So this can be filled in three different ways.

Either volumetric or weight or counting. Volumetric itself is divided into three. Weight again into two and counting into two. Actually it is the nature of the product that determines which method you should use. For example, you have these sweets that have

to be filled. You must have seen packets which say 100 sweets or 50 sweets.

There you need to add these solids by count. There you will go in for count fillers. Certain cases you will go by volume. This much ml of the powder. There you will use a volumetric.

Most of the cases you will have by weight. 100 grams, 1 kg of powder. There you will go for weight fillers. Actually the nature of the product is what determines which method you would use for solid fillers. And generally, they will have some checking systems. I told you, there are, how do we know it is exactly 100 ml or there are 100 sweets in your packages. So, they have these checking systems that use photo sense or check wares or sensing devices.

And once it is reached, it will stop. It should not be under filled nor should it be over filled. Let's start with the first one, the solid fillers which is volumetric filling. In a volumetric filling, this looks very similar to the funnels that you see in laboratories. So, there is an auger. This is an auger which is a spherical kind of a thing that is kept inside the sleeve of this hopper.

So, the diameter of the auger and the pitch. This is the diameter and this is the pitch. They are designed to suit the product that you are going to fill in the bottles. And the quality delivered is controlled by the number of turns of auger. So, this many turns, one turn or two turns for one bottle. If you have to have one turn and the bottle is filled, immediately the valve stops and you get to fill the next bottle.

Or if it is five turns, after five turns, the next bottle comes in. So, that you know after one turn what is the volume, after two turns what is the volume of product. That is one of the things that they use for volumetric filling which is the auger filler. The second one is called a cup or a flask filler. They use it for granular as well as for powders.

So, there is a cup which is having a known volume. That will take in the product from a hopper and when it is filled to the brim, the supply will cut and that is discharged into the bottles that you have to fill. So, we have the auger filler, we have the cup filler. Third one is the vacuum filler. Now, this method is very similar to what we studied in the liquids itself.

So, the powders or granules can be filled by the vacuum filler. The container or the bottle or the jar, whatever you want, you can fill it or fit it into the head. Vacuum creates an air tight seal is made and then the nozzle that is there, it will project through the sealing ring. It is the depth of the penetration will govern the height of the fill. Once the

seal is made, container is evacuated and the product flows till the vacuum is cut off. So, we have clearly seen how solid fillers can be in volumetric, weight or counting methods and we have discussed in this video the volumetric method of filling solids.

They can be either granular or in the powder form. We talked about vacuum, flask and the auger method. With that we will conclude for this session here. We will continue in the next session with the different other methods of filling solids in bottles. Okay, see you in the next class. Thank you!