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Quantitative Measuring of Flex Durability

Abstract: Flex Durability of materials is a new testing item emerging with the increasing demand on packaging. This article introduces the demand for, development of, and quantitative measuring method relating flex durability. Based on field test data, the necessity to measure flex durability quantitatively is explained.
Key Words: flexible package, Flex Durability, barrier property

The rising of package testing originates from the close attention people paid to functions of packages. Therefore, with the improving of package functionality and the increasing of package function, package test is bound to be more detailed, accurate and professional. Flex durability testing of materials is a new test item emerged with the increasing demand for package testing.

1． Measuring Demand for Flex Durability

1.1 What is Flex Durability

Flex Durability refers to the capacity of deformed materials under pressure to maintain its stable property after the external forces is removed. Generally, flex process affects physical property of materials (such as barrier property).

There is certain connection between flex durability of materials and its compressive strength, folding strength and puncture resistance. Such connection was once used as a measure to evaluate flex durability of materials, which is only a kind of estimation with bigger error.

1.2 Test Demand for Flex Durability of Materials

As an important packaging form of current retail products, flexible packages of products go through stages of transportation, storage, and selling for varying periods of time before using. Moreover, they may endure external forces such as flex , pressing and folding, thus affecting physical property of materials. However, present testing of flexible package materials are mainly for materials before packaging. For those finished packages and packed products on sale or to be used, except for seal strength test, aging test, and some physico-chemical testing, there is almost no other property testing (for example: some physical properties that attracts considerable attention in the initial stage such as barrier property and mechanical property) available. Therefore, it is difficult to decide whether the flex durability of packaging materials can meet design requirements during the transportation process of packed products. Such situation relates with the fact that it is hard to simulate influences of external forces such as flex durability, pressing and folding endured by packaging materials during production, processing and transportation. Although actual packaging products may be sampled for testing, test data cannot avoid the randomness of testing. With the increasing demand of packaging, flex durability has become an important factor affecting the selection of packaging materials. Test demand on this index is becoming higher and higher.

2． Test Method

2.1 Measuring Flex Durability of Materials

Although some people realized the importance of flex durability for materials in the past, they can only simulate flex situation artificially due to the lack of test method. However, manual simulation is difficult to be quantified in terms of test frequency and performance. Therefore, flex durability can only be evaluated qualitatively. As to what is ‘better Flex Durability ’and which kind is much better for materials belonging to ‘better Flex Durability’ materials, it is hard to find solutions relying on manual simulation. Some people even evaluate flex durability of materials by

analyzing compressive strength, folding strength and puncture resistance. Because compressive strength and folding strength are not always the category of flexible package, such evaluation method for flex durability is very low in accuracy.

ASTM F392 is the first standard test method to test flex durability of flexible packaging materials. This method can better simulate situations of flex, pressing and folding during the production, processing and transportation of films. It can evaluate flex durability of material by measuring the number of pinholes or the variation of barrier property of specimens before and after flex durability test, which can provide quantification basis to actual application of materials and design of packaging.

2.2 Test Method in ASTM F392

First, prepare certain number of specimens as is specified in standard. Then measure pinhole number, barrier property and other parameters of specimens to be tested. Condition the specimen for specified period of time and then select environmental condition of test (usually at 23℃、50％RH) and test mode (the standard provide A、B、C、D、E five test modes) to begin test.

Flex durability of specimen can be tested through the following two methods: First, measure the colored-turpentine-pinhole portions formed during the flex durability process. Second, compare gas permeability or water vapor permeability of specimen before and after test. The physical holes formed during flex testing can only be measured by colored-turpentine. If only one layer of the multi-layer laminated materials breaks or some plastic films is hard to form pinholes during flex test', flex durability of these materials should be measured using professional barrier property testing instruments. The design of multi test modes is just to make pinhole numbers or barrier property within a reasonable range during flex durability testing. In evaluating flex durability of materials, average value of several specimens should be used so as to avoid the influence of accidental factors.

3． Application

Recently, according to ASTM F392, Labthink compares flex durability of three materials : PET（VMPET，12μm）、PET（20μm）、PE/EVOH/PE（76μm）using FDT-01flex durability tester and TSY-T3water vapor permeability tester .The comparison adopts three test modes of B、C、D and evaluates flex durability through measuring water vapor permeability of specimens(not form physical pinholes). Detailed data of comparison is listed below:

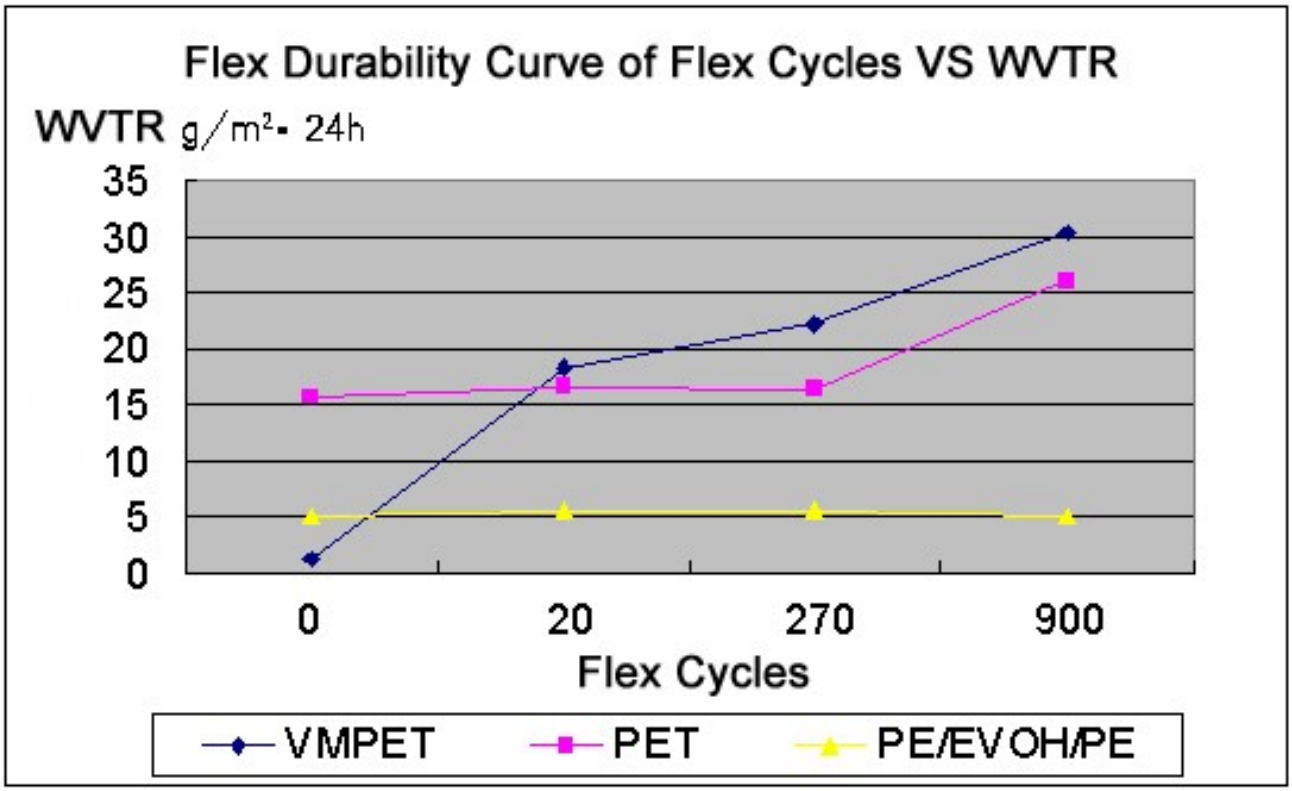
Table 1. Test data of flex durability test

	Before flex durability test WVTR[1,2]	After D mode flex durability WVTR[1,2]	After C mode flex durability WVTR[1,2]	After B mode flex durability WVTR[1,2]
VMPET	1.248	18.352	22.112	30.363
PET	15.64	16.654	16.321	26.012
PE/EVOH/PE	5.09	5.523	5.556	5.083

Note: the unit of WVTR is $g/m^2 \cdot 24h$

2. Average Test Value

Although Water vapor permeability of these three materials are all in the range of medium and high barrier property, their flex durability differ obviously, as is shown in the figure below:



PE/EVOH/PE（76μm）possesses the best flex durability among these materials and its water vapor permeability remains consistent all through the test. PET（20μm）is in the second place and can maintain its initial water vapor permeability if it has not gone through many times of flex durability test. When its number of flex times reaches 900, water vapor permeability of PET（20μm） increases obviously. However, flex durability of the acknowledged high barrier materials PET（VMPET，12μm）is very poor, even if several times of flex can make its water vapor permeability increase to ten times the original one.

4. The Significance of Measuring Flex Durability

Since barrier package materials can improve preserve effect and prolong shelf life of products, its consumption has increased significantly in spite of the higher cost. Flex durability of materials affects the stable property of barrier packaging materials during the whole circulation process. When barrier property of packaging materials is lost due to the poor flex durability of its barrier lay and packed products becomes deteriorated, there will be great loss to both packaging manufacturers and products manufactures. The reduction in the consumption of aluminum foils directly relates with its poor flex durability and folding resistance. Although its substitute, vacuum aluminum coated materials, have been greatly improved in terms of folding resistance and toughness, based on data comparison this time, aluminum coated materials still inferior to other high polymer materials in terms of their flex durability. At the same time, excessive requirement on flex durability of materials results in the increase of product cost, which disagrees with the development tendency of moderate package. Only by analyzing possible flex durability and folding strength during the whole circulation process and evaluating flex durability for packaging materials of various structures, should the most pervasive data be obtained so as to secure safety of products.