Designation: C 302 – 95

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428

Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation[1]

This standard is issued under the fixed designation C 302; 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 test method covers the determination of the dimensions and density, after conditioning, of preformed pipe insulation.

1.1.1 Procedure 1 is applicable to sections of one-piece pipe covering or to sections of segmental pipe covering that can be joined together concentrically and measured as one-piece.

1.1.2 Procedure 2 is applicable to segmental pipe covering where each section of material is measured.

1.1.3 Procedure 3 is applicable to sections of one-piece pipe covering, such as soft foam or mineral wool materials, where it is possible to penetrate the material.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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:*

C 167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations[2]

C 168 Terminology Relating to Thermal Insulating Materials[2]

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials[3]

C 870 Practice for Conditioning of Thermal Insulating Materials[2]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[4]

3. Terminology

3.1 *Definitions*—See Terminology C 168.

4. Summary of Test Method

4.1 The material to be tested is conditioned to constant weight. The density of the pipe insulation is calculated from the conditioned mass and measured dimensions.

5. Significance and Use

5.1 Density measurements of preformed pipe insulation are useful in determining compliance of a product with specification limits and in providing a relative gage of product weights. For any one kind of insulation some important physical and mechanical properties, such as thermal conductivity, heat capacity, strength, etc., bear a specific relationship with its density; however, on a density basis, these properties are not directly comparable with those for other kinds of material.

5.2 The physical dimensions of preformed pipe insulation are important quantities not only for determining the density of the pipe insulation but also for determining the conformance to specifications. The use of multilayer insulations is common, and the dimensions are necessary to ensure proper nesting of the layers.

6. Apparatus

6.1 *Flexible Steel Rule*, graduated in 1/32-in. or 1.0-mm intervals.

6.2 *Scale*, with sufficient capacity to weigh the specimen to within 0.01 lb or 5 g.

6.3 *Pin Probe*, as defined in Test Methods C 167.

6.4 *Steel Rule*, graduated in 1/32-in. or 1.0-mm intervals.

6.5 *Stainless Steel Shim Stock*, 2 in. (75 mm) wide, longer than the circumference of the pipe insulation, and 0.010 in. (0.25 mm) thick.

6.6 *Pi Tape*, graduated to read a diameter directly to the nearest 1/32 in. or 1.0 mm.

6.7 *Pieces of Pipe*, on which to install the pipe insulation under test (only required for Procedure 3).

7. Test Specimen

7.1 The test specimen shall be of a commercial size.

7.2 If sectional pipe segments are to be used for Procedures 1 or 3, the sections shall be joined together to form a hollow cylinder.

8. Conditioning

8.1 Remove any jacket on the specimen unless it is of a type

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[1] This test method is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.32 on Mechanical Properties.

Current edition approved Aug. 15, 1995. Published October 1995. Originally published as C 302 – 52 T. Last previous edition C 302 – 82 (Reapproved 1989)ε[1].

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

[3] *Annual Book of ASTM Standards*, Vol 04.02.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

that would cause disintegration of the specimen upon removal.

8.2 Condition the specimen to constant mass in accordance with Practice C 870.

9. Procedures

9.1 *Procedure 1—One-Piece Pipe Section*:

9.1.1 Weigh the conditioned pipe section to the nearest 0.01 lb or 5 g.

9.1.2 Measure the length of the specimen in six locations, uniformly spaced around its circumference, to the nearest 1⁄32 in. or 1.0 mm.

9.1.3 Measure the circumference of the specimen in six locations, uniformly spaced along its length, to the nearest 1⁄32 in. or 1.0 mm.

9.1.4 Measure the wall thickness at six locations, uniformly spaced, three on each end of the specimen, to the nearest 1⁄32 in. or 1.0 mm.

9.2 *Procedure 2—Segmental Pipe Sections*:

9.2.1 Weigh the conditioned segmental pipe section to the nearest 0.01 lb or 5 g.

9.2.2 Measure the length of the arc formed by the outer surface of the specimen at six locations, uniformly spaced along its length, to the nearest 1⁄32 in. or 1.0 mm.

9.2.3 Measure the length of the arc formed by the inner surface of the specimen at six locations, uniformly spaced along its length, to the nearest 1⁄32 in. or 1.0 mm.

9.2.4 Measure the length of the specimen in six locations, uniformly spaced around the outer surface, to the nearest 1⁄32 in. or 1.0 mm.

9.2.5 Measure the wall thickness at six locations, uniformly spaced, one on each end and two on each side of the specimen, to the nearest 1⁄32 in. or 1.0 mm.

9.3 *Procedure 3—Non-Rigid Pipe Insulations*:

9.3.1 Weigh the conditioned pipe section to the nearest 0.01 lb or 5 g.

9.3.2 Place the insulation on a pipe of the same outside diameter as the nominal inside diameter of the specimen, and tie in place. Support the ends of the pipe such that the specimen is not resting on a surface.

9.3.3 Measure the length of the specimen in six locations, uniformly spaced around its circumference, to the nearest 1⁄32 in. or 1.0 mm.

9.3.4 Measure the diameter of the specimen in six locations, uniformly spaced along its length, to the nearest 1⁄32 in. or 1.0 mm, using the Pi tape. In order to avoid compressing the insulation specimens under the Pi tape, wrap the shim stock around the specimen and use the Pi tape over the shim stock. Subtract twice the thickness of the shim stock from the diameter measured and convert the diameter to a circumference by multiplying the average diameter by π.

9.3.5 Measure the wall thickness at six locations, uniformly spaced along the length of the specimen and uniformly spaced around its surface, using the pin probe of 6.3, to the nearest 1⁄32 in. or 1.0 mm.

10. Calculations

10.1 Calculate the volume of the specimen using one of the following equations:

10.1.1 *Procedures 1 and 3*:

$$V = Lt(C - \pi\, t)/1728 \quad (1)$$

where:

V = volume of the specimen, ft^3,
L = average length of the specimen, in.,
t = average thickness of the specimen, in., and
C = average circumference of the specimen, in.

or

$$V = Lt(C - \pi t) \times 10^{-9} \quad (2)$$

where:

V = is in m^3, and L, t, and C are in mm.

NOTE 1—If the jacket is not removed before measuring the outer circumference, deduct twice the jacket thickness times π from the measured circumference.

10.1.2 *Procedure 2*:

$$V = Lt(A_o + A_i)/3456 \quad (3)$$

where:

V = volume of the specimen, ft^3,
L = average length of the specimen, in.,
t = average thickness of the specimen, in.,
A_o = average outer arc length of the specimen, in., and
A_i = average inner arc length of the specimen, in.

10.2 Calculate the density of the specimen from the conditioned mass and the calculated volume, and express the results in pounds per cubic foot or kilograms per cubic metre.

NOTE 2—If the jacket was not removed before weighing and measuring, deduct the mass of the jacket from the specimen mass. If the specimen will be used for additional testing, a jacket from a specimen from the same sample will have to be sacrificed to measure the mass per lineal foot of the jacket.

11. Report

11.1 Report the following information:

11.1.1 The average dimensions of the pipe insulation,

11.1.2 The density of the specimen in pounds per cubic foot or kilograms per cubic metre,

11.1.3 The average thickness to the nearest 1⁄32 in. or 1.0 mm. State whether or not the jacket was removed,

11.1.4 Individual dimensions and mass measurements only when specified, and

11.1.5 Preconditioning and conditioning temperatures and relative humidities used in Section 8, unless they are specified in a separate standard.

12. Precision and Bias

12.1 *Precision (Procedure 1)*—The multi-laboratory 95 % repeatability limit for three materials was found to be 6.16 %, and the 95 % reproducibility limit was found to be 9.13 % when the round robin results were analyzed using Practice E 691.

12.2 *Precision (Procedure 2)*—Both the multi-laboratory and single-operator coefficients of variation were found to be 1.3 % (Note 3). Therefore, the results on identical samples by two different laboratories or the results of two tests on identical material by the same operator should not differ by more than 3.7 % on their average.

NOTE 3—(For Procedure 2 only), the percentage variation represents, respectively, the (1σ) and (D2σ) limits.

12.3 *Precision (Procedure 3)*—The multi-laboratory 95 % repeatability limit for three materials was found to be 6.10 % and the 95 % reproducibility limit was found to be 7.67 % when the round robin results were analyzed using Practice E 691.

12.4 *Bias*—The procedures in this test method for measuring the dimensions and the density of preformed pipe covering-type thermal insulation have no bias because no material having an accepted reference value is available.

13. Keywords

13.1 pipe insulation density; pipe insulation dimensions; thermal insulation