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

On Standard GB1037
--Gravimetric Method Water Vapor Permeability Testing Standard

Abstract: based on test principle of gravimetric method and GB1037 of 70 edition and 88 edition as well as its referred standard ASTM E96, this article presents a systematic introduction to GB1037. It is pointed out in this article that GB 1037 is the comprehensive standard for gravimetric method film water vapor permeability testing. It is fault to consider this standard as purely desiccant method. It is also incorrect for someone to mention desiccant method only while neglecting water method in discussing gravimetric method.
Key Words: GB 1037, water vapor permeability, gravimetric method, cup method

With the rising and rapid development of domestic flexible packaging industry, GB 1037， *Test method for water vapor transmission of plastic film and sheet-Cup method* ， undertakes the great responsibility of providing accurate test method and obtaining scientific test data. Originally, water vapor permeability testing of flexible packaging materials didn't attract enough attention. As the demand on high property and multi-functional materials are increasing since 1990s, water vapor permeability testing gradually received attentions and gained popularization. However, for lack of systematic knowledge, some insiders held lopsided view relating GB 1037, For example, GB 1037 is thought to employ desiccant method only and not to include water method. Based on test principle of gravimetric method and GB1037 of 70 edition and 88 edition as well as its referred standard ASTM E96, this article presents a systematic introduction to GB1037.

1. Test Principle and the Application of Gravimetric Method

In gravimetric Method, there is a constant water vapor pressure difference maintained on two sides of specimen under specified temperature condition. Then measure the weight variation of permeable cup using gravimetric sensor or analyzing balance. At last, calculate water vapor permeability parameters of materials according to specimen area, thickness, weighing interval and humidity difference on two sides of specimen. Because the salient feature of this method is permeable cup, thus gravimetric method is also called cup method. According to test principle of gravimetric method, the only condition requirement is to maintain certain relative humidity on two sides of specimen. However, it does not regulate which side should be the high humidity side. This is in no way the defect of test principle. Otherwise, this defect would have been pointed out and corrected during its wide application of more than half a century. The reason is that it makes no sense to specify the humidity on two sides of specimen. By measuring weight variation of permeable cups, accurate test data can be obtained no matter which side is the high humidity side. Moreover, actual application condition of plastic film varies very much. Sometimes, both sides of film are dry. Sometimes one side is dry and the other side is wet and also there are times when both sides are rather wet. For this reason, it is one-sided if the standard specifies that all kinds of packaging materials be tested using desiccant method or water method. It is rather reasonable to select test methods according to actual conditions, which can not only better simulate the application environment but also obtain test data with great practical significance of reference.

During actual application, test instruments consist of gravimetric sensor (or analyzing balance), constant temperature and humidity container, and permeable cups, no matter the method being used is desiccant method or water method. However, in desiccant method, permeable cups are filled, with desiccant with the humidity of constant and humidity container being increased. In water method, permeable cups are filled with distilled water or other solvent being able to produce high humidity, with the humidity of constant and humidity container being lowered.

2. Instituting and Revision of GB 1037

2.1 GB 1037-70

The first edition GB 1037, with Test method for water vapor transmission of plastic film as its full name, is applicable for water vapor transmission testing of plastic film, laminated film and leatheroid. It is put forward by Ministry of fuel chemical Industry of the P.R.C., issued by Chinese Academy of Science and put into trial use since October 1, 1970. Although this edition leaves much to be desired in aspects of index definition and test principle, it has advantages in terms of detailed test procedures and operation conveniences. For example, the design of permeable cups in this standard adopts threaded winding mode, in which the sealing of specimen is realized through two rubber pad ring and one metal pad ring. The 70 edition simultaneously contains desiccant method and water method. The brief introduction to these two methods in the standard is as follows: Generally, permeable cups contain distilled water (water method). Only in testing hydrophilic specimen should the cup be filled with anhydrous calcium chloride (desiccant method), which is very similar to the selection of desiccant method and water method in ASTM E96. Although the whole standard involves two methods, there is no distinction in aspects of test principle, test instrument, specimen treatment, and their calculation formula. This standard also brings actual operation into full play in terms of test environment. It is required in the standard : for water repellent specimen , one side keeps dry and the other side 100％. Hydrophilic specimen should meet specifications of product standard or use required relative humidity. This provides a basis to water vapor permeability testing under special conditions.

2.2 ASTM E 96 reference standard

ASTM E96 is by far the gravimetric standard with the longest history. It is also the longest-standing standard method for water vapor permeability testing. The first edition is issued in 1953 and has been revised for many times since then. ASTM E96 includes test methods of desiccant method and water method and has clear description to the selection of test method and test data. According to ASTM E96, both desiccant method and water method are basic methods and their data are scientific and effective. Therefore users should select specific test method according to the application environment of materials instead of making comparisons only to their test data. This standard is by far the most strict and systematic one for gravimetric method without any distinction to test methods in terms of test principle, test instrument, specimen treatment and calculation formula. It can be seen that even referring to the strictest specifications, water method and desiccant method are consistent in these aspects, although they are specified respectively in item of test procedures (especially the procedures of permeable cup preparation and specimen attachment). From the compiling way of ASTM E96, it is obvious that desiccant method and water method should be combined for analysis in discussing gravimetric method. Neither desiccant method nor water method can completely represent gravimetric method.

2.3 GB 1037-88

Although GB 1037-88 *Test method for water vapor transmission of plastic film and sheet-Cup method* is the revised edition based on standard ASTM E96, because the institute responsible for standard drafting has changed, the focus of standard content also diverted. Compared with the 70-edition, the 88 edition has highlighted test principle of cup method as well as the definition of water vapor permeability parameters. At the same time, the description of specific testing instrument and test procedures are simplified.

GB 1037-88 is drafted by Beijing Plastic Research Institute and is under the jurisdiction of Methods of physical and mechanical testing division of China National Technical Committee of Standardization for Plastic Products. The most significant contribution of this edition is its clarification of the definitions and significances of various water vapor permeability parameters based on characteristics of packaging industry. It made more of a point to

test principle, which not only sets the scene for standard application and popularization, but also paved the way for domestic permeability test technology to be geared to international standards. However, the revision being made in detailed operation in this standard encounters great difficulty during actual application. For example, the wax sealing method of water vapor permeable cups has great difficulty in actual operation, thus not having ideal seal effect. At the same time, this standard adopts only one humidity condition of 90±2％RH, which is not favorable for water vapor permeability testing under special test conditions. Another prominent problem is that this standard produces some misunderstanding due to its simplification of detailed operation procedures. For example: in dealing with relative humidity method, this method only lists the method of filling desiccant into permeable cups. This makes some users misunderstood that it is not correct to use distilled water or other agents. The reason is that the 88 edition standard has highlighted ‘cup method’ in the title, indicating a fact that its content does not confine to ‘desiccant method’ only.

3. Conclusion

According to the systematic analysis above, GB 1037 is the comprehensive standard for gravimetric method film water vapor permeability testing. It is fault to consider this standard as purely desiccant method. Moreover, it is not correct to mention desiccant method only while neglecting water method in discussing gravimetric method. In discussing gravimetric method, desiccant method and water method should be combined for analysis. Neither desiccant method nor water method can completely represent gravimetric method.