

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."



Introduction

Building codes exist to provide a means to safeguard life and to 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 practice for many years. 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, smoke development, thermal barrier requirements and ignition barrier requirements. Together, these properties demonstrate the superior performance of polyiso.

Building Construction and Codes

The International Building Code (IBC), the International Residential Code (IRC) and 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 be different 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 varying 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	Large metropolitan hospitals, high-rise office buildings	Above or below deck roof insulation, wall sheathing, 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	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 walls with wood floors and roof 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	

Comparative Performance of Various Building Materials

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 (e.g., polystyrene XPS or EPS) and OSB.

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

Fire Resistance Property	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.	25 or less required for Types I – IV commercial structures per IBC 75 or less required for all IRC dwelling construction and IBC Type V construction
Smoke Developed Index (SDI) (ASTM E84) 100 = wood (red oak)	450 or less required
Thermal Barrier¹ (typically ½" gypsum interior finish)	Required except in specific cases such as attics and crawlspaces or unless a full scale fire test is performed
Self-Ignition Temperature²	800° – 925°F ³
Testing per NFPA 285⁴, FM4880, UL 1040 or UL 1715	Required for exterior wall assemblies in Types I, II, III and IV

¹ A thermal barrier is required to separate a material from direct fire exposure originating from the interior of a building and provide a minimum of 15 minutes of thermal protection.

² There is not a general code requirement for a required ignition temperature. However, R316.5.3 ATTICS and R316.5.4 CRAWL SPACES do not require the thermal barrier when an ignition barrier is in place. The ignition barrier can be ¼" OSB. Also, polyiso can be used in cooler and freezer walls up to 10" thick where flash ignition and self-ignition temperatures are not less than 600°F and 800°F (316°C and 427°C) respectively (2603.4.1.2).

³ <http://www.osti.gov/bridge/servlets/purl/10118544-HoOk76/webviewable/10118544.pdf>, p 2.6 and Sections 2.1.3 and 2.2.3, pp 2.3–2.4.

⁴ For a listing of polyiso and other foam plastic insulating products tested to NPFA 285, FM4880, UL 1040 or UL 1715, see <http://www.sbcni.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 for Polyiso and Other Materials

Fire Resistance Property	Polyiso	Other Foam Plastics (Polystyrenes)	Wood Structural Panel (WSP) Sheathing (OSB and Plywood)
Flame Spread Index (FSI) (ASTM E84)	25 or less required for Types I – IV commercial structures	25 or less required for Types I – IV commercial structures	No flame spread rating provided by wood sheathing
	75 or less required for Type V commercial and all residential construction	75 or less required for Type V commercial and all residential construction	Can only be used in Types III, IV and V where combustible construction is allowed without treatment
	<i>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</i>	<i>NOTE: Polystyrenes tend to melt and “drip” during this test resulting in loss of material exposure to flame spread. Also, the values are for material in initial testing position only and do not take into account ignition of molten residue on the surface floor.²</i>	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
Smoke Developed Index (SDI) (ASTM E84)	450 or less required	450 or less required	No smoke developed rating provided by OSB sheathing
	May be used in all building types	May be used in all building types	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 require a 15-minute thermal barrier ⁷	With some exceptions, products require a 15-minute thermal barrier	No IBC or IRC thermal barrier required
			Can only be used in Types III, IV and V construction without treatment
			23/32” OSB qualifies as a thermal barrier
Self-Ignition Temperature	800° – 850°F ⁸	875° – 925°F ⁹	400° – 500°F ¹⁰

Table 3: Comparison of Fire Resistance Properties for Polyiso and Other Materials cont.

Fire Resistance Property	Polyiso	Other Foam Plastics (Polystyrenes)	Wood Structural Panel (WSP) Sheathing (OSB and Plywood)
NFPA 285 Testing¹¹ FM4880, UL 1040 or UL 1715	Required for exterior walls of all Types I, II, III and IV buildings of any height greater than one story	Required for exterior walls of all Types I, II, III and IV buildings of any height greater than one story	Not required
	Not required for one-story structures when polyiso has a flame spread of 25 or less and a smoke developed rating of 450. 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.	Not required for one-story structures when the polystyrene has a flame spread of 25 or less and a smoke developed rating of 450. 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 For example, the following EPS flame spread and smoke development caveat is included on EPS products in the market today: "Flame spread and smoke development recorded while material remained in the original test position. Ignition of molten residue on the surface floor resulted in flame travel equivalent to calculated flame spread index of 125 and smoke development index of over 500." 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.

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 NFPA 285, FM4880, UL 1040 or UL 1715, see <http://www.sbcni.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 NFPA 286; §2603.5.3 *Potential heat*, referencing NFPA 259; §2603.5.7 *Ignition*, referencing NFPA 268; and §2603.9 *Special approval*, referencing NFPA 286. 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 of 800° – 850°F are reached.
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. All foam plastic products are required to meet a flame spread index of 75 or less. The standard is more stringent for foam plastic products used in Types I – IV where they must meet a flame spread index of 25 or less.
 - b. Polyiso smoke development characteristics are also similar to gypsum wallboard. This has great benefit to the fire service as they fight any building envelope fire.
 - c. Polyiso will not melt or drip when exposed to fire, so it will not produce 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. This level of protection is superior to that of wood structural panels where no thermal barrier is required. Consult a specific polyiso manufacturer for code approval data allowing a product's use without a thermal barrier.
4. Polyiso has undergone rigorous testing as an interior exposed fire rated plastic insulation and in these applications would not require a 15-minute barrier. Other polyiso interior wall applications do require a 15-minute thermal barrier. OSB is not required by code to have one. However, the time assigned to 15/32" OSB is only 10 minutes. Thus, the tested properties of, and the code requirements for, polyiso indicate that it provides superior protection against exposure to interior fires.
5. 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.

Note: For further information on code compliance of foam plastic insulating sheathing, see www.sbcricri.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 (VMHIS) and local fire authorities.

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



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