Designation: C647 – 19

Standard Guide to Properties and Tests of Mastics and Coating Finishes for Thermal Insulation[1]

This standard is issued under the fixed designation C647; 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 This guide identifies properties of mastics and coating finishes characterizing their performance as finishes for thermal insulation.

1.2 These properties relate to application and service. Each property is defined, and its significance and suggested test methods are described.

1.3 The properties appear in the following order in this guide.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

C419 Practice for Making and Curing Test Specimens of Mastic Thermal Insulation Coatings

C461 Test Methods for Mastics and Coatings Used With Thermal Insulation

C488 Test Method for Conducting Exterior Exposure Tests of Finishes for Thermal Insulation

C681 Test Method for Volatility of Oil- and Resin-Based, Knife-Grade, Channel Glazing Compounds

C755 Practice for Selection of Water Vapor Retarders for Thermal Insulation

C792 Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants

D36/D36M Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)

D56 Test Method for Flash Point by Tag Closed Cup Tester

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D562 Test Method for Consistency of Paints Measuring

[1] This guide is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.33 on Insulation Finishes and Moisture.

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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.

Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
D638 Test Method for Tensile Properties of Plastics
D747 Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam (Withdrawn 2019)[3]
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D822/D822M Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
D903 Test Method for Peel or Stripping Strength of Adhesive Bonds
D968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
D1310 Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
D1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings
D1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
D1849 Test Method for Package Stability of Paint
D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscometer
D2243 Test Method for Freeze-Thaw Resistance of Water-Borne Coatings
D2354 Test Method for Minimum Film Formation Temperature (MFFT) of Emulsion Vehicles
D2444 Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
D2453 Test Method for Shrinkage and Tenacity of Oil- and Resin-Base Caulking Compounds
D2485 Test Methods for Evaluating Coatings For High Temperature Service
D2507 Terminology of Rheological Properties of Gelled Rocket Propellants (Withdrawn 2003)[3]
D3134 Practice for Establishing Color and Gloss Tolerances
D3274 Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation
D3361/D3361M Practice for Unfiltered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
D4339 Test Method for Determination of the Odor of Adhesives
D5590 Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
E84 Test Method for Surface Burning Characteristics of Building Materials
E96/E96M Test Methods for Water Vapor Transmission of Materials
E162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
E659 Test Method for Autoignition Temperature of Chemicals
F1249 Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
G21 Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

[3] The last approved version of this historical standard is referenced on www.astm.org.

3. Terminology

3.1 Terminology C168 shall be considered as applying to the terms used in this specification.

3.2 *General Definitions:*

3.2.1 *application properties*—properties that influence or affect the effective installation of finishes.

3.2.2 *coating*—a liquid or semiliquid protective finish capable of application to thermal insulation or other surfaces, usually by brush or spray, in moderate thickness, 30 mils (0.76 mm).

3.2.3 *mastic*—a protective finish of relatively thick consistency capable of application to thermal insulation or other surfaces usually by spray or trowel, in thick coats greater than 30 mils (0.03 in.) (0.76 mm).

3.2.4 *service properties*—properties that govern performance of finishes after installation.

3.3 *Specific Definitions*—Terms specific to Sections 6 and 7 are defined as appropriate.

4. Significance and Use

4.1 Each of the properties listed should be considered in selecting materials for specific projects. A list of the selected properties with limiting values assigned will form a part of the product specification.

4.2 All of the properties are not required, and all of the tests outlined are not required. A condition to any specification must be an evaluation of the proposed use to determine which properties shall be required.

4.3 Membrane reinforcements are frequently specified and used with mastics and coatings. Service properties of such systems of finishes are often different from the unreinforced finishes; therefore, it is essential to test specimens of the reinforced system.

5. Classification of Mastics and Coatings

5.1 *Vapor-Retarder Type*—A finish intended for service on insulated units that are operated below ambient temperature at least part of the time.

NOTE 1—Practice C755 provides additional guidance.

5.1.1 Outdoor service.
5.1.2 Indoor service.

5.2 *Vapor-Permeable Type*—A finish intended for service on insulated units that are operated above ambient temperature. (See 7.6.2. Sometimes referred to as a "breather" finish.)

5.2.1 Outdoor service.

5.2.2 Indoor service.

6. Application Properties

6.1 *Consistency:*

6.1.1 *Definition*—the resistance of a non-Newtonian material to deformation or flow.

NOTE 2—Consistency is not a fundamental property but is made up of viscosity, plasticity, and other rheological phenomena (see Terminology D2507). In non-Newtonian behavior, usual for mastics and coatings for thermal insulation, the ratio of shearing stress to the rate of shearing strain varies with the shearing stress.

6.1.2 *Significance and Use*—Consistency determines whether a mastic or coating can be troweled, applied by gloved hand, brushed, or sprayed. It has a direct effect on application costs.

6.1.3 *Technical Evaluation*—Test Methods C461, D562, and D2196.

6.2 *Coverage:*

6.2.1 *Definition*—the measure of surface area in ft^2/gal (m^2/litre) (coatings) or gallons per 100 ft^2 (mastics) at which finish must be applied to obtain specified dry thickness and desired performance.

6.2.2 *Significance and Use*—The performance of finishes is related directly to the optimum dry thickness. Therefore, performance properties must be defined in terms of optimum dry thickness, and this value must be established for application purposes in terms of coverage. Coverage data are essential for estimating material quantities and costs.

6.2.3 *Technical Evaluation*—Test Methods C461.

6.3 *Build:*

6.3.1 *Definition*—the thickness to which a coating or mastic finish can be applied without sagging, running, sliding, or dripping.

6.3.2 *Significance and Use*—Finishes for thermal insulation must be capable of application on vertical or overhead surfaces at specified coverage without subsequent reduction in thickness, caused by excessive flow or slump. Build also determines the number of coats required for optimum dry thickness.

6.3.3 *Technical Evaluation*—Test Methods C461.

6.4 *Wet Flammability (during application):*

6.4.1 *Definition*—the relative ease of ignition and consequent fire hazard of a finish during application, as indicated by its flash point, fire point, and fuel contribution.

6.4.2 *Significance and Use*—Finishes that contain volatile flammable solvent will potentially ignite readily from a source such as welding sparks and spatter, electrical short circuits, open flames, or personnel smoking. Such a fire will potentially spread very rapidly over freshly finished surfaces.

6.4.3 *Technical Evaluation*—Test Methods D56, D92, D93, D1310, and D3828.

6.5 *Toxicity:*

6.5.1 *Definition*—harmful physiological response to vapor inhalation or skin contact with finishes during application.

6.5.2 *Significance and Use*—Finishes shall not adversely affect health of personnel making applications. Container labels and safety data sheets must describe legally and adequately any health hazard involved in using the product.

6.5.3 *Technical Evaluation*—Test as recommended by American Conference of Governmental Industrial Hygienists.[4]

6.6 *Temperature and Humidity Range (during application):*

6.6.1 *Definition*—the limiting temperatures and relative humidities between which practical application of finish is made without adverse effect on service properties.

6.6.2 *Significance and Use*—Application of finishes under extremes of atmospheric temperature or humidity, or both, will potentially hinder or prevent attainment of necessary coverage and proper cure, thus changing performance properties significantly. The temperature of the surface to which the finish is applied also must be considered.

6.6.3 *Technical Evaluation*—Test Method D2354, and product application tests made at maximum and minimum values of temperature and humidity in stated design conditions.

6.7 *Surface Wetting and Adhesion:*

6.7.1 *Definition*—the mutual affinity of the bonding between finish and the surface to which it is applied.

6.7.2 *Significance and Use*—Coatings and mastics must wet and bond readily to insulation surfaces without special treatments or application techniques, or both. Ease and cost of application require good surface wetting and adhesion.

6.7.3 *Technical Evaluation*—Closely observe during finish application under real or simulated field conditions.

6.8 *Gap Filling and Bridging:*

6.8.1 *Definition*—the ability to bridge, fill, and level joints and gaps in installed thermal insulation.

6.8.2 *Significance and Use*—Joints and gaps exist in installed block and blanket insulation. If these are not filled or bridged adequately, the protective value of the finish will be impaired seriously.

6.8.3 *Technical Evaluation*—Apply finish over insulation in real or simulated field conditions over typical joints and gaps. Follow with destructive examination to determine effectiveness.

6.9 *Sizing and Sealing:*

6.9.1 *Definition*—the ability of a finish to resist excessive absorption into porous insulation.

6.9.2 *Significance and Use*—Excessive penetration of finishes into insulation will affect adversely the performance of the finish and the thermal conductivity of the insulation.

6.9.3 *Technical Evaluation*—Apply finish by film applicator simultaneously on insulation and on a nonporous surface. After curing, measure the dry film thickness on the surfaces to establish the difference due to absorption. Sizing and sealing will be recommended for some insulation types.

6.10 *Corrosion or Solvent Attack:*

6.10.1 *Definition*—harmful effect on metals or thermal insulation from contact with finishes.

[4] Available from American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Dr., Cincinnati, OH 45240, http://www.acgih.org.

6.10.2 *Significance and Use*—Finishes must not attack insulation or adjacent metals to cause deterioration of the installation.

6.10.3 *Technical Evaluation*—Apply finish by film applicator. After curing, examine for evidence of softening, blistering, or shrinkage of insulation, as well as for corrosion of metal surfaces.

6.11 *Drying Time and Curing Time:*

6.11.1 *Definition*—elapsed time required for mastic or coating finish to dry or cure after application, before it may be placed in operating service.

NOTE 3—Drying time implies time during which applied finish is sensitive to local damage by weather or personnel. Curing time implies time required to reach optimum service properties.

6.11.2 *Significance and Use*—Performance properties of finishes depend on adequate drying and curing. Premature service operation will potentially lead to finish failure. Curing time data is needed to establish construction schedules.

6.11.3 *Technical Evaluation*—Test Methods C461 and D1640.

6.12 *Shrinkage:*

6.12.1 *Definition*—change in volume from wet to dry state observed after mastic and coatings have been applied and cured.

6.12.2 *Significance and Use*—While all finishes containing volatile solvent will shrink during curing, it is important that the finish not crack or delaminate during this time. Shrinkage value must be known to establish coverage rate.

6.12.3 *Technical Evaluation*—Shrinkage ring test (see Test Methods D2453 and C681) and volume solids test (see Test Method C461).

6.13 *Storage Stability:*

6.13.1 *Definition*—ability to resist change in application or performance properties on prolonged storage. Storage life is the time span during which the product can be stored under specified conditions and remain suitable for use.

6.13.2 *Significance and Use*—Both application and service properties can be affected by substandard storage stability. This property affects purchasing, storage facilities, and construction scheduling.

6.13.3 *Technical Evaluation*—Test Methods C461 and D1849.

6.14 *Freeze-Thaw Stability:*

6.14.1 *Definition*—resistance to change in application and performance properties from exposure to alternate cycles of freezing and thawing.

6.14.2 *Significance and Use*—Both application and performance properties will potentially be affected by substandard freeze-thaw stability in water-base products. Susceptibility to freeze damage affects shipping methods, storage facilities, and application schedules.

6.14.3 *Technical Evaluation*—Test Methods C461 and Test Method D2243.

7. Service Properties

7.1 *Specimen Preparation for Testing*—Specimens prepared for testing of the following properties shall be at a dry film thickness recommended by the manufacturer. Specimens shall incorporate reinforcing mesh when recommended by the manufacturer's application instructions. See Practice C419.

7.2 *Outdoor Durability:*

7.2.1 *Definition*—resistance of finishes to deterioration by exposure to various weather conditions.

7.2.2 *Significance and Use*—Both physical and chemical changes will potentially occur on weather exposure and these changes affect performance properties, service life, and maintenance schedules. For this reason, tests of properties relating to performance shall be made both before and after specific periods of outdoor exposure.

7.2.3 *Technical Evaluation*—Test Method C488 and Practices D822/D822M and D3361/D3361M.

7.3 *Environmental Resistance*—The following three properties comprise the principal environmental factors:

7.3.1 *Temperature Limits:*

7.3.1.1 *Definition*—the limiting temperatures between which finishes will perform satisfactorily.

7.3.1.2 *Significance and Use*—Temperature level, duration, and rate of change must be considered in evaluation. Temperature limits, both high and low, affect choice of finish, performance properties, and service life.

7.3.1.3 *Technical Evaluation*—Exposure of specimens to stated limiting temperature conditions, followed by standard tests for other stated service properties. See Test Methods D2485 and C792.

7.3.2 *Chemicals and Water Resistance:*

7.3.2.1 *Definition*—capability of withstanding exposure to designated chemicals, such as acids, alkalies, salts, their vapors and solutions, and water both pure and industrial.

7.3.2.2 *Significance and Use*—Attack by, or absorption of, chemicals and water will potentially reduce materially the performance and service life of finishes that are not resistant. Atmospheric contamination and spillage of chemicals are common forms of chemical exposure of finishes.

7.3.2.3 *Technical Evaluation*—Practice D543 and Test Method D1654.

7.3.3 *Mold and Mildew Resistance:*

7.3.3.1 *Definition*—capability of resisting deterioration by fungi attack.

7.3.3.2 *Significance and Use*—Growth of microorganisms in the form of mildew or mold on the surface of finishes will cause unsightly appearance and will potentially cause substandard performance.

7.3.3.3 *Technical Evaluation*—Practice G21 and Test Methods D3274 and D5590.

7.4 *Surface Flammability:*

7.4.1 *Definition*—susceptibility to ignition and consequent surface spread of flame.

7.4.2 *Significance and Use*—Resistance to surface spread of flame is important to prevent fire growth from an accidental fire. Other significant properties of cured finishes are self-ignition point, softening point, fuel contribution, and smoke developed. A surface flammability hazard will potentially affect personnel safety, property values, and insurance rates. Reinforcing mesh recommended by the coatings and mastics

manufacturer shall be shown not to negatively impact the surface flammability and fire resistance properties.

7.4.3 *Technical Evaluation*—Test Methods D36/D36M, E84, E162, and E659.

7.5 *Water-Vapor Transmission Rate:*

7.5.1 *Definition*—between two specified parallel surfaces, the time rate of water-vapor flow normal to the surface, in a steady state, through unit area, under the specified conditions.

7.5.2 *Significance and Use*—The diffusion of water vapor through a permeable finish is a function of the difference between water-vapor pressures at its inner and outer faces. If such diffusion results in accumulation of water within insulation, significant changes in thermal conductivity, and physical damage to insulation, will potentially result. In installations operated above ambient temperature a relatively high rate is desirable to permit evaporation of contained water from heated insulation. See Note 4.

NOTE 4—To minimize the likelihood of these detrimental effects of water and water vapor intrusion, a low water vapor permeance is recommended for any installation operated below ambient temperature.

NOTE 5—Practice C755 will provide additional guidance.

7.5.3 *Technical Evaluation*—Specimens shall be prepared at the manufacture's recommended dry film thickness and include the use of reinforcing mesh when recommended by the manufacturer's application instructions. Test Methods E96/E96M and F1249.

7.6 *Adhesion:*

7.6.1 *Definition*—the bonding of finish to insulation, usually by interfacial forces of attraction.

7.6.2 *Significance and Use*—Mastics and coatings shall bond strongly to insulation surfaces to afford maximum protection and resistance to delamination in service. This property is difficult to measure on insulation materials of low cohesive strength.

7.6.3 *Technical Evaluation*—Test Method D903.

7.7 *Damage Resistance*—The following two properties comprise the principal damage factors:

7.7.1 *Impact Resistance (Toughness):*

7.7.1.1 *Definition*—ability to withstand mechanical blows without loss of protective properties.

7.7.1.2 *Significance and Use*—To remain watertight and vaportight, the finish must resist mechanical damage. Impact resistance affects service suitability and service life.

7.7.1.3 *Technical Evaluation*—Test Method D2444.

7.7.2 *Abrasion Resistance:*

7.7.2.1 *Definition*—ability to withstand scuffing, scratching, rubbing, or wind-scouring without loss of protective properties.

7.7.2.2 *Significance and Use*—Abrasion resistance in severe service locations is essential to prevent the eventual penetration of water through the finish. It affects service life and maintenance schedules.

7.7.2.3 *Technical Evaluation*—Test Methods D968.

7.8 *Stress Resistance*—The following two properties comprise the principal stress factors:

7.8.1 *Flexure:*

7.8.1.1 *Definition*—ability of finishes to be deformed by bending or twisting without loss of protective properties.

7.8.1.2 *Significance and Use*—Flexibility of finishes changes with temperature, so temperature limits of use must be considered in establishing flexural limits. Finishes installed over relatively soft insulation must have good flexibility to maintain protective properties.

7.8.1.3 *Technical Evaluation*—Test Methods D747 and D790.

7.8.2 *Elongation:*

7.8.2.1 *Definition*—extension produced by tensile stress.

7.8.2.2 *Significance and Use*—Finishes must provide adequate elongation to withstand stresses exerted during expansion of substrates to which the finish is applied. Adequate elongation will prevent cracking due to tensile stresses. Temperature range of use must be considered in establishing elongation properties.

7.8.2.3 *Technical Evaluation*—Test Method D638.

7.9 *Color:*

7.9.1 *Definition*—aspect, or appearance, dependent upon the specific composition of the incident light, the spectral reflectance or transmittance of the object, and the spectral response of the observer.

7.9.2 *Significance and Use*—Color retention of insulation finishes is dependent on incidence of environmental dirt, fallout, and solar radiation and heat load. Color selection depends on identification codes as well as on aesthetic considerations. Color standards shall be established by agreement between purchaser and supplier.

7.9.3 *Technical Evaluation*—Practices D1729 and D3134.

7.10 *Odor:*

7.10.1 *Definition*—scent, emanation, effluvium, or smell from finish.

7.10.2 *Significance and Use*—Odor from finishes will potentially be undesirable if it could contaminate foods or other materials exposed to it.

7.10.3 *Technical Evaluation*—Test Method D4339.

8. Other Properties

8.1 Other properties, such as the following, will potentially be of occasional significance, but because they are not usual requirements for most installations, they are listed simply for information and consideration.

8.1.1 Bleed resistance.
8.1.2 Blister resistance.
8.1.3 Dielectric strength.
8.1.4 Efflorescence resistance.
8.1.5 Electrical conductivity.
8.1.6 Gloss.
8.1.7 Puncture resistance.
8.1.8 Tear strength.
8.1.9 Tensile strength.
8.1.10 Thermal conductance.
8.1.11 Water absorption.
8.1.12 Working life.

9. Keywords

9.1 application properties; mastic coating; service properties

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