Plastic Film Barrier Document: Data System Unification for Barrier Capability Testing

Abstract: The problem of data inconsistency among barrier property tests still exists. Minor differences can lead to significant economical losses, even safety accident of products. This paper mainly talks about the methods of unifying barrier property testing data system and the demands in choosing standard film.

Key Words: barrier property, oxygen transmission rate, water vapor transmission rate, calibration, standard film

From the laboratory capability validation of 'Barrier Property of Plastic Packaging Material Test -- Testing of Oxygen Penetration Amount and Vapor Penetration Amount', we can see that the inconsistency among different testing methods really exists. Though differences are miner, these minor differences can lead to significant economical losses, even safety accidents of products. After the capability validation, experts in the relative fields begin to pay more attention to barrier property testing unification. This paper will further discuss the probability of realization and method of implementation.

1. Analysis of the available methods of unifying barrier property testing data

There are difficulties in unifying barrier property testing data systems because of the differences in testing theories of barrier property testing. For example, pressure-difference method in air penetration test computes testing data by measuring the changes in testing chambers, and equal-pressure method gets testing data by inspecting oxygen content in airflow. Likewise, as for moisture permeability test, parameters also vary greatly: weighting method measures weight, while electrolysis sensor method and infrared sensor method measures gas content in airflow; and humidity sensor method measures the time. So the direct calibrating methods adopted by those barrier property tests are different, such as equal-pressure method using standard air in calibration, while pressure difference method using higher-graded manometers.

But those direct calibration methods can not be used to unify data system of barrier property test. First, these calibration methods only calibrate key test parameters but other parameters are also calculated in final testing results. Second, calibrate objects differ in different calibration methods, and these methods can not be used in other situations. So we must find a current and reliable method to satisfy the need.

After studying calibration methods in other test indexes, in order to unify data system of barrier property test, we must find a kind of substance that can calibrate test data of barrier property test instruments -- just as using standard blocks to calibrate the thickness of instruments, to complement the calibration different thickness gauges. As for barrier property testing, the standard substance is the standard films which have known and stable barrier properties. Users can find out whether the experimental data is within the promising range by comparing the known barrier property data of films and the actual testing data of the instruments. Therefore, the already widely-used standard film calibration method is the first consideration to unify data system of barrier property testing.

2. Standard Film and Its Selection

2.1 Introduction to Standard Film calibration

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Standard film calibration is the most commonly used calibrating method in barrier property testing. The calibration which deals with testing data, instead of experimental parameters, could be used to calibrate instruments in air penetration test, moisture permeability test and organic compounds permeability test, the focus.

There are many advantages in standard film calibration. First, it is easy to use; there is no other needed purchase besides standard substance. Second, it can effectively guarantee the accuracy and consistency of testing data. Other calibrating methods can calibrate only one testing parameter, and can not eliminate the effects of other factors to the final testing results. Third, it can be used in frequent operating and periodical calibration. Multi-chamber testing instruments do not have to break its normal testing process when determining if the instrument is working properly.

2.2 Testing Items of Standard Film

Though standard film calibration has been widely used, the property testing of the standard film needs to be strengthened to qualify for the unification of data system of barrier property. It is important to make sure that deviations would not happen when testing the same index of the films using the same instrument under the same experimental condition. The focus is whether film is still stable (or keeps its barrier property after a certain period of time) and effectively guarantees its permeability, after storage and other procedures as transportation and so on. So, the barrier property of film should include good uniformity and stability.

2.3 Standard Film Selection

First, select films of good uniformity and stability.

Second, uniform is the first consideration. For example, standard films published by NIST and used in air penetration instrument testing are the uniform film. The more kinds of materials involve in films, the more factors affect the uniformity and stability of testing data.

Third, the testing data of selected material should be universal; the data should not too close to the limit of testing instruments, and data of mid-level is fairly receivable. For if the testing data is too close to the limit of testing instruments, other factors such as environment would have more influences on the testing data.

Forth, materials that keep good barrier property after strength enforcement are the priority choice. Although uniformity and stability of barrier property are keystones in material selection, other factors in material transportation should also be considered. So, materials with good barrier property are the prior choices on the basis of satisfying uniformity and stability.

In fact, there many materials that meet the demands of standard film selection, such as PET. PET is the most commonly used material in flexible packaging with moderate barrier property and stability. The two specimens that used in laboratory capability validation of 'Barrier Property of Plastic Packaging Material Test -- Testing of Oxygen Penetration Amount and Vapor Penetration Amount' are PET with slight differences in thickness and having a barrier property of good uniformity and stability. We can see from List 1 that this material keeps good barrier property after enforced on external forces in kneading experiment by Labthink, counteracting the effect of external forces in transportation.

	Thickness	WVTR [1,2] before	WVTR [1,2] after	WVTR [1,2] after	WVTR [1,2] after

		kneading experiment	kneading experiment with pattern D	kneading experiment with pattern C	kneading experiment with pattern B
VMPET	12μm	1.248	18.352	22.112	30.363
PET	20μm	15.64	16.654	16.321	26.012
PE/EVOH/PE	76μm	5.09	5.523	5.556	5.083

List1. Data list of kneading experiment

P.S.：1. The unit of WVTR is: $g/m^2 \cdot 24h$.

2. Average testing value.

3. Summary

Relevant institutes of China have been trying to unify testing data of barrier property. For example, the original national test standards of pressure difference method and weighing method were established, since we can manage the testing data system by controlling testing methods. However, with the development of barrier property testing, equal pressure method and electrolysis sensor method were promulgated, and non-standard instruments have also been used sometimes. Now, we can not control the stability of testing data system by controlling testing methods, so it is urgent to find a new way to unify data system of barrier property testing. Standard film calibration that has been commonly used is competent for unifying data system of barrier property and eliminating obstacles in data comparison of different testing methods.