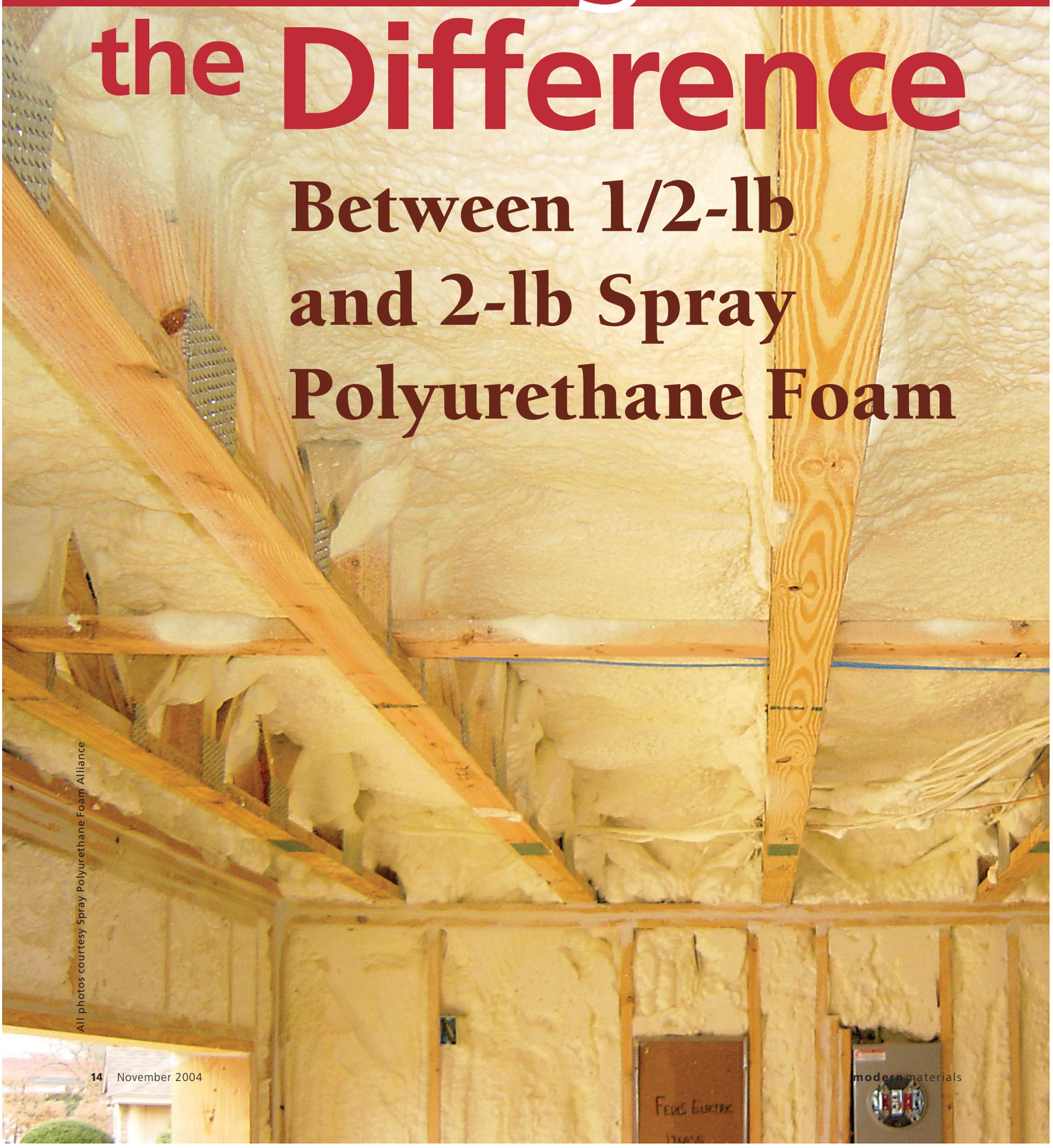
Learning the Difference

Between 1/2-lb and 2-lb Spray Polyurethane Foam



All photos courtesy Spray Polyurethane Foam Alliance

By Mason Knowles

Spray polyurethane foam (SPF) has become popular for its insulation value and air barrier qualities.[1] The plastic material comes in two basic types—[0.2-kg] 1/2-lb and [0.9-kg] 2-lb—and both are used in insulation applications as barriers in buildings. Both of these foams also can help control condensation within buildings and have other environmental benefits. Architects/engineers (A/Es) need to understand how the two foams are different... and which one may be suited for a particular project.

On the left, 1/2-lb SPF is sprayed in one pass between wood studs. It slightly overfills the cavity, but is trimmed flush to the studs. Above, 2-lb SPF can be applied in multiple lifts to achieve various thicknesses for desired R-value and air barrier performance.

The first point is quite easily answered, but the second requires a more detailed analysis of the specific building's use, construction type, environment, and other general characteristics.

1/2-lb SPF refers to generic spray polyurethane foam weighing between 6.4 kg/m^3 and 9.6 kg/m^3 (0.4 pcf and 0.6 pcf) when fully cured. Spray-applied to a substrate, it expands about 150 times its original volume to form a semi-rigid, non-structural plastic. This SPF typically has an R-value of approximately 3.5 per 25.4 mm (1 in.) and typically uses water as the blowing agent. R-value measures resistance to heat flow—the higher the R-value, the greater the insulating power.

2-lb SPF, on the other hand, weighs between 24 kg/m^3 and 32 kg/m^3 (1.5 pcf and 2 pcf) when fully cured. The material is used in interior applications, spray-applied to a substrate, before expanding about 35 to 50 times its original volume, and forming a rigid plastic with a compressive strength between 103.4 kPa and 172.4 kPa (15 psi and 25 psi). This SPF has an (aged) R-value of around 6 per 25.4 mm (1 in.) and relies on HCFCs (hydrochlorofluorocarbons) or HCFs (hydroflurocarbons) as its blowing agent.

Spray foam similarities

As mentioned above, both the 1/2-lb and 2-lb SPFs share many common characteristics. These common qualities are detailed below.

❍ *Chemical components*

Both 1/2-lb and 2-lb SPF are made from blended systems of polyol resins, catalysts, surfactants, fire retardants, and blowing agents on the B-side, with polymeric MDI (methylene diphenyl diisocyanate) on the A-side. The difference between SPF types is in how these materials are formulated—just as a baker makes dozens of different breads using water, yeast, and various flours, the SPF systems manufacturer creates several different SPFs from only a few ingredients.

❍ *Sealing characteristics*

The air barrier system within the building envelope is an important element for controlling moisture/heat transfer, and for preserving structural integrity. Inadequate air barrier systems allow leakage of air through holes, cracks, and gaps in the building envelope. Field experience shows properly installed SPF can help significantly improve the energy efficiency of buildings when used as an air leakage control and insulation system. Since 1/2-lb and 2-lb SPF is applied as a liquid, it expands in all directions, filling and effectively sealing hundreds of cracks in walls, ceilings, corners, joints, and penetrations that would otherwise allow air ingress.

❍ *Thermal barriers*

All SPF plastic insulation is required by building codes to have a 15-minute thermal barrier covering the insulation on interior applications, unless the application exempted in the code has been approved by a building code official. Approval in this case would be based on full-scale fire tests specific to the particular situation.

Spray foam, like most other organic materials, is combustible. It is formulated with flame retardants to decrease the flame spread as measured by ASTM International E 84, *Test for Surface Burning Characteristics for Building Materials,* and other tests. However, these flame spread ratings are used solely to measure and describe properties of products in response to heat and flame under controlled laboratory conditions, rather than reflect hazards presented under actual fire conditions.

Generally accepted tests for thermal barriers and building assemblies include:

- ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials;*
- Underwriters Laboratories Inc. (UL) 1715, *Fire Test of Interior Finish Material;*
- UL 1040, *Insulated Wall Construction;*
- FM Approval 4880, *Class I Insulated Wall or Wall & Roof/Ceiling Panels; Plastic Interior Finish Materials; Plastic Exterior Building Panels; Wall/Ceiling Coating Systems; Interior or Exterior Finish Systems;* and
- National Fire Protection Association (NFPA) 286, *Methods for Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.*

❍ *Safety and health issues*

Care should be exercised during the handling, processing, and application of SPF—one must read the manufacturers' and suppliers' material safety data sheets (MSDS), product labels, installation instructions, and also follow any local, state, or federal regulations and requirements.

During the spray foam application phase, aerosols are created that can be harmful to the applicator and those in the immediate vicinity of spray operations. Application requires the appropriate use of personal protective equipment by the installer to help avoid breathing fumes and keeping liquid components away from the skin or eyes. Care should also be taken to minimize exposure risk to building occupants during spray operations.

Cured SPF is relatively inert and has not been cited as a problem to allergy sufferers or to those with chemical sensitivities. Depending on the ventilation in place, odors and fumes can dissipate to non-detectable levels within minutes or hours of spraying.

Both types of SPF can work well in most attics and cathedral ceilings without the need to ventilate (although one should follow the manufacturer's instructions). However, ventilation ducts can maintain desired temperatures more efficiently because they are in a conditioned space.

In the above curtain wall (CW) construction, 2-lb SPF is used to insulate the exterior of a building, helping to eliminate thermal bridging, while adding a secondary barrier against water penetration to the inside of the building. On the right, 2-lb SPF is used to achieve high R-value in a limited space.

Determining the differences between SPFs

Despite the shared qualities between 1/2-lb and 2-lb spray polyurethane foams, it is each SPF type's unique properties that ultimately assist the A/E in selecting the proper material for his project, based on special site needs and priorities.

❍ *Installation*

1/2-lb SPF is normally spray-applied to the desired thickness with one pass, while 2-lb SPF is spray applied at lifts from 12.7-mm to 38-mm (0.5-in. to 1.5-in.) until the desired total thickness is achieved. Excess foam can be trimmed easily with saws or knives, however, most applications do not require full stud thickness, meaning trimming is usually unnecessary. For example, SPF installed at 51-mm (2-in.) thickness between 2x4 studs requires a minimal cleaning on the stud face. However, SPF installed to full stud thickness requires additional trimming with a specially designed trimming tool.

❍ *Sound absorption*

Both 1/2-lb and 2-lb SPFs have air barrier qualities that can help reduce noise from outside the building envelope (*i.e.* airplanes and car traffic). The 1/2-lb foam's density offers additional sound absorbing qualities, however, neither foam is exceptionally effective at reducing vibrational impact noises.

❍ *Permeance*

Moisture has two primary means for entry into/through the building envelope—water vapor diffusion and air leakage. As mentioned above, the excellent air barrier qualities of both 1/2-lb and 2-lb SPF helps effectively preclude the latter, however, the foam types differ when it comes to vapor diffusion.

The higher the material's permeance, the faster water vapor can pass through. Controlling water vapor within a building is important for preventing condensation, mold growth, and subsequent damage to building components. There are two basic types of moisture control within buildings:

1. The 'flow-through design,' which allows water vapor to pass through the building assembly's components without condensing.
2. The vapor retarder design, which limits the moisture entering the building assembly altogether.

A 1/2-lb SPF ranges between 6 perms and 10 perms, with a 76-mm (3-in.) thickness of material. Its high permeability allows for the fairly rapid diffusion of water vapor, so the material often requires a vapor retarder element in the building assembly. In some cases, this could be part of the assembly, and requires no additional vapor retarder material. (When this is necessary, it is typically used on the insulation's warm side.)

2-lb SPF typically has a permeance of less than 1 perm at 76-mm (3-in.), and can be used in flow-through designs without a vapor retarder. Exceptions include situations where there is a constant vapor drive in one direction (*i.e.* natatoriums and cold storage facilities), or when there is a vapor retarding material on the assembly's cool side.

❍ *Water absorption*

1/2-lb SPF has a high open-cell content (greater than 50 percent) and liquid water can enter the foam. Conversely, 2-lb SPF has a high closed-cell content (greater than 90 percent) and resists water absorption. In a building assembly, the latter SPF offers added weather or rain barrier protection.

❍ *Ozone depletion*

Twenty years ago, 2-lb SPF employed CFCs (chlorofluorocarbons) as its blowing agent, but this compound has since become known for its significant upper-ozone depleting characteristics. In the late 1980s, the industry converted to a blowing agent with low ozone-depleting properties, and spray foam providers are now moving toward non-ozone depleting blowing agents—a transition to be completed by 2005.

For 1/2-lb SPFs, the ozone layer is not as much of a consideration—the foam is formulated with water as a reactive blowing agent, resulting in zero atmospheric depletion.

Notes

[1] As spray foam formulations vary from manufacturer to manufacturer, specifiers should consult the suppliers' spray foam specification sheets to understand the exact properties.

About the Author

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