



Designation: C421 – 08 (Reapproved 2020)

Standard Test Method for Tumbling Friability of Preformed Block-Type and Preformed Pipe-Covering-Type Thermal Insulation¹

This standard is issued under the fixed designation C421; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers determination of the mass loss of preformed block-type and preformed pipe-covering-type thermal insulation as a result of a combination of abrasion and impact produced by a laboratory tumbling mechanism.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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](#)

[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](#)

3. Terminology

3.1 *Definitions*—Definitions pertaining to thermal insulating materials are defined in Terminology [C168](#).

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

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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.

4. Significance and Use

4.1 Several test methods for measuring mass loss by abrasion and impact of preformed block-type and preformed pipe-covering-type thermal insulation have been used previously. It is believed that no single test method completely covers all factors involving such forces for different kinds of materials, but this test method is intended to provide a procedure that gives reproducible results. It is used for comparing the mass loss by tumbling before and after a specific treatment of the insulation, as agreed upon by the purchaser and the manufacturer.

5. Apparatus

5.1 *Box*—A cubical box of oak wood, having inside dimensions of 7½ by 7¾ by 7¾ in. (190 by 197 by 197 mm), mounted rigidly at the center of one 7¾ by 7¾ in. (197 by 197 mm) end, so that the axis normal to a face of the box is that of a rotatable horizontal shaft. One side of the box shall be hinged as a door and shall be gasketed to be dust-tight. The box shaft shall be motor driven at a constant speed of 60 ± 2 r/min.

5.2 *Cubes*—Twenty-four room-dry, solid oak, ¾ ± 1/32-in. (19 ± 0.8-mm) cubes shall be placed in the box with the test specimens. The specific gravity of the oak cubes shall be approximately 0.65; white oak meets this requirement.

NOTE 1—Number each group of wood cubes 1 through 24. At the end of every 600-revolution test, remove one “used” cube (follow the number sequence and remove the oldest cube) and replace with a correspondingly numbered “new” cube. In this manner, cube wear is eliminated as an uncontrolled variable in the test method. When the corners of the wood cubes have been worn so that the radius of curvature is greater than 1/16 in. (1.6 mm) or the cubes have become altered so as not to be comparable with new cubes, they shall be discarded and new ones used. A conventional machinist's radius gage is used for checking the edge wear.

6. Test Specimens

6.1 Cut the insulation with a fine-tooth saw (similar to a 16-tooth band saw) into 1 ± 1/16-in. (25.4 ± 1.6-mm) cubes.

6.2 Test twelve cubes at a time cut from one piece of insulation. When flat insulation has special surfaces due to treatment or molding, cut each cube to include such special

surfaces as one face, except that the edges and corners of the insulation shall not be used.

6.3 Dry and condition specimens prior to test, following applicable specifications for the material. If the material is adversely affected by oven temperatures, then condition specimens for not less than 40 h at 73.4 ± 1.8°F (23 ± 1°C), and 50 ± 5 % relative humidity before testing. In the absence of definitive drying specifications, dry specimens in an oven at 215 to 250°F (102 to 121°C) to constant mass, and hold in a desiccator to cool to room temperature before testing. Where circumstances or requirements preclude compliance with these conditioning procedures, exceptions agreed upon by the purchaser and the manufacturer are acceptable, but they shall be specifically listed in the test report.

7. Procedure

7.1 Conduct the test in the Standard Laboratory Atmosphere at 73.4 ± 1.8°F (23 ± 1°C) and 50 ± 5 % relative humidity.

NOTE 2—Other specimen conditioning procedures or test conditions may be selected to simulate actual-use conditions, upon agreement between the purchaser and the manufacturer.

7.2 Weigh the twelve conditioned test specimens on a balance to within ± 1 %.

7.3 Place the twelve specimens together with the 24 oak cubes in the clean test box and secure the lid tightly.

7.4 Rotate the box at 60 ± 2 r/min for 600 ± 3 revolutions.

7.5 Immediately after the test period, carefully empty the contents of the box onto a 3/8-in. (9.5-mm) mesh screen and tap gently to remove dust and small particles. Carefully remove the twelve largest pieces of insulation from the screen and weigh promptly.

7.6 Clean out the box between runs.

7.7 If an additional test period is to be run, replace the twelve weighed pieces into the box and repeat steps 7.3 – 7.5.

8. Calculation

8.1 Calculate the percent mass loss to two significant figures using Eq 1:

$$\text{Mass loss, \%} = [(M_1 - M_2)/M_1] \times 100 \quad (1)$$

where:

- M₁ = original mass, and
- M₂ = final mass.

9. Report

9.1 The report shall include the following:

9.1.1 Complete description of the material tested, including type, source, and density, in accordance with Test Methods C302 and C303, and special surfaces if any,

TABLE 1 Precision

Material	Mass Loss (%)	Repeatability		Reproducibility	
		± 2.0 Sr	± 2.0 Sr (%)	± 2.0 SR	± 2.0 SR ^A (%)
Rigid cellular plastic	A 0.11	0.34	309	0.40	364
(Specimens = 3, Laboratories = 6)	B 1.00	0.65	65.0	0.83	83.0
	C 5.3	1.6	30.9	4.2	79.3
	D 31.4	2.6	8.2	8.5	27.1
	E 48.9	4.5	9.1	11.3	23.2
	F 49.6	5.3	10.7	10.8	21.8
	Calcium silicate 15 lb/ft ³ (240 kg/m ³) maximum (Specimen = 6, Laboratories = 4)	... 9.3	1.3	14.0	1.1
Perlite 14 lb/ft ³ (224 kg/m ³) maximum (Specimens = 3, Laboratories = 5)	... 54.4	4.2	7.6	9.5	17.5

^ASr=repeatability standard deviation
SR=reproducibility standard deviation

9.1.2 Conditioning or drying procedures followed and special conditions employed in the test, if any,

9.1.3 Date of test,

9.1.4 Percent mass loss, and

9.1.5 Comments on the mode and extent of abrasion, erosion, crumbling, cracking, etc.

10. Precision and Bias³

10.1 Precision—The precision of this test method is given in Table 1.

10.1.1 Repeatability—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test materials would exceed the values given for repeatability in Table 1 only in one case in twenty.

10.1.2 Reproducibility—The difference between two single and independent results obtained by different operators working in different laboratories on identical material would exceed the values given for reproducibility in Table 1 only in one case in twenty.

10.2 Bias—No information can be presented on the bias of the procedure in this test method because no material having an accepted reference value is available.

11. Keywords

11.1 mass loss; thermal insulating materials—block/board; tumbling friability

³ Supporting data have been filed at ASTM Headquarters. Request Research Report RR:C16-1006.

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