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Standard Test Methods for Hot Seal Strength (Hot Tack) of Thermoplastic Polymers and Blends Comprising the Sealing Surfaces of Flexible Webs[1]

This standard is issued under the fixed designation F1921; 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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover laboratory measurement of the strength of heatseals formed between thermoplastic surfaces of flexible webs, immediately after a seal has been made and before it cools to ambient temperature.

1.2 These test methods are restricted to instrumented hot tack testing, requiring a testing machine that automatically heatseals a specimen and immediately determines strength of the hot seal at a precisely measured time after conclusion of the sealing cycle. An additional prerequisite is that the operator shall have no influence on the test after the sealing sequence has begun. These test methods do not cover non-instrumented manual procedures employing springs, levers, pulleys and weights, where test results can be influenced by operator technique.

1.3 Two variations of the instrumented hot tack test are described in these test methods, differing primarily in two respects: (*a*) rate of grip separation during testing of the sealed specimen, and (*b*) whether the testing machine generates the cooling curve of the material under test, or instead makes a measurement of the maximum force observed following a set delay time. Both test methods may be used to test all materials within the scope of these test methods and within the range and capacity of the machine employed. They are described in Section 4.

1.4 SI units are preferred and shall be used in referee decisions.

1.5 *This standard does not purport to address all of the safety concerns, 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.* The operator of the equipment is to be aware of pinch points as the seal jaws come together to make a seal, hot surfaces of the jaws, and sharp instruments used to cut specimens. It is recommended that the operator review safety precautions from the equipment supplier.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

E171 Specification for Atmospheres for Conditioning and Testing Flexible Barrier Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *adhesive failure*, *n*—a failure mode in which the seal fails at the original interface between the surfaces being sealed.

3.1.2 *burnthrough*, *n*—a state or condition of a heatseal characterized by melted holes and thermal distortion.

3.1.2.1 *Discussion*—Burnthrough indicates that the sealing conditions (time or temperature, or both) were too high for an acceptable seal.

3.1.3 *cohesive failure*, *n*—a failure mode where either or both of the sealed webs fails by splitting, approximately parallel to the seal, and the seal itself remains intact.

3.1.3.1 *Discussion*—Refer to Fig. 1. The term may be defined somewhat differently when applied to sealing systems involving an adhesive material as a separate component.

3.1.4 *cooling curve*, *n*—the graphical depiction of the increase in strength of the seal with time, as it cools during the period immediately following conclusion of the sealing cycle (see Fig. 2).

3.1.4.1 *Discussion*—The cooling curve is a plot of hot seal strength versus cooling time. The portion of the cooling curve of greatest practical significance is the first 1000 ms following opening of the heatseal jaws.

3.1.5 *cooling time*, *n*—the time interval from when the heatseal jaws open at conclusion of the sealing cycle, to the point at which the hot-tack force is determined.

3.1.6 *delay time*, *n*—the time interval from when the heatseal jaws open at conclusion of the sealing cycle, to the point at which withdrawal of the sample from between the jaws is initiated.

[1] These test methods are under the jurisdiction of ASTM Committee F02 on Flexible Barrier Materials and are the direct responsibility of subcommittee F02.20 on Physical Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

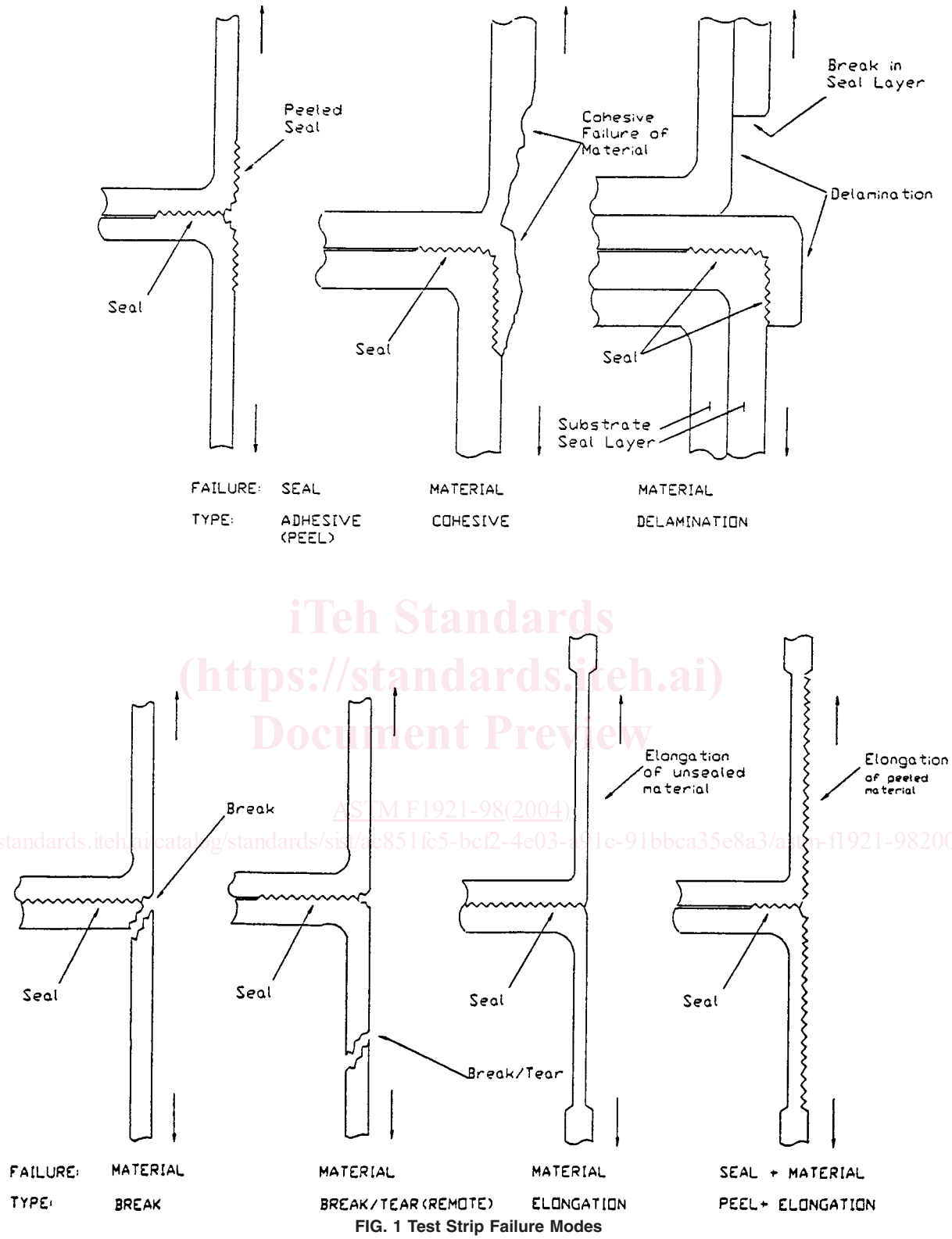

FIG. 1 Test Strip Failure Modes

3.1.7 *dwell time*, *n*—the time interval during the heatsealing cycle when the sealing jaws are in contact with, and exerting pressure on, the material being sealed.

3.1.8 *failure mode*, *n*—a visual determination of the manner in which the test strip fails during grip separation.

3.1.9 *hot tack*, *n*—strength of a hot seal measured at a specified time interval after completion of the sealing cycle but prior to the temperature of the seal reaching ambient.

3.1.10 *hot-tack curve*, *n*—a plot of hot-tack strength versus sealing temperature (see Fig. 3).

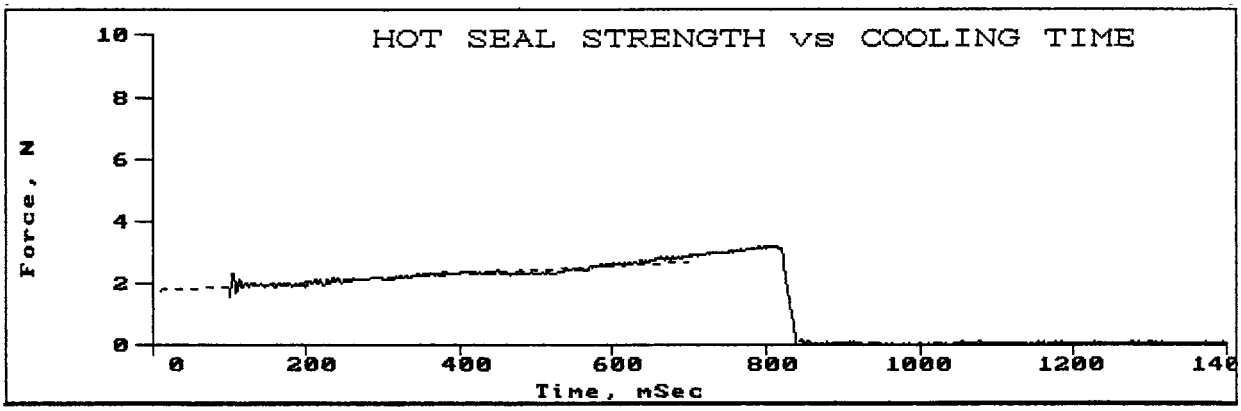

FIG. 2 Cooling Curve

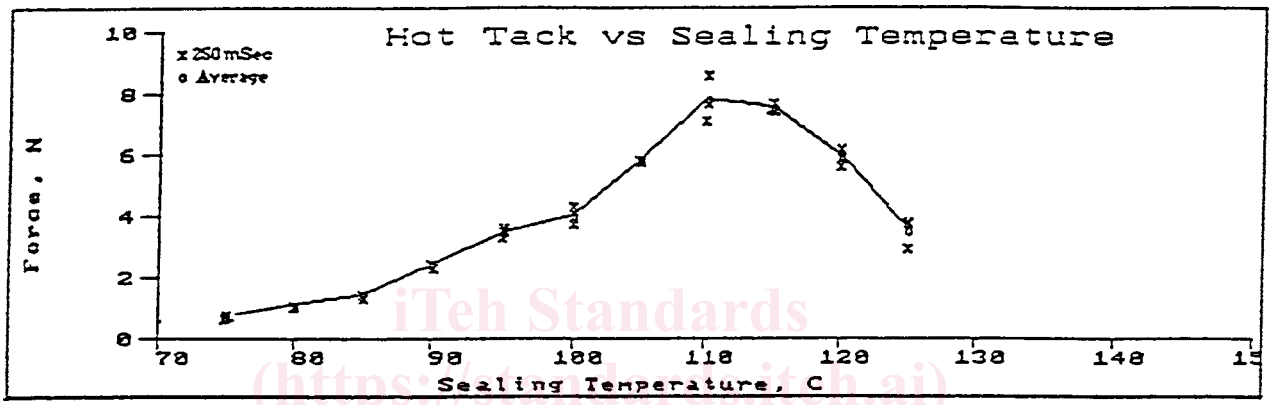

FIG. 3 Hot Tack Curve

3.1.10.1 *Discussion*—This is the basic curve used for comparing materials for their hot tack performance. It shows not only the maximum hot seal strength achievable by each material and the sealing temperature required, but also the breadth of the sealing temperature range at any specified level of hot tack.

3.1.11 *sealing temperature*, *n*—maximum temperature reached at the interface between the two web surfaces being sealed, during the dwell time of the sealing cycle.

3.1.11.1 *Discussion*—Sealing temperature will equal jaw temperature (both jaws at same temperature) if the dwell time is long enough for the interface to reach equilibrium with the jaws. At this point, seal strength will no longer rise with increasing dwell time.

3.1.12 *withdrawal time*, *n*—the time interval from when withdrawal is initiated, to the point in time when all slack has been removed from the test strip between the seal and the grips, so that measurement of the strength of the seal can commence.

4. Summary of Test Method

4.1 A sample strip is sealed by applying pressure from two flat heated jaws under defined conditions of temperature, contact time and pressure.

4.2 When the jaws of the sealing unit open, the sealed strip is automatically withdrawn from between the jaws at conclusion of a set delay time (which may be zero), by retraction of the grips.

4.3 As the grips move apart at a set speed and the sealed sample is elongated to eventual failure, the force required is measured by the testing machine.

4.4 In Method A (machines of the Theller type) the machine measures and plots strength versus time after jaw opening, starting after a withdrawal period of 100 to 150 ms, which is the cooling curve for the material. The computer then determines the force coordinates of the curve at various times, and reports the values as hot-tack strength at those cooling times. The machine is factory-set to start withdrawal within 10 ms after jaw opening.

4.5 In Method B (machines of the DTC and J & B type) the computer plots strength versus time after completion of a set delay time. The maximum force encountered during grip travel is determined from that plot and reported as hot-tack strength for the delay time employed in that test.

4.6 In both methods the operator cannot influence the test once the sealing cycle is initiated.

4.7 Hot-tack strength at various sealing temperatures is plotted as the hot-tack curve of the material tested (see Fig. 3).

5. Significance and Use

5.1 In form-fill operations, sealed areas of packages are frequently subject to disruptive forces while still hot. If the hot seals have inadequate resistance to these forces, breakage can occur during the packaging process. These test methods measure hot seal strength and can be used to characterize and