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Analysis on Purchasing Choice of High Barrier Property Material Testing Instruments

Abstract: Based on material characteristics displayed during high barrier property material transmission rate testing, this article introduces the rules and corresponding reasons for instrument choices of various methods.
Keywords: high barrier property , system zero , equilibrium , sealing , temperature

With the outstanding performance in packaging and growing applications in more fields, high barrier property material has become one of the main trends in packaging material R&D worldwide. Correspondingly, the R&D and manufacturing of high barrier property materials have put forward higher requirements for testing instruments. It's commonly believed, by operators, that data fluctuations of high barrier property materials would be greater than those of medium and low barrier property materials. What are the causes for such data fluctuations? What are the requirements for high barrier property material testing instruments? Based on the material characteristics displayed during high barrier property material transmission rate testing, this article introduces rules and corresponding reasons for instrument choice.

1. Testing Characteristics of High Barrier Property Materials

High barrier property material, also called low transmission rate material, is the material with low gas transmission rate. When testing barrier property of such materials, three testing characteristics would be observed as follows:

1.1 High barrier property materials are extremely low in gas transmission quantity and extremely slow in transmission speed.

This is the operational difficulty when testing high barrier property materials, which put forward two corresponding requirements for testing instruments: on one hand, the instruments should have excellent sealing performance. With years of testing experiences, it's admitted that leakage is the greatest obstacle when testing high barrier property materials. It should also be noted that such leakage is often not a problem of testing instruments, but a problem caused by improper specimen clamping. On the other hand, the detecting sensor should be of high precision and high sensitivity. The sensor precision determines testing limit directly, and is the main decisive factor for testing time.

1.2 It would take a long time to reach transmission equilibrium.

Equilibrium is the key in barrier property determination. As to high barrier property materials, it would accumulate for a period of time for the transmitted testing gases to be detected by the sensor. Besides, data fluctuations and errors caused by minority of gas quantity would influence judgment for transmission equilibrium. Generally, it would take several hours up to less than 20 hours to reach equilibrium for high barrier materials.

The ambient factors and corresponding interference cannot be neglected. For instance, the influence of temperature should not be ignored for both sensor and specimen: temperature fluctuations would lead to fluctuations of sensor output as well as barrier property changes of the specimens. Moreover, the long testing time would lead to compositional change of testing gases, including minor gas quantity changes and the under-mixing of mixed gases caused by gas source change. Therefore, compositional stability of testing gases should be

guaranteed.

1.3 There are higher requirements for system zero and testing process stability.

System zero is the comprehensive expression and the recorded instrument status when the residual testing gas inside instrument has been cleared to the utmost. When testing low barrier property materials, system zero is not so much influential to the testing data. It's because that the system zero value, compared to the barrier value, can be omitted. As to high barrier property materials, accuracy of system zero would directly influence testing data. Besides, fluctuation caused by temperature would lead to sensor output fluctuation. Therefore, it's also an important factor affecting system zero. Besides, ambient humidity, vibration and other environmental factors should not be neglected.

2. Key points in Instrument Selection

Comprehensively, testing instruments for barrier property material should have good performances in the following aspects:

- Sealing performance: instrumental sealing performance should be good;
- Sensor precision: the sensor of instrument should be highly precise;
- System zero: the system zero should be stable;
- Ambient interferences: the ambient interferences should be as low as possible.

Hereafter are the specific key points in instrument selection for different barrier property testing methods.

2.1 Differential-pressure Method Gas Transmission Rate Testing

Differential-pressure method is the basic method for gas transmission rate testing. Its accuracy depends on the data obtained from the pressure sensor in lower chamber. When testing high barrier property specimens, the highly precise pressure sensor is a necessity. Several points should be taken into consideration when purchasing:

2.1.1 Lower testing limit: the lower testing limit represents the lowest testable limit of the instrument, and is the comprehensive expression of sealing performance, system zero and sensor precision of the whole system.

2.1.2 System vacuum degree: system vacuum degree of differential pressure instrument can be regarded as the system zero. Yet, this so-called system vacuum degree only refers to the vacuum degree achieved after long time vacuuming, and a periodical vacuuming is not proper. Observe the lowest pressure value. For differential pressure method, system sealing performance and specimen clamping effect can be verified through vacuuming.

2.1.3 Control and monitor capability of the ambient environment. It has been widely proved that ambient environment influences system zero, transmission equilibrium and specimen characteristics. Temperature, one of the ambient environment factors, is the most influential. Therefore, instrumental temperature control capability and its range and evenness should be especially noticed. Since high barrier property materials would be influenced more obvious by environmental factors, it would be preferable if the instrument has the capability of testing other environmental factors. Data of those factors would be helpful for the analysis of abnormality.

2.2 Equal-pressure Method Gas Transmission Rate Testing

The gas sensor of equal pressure instrument directly outputs the gas quantity of testing chamber. If the sensor is inferior in precision, reduction of carrier gas flux to increase testing gas quantity in testing chamber within a unit time would be a good solution. However, the requirements for system zero should be carefully guided. When

purchasing equal pressure instruments, the following points should be noticed:

2.2.1 Lower testing limit

2.2.2 Control and monitor capability of the ambient environment. Since gas circuit of equal pressure instrument is exposed to the ambient environment, the interferences of environmental factors can not be neglected. Therefore, control and monitoring of the ambient environment should be especially noticed.

2.2.3 Gas source handling. During equal pressure testing process, a large amount of testing gas purges into the two chambers separated by the specimen. The changing of carrier gas source would influence system zero. If the instrument can further handle gas source, stability of system zero can be better kept.

2.3 Weighing Method Water Vapor Transmission Rate Testing

Component precision of weighing method instrument determines the lower testing limit, data accuracy and other key indexes. In common practices, manual operation with the weighing cup as well as weighing are needed. Errors are unavoidable, and greater data deviation would occur correspondingly when testing high barrier property materials. If those factors related to operators are eliminated, the automatic weighing method testing instruments would be of excellent performances in testing high barrier property specimens. Several issues should be noticed when purchasing weighing method instruments:

2.3.1 Automatic testing or not. As to high barrier property materials, manual operation imposes unavoidable influences on testing data. Therefore, common manual mode is not suitable.

2.3.2 Lower testing limit.

2.3.3 Control and monitor capability of the environment.

2.3.4 Vibration monitoring.

Weighing method is the most sensitive to vibration among all those methods. When testing high barrier property materials, minor vibration or shake would lead to test failure. Therefore, if ambient vibration can be monitored, it would be greatly helpful for abnormal data investigation.

2.4 Sensor Method Water Vapor Transmission Rate Testing

Sensor method water vapor transmission rate testing includes electrolytic sensor method, infrared sensor method and humidity sensor method, etc. The principles and instrument structures of those methods are similar. The only difference between those methods is that the testing principles of those sensors are different. Among the sensors, infrared sensor is most easily to be influenced by the environment; therefore, when using this kind of sensors, there are high requirements for the environment. Comparatively, electrolytic sensor has far more better stability. When purchasing sensor method instruments, the following points should noticed:

2.4.1 Lower testing limit

2.4.2 Control and monitor capability of the environment. Since infrared sensor is apt to be influenced by the ambient environment remarkably, there are higher environment requirements for infrared sensor instruments than for electrolytic sensor instruments.

2.4.3 Gas source handling. During equal pressure testing, a great amount of testing gas purges into the two chambers separated by the specimen. The changing of carrier gas source would influence system zero. If the instrument can further handle gas source, stability of system zero can be better kept.

3. Conclusions

The above mentioned information would contribute to the instrument purchase of high barrier property material testing. Furthermore, specific testing procedures should be taken care. For example, gas source, specimen sealing, prolonging vacuuming time or purging zero time, and environmental factors, etc., should all be taken into consideration. Some faulty views caused by immature testing technologies of the early stage should be corrected. At present, there is no remarkable difference between those barrier property testing methods.