The Influence of Specimen Selection on Film Property Tests

Abstract: through the introduction of the relationship between usual problems of film specimen and data errors, this article discusses the specimen specifications in material comparison, instrument comparison or inter-lab comparison. The application demands for reference films are also discussed.

Key Words: evenness, reference films, calibration, comparison, barrier property

The tests for every index of flexible packaging material rely on the testing instruments. Except the material composition and chemical analytical tests, the specimen preparation for tests, especially the physical property tests, would only need to change the material size; thus, the evenness of the material is the evenness of the specimen. The quality of the specimen evenness would influence the discreteness of the testing data directly. However, in actual tests, such data discreteness, or fluctuation is usually mixed up with testing errors of the instruments. Furthermore, it would affect the material comparison, instrument comparison or inter-lab comparison. Through the introduction of the relationship between usual problems of film specimen and data error, this article discusses the specimen specifications in material comparison, instrument comparison or inter-lab comparison. The application demands for reference films are also discussed.

1. The Usual Problems of Film Specimen

1.1 Specimen Evenness

Evenness is the key factor for the application effect of flexible packaging materials, and it's also one of the main reasons for package breakage. If the specimen's evenness is good, the actual strength of the whole package would be similar to the designed value. If the evenness is not satisfactory, the positions with inferior strength would be the flaws of the package, and would leak easily.

Usually, the discrete extent of testing data indicates the specimen evenness. The discreteness of the testing data differs from the fluctuation of testing data, since the latter relates to instrument precision, resolution and ambient factors only. However, the discreteness of testing data includes not only the fluctuation of testing data, but the evenness of the specimen as well.

The manufacturing process of the films leads to the existence of errors. Comparing with its length and width, the thickness of the material is so minor and could be so easily injured. Such injuries would lead to reduction of strength and various other properties. As to laminated films, the injuries may happen in the outer layers, or they may happen in the inner layers, such as the Aluminum-plated layer, Aluminum foil or silicon-plated layer that can not be easily observed. Since evenness and injuries of the material are both the key factors influencing testing data, and it's usually required to choose those even specimens without wrinkles, indentation or pinholes. However, in actual application, we should treat different specimens differently: if the injuries are caused by transportation or other external factors, we should avoid such flaws when sampling, so as to eliminate data failure resulting from inferior specimens. As to inherent and common specimen flaws, the sampling should not avoid the inferior positions of the specimen in order not to lose the representativeness.

According to the experiences, the inferior specimen evenness would directly lead to differences between the specimens. It's also the main cause for high data discreteness. Therefore, this issue should be especially noticed. During testing, if specimens with better evenness can not be obtained, it should be retrieved from the size and the amount of the specimen.

1.2 Specimen Size

Specimen size is the important factor affecting the accuracy of testing data. The rationality of the specimen size is decided on the retrieval performance for the inferior evenness, and is expressed as whether the data discreteness is within acceptance. The evaluation standard for specimen evenness differs for different industries; yet, in the same industry, there is similarity in evenness evaluation of the specimens. Therefore, the empirical parameters from long-term tests and researches are of great referential significance, such as the specimen size ranges in the testing standards. However, it should be noticed that though all the testing data of the same testing item has been converted to unit length or unit area, the data can only be compared when the specimen size are the same or similar. So, changing specimen size would result in increasing influence of specimen evenness to the testing data; especially when reducing the specimen size -- if the specimen size is too small, the specimen would be lack of representativeness.

However, changing testing area can result in measuring range adjustment of the instruments. Taking the permeability test as an example, it has been a globally applied method to change the testing area for the adjustment of instrument measuring range. Such method has nothing wrong when analyzing its testing principle. However, during actual tests, data change would occur owing to the inferior specimen evenness. Therefore, when the adjustment of testing area is a must, the operator should fully aware of the deviation so as to avoid wrong material property evaluation caused by unevenness of the specimen. It's suggested that the specimen increase is needed for small specimen testing to decrease the influence of unevenness.

1.3 The Amount of Specimens

Statistically speaking, the testing results of more specimens would be more similar to the actual situation; yet, such method would greatly increase the testing costs and time, and decrease the testing efficiency. Normally, the specimen number regulated in the standards can satisfy the testing demands. However, the number of specimens should be increased if the evenness is not good and the testing data is of great errors correspondingly.

In terms of conventional specimen testing, it's recommended to adopt the regulated specimen number in the standards. If possible, more specimens can be prepared for backup. When specimen evenness is inferior, it's advisable to increase the specimen number 2 to 3 times and give the statistical results. As to cases of changing testing areas, the specimen number should be changed according to experiences. For example, enlarging the testing area will not increase the fluctuation of the testing data; therefore, the specimen number can be kept. When reducing the testing area, the data fluctuation will increase remarkably, which is related to the specimen evenness. It's suggested to increase the specimen amount to at least 2 times and select the testing data according to the statistical formula to avoid potential specimen differences and the influences to the data accuracy.

2. The Influence on Actual Testing

If the testing aim for ordinary film specimen is to obtain material data, the data deviation caused by inferior

evenness can be mended by the operators, such as more careful data preparation and specimen increase, to avoid discrepancy. Usually, film specimen testing is also used as a means for material comparison, instrument comparison, inter-lab comparison, and instrument calibration, etc. However, as to film specimen, such behavior would lead to mistakes; and the reason is that the evenness of the ordinary film specimen can not guarantee data comparison and delivery. Therefore, when using ordinary film materials to carry out those works, it's improper to compare data without considering specimen differences. Though the evenness of specimen will draw the attention of the operator easily, the influence of specimen area and number is usually neglected and would lead to final evaluation mistakes.

3. Functions of Reference Films

The biggest difference between reference film and ordinary film is that reference film has better evenness and stability. Comparing with other standard materials, the element and structure of reference films are usually simpler; yet, one or some of the properties of them can achieve the regulated uncertainty scope. Alike other standard materials, evenness inspection should be done before using so as to guarantee accuracy of the fixed values and to endow the reference films with the function of data delivery. So, it can be used for data comparison and delivery. At present, in the testing items for flexible packaging materials, permeability tests, including gas permeability test, water vapor permeability test and organic gas test, etc., demand the largest amount of reference films, since the calibration for permeability instruments has its difficulties. Take the differential-pressure method gas permeability tester as an example, the common parameters that need to be calibrated include pressure, temperature and humidity, whose accuracy would influence the testing data. Though it's feasible to calibrate each parameter periodically, the large amount of parameters and the complicated processes make it impossible to calibrate frequently. In daily operation, data of permeability testing instruments may occur abnormality. Such abnormality can not be easily observed by operators because of the frequent specimen changes, which would bring hidden dangers to the data accuracy. Therefore, how to verify the error existence promptly and conveniently is of great demands.

It's an effective method to judge the existence of abnormality with films of known data. The testing principle is very similar to the blank specimen test in some testing items. Ordinary films, owing to their uncertainty in evenness, would affect the accuracy of judgment; and the application of reference films can greatly meet the needs. When verifying whether the instrument data is normal, only one test with reference film is enough: through comparison between the testing data and the referential fixed value, a rapid and accurate judgment for calibration can be achieved. Moreover, the calibration of permeability testing instruments' data system can also be achieved with the help of reference fixed value of the reference film, which has greatly improved the efficiency.

4. Conclusions

The evenness of ordinary film specimen should be highlighted. Though the data comparison and calibration method for permeability tests through film testing has been recognized and publicized, improper film selection would also lead to data system confusion, or invalid comparison results. Since reference films are much better than ordinary films in evenness and stability, data comparison and instrument calibration can be guaranteed after

changing the film specimen into the reference films.