PIMA Technical Bulletin #405

Fire Resistance Properties of Polyiso Foam Plastic Insulation Used in Wall Assemblies

Facts and Comparisons

About Polyiso Insulation

Polyiso is a rigid foam insulation used in over 70% of commercial roof construction, in commercial sidewall construction and in residential construction.

The Benefits of using Polyiso include:

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

PIMA and polyiso products have received many environmental awards. These include an honorable mention in the Sustainable Buildings Industry Council's (SBIC) - "Best Practice" Sustainability Awards Program and the U.S. EPA's Climate Protection Award for the association's leadership in promoting energy efficiency and climate protection. The EPA also awarded PIMA and its members the Stratospheric Ozone Protection Award for "leadership in CFC phase-out in polyiso insulation and in recognition of exceptional contributions to global environmental protection."

POLYISO
The top performer.

Introduction

Building codes exist to provide a means to safeguard life and protect the private and public welfare through the regulation of the design, construction practices, construction material quality, location, occupancy and maintenance of buildings and structures. Protection from the risks associated with fires is prevalent throughout the codes, and the fire resistance properties of building materials are especially important.

Polyisocyanurate foam plastic insulation, or polyiso for short, meets the most stringent building code requirements for use in buildings of any construction type and is one of the most regulated building products used in the construction of building envelopes. For example, Section 2603 of the International Building Code (IBC) and Section R314 of the International Residential Code (IRC) prescribe general fire test requirements for foam plastic insulation, in addition to specific fire tests, many of them full-scale building assemblies, for specific applications.

However, not all foam plastic insulating sheathing materials — or other commonly used combustible sheathing materials, such as oriented strand board (OSB) – have equal fire performance properties and capabilities. As a result of continuous improvement in the product and years of rigorous testing, the performance of polyiso has been validated in numerous building product tests and in historical practice. While polyiso has many benefits, its fire performance is one more reason why polyiso is a preferred building envelope insulating material.

This technical bulletin provides a synopsis of minimum fire resistance properties required for foam plastic insulation materials and compares data on polyiso with other recognized combustible materials commonly used for building construction, such as polystyrene insulation (i.e., XPS and EPS foams) and OSB. The specific material properties related to fire performance include flame spread and smoke development ratings. In addition, the performance of polyiso with respect to the thermal barrier and ignition barrier requirements of the code are presented. Together, these properties demonstrate the superior performance of polyiso.

Building Construction and Codes

The IBC, IRC and the local codes based upon them establish baselines for building material performance. Requirements are subdivided by the type of construction, as shown in Table 1.

The type of construction used is determined by a number of factors. Building codes contain many limits on the type of construction allowed for a given project, based on the building's height and area. Further, these height and area limitations can differ depending on the active or passive fire protection strategies employed. The construction types can be thought of as varying levels of fire resistance. The requirements for these levels of fire resistance dictate what materials can be used in their construction. Polyiso, because of its excellent fire performance characteristics, may be used in all building types.

Table 1: Building Construction Types

Construction Type	Description of Construction Type	Typical Building of Construction Type	Examples of Construction Type	Examples of Polyiso Applications
Type I "Fire-resistive"	Noncombustible materials and high level of fire resistance	Typical concrete and steel structure with some combustible materials allowed. Fire retardant treated lumber is permitted in some interior walls and roofs.	Large metropolitan hospitals, high-rise office buildings, highest level of fire protection	Above or below deck roof insulation, exterior wall sheathing, interior wall insulation, ceiling insulation, floor insulation, foundation insulation, air barriers, water-resistive barriers
Type II "Non-combustible"	Noncombustible materials and lower level of fire resistance	Typical concrete and steel structure with some combustible materials allowed. Fire retardant treated lumber is permitted in some interior walls and roofs.	Same as Type I with lower fire resistance rating requirements on assemblies	
Type III "Ordinary"	Exterior walls are noncombustible and interior walls of any material allowed by code	Typical construction would be steel or masonry block exterior walls with wood floors and roof framing and wood or steel interior wall framing	Warehouses, factories, storage buildings	
Type IV "Heavy timber"	Exterior walls are noncombustible and interior arches, beams and columns are of heavy timber framing with no concealed spaces	Typical construction would be steel, brick or masonry exterior walls and heavy timber interior structural members. Fire retardant treated lumber is permitted in exterior walls that have a fire resistance rating of 2 hours or less	Buildings constructed with interior exposed beams and columns	
Type V "Wood frame"	Both exterior and interior walls are of any material allowed by code	Typical residential and wood-framed construction	One- and two-family homes, offices and apartment buildings	

Material Property Data for Fire Resistance

Table 2 presents a summary of minimum material fire performance properties for foam plastic insulating materials based on the building code provisions cited above and other available data. Table 3 compares the actual performance of these same properties for polyiso to other foam plastic insulating materials, such as polystyrene (i.e., XPS or EPS foams) and OSB.

Table 2: Minimum Required Fire Resistance Properties and Code Requirements for All Foam Plastic Insulation Materials

Fire Resistance Property or Code Requirement	Requirement for Foam Plastic Insulating Materials
Surface Burning / Flame Spread Index (FSI) (ASTM E84) 100 = wood (red oak) 0 = cement board NOTE: Gypsum sheathing typically has an FSI of 20 or less.	General requirement of 75 or less for buildings constructed in accordance with the IBC and IRC
	25 or less required for most exterior walls of Types I – IV commercial structures built in accordance with the IBC
Smoke Developed Index (ASTM E84) 100 = wood (red oak)	450 or less required
Thermal Barrier[1] (typically ½" gypsum interior finish)	Required except in specific cases such as attics and crawlspaces or unless a full scale fire test is performed
Flash Ignition Temperature[2]	600°F minimum
Self-Ignition Temperature[2]	800°F minimum
Ignition Barrier[3]	Required in attics and crawl spaces in lieu of the thermal barrier where attic access is required and entry is made only for service of utilities
Testing per NFPA 285[4]	Required for exterior wall assemblies in Types I, II, III and IV
Testing per NFPA 286, FM4880, UL 1040 or UL 1715	Required for special approval to be used without thermal or ignition barriers

[1] A thermal barrier limits the average temperature rise of the unexposed surface to not more than 250°F after 15 minutes of fire exposure.

[2] There is not a general code requirement for a required self-ignition or flash ignition temperature. However, there is a requirement for the use of polyiso, when used in cooler and freezer walls up to 10" thick. In this case, the flash ignition and self-ignition temperatures must not be less than 600°F and 800°F (316°C and 427°C) respectively (2603.4.1.2).

[3] Both the IBC and IRC require the ignition barrier to be installed in such a manner that the foam plastic insulation is not exposed to fire from the interior of the building.

[4] For a listing of polyiso insulating products tested to NPFA 285, see http://www.sbcri.info/nfpa285.

NOTE: Fire test data provides a relative index. While it is not necessarily indicative of performance under exposure to fire in real-world environments, it is an accepted measure of evaluation.

Table 3: Comparison of Fire Resistance Properties and Code Requirements for Polyiso and Other Materials

Fire Resistance Property or Code Requirement	Polyiso	Other Foam Plastics (Polystyrenes)	Wood Structural Panel (WSP) Sheathing (OSB and Plywood)
Flame Spread Index (FSI) (ASTM E84)	Products are available for use in all building types. Products are available in both Class A (25 or less) and Class B (75 or less). NOTE: In contrast to other foam plastics, polyiso chars and does not become fluid (drip) during this test. Also, differences in rating depend on polyiso formulation.[1]	Products are available for use in all building types. Most are Class A (25 or less). NOTE: Polystyrenes tend to melt and "drip" during this test, resulting in loss of material exposure to flame spread. The values reported are for material in initial testing position only and do not take into account ignition of molten residue on the surface floor. [2]	No minimum flame spread requirement. Can only be used in Types III, IV and V where combustible construction is allowed without treatment.
			Use of fire retardant treated (FRT) sheathing in Types I and II permitted in limited conditions[4].
			Reported flame spread index in the range of 86 – 150[3] for 7/16" OSB (non-fire retardant treated [FRT] plywood is similar).
			Flame spread rating of 25 or less for FRT WSP. Consult manufacturers' data for reduced strength values of FRT WSP.
Smoke Developed Index (SDI) (ASTM E84)	Products are available for use in all building types. All products have a smoke developed Index of less than 450 with some less than 200.	Products are available for use in all building types. Products generally report a SDI of 200 or less. *NOTE: Polystyrenes tend to melt and "drip" during this test, resulting in loss of material exposure to flame spread. The values reported are for material in initial testing position only and do not take into account ignition of molten residue on the surface floor.* [2]	No smoke developed index requirement.
			Can only be used in Types III, IV and V construction without treatment.
			Reported SDI to not exceed 450[5,6]
			Consult manufacturers' data for reduced strength values of FRT WSP
Thermal Barrier	With some exceptions, products generally require a 15-minute thermal barrier.[7]	With some exceptions, products generally require a 15-minute thermal barrier.	No IBC or IRC thermal barrier required.
	Products can gain special approval through full-scale testing for use without a thermal barrier.	Products can gain special approval through full-scale testing for use without a thermal barrier.	Can only be used in Types III, IV and V construction without treatment.
			23/32" OSB qualifies as a thermal barrier.

Table 3: Comparison of Fire Resistance Properties and Code Requirements for Polyiso and Other Materials

Fire Resistance Property or Code Requirement	Polyiso	Other Foam Plastics (Polystyrenes)	Wood Structural Panel (WSP) Sheathing (OSB and Plywood)
Self-Ignition Temperature	800° – 850°F[8]	875° – 925°F[9]	400° – 500°F[10]
Ignition Barrier	Products require an ignition barrier in attics and crawl spaces when not protected by a thermal barrier.	Products require an ignition barrier in attics and crawl spaces when not protected by a thermal barrier.	No IBC or IRC ignition barrier required.
	Products can gain special approval through full-scale testing for use without an ignition barrier.	Products can gain special approval through full-scale testing for use without an ignition barrier.	Can only be used in Types III, IV and V construction without treatment.
NFPA 285 Testing[11]	Required for exterior walls of all Types I, II, III and IV buildings of any height.	Required for exterior walls of all Types I, II, III and IV buildings of any height.	Not required.
	Full-scale wall assembly test.	Full-scale wall assembly test.	Can only be used in Types III, IV and V construction without treatment.
NFPA 285 Testing FM4880, UL 1040 or UL 1715	Not required for one-story structures when polyiso has a flame spread of 25 or less and a smoke developed rating of 450.	Not required for one-story structures when the polystyrene has a flame spread of 25 or less and a smoke developed rating of 450.	Can only be used in Types III, IV and V construction without treatment.
	In this case, the thermal barrier is not required, provided the building is equipped with an automatic sprinkler system and the polyiso is installed in a thickness not more than 4" and is covered by a minimum 0.032"-thick aluminum or 0.016"-thick corrosion resistant steel.	In this case, the thermal barrier is not required, provided the building is equipped with an automatic sprinkler system and the polystyrene is installed in a thickness not more than 4" and is covered by a minimum 0.032"-thick aluminum or 0.016"-thick corrosion resistant steel.	

[1] http://www.osti.gov/bridge/servlets/purl/10118544-HoOk76/webviewable/10118544.pdf.

[2] See also PIMA Technical Bulletin #103.

[3] American Wood Council DCA 1, http://awc.org/publications/DCA/DCA1/DCA1.pdf.

[4] 2009 International Building Code, Section 603.1.

[5] OSB is generally classified as a Class C sheathing requiring a smoke developed rating of 450 or less per American Wood Council DCA 1, http://awc.org/publications/DCA/DCA1/DCA1.pdf.

[6] APA Technical Bulletin TT-010B reports the smoke developed index of APA performance rated wood structural panels to the 270 or less.

[7] Per IBC 2603.4.1.5, prescriptively polyiso is exempt from the thermal barrier requirement when used under a roof assembly or roof covering and is covered on the interior side with a minimum 15/32" OSB. Based on performance, OSB must be a minimum 23/32" to meet the requirements of a thermal barrier per APA TT-60.

[8] http://www.osti.gov/bridge/servlets/purl/10118544-HoOk76/webviewable/10118544.pdf, p 2.6. These are typical ranges; some products provide better performance. See Individual manufacturer information for specific product properties.

[9] http://www.osti.gov/bridge/servlets/purl/10118544-HoOk76/webviewable/10118544.pdf, Sections 2.1.3 and 2.2.3, pp 2.3–2.4.

[10] http://osbguide.tecotested.com/pdfs/en/tb115.pdf.

[11] For a listing of polyiso and other foam plastic insulating products tested to NPFA 285, see http://www.sbcri.info/nfpa285.

IBC Chapter 26 delineates the requirements of several tests for foam sheathing. These include: §2603.4 *Thermal barrier*, referencing ASTM E119/UL 263 and FM 4880/UL 1040/NFPA 286/UL 1715; §2603.5.3 *Potential heat*, referencing NFPA 259; §2603.5.7 Ignition, referencing NFPA 268; and §2603.9 *Special approval*, referencing NFPA 286/FM 4880/UL 1040/UL 1715. Many polyiso products on the market have passed this comprehensive testing. It is important to note that other common combustible materials, such as OSB, are not required to satisfy similar tests and thus provide unknown fire performance characteristics. Also, wood sheathing products can only be used in combustible construction types if they are fire retardant treated, and that has additional costs and structural performance issues.

Contact your polyiso manufacturer for specific product and assembly test results.

Conclusions

Based on the data presented in this technical bulletin, the following conclusions are substantiated:

1. Wood sheathing begins to burn at 400° – 500°F, while polyiso does not burn until temperatures greater than 800°.
2. Polyiso offers superior surface burning and flame spread fire-resistance properties in comparison to minimum building code requirements and other common combustible insulating and structural materials used for building envelope construction. Its flame spread characteristics are similar to gypsum wallboard.
    a. Polyiso has a flame spread index much lower than OSB, yet OSB has no flame spread requirements. All foam plastic products are required to meet a flame spread index of 75 or less. The requirement is more stringent for foam plastic products used in exterior walls of Types I – IV where they must meet a flame spread index of 25 or less.
    b. Polyiso will not melt or drip when exposed to fire. This is not the case for polystyrene (XPS and EPS), which produces molten material that would also be subject to adding molten fuel to the fire.
3. Polyiso, like many foam plastic materials, is generally required to have a thermal barrier, but it has the capability to be used without a thermal barrier when it meets specific testing criteria. Consult a specific polyiso manufacturer for code approval data allowing a product's use without a thermal barrier.

    Wood structural panels, like many wood based sheathing materials, are generally not required to be tested to prove they are a thermal barrier, regardless of fire characteristics.
4. Many exterior wall assemblies with polyiso insulation pass the stringent NFPA 285 test and can therefore be used in buildings of any type and any height. Wood structural panels have generally not been tested to NFPA 285 and can only be used in Types III, IV and V construction without treatment. If treated, consult manufacturers' data for reduced strength values of FRT WSP.

Note: For further information on code compliance of foam plastic insulating sheathing, see www.sbcri.info/fsc.

PIMA

For over 20 years, PIMA (Polyisocyanurate Insulation Manufacturers Association) has served as the unified voice of the rigid polyiso industry proactively advocating for safe, cost-effective, sustainable and energy efficient construction.

PIMA produces technical bulletins in an effort to address frequently asked questions about polyiso insulation. PIMA's technical bulletins are published to help expand the knowledge of specifiers and contractors and to build consensus on the performance characteristics of polyiso. Individual companies should be consulted for specifics about their respective products.

PIMA's membership consists of manufacturers and marketers of polyiso insulation and suppliers to the industry. Our members account for a majority of all of the polyiso produced in North America.

SAFETY

Polyiso insulation, like wood and other organic building materials, is combustible. Therefore, it should not be exposed to an ignition source of sufficient heat and intensity (e.g., flames, fire, sparks, etc.) during transit, storage or product application. Consult the product label and/or the PIMA members' Material Safety Data Sheets (MSDS) for specific safety instructions. In the United States, follow all regulations from OSHA, NFPA and local fire authorities; in Canada, follow all regulations from Health Canada Occupational Health and Safety Act (WMHIS) and local fire authorities.

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

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