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

Discuss Desiccant Method and Water Method from the Development Trend of Gas Permeability Test

Abstract: based on test principles of desiccant method and water method, this article analyzes differences of these two methods. It also discusses advantages and disadvantages of these two methods according to the development requirement of gravimetric method. This article concludes that water method is the main development direction of water vapor permeability testing.
Key Words: gravimetric method, water method, automatic test, humidity control

Gravimetric method is the arbitration method of water vapor permeability testing. Possessing the merits of simple structure, convenient operation and lower cost, gravimetric method has witnessed an extensive application. The forms of package are modification of permeable cup, which can be bag, bottle or other package forms. Gravimetric method can be divided into desiccant method and water method. This paper will explore these two methods in terms of their development trend and application.

1． Test Principles of Desiccant Method and Water Method

1.1 Introduction

In early period of water vapor permeability testing, desiccant method is more frequently used and is still widely used at present. In Desiccant Method, some desiccant is put inside permeable cup to absorb humidity. At the same time, this permeable cup is placed in constant temperature and humidity environment to maintain constant relative humidity difference. Specifically speaking, certain amount of desiccant is filled into permeable cup at the first. Then a specimen is sealed to the cup to form a drying environment. Next, place this permeable cup into constant temperature and humidity environment. Water vapor transmitting through permeable materials is absorbed by desiccant. weigh the increase weight of permeable cup Periodically to determine permeability of water vapor.

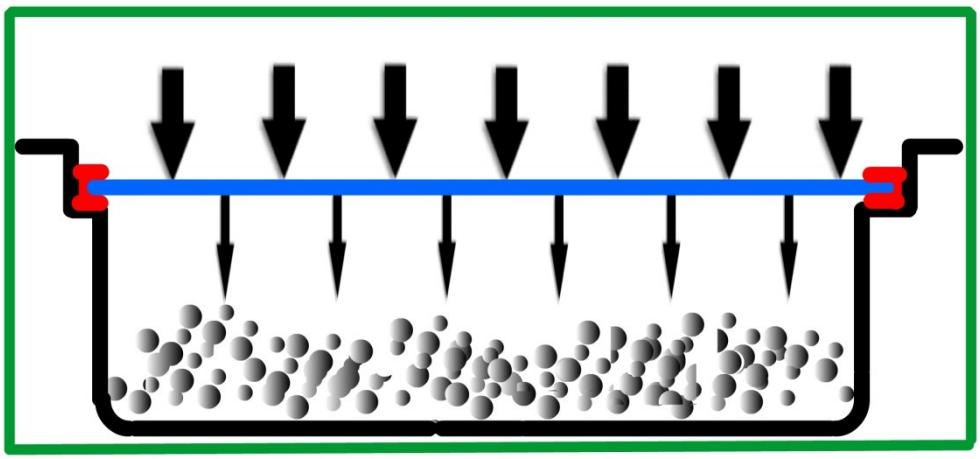

Fig.1 Sketch map of desiccant method

Although advances a litter later than desiccant method, water method has prominent advantages of its own. It can maintain high humidity environment inside permeable cup in a long period. Water method (see figure 2 for test principle) does not use desiccant. In water method, high speed gas flow purges above specimen and at the same time carries away the water vapor transmitted through specimen. Weigh the permeable cup to obtain

weight decrement of permeable cup, through which transmission rate of permeable cup can be calculated.

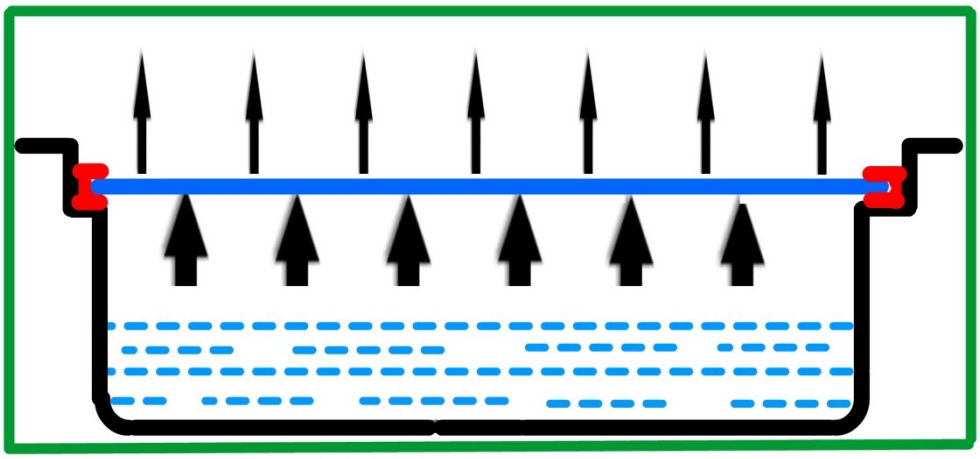

Fig.2 Sketch map of water method

1.2 Comparison of the Two Methods

The most significant difference between desiccant method and water method lies in the substance contained in permeable cups. In permeable cup of desiccant method it is desiccant while that of water method distilled water, saturated saline solution or other reagents. In each method, a relative humidity difference is formed on two sides of specimen. According to the test process and the calculation formula provided by ASTM E 96, test data of desiccant method and water method should be the same under ideal conditions. Empirical tests have proved that stability of humidity difference formed on two sides of specimen in water method tends to be much better than that in desiccant method during the course of time. Moreover, data stability and repeatability of water method are better than that of desiccant method.

2． Limitations of Desiccant Method and Advantages of Water Method

2.1 Development Requirement of Gravimetric Method

In addition to the precision of analytical balance, factors such as environment, operation process, and timing of test will also affect precision of test result (for relevant operations, users can refer to GB/T 1037). The uncertainty of these influencing factors results in unpredictable diversity between actual test curves and ideal test curves of permeability tests. Traditional gravimetric method instruments have encountered various problems during actual application. For example, on occasion when test environment differs from weighing environment, transmission equilibrium of water vapor through permeable cup will be destroyed when permeable cup leaves test environment for weighing. This will produce inestimable influence on the whole transmission process of water vapor, which will not only decrease stability of test results but also prolong test time. Operators' habits will also affect test results. The sealabilty of permeable cup is another problem to be solved as the volatilization of mix wax itself may exceed 0.5g/m^2 . Moreover, other factors such as big data fluctuation, the difficulty of cup sealing and lower test efficiency also add to the problems. Therefore, due to their complex operation, traditional gravimetric method instruments are difficult to make any breakthrough in terms of test efficiency and test precision. The development trend of gas permeability test requires test instrument of high efficiency and precision, the realization of which relies heavily on integrated test environment and weighing environment as well as the realization of automatic test.

2.2 Limitations of Desiccant Method

What permeable cup contains in desiccant method is desiccant. As the humidity adsorption ability of desiccant has upper limit, test period of desiccant method cannot be prolong without limit and non-periodical check and replacement are necessary. Therefore, it is specified in desiccant method test standards that specimens should be tested before the humidity adsorption ability of desiccant obviously decreases. Otherwise, the difference of relative humidity on two sides of specimen may not be insured if humidity adsorption ability of desiccant decreases obviously, which results in the invalidation of test results. For example: in GB/T 1037-88, it is specified that the total increment of humidity adsorption of desiccant inside permeable cup should not exceed 10%, while in ASTM E 96, the increment is required not to exceed 4%.. Therefore, the humidity adsorption ability and the quantity of desiccant as well as its contact area with permeable cup are closely related with lower measurable limit of water vapor permeability and test period. At present, it is rather difficult to control drying power of desiccant. However, the desiccant must be replaced when its humidity adsorption reaches certain degree. As the desiccant is contained in permeable cup in desiccant method, its replacement means stopping test. Moreover, to reach expected upper limit of humidity adsorption, permeable cup should be vibrated periodically for reciprocate mixture of desiccant so as to improve drying power. These procedures cannot complete automatically without manual operation. The instability of humidity controlling becomes the biggest barrier on the way to realize automatic test. At present, there is no effective solution for this problem.

2.3 Advantages of Water Method

Test environment of water method makes the realization of automatic test rather easy. There is no obstacle to integrate test environment and weighing environment. In water method, what is contained in permeable cup is distilled water, saturated saline solution or other reagent used to form specific relative humidity. Relative humidity difference on two sides of specimen is determined by purity and temperature of inside medium. This provides reliable guarantee to the production of stable humidity. Empirical tests have proved that test time of film materials is far less than the time needed to volatize all the reagent inside permeable cup. Humidity difference will not decrease during test process. External environment of permeable cup can realize constant dry and humidity through external means. Therefore, a realizable humidity difference can be guaranteed on two sides of specimen in a long period.

At present, water vapor permeability test instrument in the global market can be divided into humidity sensor method, infrared method, electrolytic method and etc, all of which adopt ‘water method’ environment mode, that is, using distilled water or saturated saline solution to realize high humidity on one side of specimen. However, ‘desiccant method’ environment mode is not adopted.

3 . Conclusion

Gravimetric method is the fundamental way for water vapor permeability testing. It is also the ‘primary standard’ to calibrate test data of other sensor method. Therefore, to improve test precision and efficiency of gravimetric method is not only the development requirement of itself, but also the basis on which other water vapor permeability testing standards to improve accuracy. Test principle of desiccant method makes it difficult to realize automatic test. That is why desiccant method develops rather slowly in the past twenty years. Possessing the function of automatic test, water method has displayed great developing potential. Now, it has become the most widely used full automatic method and the main developing direction of gravimetric method.