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An American National Standard

# Standard Specification for Hot-Application Filling Compounds for Telecommunications Wire and Cable<sup>1</sup>

This standard is issued under the fixed designation D 4731; 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.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D-9 D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.18 on Solid Insulations, Non-Metallic Shieldings and Coverings for Electrical and Telecommunications Wires and Cables. Subcommittee D02.10 contributed in the development of this standard.

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## 1. Scope

1.1 This specification covers a variety of petroleum-based and other compounds used for filling the air spaces in telecommunications wires and cables (both electrical and fiber optic) for the purpose of preventing water and other undesirable fluids from entering or migrating through the cable structure. (For related standards see Specifications D 4730 and D 4732).

1.2 A hot-application compound is a material that requires melting in order to be applied as a liquid and its melting point may affect its performance in the finished cable product.

1.3 The values stated in SI units are the standard.

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 6 Test Method for Loss on Heating of Oil and Asphaltic Compounds<sup>2</sup>

D 92 Test Method for Flash and Fire Points by Cleveland Open Cup<sup>3</sup>

D 97 Test Method for Pour Point of Petroleum-Oils Products<sup>3</sup>

D 127 Test Method for Drop Melting Point of Petroleum Wax Including Petrolatum<sup>3</sup>

D 150 Test Methods for ~~A-C~~ AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical-Insulating Materials Insulation<sup>4</sup>

D 257 Test Methods for ~~D-E~~ DC Resistance or Conductance of Insulating Materials<sup>4</sup>

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids ~~(and the~~ (the Calculation of Dynamic Viscosity)<sup>3</sup>

D 938 Test Method for Congealing Point of Petroleum Waxes, Including Petrolatum<sup>3</sup>

D 1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)<sup>3</sup>

D 2161 Practice for Conversion of Kinematic Viscosity to Saybolt Universal Viscosity or to Saybolt Furol Viscosity<sup>3</sup>

D 3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry<sup>5</sup>

D 3954 Test Method for Dropping Point of Waxes<sup>6</sup>

D 4565 Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable<sup>7</sup>

D 4568 Test Methods for Evaluating Compatibility Between Cable Filling and Flooding Compounds and Polyolefin Wire and Cable Materials<sup>7</sup>

D 4730 Specification for Flooding Compounds for Telecommunications Wire and Cable<sup>7</sup>

D 4732 Specification for Cool-Application Filling Compounds for Telecommunications Wire and Cable<sup>7</sup>

D 4872 Test Method for Dielectric Testing of Wire and Cable Filling Compounds<sup>7</sup>

## 3. Terminology

### 3.1 ~~Description~~ Definitions of Terms Specific to This Standard:

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.04.

<sup>3</sup> Annual Book of ASTM Standards, Vol 05.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 10.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 08.02.

<sup>6</sup> Annual Book of ASTM Standards, Vol 15.04.

<sup>7</sup> Annual Book of ASTM Standards, Vol 10.02.

3.2.1.1 *filling material*—any of several materials used to fill the air spaces in the cores of multi-conductor insulated wires and cables, or between buffer tubes covering optical fibers, or within such buffer tubes, or any combination of these configurations and any other cable components, for the purpose of excluding water and other undesirable fluids; especially with regard to telecommunications wire and cable, including optical cable, intended for outside aerial, buried, or underground installations.

3.3.1.2 *producer*—the primary manufacturer of the material.

3.4.1.3 *suppliers*—jobbers and distributors as distinct from producers.

#### 4. Classification

4.1 Two basic types of filling compounds are covered, as follows:

4.1.1 *Type I*—General-purpose filling compounds include all materials to be used for filling cables that are not required to function under electrical stress (for example, all dielectric fiber-optic cable), including filling compounds for fiber-optic loose buffer tubes.

4.1.2 *Type II*—Electrical-type filling compounds include materials having prescribed electrical properties and are used for filling wires and cables that are required to function fully or partially under electrical stress (including hybrid fiber-optic cable).

#### 5. Ordering Information

5.1 Orders for material under this specification shall include the following information:

5.1.1 Quantity (mass or volume) of each item,

5.1.2 Generic name of the material, such as hot-application cable filling material,

5.1.3 Type of material: Type I, General Purpose or Type II, Electrical,

5.1.4 How Furnished: drums or barrels, tank cars or tank trucks, and the like,

5.1.5 Certification, if required (Section 13.4).

5.1.6 This specification designation, and

5.1.7 Any special requirements, as listed in ~~7.2~~ and 7.2, 9.2 and 10.2 and in Sections ~~10~~ 11 and ~~11~~ 12 that apply.

#### 6. Materials and Manufacture

6.1 The material and manufacturing methods used shall be such that the resulting products will conform to the properties and characteristics prescribed in this specification.

#### 7. Chemical Composition

7.1 The chemical composition of these materials is not specified. The material may be of any chemical composition suitable for the intended purpose and that meets the requirements of this specification as hereinafter stated.

7.2 When agreed upon between the producer and the purchaser, antioxidant stabilizing additives may be included in the compound formulation to assure specified results in thermal oxidative stability testing.

7.3 Once established, the producer shall not change the composition of the compound in successive lots of material without prior approval of the purchaser.

#### 8. Electrical Properties

8.1 When a Type II (electrical) filling compound is specified, the compound shall exhibit the electrical properties in 8.1.1 ~~through~~ and 8.1.2. The electrodes used shall be parallel plates of solid or foil metal of a size and shape appropriate for the specimen holder; ~~or~~ Other electrodes may be used as agreed upon between the producer and the purchaser. The voltage applied and the time of electrification shall be appropriate for the instrumentation used and as agreed upon between the producer and the purchaser.

8.1.1 When tested, in accordance with Test Methods D 150 or D 4872, at a temperature of  $23 \pm 3^\circ\text{C}$ , the dissipation factor shall not exceed 0.0010 at a frequency of 1 MHz and the permittivity shall not exceed 2.30.

8.1.1.1 **Caution:Warning:** If any bubbles are formed in melting the compound to prepare the specimen for test, the sample shall be discarded and a new sample selected.

8.1.2 When tested, in accordance with Test Methods D 257, at a temperature of  $23 \pm 3^\circ\text{C}$ , the volume resistivity shall be not less than  $10^{13} \Omega\cdot\text{cm}$ .

#### 9. Physical Properties

9.1 Filling compound furnished under this specification shall inhibit the corrosion of any metallic wire and cable elements with which it comes in contact, while serving as a radial and longitudinal barrier to moisture transmission. Contact of the filling compound with any cable component shall not cause degradation of performance of the cable component. The filling compound shall display adhesive properties to provide adhesion between metallic sheath elements and the outer jacket materials of wire and cable.

9.2 *Other Physical Properties:*

9.2.1 Other property requirements such as Flash Point (for example, Test Method D 92), high-temperature drip/oil separation (syneresis) in the raw material state, and the like, shall be as agreed upon between the producer and the purchaser. (Additional information on oil separation is given in the appendix of this specification.)

## 10. General Requirements

910.1 All filling compounds manufactured in accordance with this specification shall meet the following requirements:

910.1.1 *Homogeneity*—The compound shall be homogeneous and free of agglomerates.

910.1.2 *Color and Opacity*—The compound shall be as nearly colorless as is commercially feasible, consistent with the requirements of the end products for which the filling compound is intended. In general, identification of cable members coated with filling compound shall not be significantly inhibited because of filling-compound color or opacity.

910.1.3 *Color Stability*—After aging a specimen of filling compound in a suitable container for a period of  $120 \pm 1$  h (5 days) at a temperature of 266°F (130°C) in a static air oven, measure the compound color in accordance with Test Method D 1500. Unless otherwise specified, the color of the aged compound shall not exceed 2.5.

910.1.4 *Foreign Material*—The compounds shall be free of dirt, metallic particles, and other foreign matter.

910.2 *Other Properties*—Other property requirements such as ~~Flash Point (for example, Test Method D 92)~~, Volatility (for example, Test Method D 6), ~~high-temperature drip/oil separation (syneresis) in the raw material state~~, thermal oxidative stability (for example, testing similar to Test Method D 3895), ~~corrosion prevention~~ and the like, shall be as agreed upon between the producer and the ~~purchaser. (Additional information on oil separation is given in the appendix of this specification.)~~ purchaser.

NOTE 1—If Test Method D 6 is referenced, a test cycle of 22 h at 107°C (225°F) is recommended in lieu of the 163°C (325°F) temperature required by Test Method D 6.

## 10.1. Temperature Characteristics

101.1 Raw material temperature characteristics, if needed, may be specified by use of pour point (for example, Test Method D 97), drop-melting point (for example, Test Method D 127), viscosity (for example, Test Method D 445 and Practice D 2161), congealing point (for example, Test Method D 938), drop point (for example, Test Method D 3954), or as otherwise agreed upon between the producer and the purchaser.

NOTE 2—Although cited in 101.1, Test Method D 127 is “not” a preferred method for determining melting point of wire and cable filling compounds since results tend to be too high to be useful in predicting material behavior in the cable-filling process. However, this may be a good test for quality control purposes. (Refer to the appendix of this specification for additional information.)

101.2 The purchaser (individual cable manufacturer or other) shall specify any other expected temperature conformance requirements (high and low) needed to ensure compliance with such end product requirements as cable drip-out temperature, cold bend, low temperature flexibility, and the like (for example, Test Methods D 4565).

## ~~11. Compatibility with other Materials~~

~~11.1 It is the responsibility of the purchaser to ensure that the filling compound ordered is suitable for the intended application and is compatible with any other components that it may come into contact with.~~

~~11.2 The purchaser shall specify the materials that the compound must be compatible with when tested in accordance with Test Methods D 4568.~~

## 12. Compatibility with other Materials

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12.2 The purchaser shall specify the materials that the compound must be compatible with when tested in accordance with Test Methods D 4568.

## 13. Quality Assurance

123.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or the purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of these inspection and test requirements, unless otherwise stated by the purchaser in the order or at the time of the contract signing. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that the material conforms to the prescribed requirements.

123.2 Each producer shall establish written nominal values and tolerances for the material properties routinely checked. For properties not routinely checked, typical values shall be specified. Once these values have been accepted by the purchaser, the producer shall not ship material that deviates from these limits without prior notification to and the approval of the purchaser.

123.3 An inspection lot shall consist of an identifiable quantity of the same material subjected to inspection at one time.

## ~~13. Certification~~

~~13.1 The producer or supplier shall, on request, furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification, and meets the specified requirements.~~

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### **15. Packaging and Package Marking**

145.1 *Packaging*—Quantities of the filling compound may be packaged in standard 55 gal (210 L) drums or in tank cars capable of protecting the material from contamination during shipment. Smaller containers may also be used as agreed upon between the producer and the purchaser.

145.2 *Package Marking*—Shipping containers shall be marked with the name of the manufacturer, trade name, type of material, lot number, mass or volume, and the date of manufacture.

### **156. Keywords**

156.1 compatibility; filling compounds; hot application; telecommunications wire and cable

## **APPENDIX**

### **(Nonmandatory Information)**

#### **X1. DISCUSSION OF FILLING COMPOUND PROPERTIES**

X1.1 Most, but not all, wire and cable filling materials are semi-solid in their natural state but are introduced into a wire or cable structure in a molten state at a relatively high temperature. The performance properties of such wire and cable filling materials (as raw materials and in finished products) is not completely understood in spite of the fact that such materials have been in regular use for many years, and numerous technical papers have been written on the subject. Since there is no one test or series of tests that can be applied to these raw materials that will guarantee desired performance in a finished electrical or optical wire and cable product, many of the detailed requirements of this specification must be left to the discretion and agreement of the producer and the purchaser. In reaching an agreement upon these detailed requirements, the following factors are among those that need to be considered by the parties involved:

X1.1.1 In evaluating properties such as melting point, flow performance, and the like, the heat history of the filling material prior to the test must be considered. Slow cooling from a molten state can, for example, depress the melting point of the material. In making tests, special care must be exercised to ensure that the material to be tested is free of any “hidden” heat history.

X1.1.2 Although opinion on this point is not unanimous, the melting point of shock-cooled material is, in most instances, the melting point that is of most relevance to electrical cable manufacturers. The cable manufacturing process used with cable filling materials will, in most cases, ensure shock cooling to assure that the melting point is not depressed. A high melting point is needed to ensure a high drip-out temperature in the finished product (see 101.2).

X1.1.3 Shock cooling is not necessarily easy to achieve. Visual observation of the cooling rate can be misleading. For any particular laboratory set-up used for cooling samples, there will be some critical sample size where all samples of that size or smaller will exhibit the same, shock-cooled, melting point. In flow tests with some types of heat sink, experimental data suggests that the critical sample size for some materials may be less than 10 g, while samples of about 10 g may be acceptable for other materials, provided the initial melt temperature is not too high. Retesting the melting point is one way to ensure that the melting point has not been depressed by cooling too slow.

X1.1.4 Depending upon the particular material, there may be a tendency for a liquid fraction to separate from the solids of the filling compound. Without going into detail, it should be recognized that such a tendency may also be affected by the heat history or by the shear history, or both, and such a tendency may be of concern to the purchaser.

X1.2 Raw material requirements appropriate to hot-melt filling materials will probably not be meaningful to materials that are introduced into wire and cable in a relatively cool semi-solid state (see Specification D 4732).

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