



# Standard Test Method for Hot Tack of Wax-Polymer Blends by the Flat Spring Test<sup>1</sup>

This standard is issued under the fixed designation D 3706; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method measures the hot tack of wax-polymer blends used to seal flexible packaging. The blend may be a uniform coating, or a post-applied adhesive.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Terminology

### 2.1 Definitions:

2.1.1 *hot tack*—the cohesive strength during the cooling stage before solidification of a heat seal bond formed by a wax-polymer blend.

## 3. Summary of Test Method

3.1 Flexible packaging specimens are heat-sealed together over a series of temperatures and dwell times. Immediately after each seal is formed and before it has started to cool, a force tending to separate the specimens is applied by a calibrated spring. If the hot tack of the blend is strong enough, the seal remains closed until it has solidified; if not, the seal separates. Thus each spring force and test condition either passes or fails. The pattern of pass and fail results is plotted to show the blend characteristics.

## 4. Significance and Use

4.1 Many flexible packaging materials are formed into finished packages by joining surfaces with heat sealed bonds. The bond is formed by heating the surfaces and pressing together the areas to be joined. Because package forming and filling equipment must operate at high speeds, the pressure holding the surfaces together is usually released before the

bond has solidified. The bonding material must have enough hot tack while still molten to hold the sealed areas together until cool. The pattern of pass and fail results with this test method is characteristic of the wax-polymer blend, and can be correlated with end use requirements.

## 5. Apparatus

5.1 *Heat Sealer*,<sup>2</sup> with jaw temperature, jaw pressure, and jaw dwell time adjustable and automatically controlled.

5.2 *Calibrated Flat Springs*, made from 0.2-mm (7-mil) spring steel in the shape and with dimensions as shown in Fig. 1. Approximate spring pull at an indicated width is given for information.

5.3 *Direct Reading Balance*, with scale divisions not to exceed 3 g (0.1 oz). Universal testing equipment with the same sensitivity may also be used.

## 6. Test Specimens

6.1 Cut 75 by 300-mm (3 by 12-in.) strips from sheets of flexible packaging. The wax-polymer blend to be tested must cover the last 50 mm (2 in.) at each end of the test side of the strip.

6.2 Because variations in coating thickness can affect results, the coating must be uniform.

## 7. Calibration of Flat Springs

7.1 Place the spring on the platform of the balance and bend one end over to form a loop. Hold the ends of the spring one above the other and 3 mm ( $\frac{1}{8}$  in.) apart by pressing on the upper end with the fingers or a pencil. Record the total force shown by the balance. Allow the spring to flex open and again press down until the ends are 3 mm ( $\frac{1}{8}$  in.) apart. Repeat for a total of five readings.

NOTE 1—A piece of rubber or plastic sheeting may be placed on the balance under the spring to prevent sliding.

7.2 Calculate the net force by subtracting the tare (weight of spring plus sheeting) from the average of five readings.

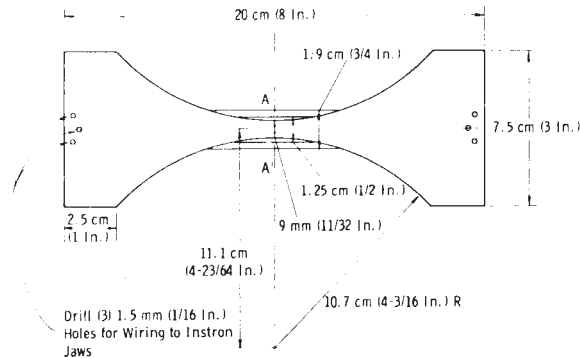
7.3 Convert the net force into flat spring strength as follows:

$$A \text{ (oz/in.)} = F \times 0.333 \quad (1)$$

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.10.0A on Physical and Chemical Properties.

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<sup>2</sup> A heat sealer available from Packaging Industries, Ltd., Airport Rd., Hyannis, MA 02601, has been found satisfactory.



Material 0.2 mm (0.007 in.) spring steel. All springs use same 107-mm (4-3/16 in.) R base arc.

Width at A-A'	Approximate Spring Pull
9 mm (11/32 in.)	0.7 g/mm (0.6 oz/in.)
12.5 mm (1/2 in.)	1.1 g/mm (1.0 oz/in.)
19 mm (3/4 in.)	3.3 g/mm (3.0 oz/in.)

Strength of springs will vary with the steel used. On new lots of spring steel, cut and calibrate 9-mm (11/32-in.) spring first, then adjust width (A-A') of remaining springs to obtain desired pull.

FIG. 1 Hot Tack Testing Springs

$$A_1 = F_1 \times 0.0131$$

where:

- A = flat spring strength, oz/in.,
- A<sub>1</sub> = flat spring strength, g/mm,
- F = net force, oz, and
- F<sub>1</sub> = net force, g.

7.4 Recalibrate the springs before each series of tests. Avoid accidental changes in spring strength that result from bending the springs or compressing them too tightly during handling.

### 8. Calibration of Heat Sealer Jaws

8.1 Confirm the temperature setting of the jaws by closing the jaws on a thermocouple for several minutes and read the potentiometric temperature. Reset if necessary.

### 9. Procedure

9.1 Bend each specimen into a loop and heat seal a 12 to 13-mm (1/2-in.) strip across the ends. Allow it to cool.

9.2 Loop the flat spring into a U-shape and insert it into the loop of the sealed specimen with the spring ends facing the seal. Tuck the loop of the spring back against the specimen loop until it fits snugly, and align the spring evenly with the edges of the specimen.

9.3 Clean the jaws of the sealer. Bring them to constant temperature by holding them closed for at least 15 s just before testing each specimen.

9.4 Holding the ends of the spring closed, insert the sealed end of the specimen into the jaws of the sealer to form a new seal not more than 3 mm (1/8 in.) from the ends of the spring. When the jaws close, release the spring. When the jaws open, observe whether the spring separates the newly formed seal.

9.5 Record as pass those bonds which do not separate more than 3 mm (1/8 in.) from the edge of the seal. Record all others as fail.

9.6 *Single-Spring Procedure*—Set the sealer jaws at 138 kPa (20 psi), and using the same calibrated flat spring, test 32 specimens under the following 16 sets of conditions, duplicating each condition:

- 70 ± 1°C (158 ± 2°F) for 0.5, 1.0, 1.5, and 2.0 s dwell
- 80 ± 1°C (176 ± 2°F) for 0.5, 1.0, 1.5, and 2.0 s dwell
- 90 ± 1°C (194 ± 2°F) for 0.5, 1.0, 1.5, and 2.0 s dwell
- 100 ± 1°C (212 ± 2°F) for 0.5, 1.0, 1.5, and 2.0 s dwell

### 10. Calculation

10.1 For the single-spring procedure (9.6), count the number of specimens that pass, then calculate the percentpass, as follows:

$$\% \text{ pass} = P \times 3.13 \quad (2)$$

where:

- P = number of pass specimens.

### 11. Report

11.1 For the single-spring procedure (9.6), report the percent pass and the flat spring strength.

*Example:* 72 % pass at 3.3 g/mm (3.0 oz/in.)

NOTE 2—The procedure could be used with a stronger spring and the percent pass would be less; conversely, the use of a weaker spring would result in a greater percent pass. It should be recognized that it is difficult to get an exact strength with a spring, and that spring force may decrease with use. For cross-checking with other laboratories, several springs would be used and the data compared by interpolation to a common force.

### 12. Precision and Bias

12.1 The precision of this test method as determined by statistical examination of interlaboratory results is as follows:

12.1.1 *Repeatability*—The difference between two test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the normal and correct operation of the test method, exceed the following values in one case in twenty:

20 % Pass

12.1.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test materials would, in

the long run, in the normal and correct operation of the test method, exceed the following values in one case in twenty:

58 % Pass

12.2 The above data were obtained in an interlaboratory study among 15 laboratories on a coated substrate.

12.3 *Bias*—The procedure in this test method has no bias because the value of hot tack can be defined only in terms of a test method.

### 13. Keywords

13.1 curtain coating; weight of wax

## ANNEX

### (Mandatory Information)

#### A1. ALTERNATIVE TO SINGLE-SPRING PROCEDURE

##### A1.1 Single Condition Procedure:

A1.1.1 Set the sealer jaws at 138 kPa (20 psi), and select the temperature and dwell time. Test the specimens in quadruplicate using flat springs with progressively higher spring strengths until at least two out of the four specimens fail.

A1.1.2 Report the value of the strongest spring for which at least three specimens pass under the conditions chosen.

*Example:* 0.8 g/mm (0.7 oz/in.) at 90°C (194°F) and 1.0 s.

A1.1.3 Precision data for the single-condition procedure are not yet available.

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