

## Latest Developments in Barrier Property Test of Package

**Abstract:** This article deals with the test principle of barrier property (gas permeability and water vapor permeability) test of package.

**Keywords:** water vapor permeability , gas permeability , package and test

Containers are directly used in liquid package. Since raw material of containers is often processed with high temperature and cooling procedure, some indexes of the raw material cannot indicate the final property of package. That is why various indexes of container should be comprehensively tested.

### 1. The realization of Package Barrier Property Test

Being one of the important indexes of flexible package, barrier property directly influences the quality guarantee period of inner content. In fact, except metal cans and packing box of pulp-molded aluminum, one complete container package mainly consists of bottle body and bottle cap. Bottle body is the main test object of barrier property test. However, massive tests have proved that the connecting place of bottle body and bottle cap is a key point influencing barrier property of package. The barrier property test of package should include three parts. Firstly, test barrier property of bottle cap. Next is barrier property testing of bottle cap. The last one is the testing of the barrier property of the connecting place of bottle cap and bottle body. Since bottle cap is often made of metal, it can be considered as possessing high barrier property. Therefore, barrier property testing of package can be divided into the test of bottle body and the test of bottle cap and connecting place.

The special shape of package makes barrier property tests present specific characteristics. Comparing with film, test methods of container package develop more slowly. In the past, gas permeance and water permeance of package are estimated by testing the sheet material of the package. However, container package wall is not uniform in thickness and the nature of material will change in the process of production, which will cause certain disparity existing between estimated and actual gas permeance of the package. Among various test technologies, test method of packages oxygen permeability enjoys the rapidest development. The introduction of ASTM F 1307 standard for package oxygen permeability test method not only accelerates the research and popularization of package oxygen permeability instruments, test results also becomes more scientific and accurate, which change the former condition of chaotic test methods and lower credibility of test data.

Labthink is the first domestic manufacturer that sets foot in barrier property test. It develops the first domestic package/film oxygen permeability tester in 2004. Based on electrochemistry principle and double function of film test and package test, this instrument meets the requirements of ASTM F 1307 and ASTM D 3985. This year, Labthink introduces the TSY-W3 for water vapor permeability test of package, which also adopts electrochemistry principle and possesses double function of film test and package test.

### 2 Principle of Package Gas Permeability Test

In gas permeability test of package, test technology of equal pressure method must be adopted. Sometimes, the

inner and external pressure difference of package is big enough to destroy bottle body and the high barrier property coating layer, all of which cause the test discontinuation. Therefore, traditional differential-pressure method cannot be used in the field of gas permeability test of package now.

Test principle of package gas permeability test is similar to that of film gas permeability test of equal-pressure method. Here we will take oxygen permeability test of package as an example. First, use the package to divide the permeation chamber into two independent airflow systems with one side as the flowing testing gas (pure oxygen or mixed gas of oxygen) and the other side flowing dry nitrogen gas. Pressures of the two sides are equal but oxygen partial pressure is different. Under the function of oxygen concentration difference, oxygen transmits through the film and diverts into the sensor by nitrogen carrier gas. Oxygen gas transmission rate (O<sub>2</sub>GTR) of the package can be calculated according to the oxygen quantity that is accurately measured by the sensor in nitrogen carrier gas.

With this instrument, oxygen permeability of the connecting place can also be test, which provides an efficient test method for the understanding of package barrier property. The difference between oxygen permeability test of the connecting place and the pure package oxygen permeability test mainly lies in the preparation of specimen. Oxygen permeability test of the connecting place is shown in figure 1 below:



Figure 1. Package Test Condition

Similar to film gas permeability test of equal-pressure method, this method is mainly used in oxygen permeability test of specimens. It can also realize carbon dioxide permeability test. However, it is not able to test gas permeability of nitrogen and other gases.

### 3 Principle of Water Vapor Permeability Test of Package

Water vapor permeability test of package can be tested with gravimetric method and sensor method. Since the

measuring range of weight sensor limits its precision in gravimetric method, it is not ideal to test water vapor permeability of package with gravimetric method. Moreover, the long test period of about one month will increase the difficulty of environment controlling.

Test principle of package water vapor permeability test with sensor method is similar to that of gas permeability test (see figure 2). Replace the upper test chamber with special enclosure (auxiliary with the instrument), and then use the package to divide the permeation chambers into two independent airflow systems with one side being the flowing carrier gas (dry) and the other side maintaining certain relative humidity. Water vapor concentrations of the two sides are different but the concentration difference (relative humidity difference) is stable. Under the function of concentration difference, water vapor transmits through the package wall and diverts into the sensor by carrier gas. Water vapor transmission rate of the package can be calculated according to the water vapor quantity that is accurately measured by the sensor in carrier gas. Labthink TSY-W3 can perform thorough water vapor permeability test of package.

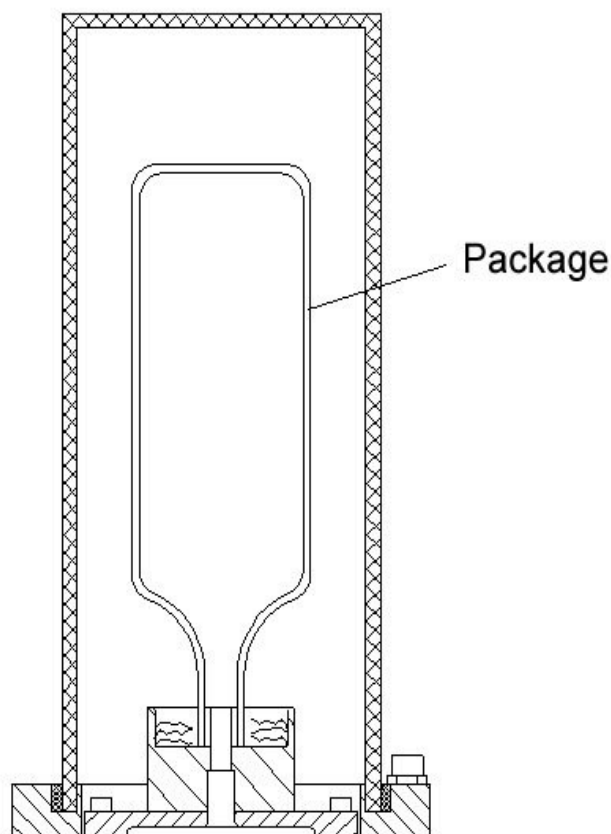


Figure 2 Principle of Water Vapor Permeability Test of Container Package

#### 4 Conclusions

Barrier property test of container package is a great progress from traditional barrier property test of film. Using the test methods introduced in this article, water vapor permeability test of almost all flexible packages (including

flexible bag, paper box and bottle) can be tested, which can provide more comprehensive test data for investigating the influence of package barrier property on quality guarantee period of inner content.