INSULATION FACTS #82

NAIMA
North American Insulation Manufacturers Association

www.naima.org

Mineral Fiber Insulation Products for Commercial and Industrial Applications:

Codes and Standards for Insulation Used on Pipes

Temperatures From 40°F to 1400°F (4°C to 760°C) Per ASTM C547

This Fact Sheet addresses the importance of specifying commercial and industrial pipe insulation that meets prescribed codes and standards for quality and safety, and illustrates the consequences of using insulation that does not meet those standards.

Introduction

Importance of Standards

Codes and standards play an important role in the information infrastructure that guides design, manufacturing and trade in the global economy. They dictate specific methods for testing and prescribe levels of acceptability. In the U.S., numerous codes and standards exist that are specifically designed to ensure the quality and safety of commercial and industrial pipe insulation. These codes and standards provide a means for achieving predictable technical performance when installed in a consistent manner and used according to standard guidelines.

This fact sheet lists the common ASTM Standards and Test Methods for fiber glass and rock wool pipe insulation.

Non-Compliant Products

A growing number of imported pipe insulation products, however, do not meet the same high standards of quality and safety. To avoid potential liability, it is incumbent upon specifiers to request documentation proving that these products have been tested and perform according to the claims being made in manufacturers' data sheets.

Costly Consequences

The consequences of using pipe insulation that does not meet the technical standards for quality and safety can be costly indeed:

- Greater installation costs for the contractor
- Increased operations and maintenance costs for the facility owner
- Safety risk to installers, facility employees, or general public if there is an accident that results from a product that does not meet specifications

Specific Problems

A number of specific problems can arise if the specified codes and standards for pipe insulation are not adhered to by designers, manufacturers, distributors, fabricators and contractors. Examples of these types of problems are described in this document.

Testing for Product Compliance

Testing for product compliance addressed by various codes and standards often includes:

Insulation

- Maximum use temperature
- Thermal conductivity
- Dimensions
- Dimensional stability (linear shrinkage with a heat soak and sag resistance)

- Mechanical strength (including compressive strength, breaking load, modulus of rupture, and tumbling friability)
- Water vapor sorption
- Water vapor permeability of factory-applied jacketing for below ambient applications
- Corrosion of carbon and stainless steel

Facings

There are also several standards for the pipe insulation facings used to secure the insulation to the pipe or as a vapor retarder for insulation on cold pipes. These facings typically consist of multi-layer laminates and the standards that address the technical performance of these facing materials include requirements for:

- Vapor permeance
- Burst strength
- Puncture resistance
- Tensile strength
- Dimensional stability
- Mold/fungal resistance
- Flame propagation

The issues addressed by codes and standards that could affect the health and safety of the insulation installers and the public are:

- Handling and storage
- Surface burning characteristics
- Combustibility

Pipe Insulation Differs From Other Forms of Insulation

What sets pipe insulation apart from other forms of thermal insulation such as blankets, boards, sheets and block, is that pipe insulation is usually pre-formed into standardized 'pipe dimension' sizes allowing it to be quickly and professionally installed.

While blankets and sheet insulation can be wrapped around a pipe, they are not specifically engineered for that use and consequently the thermal performance, quality of installation, and system integrity may not be consistent and predictable. Pre-formed pipe insulation, by contrast, is specifically designed and manufactured in diameters and thicknesses to fit a particular pipe size. There are some blanket insulations specifically engineered as pipewrap which are covered by ASTM C553.

Goal of Codes and Standards

Safety

Codes and standards are designed to make products and services safer to buy, safer to install, and safer to use. For commercial and industrial pipe insulation, codes and standards provide a means for achieving predictable product performance when installed in a consistent manner and used according to standard guidelines. This is so that the installer, the facility and the general public work at reduced risk.

Product Quality

Codes and standards also enhance product quality and performance by addressing product consistency and uniformity as they relate to safety. Since the ultimate goal is to hold all parties to the same quality and safety standards, these same codes and standards can serve as a resource for product liability challenges.

ASTM International

ASTM International is one of the largest voluntary standards development organizations in the world—a trusted source for technical standards for materials, products, systems, and services. Standards developed at ASTM are the work of over 30,000 ASTM members. These technical experts represent producers, users, consumers, government and academia from over 120 countries.

ASTM Standard Specifications for Insulation and Facing Materials

Calcium Silicate	ASTM C533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
Mineral Fiber	ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation
Perlite	ASTM C610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
Cellular Glass	ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation (not specifically for pipe insulation but it includes pipe applications)
Metal Mesh Covered Mineral Fiber Blankets	ASTM C592 – Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
Mineral Fiber Pipe and Tank Wrap	ASTM C1393 – Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks
Jacketing Materials for Thermal Insulation	ASTM C921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

ASTM Technical Performance and Test Standards for Thermal Pipe Insulation	
Properties	**ASTM Reference**
Maximum Use Temperature	ASTM C411 – Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation ASTM C447 – Standard Practice for Estimating the Maximum Use Temperature of Thermal Insulations
Thermal Conductivity	ASTM C177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus (for a homogeneous material in a flat shape) ASTM C335 – Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation (for a material that can be placed around a test pipe, either as a homogeneous or non-homogeneous system) ASTM C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus
Dimensions	ASTM C302 – Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation ASTM C450 – Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging ASTM C585 – Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
Dimensional Stability	ASTM C356 – Standard Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat C547 – Standard Specification for Mineral Fiber Pipe Insulation, Section 11.1.7.4 Procedure (for sag resistance)
Mechanical Strength	ASTM C165 – Standard Test Method for Measuring Compressive Properties of Thermal Insulations (this is not specifically suited to pipe insulation but rather to the material itself cut into a block shape) ASTM C446 – Standard Test Method for Breaking Load and Calculated Modulus of Rupture of Preformed Insulation for Pipes. (ASTM website said that this is a withdrawn standard) ASTM C421 – Standard Test Method for Tumbling Friability of Preformed Block-Type Thermal Insulation and Preformed Pipe-Covering-Type Thermal Insulation
Water Vapor Sorption	ASTM C1104/C1104M – Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
Water Vapor Permeance of Factory-Applied Jacketing for Below Ambient Applications	ASTM E96/E96M – Standard Test Methods for Water Vapor Transmission of Materials
Corrosion of Stainless Steel and Other Materials	ASTM C692 – Standard Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel ASTM C871 – Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
Fungi Resistance	ASTM C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings

Other Standard Test Methods Applicable to Insulation Materials	
Properties	**ASTM Reference**
Flame Spread	ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials CAN/ULC-S102 – Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
Non-combustibility	ASTM E136 – Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C CAN/ULC-S114 – Standard Method of Test for Determination of Non-Combustibility in Building Materials
Testing of Cellular Glass	ASTM C240 – Standard Test Methods of Testing Cellular Glass Insulation Block. This standard includes testing methods for density, water absorption, compressive strength, flexural strength, thermal conductivity, and selection of samples for chemical analysis
Facing/Vapor Retarders	ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM Standard Test Methods for Facings	
Burst Strength	ASTM D774/D774M – Standard Method for Bursting Strength of Paper
Tensile Strength (paper and paperboard)	ASTM D828 – Standard Test Method for Tensile Properties for Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus
Tensile Strength (thin plastic sheeting)	ASTM D882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting
Dimensional Stability	ASTM D1204 – Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
Vapor Permeance	ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials
Flame Spread	ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM Fabrication Standards	
Cellular Glass Pipe and Tubing Insulation	ASTM C1639 – Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation
Additional Relevant ASTM Standards Frequently Specified for Pipe Insulation	
Thermal Insulation in Contact with Austenitic Stainless Steel	ASTM C795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
Handling, Shipping, etc. of Thermal Insulation in Contact with Austenitic Stainless Steel	ASTM C929 – Standard Specification for Handling, Transporting, Shipping, Storage, Receiving, and Application of Thermal Insulation Materials for Use in Contact with Austenitic Stainless Steel
Corrosion of Metals	ASTM C1617 – Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals
Testing Frequency and Quality Control	ASTM C390 – Standard Practices for Sampling and Acceptance of Thermal Insulation Lots

Potential Quality Issues if Codes and Standards are Not Met

Following are a few examples of what can happen if the specified ASTM codes and standards for pipe insulation are not adhered to by the designers, manufacturers, distributors, fabricators, and contractors.

Potential Problems if Codes and Standards are Not Met	
Physical and Chemical Deterioration	An insulation material not constrained by codes and standards could physically and chemically deteriorate from "runaway" exotherming when first installed on a hot pipe; this could pose a threat to health and safety. Also, this "runaway" exotherming could damage the insulation and could lead to greater heat loss than predicted in the project design. (ASTM C411 and C447)
Heat Loss	When an insulation material's thermal conductivity is unstable over time and increases due to physical and/or chemical instability, this could result in greater heat loss than that predicted in the project design. (ASTM C177, C335 and C518)
Increased Labor Costs	When a pipe insulation section does not fit the pipe correctly, more labor hours to install will result, thereby increasing the contractor's costs for the project. (ASTM C302 and C585)
Gaps Can Impact Predicted Performance	When an insulation section shrinks significantly when first installed, the result could be a large gaps between adjacent sections, resulting in heat loss or heat gain to the system impacting the predicted performance in the project design. (ASTM C356)
Increased Project Cost	When an insulation shipment arrives at the job site with unacceptably high level of breakage and other damage due to weak or brittle material, this could increase both project cost and duration. (ASTM C165 and C446)
Increased Thermal Conductivity	When an insulation material absorbs a high level of water vapor from the atmosphere, this could result in an increased thermal conductivity and an increased heat loss or gain. (ASTM C1104)
Water Condensation	When the water vapor permeability of factory applied jacketing is greater than that value used in design, this could result in a high level of water condensation within the insulation leading to the replacement of the insulation materials. (ASTM C1136 and E96)
Corrosion	When the insulation has high concentrations of corrosive chemicals (such as chlorides), over time this could lead to corrosion of the insulated pipes. (ASTM C795)
Fire	When the insulation, either faced or unfaced, catches on fire and the fire spreads down the material's surface, this would pose a threat to health and safety of those inside the facility. (ASTM E84)
Combustible Gases	When the insulation is exposed to a fire and the result is the release of a large quantity of combustible gases, these gases, in turn, could further feed the fire. (ASTM E13)
Moisture Problems	When the facing fails to adequately retard the ingress of water vapor on a below ambient system, over time this failure could lead to wet insulation and other moisture problems in the facility. (ASTM E96)
Inconsistent Product Quality	When the insulation materials are not tested every 3 years for all applicable properties there are no assurances the end user will receive product that complies to the standards. (ASTM C390)

Conclusion

The goal of codes and standards is to provide the public with means for achieving predictable technical performance while assuring that the material can be installed in a predictable manner and, once installed, assuring the materials' longevity, all this without adversely affecting either the installers' or the public's health and safety. A variety of costly problems can occur if referenced codes and standards with performance criteria are not adhered to by designers, manufacturers, distributors, fabricators, and contractors. If there is any doubt as to the conformance of the insulation product, documentation detailing testing and adherence to codes and standards should be obtained.

About NAIMA

NAIMA is the association for North American manufacturers of fiber glass, rock wool, and slag wool insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials.

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