

Food Packaging Technology
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Lecture – 20
Testing of package performance

Hello everyone. Welcome to another session in module 3 of the Food Packaging Technology course. This week we had dealt with different testing of packaging material. Before that we went into the design. So once the testing is over, I told you in the last class, we are moving on to testing of package performance. This seems to be a new word but it is actually just wholesome of what we have studied till now.

When you say performance, whether it is in a classroom, you will ask what is the performance of this student X or student Y. That means compared to the whole class, how does this student fare academically or extracurricular wise. Similarly, in a packaging, once you have tested it, you will find out what is the packaging performance. Is it fulfilling all that it is claiming? So, the word performance itself is defined as fulfillment of a claim, a promise or a request.

Now in packaging, performance is a fulfillment of a promise that the packaged products are received by the consumer in an acceptable condition. So that is when you test the performance. Is it you are promising or you are claiming that your package has good barrier properties, it has a shelf life of 6 months. But in reality, does that happen? That is what you will test in a package performance test. Till the consumer, is the consumer going to get it in an acceptable condition.

And total package performance is that the package completely fulfills their functions and the products get to the consumer with full satisfaction. Products in the package should retain their taste, color, texture and more than anything, it should be safe for consumption. So, let's come to that word total package performance testing. This particular class today, it is the application of completely unified, coordinated, interrelated testing activities. So, what is that? You have learned a number of tests till now.

So when these tests are done in unison and you're comparing them, so that is what they are saying application of unified, coordinated, interrelated testing activities. Why? To ensure the package is duly fulfills all their functions. Now this, for this you need to have a knowledge not only of the package but also of the product as well. And such activities, whether it's a unified activity, the number of tests is done, it can be interdepartmental,

goes into different disciplines in the same organization. So, it's not just that you do one test and say the package has passed.

You do a number of verified tests and together does that fulfill the function or does that fulfill the actual claim that it is making. That is what we do in a total package performance test. Now let's look at the functions of a package. The functions of a package are very important because that is exactly what we are going to test in a package performance test. Just like you test, evaluate a student in a class, you're going to evaluate if your package passes or fulfills all the promises or the functions that it has to meet.

So, one of the main important functions is protection. So, package must protect its contents from both mechanical and climatic hazards. So, does it do that? That's one of the tests that we'll be doing. Another one is contain. The package must contain all the contents and keep it secure from the manufacturer till it reaches the consumer.

The retail packages, which are the smaller ones, they must carry, or primary packages, they must carry all the details. Your primary and secondary will come under retail packages. They must contain all the details, not only to identify the contents, but to meet the labeling requirements also and to inform the consumer. So, does it do that? That also comes under this testing of performance. And it must provide the consumer with convenience.

So what are the conveniences that a consumer will expect? Ease in opening, for sure. Dispensing, how do you pour it out? As well as providing easy handling during production, processing, and warehousing. So, the first thing that we will check is what are the functions that this package has to perform. And we will see if it does perform these functions. Before I go in details to the different package performance tests, before we move further, let's look at different changes or the interaction between three very important factors, which is food, package, and the environment.

Now whatever factors there, it can either move from the environment to the food or from the food to the environment. And so, the package is a very important factor, which actually helps in the shelf-life determination. And one of the factors here is light, which is from the environment. If it comes from the environment to the food and the package is permeable to this light, it causes changes in color, flavor, and nutrition degradation. A second factor is oxygen.

Again, oxygen can move from the environment to food and cause oxidation, color, flavor changes, and that is because the package may be permeable to the oxygen. A third one is carbon dioxide. Here carbon dioxide can move from the environment to the food or from

food to the environment. If it moves from the food to the environment, there is a carbon dioxide loss, carbonation loss, or respiration changes. So, this again causes changes in the food product .

Another factor is water vapor. Again, all these factors can move in either way. A water vapor moves from the environment to the food. That way, the product, which is usually hygroscopic or powders, they can become sticky. It results in a texture loss and microbial growth .

What if the water moves from the food to the environment? In that case, you have dehydration and texture loss. Another one is aroma. Here again, from the environment to the food, if the food picks up these aromas, which is penetrating through the package, again, can cause flavor and aroma changes. All these can also be a migration, where the package is the one which is the environment, the package monomers from the package can move into the product. This causes aroma, flavor, and toxicity.

Aromas and changes can also be toxic. This is again migration, which we have studied in the testing materials. Another one is absorption from the package itself. You can have certain aroma absorbed into the food. That is a direction from the food to the package.

So either way, it can have a flavor loss or it can take up the flavors from outside. This is also important when you remember when you're doing your testing performance that all these environments, how important it is. So, I thought it was important to go through this table because there is a very strong interrelationship between the food package and the environment. Now coming to our topic for the session, testing performance of packaging materials, what are the objectives of these tests? Now knowing what the package does, the performance objectives might be many. One of them might be, does it protect and preserve the contents of the package? Number two, is it good enough to run efficiently in the production machinery? Does it contain and carry the contents properly, securely? While it has been shipped, handled, is it un-stored? Is it satisfied? Is it still intact? Number five, to identify the contents and sell and motivate.

Does it perform its function of identifying with the consumer and communicating with the consumer? And last but not the least, does it provide ease of use at the most economical cost? So, ease of use is an additional thing that you provide in the package. But you should also remember that such ease, there are so many mechanisms that can be added to the package, but it should not ultimately result in a high increase in the cost of the product. So, meeting these objectives of the test will be the total performing package. So if your package meets all these requirements, it means it's a total performing package. If you're a student in a class gets 95, performing student.

If a student is very good at, he gets an A plus in your extracurricular, totally performing. Same thing, a package, these are different points. If it gets through all these, you have a totally performing package. And that actually ultimately helps in customer satisfaction. Now we went through what is a packaging performance test.

We saw what are the different objectives. Now let's look at the requirements of packaging performance. You got five requirements for packaging performance. One is material requirement, product requirement, production requirements, distribution requirements and consumer requirements. Let's go through all this one by one.

You will have a fairly good idea. We'll just go through these. One is material requirements. So, the questions that you have to ask regarding the materials when you do a package performance test. And the questions are, what are the package materials or package forms that are suitable naturally? What is the strength, stability, dimensional and the permanence or what is the barrier properties of these materials? Another question is what converting and manufacturing processes are applicable to this material? So, you have to take these packages through different converting process, folding, sealing.

Is it compatible to all of these? Another one is, do they meet all the legal, regulatory, industrial requirements? Are they environmentally acceptable? So, once you get the answers to these questions and determine the requirements for the packaging with proper testing packaging material specification, you will be able to meet these requirements. The second requirement for package testing performance is the product requirement. Now we talked about the package. Next, we come into the product. What is the storage, stability, safety and the use conditions that are required for the product? These are not going to be the same, like for milk it will be different, for your sweets it will be different.

So depending on that, what are these, you need to answer these questions and test it accordingly. Another is, what is the product's physical, chemical and sensory characteristics? Is it sensitive to oxygen, moisture, light, any type of environmental conditions? Is the product hazardous? Another important question. Now knowing the product, so we have to test the product, we have to test the package. When you know the product and package relationship, requirements will result in using the proper testing procedure to meet the requirement. So once these two requirements, see all of these are interconnected, you need to go through each of these step by step and then only you can see your package is a performing package.

Third one is a production or operation requirements. Here you will ask questions like, what is the machinery that is used or what is the machinery through which the package

has to go through? Are there any changes in the existing production system? What is the speed and efficiency level that you need to meet? What is the processing and handling environment? Have all the production needs been identified? Very important. Now when you determine the production needs, this will be the basis for all the production tests. So, once you know all the needs that you have in your production, okay, suppose it has to be very high efficiently, moving on high speed, so such kind of packages have to be chosen .

Next one is distribution requirements. Now all these packages have to go through shipment or through air or through rail. Now we will go into detail of this in the next few weeks on distribution or transport worthiness tests, but for now you just understand that these packages have to go through different environments. So, there are certain tests that will actually simulate the environment in the laboratory and see if the package withstands these different difficulties. So, what is the environment distribution? What you have to find out, you have to state what is the mode of transport for that particular product? What is the travel distance usually and what is the duration? Is it a 10 hours or 5 hours or 2 hours or even days or months? That has to be defined. Will there be intra-transfer or in-transit transfers? During transfer do you go from a rail to a road transport? So, all those things have to be considered .

What are the conditions of temperature and humidity during shipment? Another thing that you need to consider. How are the packages stored? Are they stored in pallets or in pallet racks? What are the handling methods that are used? So all these answers, if you have answers to these, it will determine the type of testing procedures that you are going to use. Now suppose the package you are defining that it has to go through the road and it has to be stacked. So, naturally there is a test called compression test and that has to be done to see if it is going to withstand the compression during the transportation. So once you define what are the things it is going to go through in the distribution system you will be able to perform such tests and if your package fulfills or if it passes those tests it is almost a performing package .

Fifth and the last requirement is your consumer requirements. Again, a very important requirement. Who are the consumers for this product? What are the use conditions? Are there any special consumer needs that they have like tamper evident, child proof or easy open packages that are required for the package? Are there any special opening or dispensing features that are used? Are the labels, colors, text printed correctly and legibly? And usually, you will also see whether the use instruction, how to use it, how to store it, are they also followed? How are they disposed of and will the consumer be exposed to any safety issues? So, the consumer will be totally satisfied if all these needs are met. So knowing, identifying, defining and establishing these five requirements for

the package performance helps you to develop a program for total package performance testing. So, before you do any tests you need to go through these one by one, define each of these and then do your tests accordingly.

We are coming to the total package performance testing. Now a successful package is one that passes the total package performance test and to produce this total performing package, Brannan in 1992, he presented the whole thing in the form of a wheel. Now this is a system which has got five different spokes, which is materials, product, production, distribution and consumer. So these five spokes are very important, these five sections, just like a wheel is kept together if these five are in balanced, the action and motion is also balanced. That is to say that you cannot have one of these requirements not fulfilled and say it is a performing package.

So all five of them are equally important. Now the five spokes represent the sets of testing procedures that need to be performed. And each area is designed to be met for the package performance. For example, these are all attached to the inner circle for production. One of the tests that you need to do, machine operations have to be performed. In distribution, distribution environments, you need to consider all the distribution environments and perform all the tests that might help determine if your package is going to go through the different distribution environments.

In the schema, again we discussed that utility and end use, is it going to perform that? Is all the tamper evidence going to stay intact till the end? In materials, packaging manufacturing, what are the material, endure all the manufacturing processes and the machinery through it goes? And for the product, the shelf life. Now in this wheel system, all these five spokes are equally important. Coming to the first one, product manufacturing testing. And during manufacturing, the different materials should be able to withstand all the production lines through which it is going through.

They should be tested for structure. What are the things included in structure? Physical, chemical and permeance properties. Permeance is your barrier property. So, these are the tests that need to be done for the packaging material itself, which is the first thing. Now on the structure, you also need to evaluate the converting and manufacturing quality of packaging material .

Another one is environmental test. How can it be disposed? Is it going to impose any safety issues? This is another thing that we need to determine. Material is also tested for the layers of the structural construction. And in structural construction, all the tests that we mentioned, the gauge, the basic weight or gramage, yield, tensile test, impact test, all these have to be done. Now if it is corrugated boards, you will test for materials and

construction.

Surface coating, how is it? The compression strength. Now all these will come under the material of the product manufacturing testing. The other spoke, second spoke is your product itself, where we will look for storage or shelf-life testing. This is for the product itself. Now in this program, you will ensure that the package meets the requirements of the product itself. The product is stored and tested in controlled environments.

We have already discussed that. They will be kept under controlled environments of temperature and humidity and you will test the shelf life of the product at regular intervals. So, they are tested for physical, chemical, microbiological, sensory and other characteristics. So, you want to see after the particular storage shelf life, does the package still help in protecting your materials. And this is usually done for package development during the early stage, but you can also test it under simulated distribution environment conditions also.

Third one is your machine operating test. Now the actual operating package and the product, they have to be tested on your real time, on your package machinery. And why is that done? To meet the production performance requirements. So, you have to see that your product will actually withstand or meet the production line speeds. Efficiency levels are maintained. You will check for the seals and the quality of the perforations.

And the cartons if it's there, you will also check for their forming and assembly. How good is it? Is it easy enough to assemble? Is it easy enough to seal? And shipping containers, you'll perform all the quality tests, which is the transfer worthiness test and also the line handling of the quality test. So, we talked about testing for the product, testing for the material, packaging material, testing for machine operating test. And fourth program will be distribution environment testing. Now distribution environments testing, you will check according to the ASTM, American Standard for Testing and Materials, D4169, which actually details the different environment tests that need to be done.

And once you have established that distribution cycle, what is the cycle through which it is going through, you will do accordingly the different tests. For example, drop test or the impact test or the handling, loose vibration test, these may be done accordingly. The last one is the end use packaging utility test. Now this is very important that you do these kinds of tests till the end of the shelf life or up to two years.

For example, you have put in a convenience of dispensing. You have to see that dispensing use is available till the end of two years or till the end of the shelf life of the

product. It's not easy to say in the first month you can easily dispense it. But at the end, after two years or at the end of the shelf life, you're unable to dispense it as easily as you could do in the beginning. So that performance has to be done. Each of these utility or conveniences that we incorporate in the package will be there till the end of the shelf life of the product .

So let's conclude. So using total package performing tests in packaging development work, what it guarantees is that all performance requirements of the package and the product they have been looked into. So, before you begin your test, once you have your package performance evaluation done, you will not have a loophole. All the tests will be performed and you can say that your package has gone through all the tests. Now successful testing is synonymous to successful packaged product. If your product or package material is going to go through successfully through all of these, you're sure that your consumer is going to be very satisfied.

A total performing package is a result of total package performance testing. So using the total package performing testing wheel that we went through, that concept is important in product development. But it requires an understanding of all five sections, all five spokes, and this has to be coordinated in the organization very well. That is a real challenge.

So I think this is a relatively simpler topic. It's a wholesome conclusion of all the tests that we have done in the previous videos this week. And once you have the performance test done, you are almost ensured that you're going to deliver a successful package to your consumers. So, with that, we've come to the end of today's session. Hope to see you in the next session. Thank you!