

Auto Gas Permeability Testing and Air Permeability Testing of Materials

Abstract: Based on the requirements of material auto gas permeability testing, this article introduces testing methods of auto gas permeability testing and air permeability testing. It also presents a detailed description about the suitable materials as well as the similarities and differences of these two testing methods.

Key Words: permeability, auto gas permeability, air permeability, film, nonmetal

Auto gas permeability testing of materials is one of the important indexes in its physical property testing. Low permeability material is known as possessing certain barrier property to gases. Among these materials, materials with extremely low auto gas permeability are called barrier materials and are massively used as functional materials (such as commodity package). High permeability materials are said in relation to materials with certain barrier property. Being versatile materials, they possess big auto gas transmissibility and plenty of varieties.

1. Auto Gas Permeability Testing

Auto gas permeability testing is to carry out permeability testing of specific gases to materials with certain air barrier property. Most of these materials are macromolecule polymer or multi-layer complex materials made of high polymer and are widely used in the fields of product package such as food, pharmacy, chemical, electron and war. Among that, materials with very good barrier property (low auto gas permeability) can be used in package of sensitive commodities such as oxygen and water vapor. This kind of materials is the developing focus of plastic package industry in recent years and is also the developing base of new type package such as gas packing, vacuum packing, and sterile packing.

Auto gas permeability testing of materials is mainly carried out with differential pressure method and equal pressure method and the former is the most widely used one(detailed information can refer to the article named Auto Gas Permeability Testing and Its Testing Instruments updated from October 10 to 15,2005 at Labthink Lab Forum.) Being a pure physical testing method and fundamental testing method in auto gas permeability testing, testing principle of differential method is clear and intelligible and is similar with that of air permeability testing instruments. Differential pressure method can be further divided into vacuum method and positive method. According to the requirements of testing standards, vacuum gauge or gage pressure sensor with extremely high resolution should be adopted. Minute change of pressure in testing process must be accurately recorded.

Auto gas permeability testing has the following characteristics:

First, to auto gas permeability testing instruments of vacuum differential pressure method, vacuum degree of testing chambers is an important index. In standard ASTM D 1434-82(2003), low pressure side is required to be less than 26Pa, while in standards ISO 2556:2001and GB/T 1038-2000, that should not exceed 27Pa. Auto gas permeability instrument should be equipped with vacuum pump of very high vacuum pumping ability. Since vacuum degree can directly influence situation of specimens, whether the required vacuum degree can be satisfied will exert certain influences on testing data.

Next, precision of vacuum gauge can directly influence accuracy of testing results. Moreover, precision selection will impose certain limitation on measuring range of vacuum degree. Since this kind of materials is low in auto gas permeability and pressure variation ratio of lower testing chamber during testing process is also very small, large measuring range is not necessary for vacuum gauge. Oxygen permeability testing data of five high permeability materials are listed in table 1. In this group of testing, maximum pressure variation was not bigger than 20Pa until the finish of testing.

Table 1. Data List of Oxygen Permeability Testing

Material	Temperature ℃	humidity %RH	thickness μ m	testing duration h	Ending pressure of testing Pa	auto gas transmitting quantity ml/m ² ·24h·0.1MPa
A	24.2	63.8	90	22.0	2.47	0.05
B	24.3	53.6	100	7.5	8.22	1.04
C	24.1	58.6	100	6.4	15.07	2.01
D	21.4	42.3	250	2.1	9.32	3.467
E	23.1	27.1	60	2.7	12.60	5.44

Thirdly, temperature fluctuation can directly influence barrier property of specimens. Its influence on permeability coefficient, solubility coefficient and diffusion coefficient follows Arrhenius equation.

At present, professional auto gas permeability instruments used for material of low auto gas permeability develop rather rapidly. With powerful function, Labthink VAC-V1 auto gas permeability instrument can completely satisfy domestic and international standards.

2. Air Permeability Testing

When high gas permeability materials such as plastic froth, leather, textile, cardboard, paper, porous ceramics and so on are used in some specific fields, gas permeability of these materials should be quantified. For example, gas permeability of cigarette paper can impose direct influences on the appearance, smell and content of fume of cigarette, while gas permeability controlling of textile is a key factor for wearing amenity of clothes. Gas permeability testing for this kind of material is called air permeability testing, in which professional air permeability testers should be adopted.

Testing methods for the above mentioned materials can be divided into two kinds: testing differential pressure by fixed flux or testing flux by fixed differential pressure (for detailed information please refer to Automobile Technology and Material and Air Permeability Testing for Automobile nonmetal published in September and October, 2005). The former one is mainly used in

the testing of polyurethane foam plastics as well as flexible or semi-rigid multi hole elastic materials. While the latter one is mainly used for the testing of textile, non-woven fabrics, leather and so on. In Air permeability testing of paper and leather, the time needed by certain volume air to transmits through specimens under specified differential pressure should be tested, which may classified as test mode of testing flux by fixed differential pressure. The last procedure is to calculate with tested flux.

Comparing with the above introduced auto gas permeability testing, air permeability testing possess the following characteristics:

- First, test objects are different .Auto gas permeability testing is mainly used in film testing, while air permeability testing is mainly used in the testing of multi-hole materials and non-woven fabrics.
- Secondly,auto gas permeability testing can be used for material permeability testing of oxygen, nitrogen gas, carbon dioxide and air, while air permeability testing is mainly used for permeability testing of materials to air.
- Thirdly, the length of testing time varies a lot. Testing time of air permeability testing is a lot shorter than that of auto gas permeability testing, the reason for which that auto gas permeability of materials being tested in these two methods differs very much.

Fourth, since air permeability testing is mainly used for material of high auto gas permeability, the instruments will not need high sensitive vacuum gauge or pressure transmitter and its demand on vacuum pumping ability of vacuum pump is also not high. However, to satisfy testing requirements of different gas transmitting quantity, pressure gauge with wider measuring range is demanded.

Fifth, pressure transmitter and vacuum pump are not the complete key elements of air permeability instruments, precision and measuring range of flowmeter is also very important.

For different materials, the difference in testing standards and testing method also cause great difference in the units of testing data. For example, final testing results of textile is gas transmissibility(mm/s), while that of the leather is transmitting quantity(ml/cm².h). Under the help of professional operating software, the same instrument can complete data conversion of the above mentioned testing.

At present, the development of air permeability instruments varies greatly. For example, air permeability testers for textile, paper and so on is abundant in type, while that of polyurethane foam plastics and the porous elastic materials are very rare. TQD-G1 air permeability tester developed by Labthink this year is the instrument simultaneously possesses the modes of testing differential pressure by fixed flux and testing flux by fix deferential pressure. Moreover, Labthink can manufacture instruments according to required testing range and testing precision from customers. Such instruments are more superior in utility.

3. Conclusion

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In gas permeability testing of materials, property difference of the materials will result in obvious difference of testing instruments. Selecting corresponding instruments according to testing requirements is the optimal way to obtain practical testing range and testing precision. Although there are specific testing instruments on sale for materials of flexible package, cigarette paper, textile and so on, the development of TQD-G1 air permeability tester is no doubt an favorable factor in promoting auto gas permeability controlling of materials such as polyurethane foam plastics, porous elastomer and so on,.