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

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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 the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

C 419 Practice for Making and Curing Test Specimens of Mastic Thermal Insulation Coatings[2]

C 461 Test Methods for Mastics and Coatings Used with Thermal Insulation[2]

C 488 Test Method for Conducting Exterior Exposure Tests of Finishes for Thermal Insulation[2]

C 639 Test Method for Rheological (Flow) Properties of Elastomeric Sealants[3]

C 681 Test Method for Volatility of Oil- and Resin-Based, Knife-Grade, Channel Glazing Compounds[3]

C 733 Test Method for Volume Shrinkage of Latex Sealants[3]

C 755 Practice for Selection of Vapor Retarders for Thermal Insulation[2]

C 792 Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants[3]

D 36 Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)[4]

D 56 Test Method for Flash Point by Tag Closed Tester[5]

D 92 Test Method for Flash and Fire Points by Cleveland Open Cup[5]

D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester[5]

D 529 Practice for Enclosed Carbon-Arc Exposures of Bituminous Materials[4]

D 543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents[6]

D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[7]

D 638 Test Method for Tensile Properties of Plastics[6]

D 658 Test Method for Abrasion Resistance of Organic Coatings By Air Blast Abrasive[7]

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[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 04.07.

[4] *Annual Book of ASTM Standards*, Vol 04.04.

[5] *Annual Book of ASTM Standards*, Vol 05.01.

[6] *Annual Book of ASTM Standards*, Vol 08.01.

[7] *Annual Book of ASTM Standards*, Vol 06.01.

D 747 Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam[6]
D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[6]
D 822 Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Exposure Apparatus[7]
D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[8]
D 968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive[7]
D 1310 Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus[7]
D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature[7]
D 1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments[7]
D 1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials[7]
D 1823 Test Method for Apparent Viscosity of Plastisols and Organosols at High Shear Rates by Extrusion Viscometer[6]
D 1824 Test Method for Apparent Viscosity of Plastisols and Organosols at Low Shear Rates by Brookfield Viscometer[6]
D 1849 Test Method for Package Stability of Paint[9]
D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials By Rotational (Brookfield type) Viscometer[7]
D 2243 Test Method for Freeze-Thaw Resistance of Water-Borne Coatings[9]
D 2354 Test Method for Minimum Film Formation Temperature (MFT) of Emulsion Vehicles[10]
D 2444 Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)[11]
D 2453 Test Method for Shrinkage and Tenacity of Oil- and Resin-Base Caulking Compounds[3]
D 2485 Test Method for Evaluating Coatings for High Temperature Service[7]
D 2507 Terminology of Rheological Properties of Gelled Rocket Propellants[12]
D 2939 Test Methods for Emulsified Bitumens Used as Protective Coatings[4]
D 3134 Practice for Establishing Color and Gloss Tolerances[7]
D 3274 Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation[7]
D 3361 Practice for Operating Light- and Water-Exposure Apparatus (Unfiltered Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products Using the Dew Cycle[7]
D 3828 Test Methods for Flash Point by Small Scale Closed Tester[13]
D 4339 Test Method for Determination of the Odor of Adhesives[8]
E 84 Test Method for Surface Burning Characteristics of Building Materials[3]
E 96 Test Methods for Water Vapor Transmission of Materials[2]
E 162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source[3]
E 659 Test Method for Autoignition Temperature of Liquid Chemicals[14]
G 21 Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi[15]
G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[15]

3. Terminology

3.1 *General Definitions:*

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

3.1.2 *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).

3.1.3 *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).

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

3.2 *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 may not be pertinent in any specific situation, and all of the tests outlined may not be required. A condition to any specification must be an evaluation of the proposed use to determine which properties may be required.

4.3 Membrane reinforcements are frequently specified and used with mastics and coatings. Service properties of such systems of finishes may be 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.

[8] *Annual Book of ASTM Standards*, Vol 15.06.
[9] *Annual Book of ASTM Standards*, Vol 06.02.
[10] *Annual Book of ASTM Standards*, Vol 06.03.
[11] *Annual Book of ASTM Standards*, Vol 08.04.
[12] *Annual Book of ASTM Standards*, Vol 15.03.
[13] *Annual Book of ASTM Standards*, Vol 05.02.
[14] *Annual Book of ASTM Standards*, Vol 14.02.
[15] *Annual Book of ASTM Standards*, Vol 14.04.

NOTE 1—Practice C 755 may provide 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 D 2507). 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 C 461, C 639, D 562, D 1823, D 1824, and D 2196.

6.2 *Coverage*:

6.2.1 *Definition*—the measure of surface area in square feet per gallon (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 C 461.

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 C 461.

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 may ignite readily from a source such as welding sparks and spatter, electrical short circuits, open flames, or personnel smoking. Such a fire could spread very rapidly over freshly finished surfaces.

6.4.3 *Technical Evaluation*—Test Methods D 56, D 92, D 93, D 1310, and D 3828.

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 should not adversely affect health of personnel making applications. Container labels 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.[16]

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

6.6.1 *Definition*—the limiting temperatures and relative humidities between which practical application of finish can be 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, can 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 D 2354, 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.

6.10 *Corrosion or Solvent Attack*:

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

[16] ACGIH, 1014 Broadway, Cincinnati, OH 45202.

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 may lead to finish failure. Curing time data are needed to establish construction schedules.

6.11.3 *Technical Evaluation*—Test Methods C 461 and D 1640.

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 D 2453, C 681, and C 733.

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 C 461, D 2939, and D 1849.

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 can 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 C 461 for bituminous materials, and Test Method D 2243 for other materials.

7. Service Properties

7.1 *Specimen Preparation for Testing*— See Practice C 419.

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 may occur on weather exposure and these changes affect performance properties, service life, and maintenance schedules. For this reason, tests of properties relating to performance should be made both before and after specific periods of outdoor exposure.

7.2.3 *Technical Evaluation*—Test Method C 488 and Practices D 529, D 822, D 3361, and G 23.

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 D 2485 and C 792.

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 can 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 D 543 and Test Method D 1654.

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 can cause substandard performance.

7.3.3.3 *Technical Evaluation*—Practice G 21 and Test Method D 3274.

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 can affect personnel safety, property values, and insurance rates.

7.4.3 *Technical Evaluation*—Test Methods D 36, E 84, E 162, and E 659.

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, can result. In installations operated above ambient temperature a relatively high rate is desirable to permit evaporation of contained water from heated insulation.[17]

NOTE 4—Practice C 755 may provide additional guidance.

7.5.3 *Technical Evaluation*—Test Methods E 96.

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 should 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 D 903.

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 D 2444.

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 D 658 and D 968.

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 D 747 and D 790.

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 D 638.

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 D 1729 and D 3134.

7.10 *Odor*:

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

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

7.10.3 *Technical Evaluation*—Test Method D 4339.

8. Other Properties

8.1 Other properties, such as the following, may 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

[17] 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.