PIMA Technical Bulletin #107

Dimensional Stability of Polyiso Roof Insulation

About Polyiso Insulation

Polyiso is a rigid foam insulation used in more than 70% of commercial roof construction and offers a continuous insulation solution for commercial and residential wall assemblies. As one of North America's most widely used and readily available building products, Polyiso is a cost-effective insulation option for reducing building energy use and improving the overall service-life of roofs and walls.

The benefits of using Polyiso include:

- High R-value per inch of thickness
- Excellent fire test performance
- Extensive building code approvals
- Cost-effective continuous insulation (ci) solution
- Compatible with most roof and wall systems
- Dimensional stability
- Compressive strength
- Moisture resistance
- Thinner walls and roofs with shorter fasteners
- Long service life
- Preferred insurance ratings
- Virtually no global warming potential
- Zero ozone depletion potential
- Recyclable through reuse
- Recycled content (amount varies by product)
- Regional materials (nationwide production network)

POLYISO

Surround yourself with the best.

Dimensional stability is an important physical property for many types of roofing and insulation materials. ASTM and CAN/ULC material specifications for foam plastic insulations utilized in roof applications include requirements for dimensional stability. However, the test method, environmental exposure conditions, and duration may vary.

Given the variety of test methods and exposure conditions (*see* Table 2), direct comparisons of dimensional stability test results between dissimilar methods and dissimilar materials are not meaningful. This technical bulletin sheds light on the methods used to determine dimensional stability that are referenced in the material specifications in the US and Canadian building codes for polyiso roof insulation.

Important Note: Small-scale dimensional stability results do not directly correlate to full-size boards of polyiso insulation, nor should they be extrapolated to describe the performance of full-size polyiso insulation boards in end uses.

What Does Dimensional Stability Mean and How is it Tested?

Dimensional stability is the measurement of a material's change in linear dimensions – length, width, and thickness – after exposure to a prescribed set of environmental conditions for a defined period of time. The amount of dimensional change is expressed as a percent (reported to the nearest 0.1%) relative to initial linear dimensions determined prior to environmental exposure.

The material specifications for polyiso insulation, ASTM C1289[1] in the US and CAN/ULC-S704.1[2] in Canada, contain requirements for dimensional stability that list a maximum linear change for all polyiso types and classes. The dimensional stability test method referenced in both material specifications is ASTM D2126.[3]

The test specimen size required to demonstrate compliance with ASTM C1289 measures 12 inches in length by 12 inches in width by 1 inch[4] in thickness (300 mm by 300 mm by 25 mm) with facings intact on both sides. The length, width, and thickness dimensions of each test specimen are measured prior to and following exposure to the specified environmental conditions and duration (*see* Table 1). The change in linear dimensions (length, width, and thickness) of each specimen is calculated, and the average value for each dimension is expressed as a percent (reported to the nearest 0.1%).

1. ASTM C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
2. CAN/ULC-S704.1, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced
3. ASTM D2126, Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
4. For all ASTM C1289 product Types, Classes and Grades except Type II, Class 4 products. The test specimen thickness for Type II, Class 4 products is 1/2-inch (12.7 mm).

By comparison, CAN/ULC-S704.1 requires test specimens that measure 300 mm in length, 300 mm in width, and 25 mm in thickness for Types 1, 2, and 3 polyiso products, or 6 mm in thickness for Types 4, 5, and 6 polyiso products, with facings intact on both sides. It is important to note that CAN/ULC-S704.1 requires dimensional stability to be determined for length and width dimensions only.

Table 1: Dimensional Stability Test Conditions Specified in ASTM C1289 and CAN/ULC-S704

ASTM C1289			CAN/ULC-S704.1		
Temperature	**Relative Humidity**	**Exposure Duration**	**Temperature**	**Relative Humidity**	**Exposure Duration**
200 ± 4 °F (93 ± 2 °C)	Ambient	7 days	80 ± 2°C	Ambient	28 days
-40 ± 6°F (-40 ± 3°C)	Ambient	7 days	-29 ± 3°C	Ambient	7 days
158 ± 4°F (70 ± 2°C)	97 ± 3 %	7 days	70 ± 2°C	97 ± 3 %	28 days

Laboratories conducting dimensional stability testing have environmental chambers capable of maintaining the required temperature and relative humidity. Test specimens are arranged in the chamber to provide air circulation on all six sides of each specimen. Following environmental exposure for the specified duration (*see* Table 1), specimens are removed from the chamber and placed for 2-hours in ambient laboratory conditions (i.e., 73°F, 50% RH) to come back to room temperature. The dimensions of each specimen are then measured and the change in length, width and thickness[5] is calculated. Changes in general appearance, such as distortion of the specimens (i.e., warping) are also noted.

Exposure Conditions

The ASTM D2126 standard test method identifies several common exposure conditions for the evaluation of rigid cellular plastic materials. For roof applications, typical exposure conditions for dimensional stability testing of foam plastic insulation include low and high temperature conditions at ambient relative humidity as well as a high temperature, high humidity condition. Exposure conditions identified in the material specifications for various other insulation materials are provided in Table 2 (*see* Table 1 for details related to polyiso insulation products).

It is important for users and designers to remember that different test methods are used for different insulation materials types and for different end-use applications. As a result, the methods do not provide results that are comparable. It is also important to note that results from laboratory testing conducted under controlled conditions are not intended to predict performance in end-use applications. For example, when polyiso insulation is installed with other materials in various building envelope assemblies.

5. Dimensional stability for product thickness is not required to be quantified in CAN/ULC-S704.1 standard.

Table 2: Dimensional Stability Test Methods and Environmental Exposure Conditions for Other Types of Insulation Materials [6,7]

Insulation Material and Specification		Dimensional Stability Test Method	Test Specimen Size and Other Characteristics	Environmental Exposure Conditions		
				Temperature	Relative Humidity	Exposure Duration
Polystyrene Insulation						
United States	ASTM C578	ASTM D2126	4 inches × 4 inches × 1 inch (100 mm x 100 mm × 25 mm)	158 ± 4°F (70 ± 2°C)	97 ± 3 %	7 days
				-40 ± 6°F (-40 ± 3°C)	Ambient	7 days
Canada	CAN/ULC-S701.1	ASTM D2126	4 inches × 4 inches × 1.5 inches (100 mm x 100 mm × 38 mm)	158 ± 4°F (70 ± 2°C)	Ambient	7 days
Spray-Applied Polyurethane Foam Insulation						
United States	ASTM C1029 (General uses)	ASTM D2126	12 inches × 12 inches × 1.5 inches (305 mm x 305 mm × 38 mm) Applied to ¾ inch (19 mm) CDX plywood	158 ± 4°F (70 ± 2°C)	97 ± 3 %	7 days
	ASTM D7425 (Roofing uses)	ASTM D2126	12 inches × 12 inches × 1 inch (305 mm x 305 mm × 25 mm) Applied to ¾ inch (19 mm) CDX plywood	70 ± 2°C (158 ± 4°F)	97 ± 3 %	14 days
Canada	CAN/ULC-S705.1 (Medium-Density)	ASTM D2126	4 inches × 4 inches × 2 inches (100 mm × 100 mm × 50 mm)	-40 ± 6°F (-40 ± 3°C)	Ambient	28 days
				176 ± 4°F (80 ± 2°C)	Ambient	28 days
				158 ± 4°F (70 ± 2°C)	97 ± 3 %	28 days
Cellulosic / Wood Fiber Board						
United States	ASTM C208 / C209	ASTM D1037	3 inches × 12 inches (76 mm x 305 mm)	68 ± 4°F (20 ± 2°C)	90 ± 5 %	To equilibrium
Canada	CAN/ULC-S706.1	ASTM D1037	3 inches × 12 inches (76 mm x 305 mm)	68 ± 4°F (20 ± 2°C)	90 ± 5 %	To equilibrium
Mineral Wool Roof Insulation Board						
United States	ASTM C726	ASTM D2126	12 inches × 12 inches (305 mm x 305 mm)	158 ± 4°F (70 ± 2°C)	97 ± 3 %	7 days
Canada	CAN/ULC-S702.1	No requirement				

6. Each edition of the building code adopted in the US and Canada identifies specific editions of reference standards (i.e., test methods and material specifications). Users are directed to review the specific versions of standards referenced by the governing edition of the building code in their local jurisdiction.

7. The table lists temperature, relative humidity, and duration of environmental exposure conditions.

How Should Dimensional Stability Test Results Be Used?

Dimensional stability data is not directly comparable when it is determined using different test methods, different test specimen configurations, or different exposure conditions. As Table 2 illustrates, the test methods, test specimen sizes, and environmental exposure conditions required by ASTM and CAN/ULC material specifications used in the US and Canada for several insulation types all differ. In addition, small-scale dimensional stability test results do not directly correlate to full-size insulation boards, nor should the results be extrapolated to describe the performance of full-size insulation boards in end use applications.

Dimensional stability data may be used by manufacturers to aid in quality control processes and to demonstrate compliance of products with the requirements of the applicable standard and/or material specification.

For designers and users, dimensional stability information may be useful to compare the performance of similar products and materials with the important caveats that both test methodology (test specimen dimensions, exposure conditions, etc.) and type of material tested (i.e., cellular plastics) need to be the same.

Summary

Dimensional stability of building materials is an important physical property referenced in insulation standards and material specifications in the US and Canada. When reviewing manufacturers' technical information for thermal insulation products in roofing applications, it is important to remember that the test method used for the evaluation, as well as the test specimen dimensions and exposure conditions, must be the same in order to make valid comparisons across different insulation material types. PIMA encourages designers to contact product manufacturers for the most current technical information and building code compliance documentation.

ABOUT PIMA

Since 1987, PIMA has served as the voice of the North American rigid polyiso insulation industry. PIMA is a leading advocate for safe, cost-effective, sustainable, and energy-efficient construction. The Association is comprised of polyiso manufacturers and industry suppliers, and represents the public policy interests of its membership at the local, national, and international levels to advance high-performance building practices.

PIMA produces technical bulletins to address key topics related to polyiso insulation. These publications inform architects, specifiers, and contractors about the performance characteristics of polyiso insulation. Always consult individual manufacturers for product specific information, including product data sheets and installation instructions.

For more information on polyisocyanurate insulation, visit www.polyiso.org

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