

Reference material Used in the Calibration of Gas Permeability Test

Abstract: based on the classification and requirements of standard materials as well as the NIST's introduction of to film standard material, this article elaborates on the source, the requirements and the application of reference material being employed in the calibration of gas permeability test.

Key words: equal-pressure method, calibration, reference material, standard material

Since standard material or standard measuring device is essential for calibration, how to calibrate permeability testing instruments had once been a factor impeding the development of permeability testing. Calibration methods have now become very mature. Instrument can be calibrated with reference material, standard gas or standard devices such as manometer, and standard weights.

Reference material has known permeable parameters such gas permeability. Through a series of testing, the permeability of reference material will not change obviously within certain period. Moreover, reference material is stable in its own properties. It is a special kind of standard material used for calibration of permeability testing and is rarely used in other fields. This article deals with reference material in terms of its uses, conditions and actual applications.

1. Uses of Reference Material

First, reference material can unify data system of testing. Comparability of different methods can be considered as the fundamental demand on reference material application. As is well known, there will be more than one test methods for each kind of permeability testing. For example, there are equal-pressure method and differential-pressure method for gas permeability testing. There are gravimetric method, infrared method and electrolytic method for water vapor permeability testing. Particularly, for gas permeability testing of materials, differential-pressure method and equal-pressure method vary greatly in terms of test environment and test principle, which imposes direct influence on test data of the two methods. Therefore, test data of different methods are difficult to be compared. However, reference material can unify test data of various methods and increase the comparability of test methods.

Secondly, reference material is also widely applied to evaluate the condition of instrument components, to calibrate data system of instrument and to prolong valid period of equal-pressure method sensor. For example, oxygen sensor adopted in equal-pressure method will be depleted with time. It is subjective and unreliable to decide the depletion of oxygen sensor only by personal experience. Reference material has obtained good reputation during actual application since its test data can be used to compare with standard value so as to evaluate working conditions of instruments. Moreover, when oxygen sensor is depleted to certain extent and affects test data, the use of reference material can calibrate data system of instrument and prolong lifespan of sensor.

2. How to Select Reference Material

Since the process of film production is rather complex, there are many factors affecting the stability of permeable parameters. Generally speaking, institutions of standard material should carry out systematic test to films in terms of stability of physical property, repeatability of test data and valid preserve period. The film cannot be used

to evaluate testing stability and data calibration of permeability instruments unless all the above mentioned aspects meet the requirements.

It has been proved that the standard material specified in equal-pressure method oxygen permeability test standard ASTM D 3985 is SRM 1470, which is issued by NIST: POLYESTER FILM FOR OXYGEN GAS TRANSMISSION MEASUREMENTS.

3. Briefing on Reference Material

3.1 SRM 1470

Issued by NIST, SRM1470 takes the form of 23 μ m thick sheets of PET film. It can maintain a stable value of O₂GTR. The measured result under one atmospheric pressure is 63.8cm³(STP)/(m²·d·atm). What was employed for the data collection is the computer-controlled manometric permeation measuring facility

NIST official website has such description to SRM 1470: the known permeability value of nitrogen gas, oxygen gas, and carbon dioxide gas are compared with values obtained through common technology such as differential-pressure method, volumetric method and coulometric method. SRM standard material is intended for use in the measurement for oxygen gas transmission rate of thin films using manometric, volumetric, or coulometric methods.

3.2 Labthink PC Film

Labthink pc film takes the form of 125 μ m thick sheets of polycarbonate film. Its oxygen permeability under standard test condition (one atmospheric pressure, 23 $^{\circ}$ C) is 430.206 cm³/m²·24h·0.1MPa. Long term tests have proved that barrier property of this material is rather stable.

Labthink barrier laboratory has conducted a two-year research to this material study the stability of its property. Some of the data are listed below:

| time | times | Test temperature (°C) | average oxygen permeability (cm ³ /m ² ·24h·0.1MPa) |
|---------------|-------|-----------------------|---|
| 2005-7-6~8 | 3 | 40 | 635.512 |
| 2005-7-14~16 | 3 | 40 | 624.805 |
| 2005-7-25~27 | 3 | 40 | 635.463 |
| 2005-8-11~12 | 3 | 40 | 632.385 |
| 2005-11-18~22 | 3 | 40 | 617.000 |

PC films adopted in this group of tests are obtained from the same batch. The data show that barrier property of the material does not change with time. Other mechanical tests have showed that such material possess better physical stability. In 2006 and 2007, Labthink also tested this material under different temperature (10 $^{\circ}$ C~50 $^{\circ}$ C) and pressure difference (0.03 MPa~0.15MPa), both data stability and data repeatability appear to be very good.

4. Conclusion

For gas permeability testing, the inconsistency of test data between differential-pressure method and equal-pressure method as well as the depletion appeared during application makes calibration the chief factor to

guarantee data accuracy. Films are the standard materials adopted in reference material calibration. Therefore, only when stable and effective reference material is employed can users obtain effective calibration data.