

Food Packaging Technology
Dr. Maya Raman & Dr. Jenny Ann John
Department of Food Science & Technology
Kerala University of Fisheries and Ocean Studies
Week – 07
Lecture – 33
CA & MA Packing Machine

Hello, everyone. Welcome back to the fifth module of the Food Packaging Technology course. We are in the seventh week. We were discussing the packaging equipment and machinery and one of that we discussed yesterday was the Vacuum Packaging Machine. Today, we move on to the control atmospheric and modified atmospheric packaging machines.

We have already learned, what is a Controlled Atmospheric Packaging. So, this is you change or modify atmosphere inside the package but, at a very controlled manner. The gas composition is precisely controlled and usually you decrease the oxygen content and you increase the carbon dioxide content by precise control. Each time the gas composition is precisely controlled throughout the storage period.

In short, they remove the air completely and replace it with the desired gas composition and they control it throughout the storage period. For example, look at this table here. You have the different commodities, fruits, apples, lettuce, tomatoes, avocados. So, they do, each of them they have their own respiration rate. So, oxygen is required.

You cannot completely eliminate it but you can reduce it. What happens if you reduce the oxygen level is that the respiration rate decreases. As respiration rate decreases, the shelf life also increases. On the other hand, if you completely remove the oxygen level, what happens is, respiration completely stops and the product decays. This is specially applicable to all horticultural products.

There is a tolerance level, minimum oxygen and the maximum carbon dioxide which the fruits and vegetables can tolerate and there is an optimum level. So, it is usually this optimum level that is maintained in a CA storage or a controlled atmospheric storage. This depends on the produce that you are going to pack. On the other hand, a modified atmospheric package has the same principle, reduce the oxygen level, increase the carbon dioxide level. But here what happens is we don't have a precise control.

You will modify the atmosphere but you will not keep a precise control all throughout the storage period. This involves flushing out the gas, replacing it with a different gas

composition. But at the same time, this may change during the time of storage. So, we know that the normal air composition is 21% oxygen, 78% nitrogen and less than 0.1% carbon dioxide.

In a modified atmospheric packaging, the oxygen level is drastically reduced. The nitrogen level can be increased and the carbon dioxide level is again increased. Now nitrogen is like an inert gas. It just adds to the gas composition. What happens if, what is the advantage of doing this? Longer shelf life, improved sensory attributes and enhanced food products.

The thing is for fatty products, you can reduce your oxygen level completely or you can eliminate your oxygen and replace the air with carbon dioxide and nitrogen only. And products which are fragile like Lays chips, these can again be filled completely with nitrogen so that it has a cushioning experience with the nitrogen that is filled in it. There is no crushing during transit of the chips. So, these are so many advantages that you have within a modified atmosphere. The greatest use for this MAP technology is for your fresh cut products.

So, you know that when a fresh cut product is kept inside the package, it is still respiring. You have something else that is an emitter which is the ethylene which is responsible for the ripening. So, one of the things that we can do in a MAP is you can incorporate an oxygen absorber or a carbon dioxide emitter or an ethylene absorber. So, what was oxygen absorber that we had already learnt about? The iron powders. These get easily oxidized so they can absorb any excess oxygen that is there in your package.

Carbon dioxide emitters or absorbers, you have calcium oxide, activated charcoal, magnesium oxide. These can act to produce carbon dioxide. Sodium bicarbonates are there, which again produce carbon dioxide. Ethylene absorbers are very important because any ethylene that is produced in excess amount will induce ripening in the rest of the products. That can decrease the shelf life.

So, potassium permanganate is a very good ethylene absorber. You have clay powder, hydrocarbons and silicones which again can be used as your ethylene absorber. So, basically, this can be used as an active package where the package has roles other than just containing and protecting the package. There are two types of map packages that we have, active and passive. In the active, the gas inside the package is completely removed and replaced by gas of the desired composition.

On the other hand, in a passive, the product is packed in a selected film. You will introduce an atmosphere of desired composition into the package and it is sealed. But

over time, as the produce continues to respire, the gas composition inside is passively altered. So, you can actually increase the shelf life over time. Because due to respiration, what happens is carbon dioxide is released, oxygen is absorbed.

So, naturally the carbon dioxide composition inside the package will slowly increase. And this is again helping into increasing the shelf life of the product but passively. So, you have got two types of MAP, active and passive. What are the gases used? As we all know, most important gas is carbon dioxide. This inhibits all your aerobic bacteria.

They require oxygen but if your carbon dioxide level is high, aerobic bacteria naturally decreases. Another important gas is your nitrogen which expels the air, especially oxygen. Once it replaces the oxygen, again it prevents oxidation. A third one is oxygen where you need to exclude oxygen in most of the cases except in the case of vegetables and meat where the product needs a little amount of the oxygen. Carbon monoxide is also a very important MAP gas which is introduced into the package to increase the shelf life.

Now other than these, you have got a number of novel gases or the inert gases that are used in map. They do not contribute to the reactions but they can actually prevent certain harmful chemical reactions. These are the argon, helium, neon and xenon. Now if you look at this, the MAP, the gas mixtures that are used in different products. For red meat if you notice here, you can use 70% oxygen but replace or increase the carbon dioxide content from 0.1 to 30%. So, this helps to reduce oxidation, at the same time keeps the red bloom because of the oxymyoglobin. Oxygen reacts with the myoglobin in the meat or the red pigment to produce oxymyoglobin which is desirable. If you completely eliminate the oxygen, you get a brown color which is not desirable. It does not give you the fresh look of a meat. But on the other hand, if you look at portions of meat which are cooked, for example pork steak or the beef portion, look at the cooked hams.

Here, you can completely eliminate the oxygen and increase it, increase the carbon dioxide and nitrogen. I hope it is clear now. Here, because it is already cooked, it is already the myoglobin, you have a particular color which is not necessarily the bright red color. You can have a brown color in hams and sausages. You also have the nitric oxide which gives you the pink color.

So, there is no requirement for oxygen. Moreover, these are high fat products. So, to prevent oxidation, these kind of cooked or processed meat, you can completely eliminate the oxygen. But in fresh meat, be sure that you do not completely eliminate the oxygen but you increase the carbon dioxide level. You can decrease the oxygen but do not eliminate it.

Now coming to cheese, you can eliminate the oxygen, have nitrogen and carbon dioxide alone. But, look at fruits and vegetables. You need to have a little amount of oxygen to keep the product fresh. Now, when you modify a gas package, there are two ways of doing it. One is gas flushing, one is compensated vacuum.

In gas flushing what they do is, they will continuously flush gas into the atmosphere of the package and it replaces the air inside with the gas that you want. This is less effective. Usually, you still have some oxygen left in the package, about 2 to 5 percent. This is not suitable for oxygen sensitive products. Those products which are highly susceptible to oxidation do not go for gas flushing.

Because you cannot completely eliminate the oxygen by just gas flushing. But it is a simple and rapid operation and can be used for production not really oxygen sensitive and it has got a high packaging rate. On the other hand, if you go for compensated vacuum, this is two stage process. The first is the evacuation stage where a compressor is used to completely create a vacuum inside the package.

Then, gas flushing takes place. So, because it was completely evacuated, you are sure that all the oxygen in the package is removed and then you replace it with the gas of your choice. Here, you will achieve a lower residual oxygen level and it is good for products which are oxygen sensitive. Let's look at the machine system for a MAP. So, the first machine system is a form fill seal machine which we have already discussed. A form fill seal machine can incorporate a map technology in its process.

And this Form Fill Seal machine can either be vertical or horizontal. You can have can form pouches or trays and the desired gas mixture is introduced while you are packaging it. So, you have your packaging material, you fill it with the product, you seal it before sealing you completely evacuate and fill in the gas composition that you desire and then you seal it completely. So, the form fill seal machine can incorporate your MAP technology which finally helps in increasing the shelf life of the product. Another machine system is your chamber machine.

This is very similar to your vacuum packaging that you have just discussed. In the vacuum packaging you completely eliminate the gas that is inside the package. Here you eliminate and replace it with the gas that you desire. The machine system will be the same. In a chamber machine you usually have a chamber where the filled package is kept, vacuum is pulled out, the package is again flushed with the gas mixture of your choice and then sealed.

All these cases whether it is a vacuum packaging or it is a map or it is kept, the material that you use for packaging should be a gas barrier which is very important. You should see that none of the gas is moving out from the package, nothing is coming into the package. Most chamber machines are usually a batch process, slower relatively and it is suitable for bulk or master packets. The third type of machine system for map is known as a snorkel machine.

Here, they do not have a chamber. What they do have is, as you see in this picture, the product is loaded into the package and then the snorkel or the nozzle or the probe is inserted into the package. You remove the air, replace it with the desired air of your choice and then remove it from the snorkel and seal it immediately. So, you have a form fill seal machine, you have the chamber machine and your snorkel machines which are all machine systems that are used for the modified atmospheric packaging. Similarly, what are the machines that you use in a map? One is the thermoforming packing machine. Thermoform as named suggests you have thermoformed or heat processed trays.

Package is filled with the product, it moves, this is a continuous inline system, need not be a back system. Once the product is filled, you can seal it lightly, remove the gas from the package and replace it and then seal it completely. But unlike your pouches, it will be on a tray. Another machine is your vacuum chamber machine which is familiar to you by now, which completely removes the air. As we have discussed, vacuum packaging is a form of map.

The form fill seal machine can be horizontal or in the vertical. Not discussing this because it is already discussed in the machine systems. Now what are the important characteristics of the packaging material? One, the permeability of the package to gas and vapor. It should be impermeable to gas and moisture. Number two, good mechanical properties, it should withstand any pressure from inside or outside.

It should be heat sealable and not allow any gas to enter. And number four, desirable is transparency. So, you can see the product that is there in the package. Let's list the advantages of using a map package.

First and foremost, is the shelf-life extension. Not only is the shelf life extended, you can retain the form and texture of the product. Retain the sensory and the nutritional attributes of the product. More advantages, you can use less preservatives. As the package environment is such that the spoilage is reduced, you can actually reduce the amount of preservatives that you add. MAP is an excellent technology for packing of fresh products.

Moreover, you have decreased distribution cost, longer distribution distances and deliveries. So overall, it is a very convenient package, reduces economic loss due to shelf life. But at the same time, there are a few disadvantages of map. Capital cost, it comes with a price, the machines is not cheap, the gas composition maintenance is not cheap.

So, there is a high capital cost. It requires special equipments and training costs. The person that is using it needs training. Package is supposed to have good barrier properties. So that naturally adds to the cost of the package. Then the analytical equipment that is needed to assess and regulate the gas mixture is again costly.

The cost of the quality assurance systems that is going to be used. But the benefits of MAP is lost once the package is opened. So, it is only till it reaches the consumer and it is open. You cannot continue with the gas composition once it is open. You will have to naturally keep it in the refrigerator or for another suitable storage condition so that the shelf life is extended.

You need necessary temperature control. We had already discussed that MAP is usually done in conjunction with a chilling proceed. So, chilling and map together will increase the shelf life. Another disadvantage is different gas formulation for different products. Now we have already discussed that how for vegetables, for fruits, for high fatty products, you need different gas composition. So, that is a bigger disadvantage because it cannot be uniformly used for a product.

You need to formulate different gas composition and that again is a costly affair. Moreover, it increases the pack volume. In the case of vacuum packaging, you could decrease the pack volume because the gas was removed, it takes the shape of the product, you increase the package volume, increase the amount number of packages that can be transmitted. So that way you actually decrease the shipment cost. But in the case of map, you are increasing the volume which is quite contrary.

So, with the advantages and disadvantages, MAP is still a mowing technology. It is especially being used for freshly cut products. A lot of product takes advantage of this technology. But it has to be used in conjunction with your chilling or freezing methods and that actually helps in the shelf-life extension. So, I hope you have a good idea of map and CA packages which is an advanced technology being used commercially also right now.

In the next class, we will continue with another advanced technology which is a gas packing machine which is a little different from but not very different but still there is

much slight difference when you have a gas packing machine. See you all in the next class. Thank you.