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Suggestions for Barrier Property Testing of High Transmission Rate Materials

Abstract: based on experiences and material characteristics indicated in the barrier property testing for high barrier property materials, this article proposes corresponding operation suggestions for different barrier property testing items and methods, so as to better satisfy the testing demands for high transmission rate specimens with the common barrier property testing instruments.
Key Words: high transmission rate, low barrier property, flow rate, concentration, testing area

In some industries, certain transmission rates are required for specific applications. Handi-wrap and battery separator film are examples of low barrier property materials, which are also called high transmission rate materials. Owing to the special material characteristics, it's ideal to apply specific testing instruments for transmission rate testing of high transmission rate materials. However, the applications are often new to the industries, and there are often no specific instruments for the new testing demands. Therefore, the already existing barrier property instruments have to be applied. The operators should bear in mind that when testing high transmission rate materials, they would show characteristics differing from medium and high barrier property materials. Moreover, fittings should be used in testing extremely high transmission rate materials for accurate and effective data.

1. Testing Characteristics for High Transmission Rate Materials

High transmission rate materials have the following features in barrier property testing: first, the increased gas transmission quantities, which require a sufficient testing gas supply. Second, the larger gas flow rate, which requires the detective sensor to be more sensitive and be with broader measuring range. Third, there is no sufficient time for equilibrium determination.

At present, tests for high barrier property specimens are emphasized; and there are still difficulties in testing high transmission rates specimens.

It should be especially noted that the above-mentioned transmission equilibrium determination is the key point in barrier property testing. The conditions for determination should be strictly followed to avoid false judgment or even termination before reaching transmission equilibrium. As to medium and high barrier property specimens, several hours are needed for equilibrium. But for low barrier property materials, i.e., high transmission rate materials, such as non-woven and coated textile materials as well as battery separator films, they would achieve transmission equilibrium in a relatively very short period. That's why the process of spacing sampling equilibrium determination has been deleted in water vapor transmission rate testing standards for textiles.

For high transmission rate materials, the testing obstacles are mainly the increased gas transmission quantities and the greater gas flow rates. For example, the equilibrium determination for differential-pressure method gas transmission rate testing depends on gas pressure changing rate of the lower chamber. When purging testing gas into the upper chamber to test high transmission rate specimen, the pressure of the lower chamber would increase rapidly owing to the high transmission property of the specimen. As to equal pressure method gas transmission rate tester, the determination relies on oxygen concentration in the testing chamber, which would be directly measured by the sensor. However, when testing materials with extremely high transmission rates, the oxygen concentration in the testing chamber would go beyond the upper measuring range of the sensor and influence its life span. As to water vapor transmission rate testers, water vapor quantity going through the material would increase during the whole testing process. Therefore, great amount of solution consumption or exhaustion should

be avoided. At the same time, an effective control of ambient humidity should be emphasized.
With a sufficient amount of testing experiences, the author summarizes the following suggestions that can help expand the measuring range and improve data repeatability when testing high transmission rate materials.

2. Gas Transmission Rate Testing for High Transmission Rate Materials

2.1 Differential Pressure Method
The accuracy of differential pressure method testing is mainly decided by the data obtained from the pressure sensor in the lower chamber. When testing high transmission rate specimens, only the pressure sensor with excellent sensitivity and precision can be suitable for the rapid pressure changes.
As to differential pressure method testing, measuring range can be expanded with the help of the following means:
First, to change the testing mode. Owing to the fact that high transmission rate materials would achieve equilibrium in a very short period of time, the pressures at the beginning and the end of the test can be preset. Then, gas transmission rate of the material can be calculated by measuring the time between pressure changes. According to experiences, measuring range can be expanded in this way; and data repeatability can be greatly improved. Yet, owing to the rapid pressure change, only automatic testing instruments can be used for such high transmission rate materials. The fuzzy testing mode, installed in Labthink PERME V series differential pressure method transmission rate testers, can realize high transmission rate specimen testing.
Second, to change the testing area with the MASK fittings. By changing the testing area, the amount of testing gas through the specimen within a unit time can be effectively regulated. Labthink is now supplying her customers with an efficient and convenient MASK fitting, which has several selectable transmission areas.
2.2 Equal Pressure Method
Gas sensor of equal pressure method instrument directly outputs the gas quantity inside testing chamber. An over-range would directly influence life span of the sensor. So, for equal pressure method, reducing testing gas quantity inside the testing chamber within a unit time is the key for high transmission rate testing. There are three ways as follows:
First, to change the testing gas. Generally, the measuring range is expanded by reducing the oxygen concentration differences between the two sides of the specimen. For example, to replace pure oxygen with air or with other mixed gases. When calculating, the concentration of testing gases should be converted.
Second, to speed up purging speed of the carrier gas, so as to reduce testing gas concentration inside testing chamber. Since the testing gas quantity is obtained from both testing gas concentration and purging speed of the carrier gas, the accelerating purging speed of carrier gas would not influence the testing data.
Third, to change the testing area with MASK fittings, so as to reduce quantities of testing gas transmitted through the specimen within a unit time.

3. Water Vapor Transmission Rate Testing for High Transmission Rate Materials

3.1 Weighing Method
When measuring high transmission rate materials with weighing method instruments, precision of the instrumental components and volume of the water vapor transmission cups should be especially emphasized. Weighing method has two sub-methods, namely, desiccant method and dish method (which is also called water method). According to numerous tests, it has been discovered that dish method is the ideal way for high transmission rate specimens. This is because desiccant method is limited by the moisture absorption level, and may be led to the over-range of the cup weight when adding more desiccants. However, when testing high transmission rate specimens with dish method, the amount of distilled water, or saturated saline solution in the cup should be

carefully observed. A certain amount of solution inside the cup after testing should be guaranteed, so as to avoid dried cup. If the cup cannot meet the requirement, bigger cups should be applied or customized. On the other hand, the humidity inside testing chamber should be carefully controlled. At present, Labthink PERME W series dish method instruments have the perfect capacity to automatically regulate humidity inside the testing chambers, which is advantageous in testing high transmission rate specimens.

In order to enlarge measuring range, using MASK fittings to change testing area is an effective way besides the above-mentioned ways of changing the instrument parts (such as cup). Convenient in operation, the MASK functions as a customized cup with specific area.

3.2 Sensor Method

The principle and instrumental structure for sensor method water vapor transmission rate testing are similar to those for equal pressure method gas transmission rate testing. However, the means to enlarge measuring range for equal pressure method instruments do not apply to sensor method instruments. As to sensor method, the only way to enlarge measuring range is to change the testing area with MASK.

Since some materials are sensitive to water vapor, changing testing gas or changing the gas concentration difference between the two sides of specimen is not proper. Therefore, when testing water vapor transmission rate, completely different testing results can be obtained in different testing conditions. This is completely different to the testing results of oxygen and other regular gases. Therefore, it's not proper to enlarge measuring range by changing testing gas or reducing water vapor difference between the two sides.

4. Conclusions

With the introduction of new materials and new applications, high transmission rate materials have been widely used. This article has put forward some effective, convenient, rapid and accurate means to enlarge measuring ranges of barrier property instruments. Meanwhile, leakage, especially leakage at the edges of the packaging, during barrier property testing, should be emphasized, so as to avoid errors caused by false operation.