Designation: C447 – 15

Standard Practice for Estimating the Maximum Use Temperature of Thermal Insulations[1]

This standard is issued under the fixed designation C447; 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 practice covers estimation of the maximum use temperature of thermal insulation including loose fill, blanket, block, board, and preformed pipe insulation. It is based upon selected performance criteria, and characterization of product properties during and after use conditions.

1.2 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.

1.3 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C165 Test Method for Measuring Compressive Properties of Thermal Insulations

C167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations

C168 Terminology Relating to Thermal Insulation

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation

C302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation

C303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C335/C335M Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C421 Test Method for Tumbling Friability of Preformed Block-Type and Preformed Pipe-Covering-Type Thermal Insulation

C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

D1621 Test Method for Compressive Properties of Rigid Cellular Plastics

D1622/D1622M Test Method for Apparent Density of Rigid Cellular Plastics

3. Terminology

3.1 Definitions contained in Terminology C168 shall be used in this practice.

4. Summary of Practice

4.1 Dimensions, weight and other pertinent properties of the insulation are measured before, during, and after exposure to a hot surface.

4.2 Properties during and after exposure, and, in some cases, the degree of change in properties are reported for use in establishing the maximum service temperature of the insulation.

5. Significance and Use

5.1 This practice is intended for use as a guide in evaluating the behavior of insulations at elevated temperatures, and in judging suitability for use under the conditions of an intended application. It is not intended for acceptance or certification testing on a lot basis.

5.2 No single test for estimating maximum use temperature can be used that will apply to all types of insulations, nor can any single maximum use temperature be applied to any insulation that will be applicable under all possible conditions of use. Maximum use temperature depends on thickness, temperature gradient, heating rate, and other factors. When the various test methods listed herein are employed, the test results serve as guides and, as such, shall be applied with good

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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.

engineering judgment in arriving at an acceptable temperature limit for the products and applications being considered.

5.3 The criteria used to establish acceptable performance is provided in the material specification or as agreed upon by the purchaser and seller.

5.4 In most cases, the properties covered by the applicable material standards (for example, thermal transmission, strength, and so forth) are the properties important to the end use of the product. Major changes in those properties resulting from in-service conditions often causes failure or substandard performance of the installed system.

5.5 Unless removal and reuse of the insulation is an important consideration, properties that relate primarily to handling and installation shall be eliminated from the evaluation.

NOTE 1—Installation assemblies: some systems create conditions that affect the performance from the data obtained in the test procedures of this practice.

5.6 The listing of a test procedure in this practice does not imply that the performance of that particular procedure is required. Only those tests which are relevant to the requirements of the application involved, or which are agreed upon by the purchaser and the seller are preformed.

5.7 Most of the changes that occur in the functionally important characteristics of all types of thermal insulation during service result from changes in the matrix or binder system first, followed by changes in the bulk filler materials where such fillers have been used.

5.7.1 In general, these changes are temperature-dependent and the major portion of the change takes place quickly once the critical temperature has been reached.

5.7.2 Typically, organic thermoplastic materials or binders will change in the 140 to 240°F (60 to 116°C) temperature range. Thermosetting organic materials or binders will start to deteriorate above 350°F (177°C). Hydrated inorganic binders such as clays, Portland and lumnite cements, gypsum, sodium silicates, oxysulfates, and oxychlorides lose varying amounts of water of crystallization at temperatures from 250 to 900°F (121 to 482°C) depending on the compound. Glass fibers and glass foams start to sinter around 1000°F (538°C). Rock or slag wools, perlite and refractory fibers occassionally show change at temperatures in excess of 1300°F (704°C).

5.8 If, after testing specimens exposed to the maximum service temperature, additional tests are made of specimens exposed to intermediate temperatures (third or quarter points in the full service temperature range), the results of such tests, when plotted with proper curve-fit techniques, give indications of changes in product characteristics throughout the service range. These results are used to bracket the temperature range within which a change has occurred (for example, significant change in slope of curve).

5.9 Some properties of thermal insulations containing trapped gases other than air change with time at different rates depending on the age, thickness, facing and boundary conditions. Elevated temperature exposure often accelerates these changes. In many cases changes in properties continue over a very long period of time. It is beyond the scope of this recommended practice to establish a minimum time period for evaluation of long-term changes.

6. Test Conditions

6.1 If required, testing shall begin at the hot-face temperature of the desired application or the maximum use temperature that is claimed. When there has been significant deterioration of the properties tested during or after exposure at the maximum hot-face temperature, additional specimens will be exposed at lower temperatures (third or quarter points of the temperature range from ambient to maximum) to establish the maximum hot-face temperature. Additional tests shall be made until enough data have been obtained to establish acceptable performance.

6.2 The criteria necessary to establish acceptable performance by any of the methods described shall be as provided in the material specification or as agreed upon between the purchaser and seller. For example, the specification of a minimum compressive strength or a maximum percent dimensional change as criterion for estimating the maximum use temperature.

6.3 With anisotropic materials that are produced initially in large cross-sections and mechanically fabricated in subsequent operations to produce boards or preformed pipe insulation, it is advisable to examine properties of interest in all three axes.

6.4 Since soaking heat exposure seldom occurs under "as installed" conditions, and such exposure often produces misleading results test specimens shall be conditioned using hot-face-/cold-face methods. Limit soaking heat exposure to preliminary evaluation and quality control testing.

6.5 The elevated temperature exposure time required to effect major change depends on the type of product being tested. Preliminary trials shall be made to establish the minimum hot surface exposure time required for a particular insulation material. The minimum exposure time has been reached when the property of interest shows no more than expected random variations in three consecutive readings taken at three hour intervals.

7. Test Specimens

7.1 The test specimens shall be selected to be representative of the material under evaluation. Original surfaces shall be retained at least on the hot face of the specimens.

7.2 Other specimen dimensions shall conform to the requirements of Test Method C411. Where further fabrication of the specimen after exposure is not practical, additional specimens, precut to the required size, shall be exposed separately.

8. Procedure

8.1 *Hot Surface Performance*—Test and report the hot surface performance of the insulation in accordance with Test Method C411 with the following exceptions and additions.

8.1.1 The thickness of the test specimens shall be the intended thickness of the application or the manufacturer's recommended minimum and maximum thickness for the test