Labthink Instruments Co., Ltd.
144 Wuyingshan Road, Jinan, P.R.China
Phone: +86 531 85068566
FAX: +86 531 85812140

The Causal Factors of Gas Composition Change inside Packages

Abstract: This article will introduce the causal factors of such gas composition change and its test methods in details.

Keywords: packaging , gas composition, Labthink

As it has been well known that oxygen, water vapor and so on is the causal factors to the deterioration of food and medicine. Consequently removing the resources of oxygen and water vapor, and controlling the gases composition inside packages can efficiently extend the guarantee period of products and improve the quality of products. Therefore new packaging methods with various barrier packaging materials gained popular application, such as MAP, CAP and vacuum packaging. However, even the gases composition has been controlled and materials with high performance of barrier property have been applied to stop the permeation of oxygen and water vapor, the actual packaging effect is still quite different from the estimated result. This article is going to introduce the causal factors of gases composition change inside packages and its test methods in details.

1. Analysis of Gas in Packages

When packaging is completed, the gases composition inside packages will be temporarily stable. But as the preservation period goes on, the volume of oxygen or other gases (which are sensitive to products) may change, and this will further change the composition of gases inside packages and influence the quality of product. Based on analysis, the increase of oxygen and water vapor inside packages is mainly caused by the following factors.

First of all, it is the gases from outside the packages. Gases can get through the packaging by two means: permeation and leaking. The biggest differences between these two are the permeated gases volume and permeation location. Permeation means gases get through the packaging from the side of high concentration to the side of low concentration. The permeation rate is mainly decided by the barrier property of the packaging. Materials with high performance of barrier property can efficiently solve this problem. But leaking is referring to that gases get through the packaging by its cracks, tiny holes or the loose joint between two materials. Such leaking is most likely found at the hot sealing of packages or around container caps. As a package, leaking and permeation exist at the same time. Thus attention should be paid to the general effect of both of them when we are conducting tests.

Second factor is the gases inside packages, and such gases include the remaining gases and the adsorbed gases. Remaining gases are the gases (such as oxygen) remain inside packages after the packaging process is over. Though in MAP, CAP and vacuum packaging, there is gases replacing and degassing process (especially to the oxygen), the accuracy of operation and time is quite limited, the degassing effect is not satisfactory. Even the so-called ‘vacuum packaging’ is just trying to lower the gases volume but not completely degas. The adsorbed gases are also significant because except metals and glass other materials have a property to adsorb gases. The adsorbed gases volume is often related to the structure of the material and the contact period between the material and the gases. However adsorption is not equal to absorption. If there is a change in the environment surrounding

the packaging, and the concentration of the gases inside packages is lowered to a certain level, the adsorbed gases will be released.

2. Test Methods

Although the gases composition changes very slowly inside packages, such change will still affect the guarantee period of product. Manufacturers adopted many means to control gases to slower the increase of oxygen and water vapor inside packages. For example, multi-layer of barrier materials in order to improve the barrier property of packages; placing desiccant, absorbent or oxygen scavenger to absorb remaining gases and permeated gases from outside. But how is the effect of these measures? It requires analyzing the package. Referring to each causal factor of gases composition change, below is an introduction to respective test methods.

2.1 Barrier Property Test

Barrier property test is very important to packaging materials with high performance of barrier property. In the past it was only possible to test the barrier property of film or flake. However in actual packaging we often see containers and packages, thus barrier property test data of materials could only be reference in choosing materials. The data is not able to indicate the final barrier property of packages, because the thickness around packages is not even, and some property of materials might change during the manufacture. Therefore the estimated result is often different from actual test result. Based on such situation, not only the barrier property of packaging material should be tested, but also the barrier property of final package should be tested. A right choice is based on the data of both tests. Currently there is development on the tests of permeation of oxygen and water vapor, and respective test instruments are already on the market. Those instruments can well satisfy the need to test the barrier property of whole packages. (Photo 1 is PERME series TOY-C1 equal-pressure method film/container oxygen permeation tester, which is produced by Labthink Languang; Photo 2 is its PERME series TSY-W3 electrolysis water vapor permeability tester)

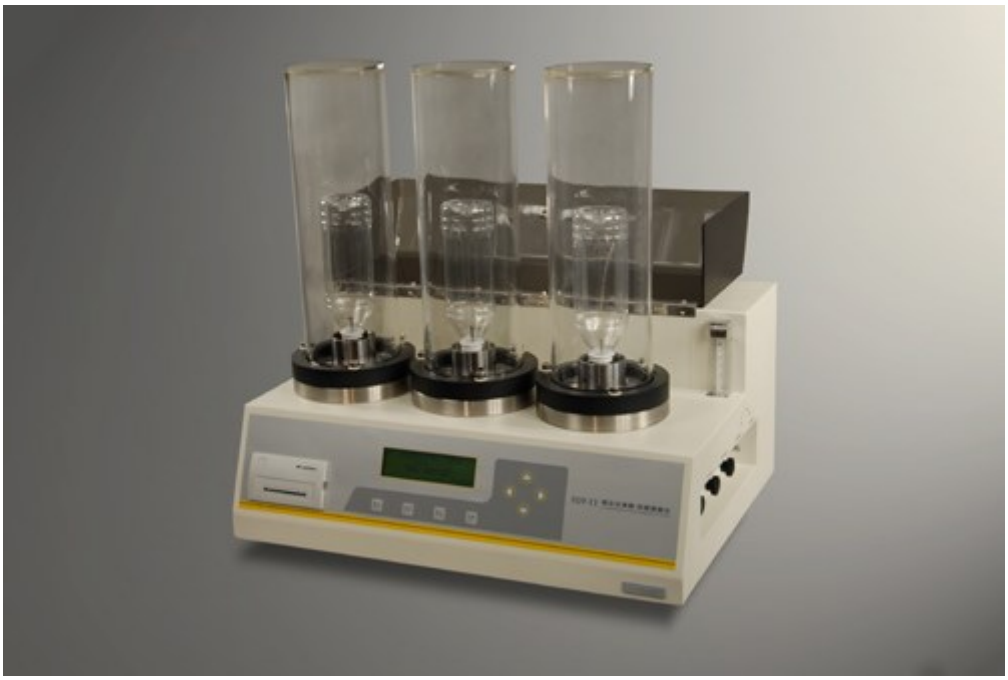

Photo 1. PERMETM TOY-C1 Equal-pressure Method Film/Container Oxygen Permeation Tester

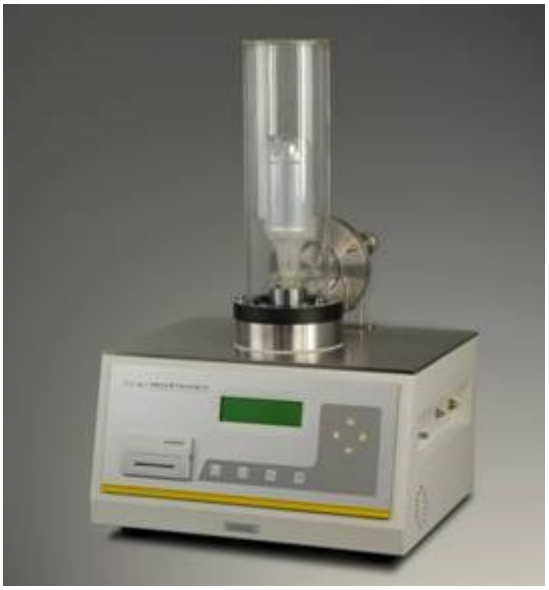

Photo 2. PERMETM TSY-W3 Electrolysis Water Vapor Permeability Tester

2.2 Air-tightness Test

The air-tightness test can indicate the possible leaking of a package. If air or liquid get through packages by certain leaking point, the barrier property of package materials will totally loose its function and the contained products will deteriorate very fast. The relevant tightness index is different to each specific form of packaging. Regarding hot sealing bags, hot sealing operation may often weaken the mechanical strength of packages. Therefore the hot sealing parts are usually the weakness of soft package tightness. Furthermore as it needs pressure to seal soft packages, pressure is not equally shared over the whole package. The very first leaking point is often the part which suffered the smallest pressure. As a result, it needs to test the tightness of whole package to make an objective evaluation. Increasing the pressure inside packages is the main method to conduct the tightness test of whole soft packages. When we are testing the tightness of soft packages, we need to simulate the actual situation of it taking on pressure by creating a pressure difference between inside and outside of packages. There are two ways to perform such simulation, as positive pressure method (to inflate package and create greater inside pressure, such as the Labthink Languang product, PARAM series of LSSD-01 Leak and Seal Strength Tester) and the negative pressure method (to create vacuum environment and reduce the pressure outside the bag, products like Labthink Languang PARAM series MFY-01 Tightness Tester). As to the screw-type containers, the tightness is most likely to be influenced by the joints between caps and bottles. Such test can be run on Labthink Languang products of PARAM series LSSD -01 Leak and Seal Strength Tester.

2.3 Head-Space Gases Analysis

Packaging process is finished does not mean we should pay no further attention to it; there is still lots of remaining gases inside packages. Once filling is finished, it is very difficult to control and change the gases composition until the package is opened. Packaging materials with barrier property can only slower the permeation of gases, not remove the gases inside packages (exceptions are those in which deoxygenation technology are applied). If the volume of remaining gases exceeded the maximum concentration limit, then no barrier material and packaging

technology is able to reach the requirement of product guarantee. Therefore we need to test the remaining gases inside packages, and adjust packaging techniques accordingly.

Remaining gases and adsorbed gases can both be tested by testing the head-space gases—testing the composition of gases gathering on the top part of packages. The only difference is the test time. If it is remaining gases to be tested, tests should be conducted right after the packaging process is over. If we want to test the adsorbed gases, we have to take the test over a period of time after the packaging process, and conduct tests for several times as time goes on. A curve of gases concentration should be drawn for comprehensive analysis, as the release of gases is also a slow process. Such test can be done by the PARAM series HGA-01 Head-space Gas Analyzer made by Labthink Languang. Of course we can also lower the concentration of certain gases in the package environment in order to accelerate the release of adsorbed gases.

3. Summary

As a summary, though changes of gases composition inside packages cannot be avoided, we can comprehensively analyze a product and predict its guarantee period by testing the barrier property of whole packages, the tightness of packages and the composition change of head-space gases. These tests can also help us to find out the weakness in our package design and provide us with accurate test data to improve the structure of our packages.