Chapter

10

Foamed-in-Place Insulation

Foamed-in-place insulation materials have become fairly popular in the commercial and residential building industry since the early 1970s. The technical data, however, can be as dizzying as high school chemistry because the benefits of the different materials are determined by more than just R-value alone. Cost, thoroughness of installation, and air and vapor retarder properties all are to be considered when selecting a foamed-in-place insulation product.

A plastic foam material consists of a gas phase dispersed in a solid plastic phase and derives its installed properties from both. The solid plastic component forms the matrix, whereas the gas phase is contained in voids or cells. It is often referred to as the *blowing* or *foaming agent*. Although specific processes vary, foamed-in-place insulations start as a liquid that is sprayed through a nozzle into wall, ceiling, and floor cavities. The chemical reaction created by the mixing at the nozzle causes the material to expand while it is sprayed onto or into a wall cavity. The insulation is a cellular material with millions of tiny air-filled cells. The term *cellular plastic,* a synonym for *plastic foam,* is derived from the structure of the material.[1]

Foams are classified as open-cell or closed-cell. In *open-cell foams,* the individual cells are interconnected. These insulation materials are of low density and flexible, with a rigidity similar to that of a sponge or sponge rubber. Polyicynene, for example, uses water as a blowing agent and heat to create the open-cell structure that provides the thermal performance, and can be installed in any thickness.

In *closed-cell foams,* each cell (more or less spherical in shape) is completely enclosed by a thin wall or membrane of plastic. These foams comprise the high-density, rigid foams like polyurethane foam. The typical installation is only 2.5 to 3", not filling the cavity completely. Closed-cell foams also take longer to completely dry (cure), although spray polyurethane foam (SPF) typically rises and sets in between 5 and 15 seconds and is dry to the touch in less than a minute.

Foamed-in-place materials require special equipment to meter, mix, and spray into place. Installation of foamed-in-place insulation is always done by certified insulation installers. Spray-foam materials cost more than conventional blanket insulation but provide a more complete coverage and may perform as an air retarder. An approved 15-minute barrier, such as gypsum wallboard, must cover all foam materials on the inside of a building except where approved by building codes or local building code officials based on diversified fire tests specific to the application.

Foam systems provide good air leakage control, moisture control, and sound control, in addition to providing thermal insulation. In other words, many of these products in certain climates can serve as a one-step insulation, moisture/vapor barrier, and wind barrier system. The foam system can take the place of building wrap, fiberglass, polyethylene vapor barrier, tape, foam, and caulking and eliminates the labor-intensive work associated with airtightness detailing when insulating with conventional insulation products.[2] Elimination of the air barrier may offset some of the additional costs.

Polyurethane foam insulation has come under scrutiny in the past two decades in the wake of growing environmental awareness. The public health concerns resulting from the use of formaldehyde in urea formaldehyde foam insulation (UFFI) may have been the catalyst for more public and scientific protests surrounding the environmental consequences of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) that are used in the blowing agents that create the foam's insulating cells. (For a complete discussion of UFFI, see Chap. 16.)

A chlorofluorocarbon (CFC) is a compound consisting of chlorine, fluorine, and carbon. CFCs are very stable in the troposphere. They were developed in 1930 by DuPont and General Motors for use as safe refrigerant alternatives to sulfur dioxide and ammonia, which were corrosive and toxic. DuPont began selling CFCs under the trade name Freon for use in refrigerators (CFC-11) and air conditioners (CFC-12). Besides being used as refrigerants, CFCs were used as nontoxic and nonflammable blowing agents for making foam (CFC-11, CFC-12). During the early 1970s, scientists discovered that CFC molecules did not easily decompose in the lower atmosphere because of their chemical stability. Instead, they were drifting into the stratosphere and attacking the ozone layer, which shields the earth from harmful ultraviolet radiation.[3] They are broken down by strong ultraviolet light in the stratosphere and release chlorine atoms that then deplete the ozone layer.[4]

A hydrochlorofluorocarbon (HCFC) is a compound consisting of hydrogen, chlorine, fluorine, and carbon. The HCFCs are one class of chemicals being used to replace the CFCs. They contain chlorine and thus deplete stratospheric ozone, but to a much lesser extent than CFCs.[4]

The initial hypothesis linking CFCs and depletion of the stratospheric ozone layer was first published in 1974. Between 1974 and 1987, scientists continued to research and understand atmospheric processes that were affecting stratospheric ozone.[5]

The ozone layer is the region of the stratosphere containing the bulk of atmospheric ozone that lies approximately 10 to 25 miles above the Earth's surface. Depletion of this layer by ozone-depleting substances (ODS) will lead to higher ultraviolet radiation (UVB) levels, which in turn will cause increased skin cancers and cataracts and potential damage to some marine organisms, plants, and plastics.[4]

In 1987, an international team of scientists collected and analyzed evidence reportedly linking the Antarctic ozone hole to ozone-depleting chemicals. In response to this growing threat, the international community negotiated the Montreal Protocol, which led to the U.S. Congress passing the Clean Air Act Amendments of 1990. These amendments set into place restrictions on the production and consumption of ODS, a ban on nonessential products, requirements for approving the use of safe substitutes only, and a requirement for warning labels.[5]

A July 1992 ruling required producers of class I substances (CFCs, halons, carbon tetrachloride, and methyl chloroform) to gradually reduce their production of these chemicals and to phase them out completely as of January 1, 2000. As of 2003, there will not be any production and/or importing of HCFC-141b, the most common blowing agent of polyurethane products. An identical ban on HCFC-142b and HCFC-22 will be enforced in 2010. As of 2015, there will not be any production and/or importation of any HCFCs, except for use as refrigerants in certain equipment.

The scheduled phase-out of CFCs and HCFCs has played a role in the research and development of various spray-foam materials. (The switch by conventional polyurethane manufacturers from CFC-11 to HCFC-141b has greatly reduced the ozone-depletion impacts, but even HCFC depletes ozone to some extent.[6]) Polyurethane, once an industry leader, now has competition from Icynene, Air-Krete, Tripolymer Foam, and other products that have been developed without using CFCs or HCFCs for foaming agents.

Icynene

Icynene Insulation System is the registered trademark for polyicynene insulation that is manufactured by Icynene, Inc. This foamed-in-place product arrived on the Canadian market in 1986. The low-density, open-cell modified polyurethane typically is foamed into open cavities and is installed with conventional spray equipment.

Product description

Polyicynene is an organic material developed from products of the petrochemical industry that has the texture and appearance of angel food cake. The foam is made up of millions of tiny cells filled with air that provide permanent control of air and moisture movement. The product is applied on the building site by a trained and licensed installer and provides a custom insulation that fits into virtually any size of cavity (Figs. 10.1 and 10.2).

The Icynene Insulation System is a two-part system consisting of isocyanate MDI and polyicynene resin. The two liquid components are mixed under heat and pressure in a 1:1 ratio within a spray-gun mixing chamber. Water serves as the foaming agent, reacting with the other components to generate CO_2, which expands the foam. This eliminates polyurethane's HCFC-related environmental problems but also means a lower R-value because the cells are filled with air, not a blowing agent. Triggering the gun allows the material to be released to the substrate, similar to spray painting, where it reacts from the mixture and expands to 100 times its liquid size. Within seconds, the foam expands to its full thickness, filling (and sometimes overfilling) the cavity. The labor involved in applying 10" of foam is not a great deal more than in a 2" application, so thicker applications are more cost-effective than thinner ones.

Figure 10.1 Spray application of Icynene. (*Icynene*)

Figure 10.2 Icynene after being scarfed. (*Icynene*)

According to the manufacturer, the Icynene Insulation System provides an environmentally safe, complete insulation and air retarder system that windproofs and seals wall, floor, and ceiling cavities against air movement, including spaces around electrical outlets and light fixtures, at baseboards, and behind window and door frames. In fact, the company promotes the Icynene Insulation System for its air-sealing properties as well as for its insulating properties. The foam does not shrink or sag and adheres to most surfaces. Because the foam remains flexible, it expands and contracts with seasonal movement of a building to remain airtight.

The Icynene insulation is noncorrosive. It is neutral, neither acidic nor alkaline, and it cannot support bacterial or fungal growth. Since it is a "breathing" foam, any moisture in the building's concrete or lumber can escape through the insulation as the building dries out, reportedly eliminating any risk of rot or mildew.

The Icynene insulation is sprayed in place by a professionally trained and licensed contractor after electrical and plumbing services are in place. Gypsum wallboard typically is installed directly over the Icynene insulation 10 minutes after application. According to the manufacturer, building wrap, polyethylene, taping, foaming, and caulking are eliminated because the foam works as an air retarder. (A separate vapor retarder is indicated for regions with cold winters.) Designers and builders should still verify this design requirement with local experts based on climate behavior and use of polyicynene.

Icynene, Inc., has developed a second formulation that can be foamed, by pouring, into closed cavities. The product expands from bottom to top to fill the cavity. A minimum of two pours, or lifts, are typically recommended. The cavity-fill product has a slightly greater density with an R-value of 4 per inch.

R-value

The R-value of the Icynene insulation is rated at 3.6 per inch. In a nominal 2 × 4 wall, this equates to an R-value of about R-13. In a 2 × 6 wall, this is about R-20. Unlike foams filled with CFCs or HCFCs, the R-value of air-filled foam does not decline as it ages.

Limitations

In the event that cavities are overfilled, excess insulation needs to be trimmed off due to its great expansion rate. A hand saw or Sawz-All blade can be used for scarfing the excess material. Polyicynene is not biodegradable, but the insulation waste can be used in the attic as loose-fill insulation. Working with Icynene, although not difficult, is a little laborious when it is necessary to run additional plumbing or electrical cabling through cavities after application of the foam.

Health considerations

Icynene insulation is water-based and does not produce formaldehyde, CFCs, or HCFCs. It has been tested extensively in both Canada and the United States and found to have no harmful emissions. The product also has been recommended for use in homes where specific environmentally sensitive conditions need to be maintained. The Icynene Insulation System is endorsed by the Envirodesic Building Program. Envirodesic certification identifies a growing family of cleaner products, healthier buildings, and expert services that promote “maximum indoor air quality”.[7]

Fire resistance

Icynene insulation will be consumed by flame, but since it contributes no fuel in the event of fire, it will not sustain flame on removal of the flame source. It must be covered by gypsum board or another acceptable 15-minute thermal barrier if required by applicable building codes.

Standards

Icynene has been evaluated by the Council of American Building Officials National Evaluation Service and complies to the BOCA, SBCCI, and ICBO *Uniform Building Codes* and the *Canadian National Building Code.* It has been the subject of research projects by the NAHB Research Center, Upper Marlboro, Maryland; Oak Ridge National Laboratories, Oak Ridge, Tennessee; and the Florida Solar Energy Center, Cape Canaveral, Florida.

Air Krete

Air Krete, a proprietary cementitious foam insulation, has been around since the mid-1980s. It is an inorganic foam made from magnesium oxychloride cement (which is derived from sea water) and a particular variety of ceramic talc mined in Governor, New York. These minerals are mixed with a proprietary foaming agent ("glorified soap suds," according to Air Krete inventor R. Keene Christopher) and sprayed with pressurized air through a foaming gun.[8]

Air Krete was developed and patented by Air Krete, Inc., of Weedsport, New York. The company licenses manufacturers and installers and provides the proprietary ingredients. According to the manufacturer, the marketing strategy is to license the Air Krete technology to various manufacturers in the United States and worldwide so that these manufacturers can be in close proximity to their market areas, typically within a 200-mile radius.

Product description

Foamed under pressure with a microscopic cell generator and compressed air, the insulation is fireproof, insect-proof, and nontoxic. It can be foamed in place in closed-wall cavities or masonry-block cavities. Gypsum wallboard, paneling, planks, and lath and plaster are interior finishes that have performed well with Air Krete.

For open-cavity installations, a fine screen is stapled across the opening to hold the foamed-in-place material when it is being installed. Air Krete will need a short drying period before a wall can be closed up. The resulting product is nontoxic, odorless, lightweight, and rigid, but the material is friable (easily crumbled) when dry.[9] Air Krete eliminates air infiltration per American Society for Testing and Materials (ASTM) C518.76 at 750°F and does not shrink per ASTM 951. It also does not expand or settle and is 100 percent cavity filling. The product is fully cured in 28 days.

Air Krete is also a soundproofing material that is used very effectively in interior sound partitions. Water noises are effectively reduced when Air Krete is used to encase plumbing pipes. The insulation used to be pink but now has a blue-green tint, achieved with an inert mineral pigment.[8] No CFCs or HCFCs are used as foaming agents. It is fireproof, rot-proof, and bug-proof and does not off-gas at all.

R-value

Air Krete maintains an R-value of 3.9 per inch.

Limitations

The cured material is friable and will turn into powder when rubbed lightly by hand. Friability does not seem to be a problem in closed cavities, but one may want to test the material before using it in locations subject to extreme vibration.

Air Krete is not flexible after it cures. Since it does not bond to surfaces, shrinkage or movement in a frame wall may open up small gaps. Gaps created by wood framing that has dried out also may be a likely cause of this problem. Air Krete is relatively high in cost. Labor is also an important factor, owing to the work involved in stapling the screen over the cavities.[8]

Health considerations

This product is considered nonhazardous as a waste using U.S. Environmental Protection Agency (EPA) methods. The MSDS reports that eye, skin, or respiratory protection is not required.

Environmental considerations

Air Krete is nontoxic, does not create any ozone-depleting CFCs, has very low VOC emissions, and does not contain any formaldehyde or carcinogenic fibers.

Fire resistance

Air Krete is most impressive as a noncombustible insulation. The material does not burn, does not release any smoke, and is often used as fire-stop material. It is also reported that a standard, 2 × 4 framed wall filled with Air Krete insulation has even passed a 2-hour firestopping test.[8]

Spray Polyurethane Foam (SPF)

Foamed-in-place polyurethane foam, typically referred to as *spray polyurethane foam* (SPF), is a closed-cell, higher-R-value foamed plastic insulation that is fabricated by an installer at the home site from two liquid components. Closed-cell foams insulate differently from conventional mass insulations. For example, a 1" sample of polyurethane foam consists of millions of tiny closed plastic cells filled with an inert gas. The inert gas resists heat transfer better than regular air.

Application equipment allows for the materials to be metered, mixed, and then either sprayed in place or poured into cavities. A cousin to SPF insulation is the single-component foam. Typically used for sealing around windows, doors, etc., it is available in spray cans at just about any hardware or home improvement store.

Product description

SPF compounds are comprised of isocyanates and polyols that have been in use for over 30 years. It is applied in liquid, two-part states. As the two materials mix, they expand, typically at an average ratio of 30:1 (or more). During the process of the two parts mixing, a chemical reaction generates an internal heat. If installed improperly, the foam can generate an internal heat high enough to start a fire inside the core of the foam. Spray formulations are fast-reacting to allow vertical and overhead applications. Additional layers can be applied almost immediately in consecutive passes.

Usually pale yellow in color, polyurethane foam resists water, mildew, and fungus; does not shrink or settle; contains no urea formaldehyde; is 80 percent cured in a few minutes; and is 95 percent cured in 24 hours. Polyurethane foam adheres to most surfaces, insulates hard-to-reach areas, is odorless, and resists mildew and fungus. Polyurethane foam also has no nutritional value that would attract insects or other pests

As discussed in previous chapters, intrusion of air into the stud wall cavity causes convection (movement of warm air to the top of the cavity and cold to the bottom). Like other foamed-in-place insulation products, polyurethane foam contains no seams or joints, thereby eliminating air leakage. After the insulation is installed properly, there should not be any air circulation from one side of the stud space to the other. Polyurethane foams reduce the temperature variance and the effect of convective looping. Any structural cracks or breaks in the system will reduce the effectiveness of the insulation, however.

Polyurethane foam (closed-cell, $1\frac{1}{2}$ to 2 lb/ft^3 density) has a structural quality that actually increases the twist and rack resistance of framed walls. The National Association of Home Builders Research Center (NAHB) conducted tests on 45 different wall designs, with and without foam. These tests proved that foam walls are three times as strong as walls without foam. (Additional testing of SPF by the NAHB Research Center between metal studs produced similar results.) Polyurethane foam is tack-free within seconds of the application, and 80 percent of the physical properties are present after 12 hours.[10]

R-value

Depending on the specific manufacturer, SPF products can have some of the highest R-values of any residential insulation. A range between 6 and 7 per inch can be expected.[10]

Limitations

All polyurethane foam insulations must be installed by certified installers. Safety gear and ventilation equipment are required during installation. The installation of polyurethane foam can be a messy process. Since the material adheres to any surface, extensive masking may be required on specific job conditions.

CFCs were formerly used as blowing agents but were banned from use by the Montreal Protocol, an international plan to limit the production and ultimately the release of CFCs. Currently, polyurethane foam insulation is blown with HCFCs such as HCFC-141b, which are less threatening to the earth's upper atmosphere but still have ozone-depleting potential. Production of this chemical for use as a blowing agent is to cease by January 1, 2003. Ferrous metals should be painted with a primer prior to application of rigid polyurethane foams.

Polyurethane foams are not UV stable and can be biodegraded by both direct and indirect sunlight. If exposed for any long period of time, the finished product needs to be coated with an elastomeric coating designed to protect the SPF from sunlight. Without some type of UV protection, the foam will degrade, compromising the thermal performance. SPF typically turns from a light yellow to a dark orange or brown color after UV exposure. Eventually, the surface degrades into a light powder that can be eroded by wind and rain to expose the foam below, thus starting the process again. The eroded surface of the SPF appears similar to that of an eroded dry creek bed within a few years.

Fire resistance

Building codes require foam plastics to be fire tested, usually with ASTM E84 as a minimum criterion. Some polyurethane foam manufacturers produce two formulations. One type is a class 2 foam with a flame spread of 30 and smoke development of 220 (class 2 foam is less than 75 flame spread and less than 450 smoke development) at 1", and the other is a class 1 foam with a flame spread of 25 or less and smoke development of 210. All cellular plastics such as spray-foam products are required by building codes to be covered by a 15-minute thermal barrier when installed in a habitable area. A 15-minute thermal barrier can be $^1/_2$" sheet rock, spray cementitious products, or other tested materials. Exposed foam is a potential fire risk and should be protected from open flames during the construction phase and prior to installation of the thermal barrier.

Cost

One manufacturer admitted that full-cavity applications of polyurethane foam are two to three times as expensive as conventional insulation systems. One should note, however, that a 2000-ft^2 home with 2 × 4 walls, 1" of polyurethane foam, and an R-11 batt cost slightly more than the same wall with an R-15 batt.[10]

Water-Blown Polyurethane

Product description

In an effort to curtail the use of HCFCs in polyurethane products, several manufacturers have developed insulations that use non-ozone-depleting hydrofluorocarbon (HFC). Foam-Tech, Inc., uses HFC-134a as the foaming agent in its SuperGreen polyurethane foam.

The hydrofluorocarbons (HFCs), compounds consisting of hydrogen, fluorine, and carbon, are a class of replacements for HCFCs. Because they do not contain chlorine or bromine, they do not deplete the ozone layer. All HFCs have an ozone-depletion potential of 0.[4] The higher cost of this foaming agent results in an upcharge of about 10 percent over conventional polyurethane. Preferred Foam Products of North Branford, Connecticut, produces the HFC-based foam components for Foam-Tech, the sole customer. While HFCs are ozone-safe, they may still have significant greenhouse gas impact.[11]

Open-celled semirigid water-blown polyurethane does not contain any ozone-depleting chemicals, CFCs, HCFCs, fibers, formaldehyde, or asbestos. Open-cell SPF is applied with specialized equipment designed for the application of a two-component urethane system from the interior to open-wall cavities. (The foam expands up to 120 times its liquid volume within seconds and is applied by approved contractors with qualified installers.) The R-value is 3.81 per inch. Open-cell SPF, like all other SPF products, is used as an air barrier system that reportedly can withstand 160-mph wind gusts (Fig. 10.3).

Another manufacturer, Resin Technology Company, has developed a closed-cell water-blown polyurethane (RT-2050) with an installed density of about 2 lb/ft^3 (32 kg/m^3) and an open-cell water-blown polyurethane with an installed density of 0.5 to 0.8 lb/ft^3 (8 to 12.8 kg/m^3). The latter is described as a flexible open-cell polyurethane foam, similar to Icynene.[6]

Figure 10.3 Water-blown polyurethane. (*Sealection 500*)

Phenolic Foam

Product description

Phenol-formaldehyde, or phenolic foam, is still available as an insulation product but is not as common because of its corrosive catalysts. It uses air as a blowing agent and has very good fire-resistance properties. It does exhibit some shrinkage over time, which degrades its thermal performance. Phenolic foams still have a high strength-to-weight ratio and are less flammable than most other plastic foams. Typically used in board product form, the major disadvantage of phenolic foam is its shrinkage. Tripolymer foam is a non-CFC, non-HCFC cavity-fill insulation that is essentially a phenolic foam. It is discussed in the next section of this chapter.[6]

Tripolymer Foam

Tripolymer products are phenol-based synthetic polymers made exclusively by C. P. Chemical Company, Inc., of White Plains, New York. Known proprietarily as Tripolymer Foam, it is essentially a modified phenolic foam that has been installed in over 1.8 million homes nationwide over the past 30 years. Tripolymer Foam is a non-CFC, non-HCFC cavity-fill insulation used primarily in masonry block walls. It has been used extensively in schools, hospitals, universities, and residential housing as insulation and soundproofing.

Product description

Tripolymer Foam is installed by C. P. Chemical's network of certified insulation applicators. Specially engineered equipment (patent nos. 4,103,876 and 4,246,230) have been designed by C. P. Chemical Company for application of Tripolymer Foam insulation and are required in the installation of the foam.

Tripolymer Foam products are phenolic-based, methylene-linked synthetic polymers. The Tripolymer Form system consists of two components: an aqueous resin solution and foaming agent/catalyst. These materials are mixed together with compressed air and blown into walls and spaces by trained applicators, usually from the exterior of the home to minimize extraneous residue adhering to interior materials.

Tripolymer Foam does not wet or distort gypsum wallboard systems and can be used to insulate brick, block, stucco, wood frame, or steel frame structures. It first looks like shaving cream but sets in approximately 10 to 30 seconds. Final curing is within 48 to 72 hours, depending on thickness. There is no further expansion once the foam leaves the delivery hose. It has very good fire-resistance properties, is fungi-resistant, and nontoxic, and does not contain any petrochemicals or fire-retardant chemicals (Fig. 10.4).

The cellular structure of Tripolymer Foam provides an effective acoustical barrier against airborne sound transmission. This system lends itself to new construction and interior partition walls, as well as existing construction where noise problems become evident. A minimum thickness of 2" is recommended. Tripolymer Foam reduces the resonance vibration of interior finishes that normally amplify sound levels. The actual amount of noise reduction is affected by the composite wall and ceiling construction.

R-value

Tripolymer Foam insulation has an R-value of 4.6 per inch at 75°F, 5.0 per inch at 0°F, and 4.8 per inch at 32°F. The manufacturer reports that there is no thermal degradation or reduction in R-value over time.

Limitations

Few, if any, limitations exist for residential use of this foam. The manufacturer does warn that it should not be used against surfaces with temperatures in excess of 212°F for prolonged periods of time.

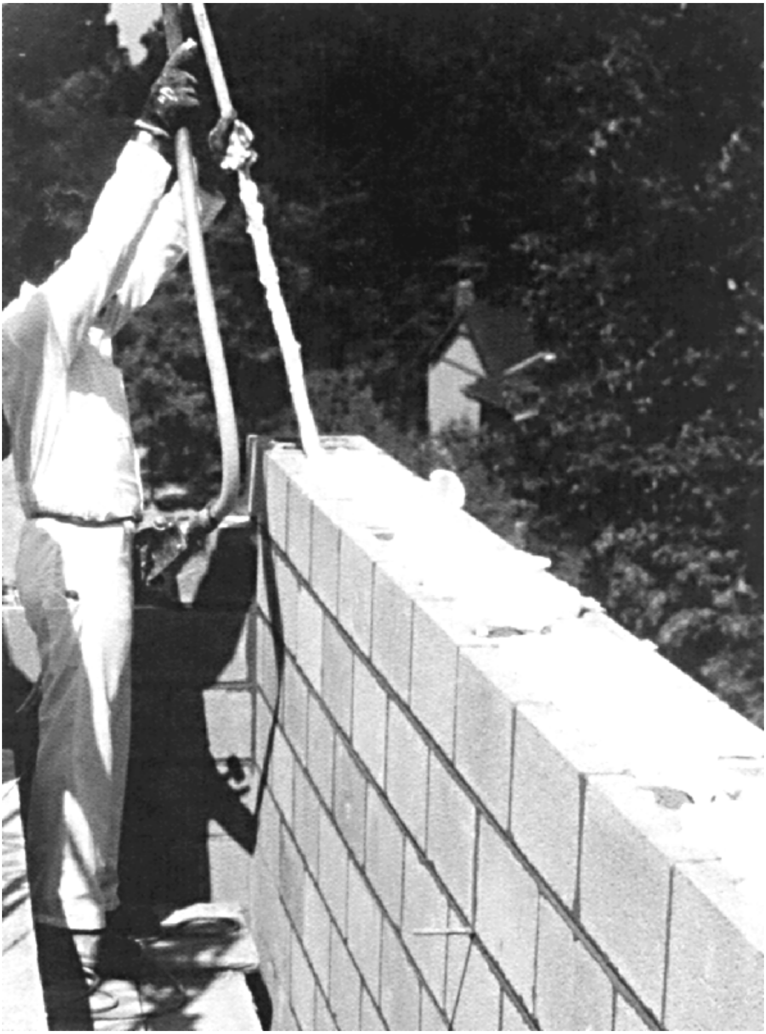

Figure 10.4 Tripolymer foam insulation. (*C.P. Chemical Co., Inc.*)

The foam will not support compressive loads, nor should it be used for flotation (such as floating docks) or applied underground without adequate protection.

Some users have reported a certain amount of shrinkage over time, which degrades its thermal performance. Independent testing conducted by MacMillan Research, Ltd., examined a sample of foam and found that it showed no shrinkage in the accelerated aging test. After 6 days under such conditions, a loss in weight of 4.7 percent was experienced, and no discoloration was apparent. (The 6 days in incubation is the approximate equivalent of 2 years in actual use.)[12] These results seem to contradict earlier observations of shrinkage, sometimes of up to $^{1}/_{4}$" away from the studs.[13] C. P. Chemical Company reported that the only objectionable shrinkage usually is associated with improper equipment use. Typically, shrinkage of $^{1}/_{8}$" in a wall cavity is the maximum shrinkage to be expected.

Environmental considerations

Tripolymer Foam is reportedly environmentally safe because it does not produce or emit CFCs or HCFCs.

Fire resistance

Increased fire resistance over other plastic foams is one of this product's strengths. Fire characteristics when tested according to ASTM E84 reveal that the product has a flame spread of 5, smoke development rating of 0, and fuel contribution of 0. It also dramatically improves the fire safety ratings of any applied material because it will not burn or produce smoke.

Tripolymer Foam increases the fire ratings of many wall systems. ASTM E119 test results show that when Tripolymer Foam is installed in $3^{1}/_{2}$" steel stud walls, fire ratings increase from 1 hour to 1 hour and 45 minutes. In a $3^{1}/_{2}$" wood stud wall system, fire ratings increased from $^{1}/_{2}$ hour to $1^{1}/_{2}$ hours plus. In renovation applications, Tripolymer Foam can be used to raise existing fire ratings of noncompliant or substandard fire-rated walls without the demolition of existing walls or the addition of extra layers of gypsum wallboard.

Installation precautions and limitations

Materials should be installed according to the manufacturer's instructions through equipment manufactured by C. P. Chemical and by a factory-trained/certified insulation contractor with a current certification card. The spraying equipment generates 3.5 to 10 ft^3/min of material from guns attached to delivery lines that can run up to 300 ft in length. Tripolymer Foam products can be installed easily and efficiently in new or existing masonry construction, either during construction or after completion by a pressure-fill method.

In masonry cavity walls, the foam insulation is installed between masonry wythes, occupying the full thickness of the cavity. Filling is to be performed as the masonry walls are constructed, since fills are not to exceed 10 ft in height. Tripolymer Foam can be foamed in place between brick veneer and cement blocks during construction. The application hose is dropped to the bottom of the cavity and withdrawn as the foam fills the cavity. The foam insulation also can be installed in a similar manner in masonry cores for the full thickness of the cell as the wall is constructed. Fills are not to exceed 15 ft in height.

If construction practice prohibits working with the masons as the walls are erected, the foam can be installed in masonry walls by drilling holes either in the face of the concrete masonry unit or in a mortar joint. The hose is inserted around the entire wall area at 5 ft above floor level. Filling is repeated at a height no greater than 15 ft in vertical height until completion of wall area fill cores.

Existing residential wood frame construction is easily insulated with Tripolymer Foam by removing exterior siding and drilling through the exterior sheathing. The foam is then injected into the cavity space through 1 to 2" openings. The foam also can be sprayed into new wood stud construction.

Appendix

Air-Krete
P.O. Box 380
Weedsport, NY 13166-0380
Phone/Fax: 315-834-6609
info@airkrete.com
http://www.airkrete.com

C. P. Chemical Co., Inc.
25 Home St.
White Plains, NY 10606
914-428-2517
Fax: 914-428-3630
Info@Tripolymer.com
http://www.tripolymer.com/

Demilec (Canada) Inc.
Sealection 500
870 Curé Boivin
Boisbriand, Québec
Canada, J7G 2A7
450-437-0123
Fax: 450-437-2338

Foam Enterprises, Inc.
Comfort Foam
13630 Watertower Circle
Minneapolis, MN 55441
800-888-3342
Fax: 763-559-9045
info@comfortfoam.com
http://www.comfortfoam.com/
http://www.foamenterprises.com/

Great Northern Insulation
Sealection 500
935 Keyes Drive
Woodstock, Ontario
Canada, N4V 1C3
800-265-1914
519-537-5873
Fax: 519-539-7946
http://www.gni.on.ca/noframes.html

Icynene, Inc.
5805 Whittle Road, Suite 110
Mississauga, Ontario
Canada, L4Z 2J1
888-946-7325
905-890-7325
Fax: 905-890-7784
Email: *inquiry@icynene.com*
http://www.Icynene.com/

Institute for Research in Construction
National Research Council of Canada
Ottawa, Ontario,
Canada, K1A 0R6
613-993-2607
Fax: 613-952-7673
Email: *Irc.Client-Services@nrc.ca*

NAHB Research Center HomeBase Hotline
400 Prince George's Boulevard
Upper Marlboro, MD 20774-8731
800-638-8556
http://www.nahbrc.org

Spray Polyurethane Foam Division
1275 K Street NW
Washington, DC 20005
800-523-6154

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048 Merrifield, VA 22116
800-DOE-EREC
E-mail: *doe.erec@nciinc.com*

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