

Food Packaging Technology
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Active packaging – Part 1

Hello everyone. Welcome back. We're going to start with the fourth module, very important topic today, active packaging. And because it's a little more vast topic, I'm going to take it as a two part section. What is active packaging? Now packaging itself, you can divide it into four different categories, passive packaging, active packaging, intelligent packaging and smart packaging. Passive packaging is what we all know about the normal traditional packaging that we use, which has the normal functions that we already studied convenience, protection, preservation, containment, that is a fundamental package that we have been using traditionally.

Now coming to active packaging. This is a package that reacts to stimuli. For example, if your package has got a high amount of oxygen, there will be oxygen absorbers which will reduce the level of oxygen in the package. So, the package is responding to the stimuli.

So we'll go into detail into this active packaging for the coming slides. Now there's another new term that is called intelligent and smart packaging. Intelligent packaging, they will carry out intelligent functions. What are the intelligent functions that a package can carry out? You'll ask. Sensing, detecting.

So they sense any changes happening inside the package, they detect it, and sometimes they can record it and even better they communicate it to the consumer. So that also will be dealt in the forthcoming videos. Smart packaging is another term that is more functional and useful and involves technology. So many of these rely on chemical, electrical, electronic and mechanical technologies or a combination of these. This is needed for sensing, detecting and communicating to the consumers.

Right. Now this picture shows you very clearly active package. This is the traditional passive package functions, preservation convenience and the active package will in addition, it will give you an active preservation. Okay, they are responding to stimuli and the intelligent package, once it responds to stimuli, it will communicate to the consumer and help in the marketing. As I told you, when it responds to stimuli, there are two things that happens.

There is something called actively releasing certain compounds or actively scavenging. So, what can you actively release? Carbon dioxide, antioxidants, ethylene, antimicrobial agents, flavors, ethanol and preservatives. From the active package layer, active agents, it is released into the food. And certain cases you need to scavenge or remove certain components from the food. For those active scavengers, you can actually scavenge carbon dioxide, oxygen, ethylene, odor, moisture.

So moisture is obvious when the moisture level increases, there must be something to absorb. So, let's go into detail in the forthcoming slides. So, this table shows you the different active packaging systems that is used in the Food Technology industry. The first and foremost is the oxygen absorbers. Now oxygen is actually a component in a package system that is not required for certain foods, especially for high fat foods.

So what happens is if there is a high oxygen level, the oxygen absorbers will absorb the increased level of oxygen and maintain the oxygen level inside the package. So generally, they use iron-based components. Iron powder is used which can be used to absorb the oxygen. So, this is used in breads and cakes. You can have it in biscuits and even in fish and meat and coffee and snack foods.

The second one is a carbon dioxide absorber or an emitter. So, in this case you can have carbon dioxide emitted into your package. So that is important because certain cases you need to keep your oxygen level low and your carbon dioxide level higher. So here there are two ways you can do this. You can either have a physical absorbent like zeolites or active carbon powder or you can have chemical absorbents like calcium hydroxide or magnesium hydroxide.

And this is used in products like coffee, fresh meat, nuts and snack foods. So now that we have gone through the two gas systems, the third one is the antimicrobial package. Here we use antimicrobial agents which will control the level of microbes inside the package. So, you can have any antimicrobial agent in your package like your organic acids. You can have silver zeolites or you can have even natural spices and herbs can be used.

Vitamin E can be used. So, all these antimicrobial agents in your package can actually control the level of microorganisms that is going to attack your food. Now this can be again used in cereals, meat, fish, bread, vegetables and fruits. Ethanol emitter. This again is going to control your microbial load.

You use generally encapsulated ethanol. Again, for number of bakery products and even

for products like pizzas and crusts. The next one is very important, moisture absorbent. We all know the importance of water activity and how water activity, your oxygen, carbon dioxide plays a very important role in the shelf life of a product. So, moisture absorbers, you can use your clays, activated clays.

Silica gel which two of them are very commonly used. Polyvinyl acetate is also used. This again is used for fish, meat, poultry, snacks or any kind of foods that you can think of. So, you can see the list is unending. We will go into details of these also.

Self-cooling and self-heating cans are very interesting mechanism when you suppose you go into a higher, going for camping into a mountain camp and you want to have something really warm. So, you have cans which can be self-heating. You don't need to light a fire. You can have your product warm or you go to some other places where you don't have a refrigerator and you have can and you want to have a cool product, you can use your self-cooling cans. So, this again you can use quicklime water, ammonium nitrate water.

We will go into details. It is a very interesting system and this can be used for all your ready to eat meals and beverages. Another one is changing gas permeability. This especially is for fruits and vegetables. Now you know that fruits and vegetables are still living.

They are respiring. So, you need to allow the gas to permeate in at a particular level. It should not be too high. The ripening or the respiration rate is high. It should be adjusted and that is usually done by self-chain crystallizable polymers and that helps in changing the gas permeability of your packaging material. Now this was taken from a source that is shown here.

So this is a gist of what we just saw. Ethylene scavengers which are again for ripening to prevent ripening. Your antimicrobial agents, carbon dioxide emitters, antioxidants, oxygen scavengers. Very important active system where these active agents will respond to the stimuli and control the environment that is in the package. Now when you have an active package system, two very important things of delivering this agent.

Those are either sachets or pads. Now these sachets and pads, they cannot be used in liquid foods. They are the most widely used form in any packaged foods, usually in solid foods. Let's go into the detail of what we just saw. The first one that we discussed was oxygen absorbers.

So, we will go into the detail of this. Here as I mentioned, you can either use powdered iron or ascorbic acid. Those of these can be used as an antioxidant or an oxygen absorbing agent. Now when you use iron powder, you can very drastically reduce the oxygen concentration in the headspace to less than 0.01% which is much lower than the usual levels that you can get from your vacuum or even the gas flushing.

That is interesting. This is the pads and sachets that we were talking about and how these absorbers can be added onto or embedded into the package material so that it can be active. So, if you want an even better shelf life, you can go in for films containing PVDC, polyvinylidene chloride, copolymer or ethylene vinyl alcohol copolymer or a metallized barrier. So, this actually makes it a better barrier in addition to using these oxygen absorbers. So, iron-based powders as we said is the one that is generally used in the food industry. The second one we talked about was carbon dioxide emitter.

So here again we mentioned in the table that you can have a physical absorbent like your zeolite or active carbon or you can have a chemical absorbent like your calcium hydroxide or your magnesium hydroxide. This is usually packaged in small packets or pouches or in paper that is coated with perforated PP so that it can help in the absorption or in the emission. So, if you have a sachet that contains calcium hydroxide and iron, there you have a double roll. You can either absorb carbon dioxide or as well as the oxygen. And this is very well used for coffee, ground coffee.

This kind of combination is used. So other sachets that you can available as a carbon dioxide emitter absorber, you can either have ascorbic acid and ferrous carbonate or ascorbic acid with sodium bicarbonate. This absorbs the oxygen and creates an equivalent volume of carbon dioxide. They emit carbon dioxide at the same time absorbs the oxygen because once the oxygen is absorbed, you create a vacuum. So, the package has a tendency to collapse. So if you can emit an equivalent amount of carbon dioxide, that helps to maintain the integrity of the package.

And then you have this carbon dioxide fresh pads that can be used for your meat, poultry and seafoods. So generally, the bottom of these trays, they have these sachets which have got the sodium carbonate or sodium bicarbonate. And the juice dripping from the meat will attach to these pads and release the carbon dioxide from this bicarbonate, which is a very interesting system. This is the picture taken for the carbon dioxide absorbers. Like we said, the calcium hydroxide will absorb the carbon dioxide and become calcium carbonate.

The third one is ethylene absorbers. Now why ethylene? Ethylene is one of the components that releases from vegetables and fruits for ripening. So, when the fruits

ripen, it's a plant hormone that is inducing ripening in fruits and vegetables. So, if you can actually absorb the ethylene, you can delay ripening. If you delay ripening, you increase the shelf life of the fruits and vegetables. And the products that are the components that are used for this is usually potassium permanganate.

The equation is shown here. The permanganate, it oxidizes the ethylene. There is a series of reactions and that is oxidized to acetaldehyde and then again to acetic acid. And further it can oxidize to carbon dioxide in water, which is harmless and can be in the package itself. So, potassium permanganate is toxic. So, it cannot be integrated in the food contact packaging.

It should be just outside. So, what they do is they take four to six percentage of this potassium permanganate and this is usually added to any inert substrate. So, you can have alumina, silica gel or even activated carbon. And that is placed in the sachet and that can be safely added to the package but not in contact with the food. So that way you can have an ethylene absorber incorporated into your packaging system.

The fourth one, ethanol emitters. I already mentioned that ethanol is again an antimicrobial agent. So antimicrobial agents, it has been used over centuries for these antimicrobial activities. You can have sachets that contain 55% ethanol, 10% water. This should be absorbed into your silicon dioxide powder and it should be filled into a paper EVA sachet.

And this can be used as an ethanol emitter. So, over the time ethanol is emitted into the package. That has an antimicrobial effect on the food. The problem here is you have the smell of ethanol when you open the package. So that can be a problem. So, ethanol emitters were generally used in Japan to extend the shelf life of high moisture bakery products.

So this is what I have already told you that you can have the smell of ethanol when you open your package but it is not a problem if your product is heated prior to consumption because the ethanol vaporizes off and that will not be a problem for foods that are heated before consumption. But for the other kinds of foods, it can be a disadvantage. The fifth one of active packaging system is the moisture absorbers. This is a very important system because if your moisture level increases there is a high chance for microbial deterioration, chemical deterioration and enzymatic changes that is taking place. So, water can accumulate in the food in the package because of temperature fluctuation in high moisture packages.

So basically in certain cases especially in flesh foods you have these drip losses that

takes place from the tissues. And from horticulture products like fruits and vegetables you have your transpiration from these products. All this will build up the moisture level inside your package which is not good for the shelf life of the product. So, you have to have these drip absorbent pads are there. This usually consists of two layers of microporous or nonwoven plastic films like LDP or PP and that can absorb 500 times its own weight of water.

That is one kind of moisture absorbers that you use and the typical ones is super absorbent polymers include polyacrylate, carboxymethyl cellulose or you can have graft copolymer of starch which again has a very strong affinity for water. Now that we have completed five very important active packaging systems, we are coming to another necessary one, antioxidant packaging. So, antioxidants are components which actually help in reducing rancidity. They will prevent lipid oxidation by themselves you know they quench the carbon dioxide they can prevent lipid oxidation. So, you have natural antioxidants and you have these synthetic antioxidants.

So these can be incorporated into your package rather than into your foods. So, we know that BHA, BHT, TBHQ normally use antioxidants but up to a certain level. But the same thing can be done when you embed it into a package you can get the same effect without adding it into your foods. So that is one advantage of having an antioxidant packaging. Vitamin E is a natural replacement for your BHA and BHT but it is equally effective.

Antimicrobial package we have already discussed this when we went through our table. So, this again we have components which will have antimicrobial activity. The main reason for using antimicrobial agents in your packages because consumers demand less of preservatives to be added into their food just like the antioxidants. So, this again can be added into the package and have the effect of the antimicrobial added into the food itself. So this will extend the lag period and reduce the growth rate of the microorganisms.

So we know some of the natural and synthetic antimicrobial agents that are available in the food industry the same can be added into the package. So, you have benzoates, propionates, sorbates, these are the usual salts organic acids and alcohols that you add. Your fungicides which act against fungi you have enzymes that can be added as an antimicrobial agent. Nowadays, chitosan has been very extensively being used as an antimicrobial agent and this is a dual role. Chitosan has a dual role as a film matrix and as a carrier of antimicrobial additives.

So bacteriocins is another compound that natural antimicrobial agents. So this again can be incorporated into your package and among the bacteriocins, Nisin is one of the most

commonly used one in the food industry. Another one is silver is now most commonly used in nano engineered antimicrobial material. Nano engineering and nanotechnology are fast gaining importance and silver nanotechnology is one of the things components that can be used as an antimicrobial agent. Edible films along with these antimicrobial agents is another option that you can have in your active packaging systems.

Coming to the last active packaging system in this video, we have the flavor or the odor absorbers and releasers. Now this is a contradictory system because you can have flavors being released during the shelf life of the product or you can have some of the flavors or flavors being absorbed. Now that is a problem there because this can actually, even though there is a spoilage treatment, it can mask the spoilage which is not actually good for the consumers. So, there are FDA approved flavors that have been released into a thin layer of plastic inside the bottle cap. So, before the seal is broken, the fragrance is infused with water and that gives you as soon as the consumer opens the seal, you get a fruity scent which helps, it is an appeal to them.

And like I said, if it is spoiled, it can again mask it. So, it is a contradictory type of active packaging system. So, recap of what we did. We went through the active packaging system which is a very important system which responds to stimuli. If there is a change, they respond and maintain the condition inside the environment or the condition inside the package. We went through oxygen absorbers, carbon dioxide absorbers, emitters, ethylene absorbers, ethanol emitters, moisture absorbers, antioxidant packaging, antimicrobial and the flavor or the odor absorbers or the releasers.

We have come to the end of this session. We will continue with the same topic in the next video. Thank you. you