INSULATION IS NOT ENOUGH

HOW TO IMPROVE THE ENERGY EFFICIENCY, COMFORT, COST OF OWNERSHIP AND DURABILITY OF HOMES

Helping Make Buildings Better™

BASF
The Chemical Company

BASF Polyurethane Foam Enterprises LLC

Why Insulation is Not Enough

The fact is, you can't achieve the kind of energy efficiency your customers want by simply adding insulation. You need an air barrier to stop uncontrolled air leakage. The United States Department of Energy reports that over 30-40 percent of the cost of heating and cooling a home is lost to uncontrolled air leakage.

In addition to costing the homeowner money, air leakage also contributes to problems with moisture, mold growth, thermal comfort, noise, dust and pollutants, as well as premature structural deterioration and ice damming.

Glass fiber insulation will not stop air leakage[1], no matter how much you install. In fact, if you visit older homes you might see dirty, discolored glass fiber—a telltale sign of air movement, as it collects dirt like a filter.

With uncontrolled air leakage, the furnace and air conditioner have to work harder to maintain the indoor environment. COMFORT FOAM® combination insulation and air barrier eliminates uncontrolled air leakage by contributing to a monolithic, air impermeable building envelope system. This allows the heating and cooling equipment to do its job uncompromised by having to make up for the air it is conditioning leaving the house.

Increasing the operating efficiency of the heating and cooling equipment reduces energy consumption and therefore energy costs. The inclusion of an effective air barrier system may allow the equipment to be downsized—in some cases by a substantial amount.

[1] *AIR SEALING: Seal air leaks and save energy!* Technology Fact Sheet, Office of Building Technology, State and Community Programs, Energy Efficiency and Renewable Energy, US Department of Energy

Breaking News:

Building America Launches Field Test Comparing COMFORT FOAM® with Traditional Systems

Building America, a private/public partnership sponsored by the U.S. Department of Energy, has launched a field study to measure the real-world energy-efficiency performance of COMFORT FOAM® medium-density (2 lb), closed-cell spray-applied polyurethane foam insulation and air barrier compared with traditional insulation systems, including glass fiber batts, damp-spray cellulose and low-density (1/2 lb), open-cell spray-applied foam.

The study is being conducted by Building Science Consortium and Venture, Inc. and comprises four test homes in an affordable housing development in Royal Oak Township, near Detroit, MI. The houses are one-and-a-half-story, three-bedroom cape-style designs with conditioned basements and cathedral ceilings, offering 1260 ft^2 of living space with 444 ft^2 of unfinished, conditioned basement. The four test homes are identical except for the insulation systems, and all are expected to achieve 37 percent whole-house energy savings compared with the Building America Benchmark.

The study will include an evaluation of the speed and ease of installation, multiple short-term energy monitoring tests, and air leakage and flow characteristics testing using a blower door, duct blaster and flow hood, as per RESNET standards.

Making Foam Pay:

The Dollars and Sense of Using the Most Efficient Insulation and Air Barrier

Homebuyers want a lower cost of ownership over the long-term. One of the best ways for builders to provide customer satisfaction—and profit from it—is to use COMFORT FOAM® closed-cell, spray-applied polyurethane foam: a fully-tested, proven combination insulation and air barrier.

Most developers cite the slightly higher up-front material cost of closed-cell polyurethane foam insulation as their primary reason for not using it more often. The Partnership for Advancing Technology in Housing (PATH) estimates the installed costs for various insulation products[1], as shown below.

Insulation	Cost / ft²	Cost / 1,200 ft² home	R-value
Spray-Applied Polyurethane Foam (3" application)	$1.25 to $2.25	$1,500 to $2,700	R-19
Spray Foam (1" application with R-19 batt)	$1.60	$1,920	R-25
Glass Fiber Batt Insulation	$0.70	$840	R-19
Cellulose Wall-Spray	$1.20	$1,440	R-19
Cotton Batt Insulation	$1.20	$1,440	R-19
Sheep's Wool	$2.40	$2,880	R-19
Blown Insulation (attic)	$0.50	$600	R-38
Cementitious Foam through a Membrane	$1.45 to $2.45	$1,740 to $2,940	R-19

Costs will vary according to local product availability and material cost, labor rates, and thickness of insulation.

What these figures don't take into account is the need to also control air leakage. If you want to build a truly energy efficient home, insulation alone is not enough. You need an effective air barrier system to make a home truly efficient.

Air moves around, through and behind traditional insulation materials. As we add insulation thickness (R-value) in hopes of raising energy efficiency, we in effect promote convection loops within the insulation. Energy efficiency is lost through the movement of cold air around glass fiber materials, and the phenomenon exists in low-density, dry-blown cellulose, wool and almost every blown-in insulation product. Board stock, although not subject to internal convection loops, loses effectiveness through loops behind the insulation boards themselves. If the edges are not fully and completely sealed to one another, warm or cool air can flow around them and may account for an energy efficiency reduction of up to 15 percent.

Thermal bridging is another factor that can affect energy efficiency when using traditional materials. Wood, although an insulator to some degree, still conducts thermal energy. To eliminate thermal bridging through wood stud systems, the insulation must be in contiguous/intimate (fully-adhered) contact with the studs. Batts, blown-in and board stock materials do not exhibit this characteristic and, therefore, do not reduce the potential for thermal bridging. SPF, as a fully-adhered, fluid-applied insulation material, all but eliminates thermal bridging in a 2 x 4 structure at an application thickness of three inches.

COMFORT FOAM insulation provides both superior insulation performance at over R-6 per inch and virtual air impermeability in a single installation. COMFORT FOAM insulation and air barrier offers a closed-cell content of greater than 90 percent and meets ASTM 1029/SPFA guidelines when applied at only 1.5-inch thickness. COMFORT FOAM also surpasses ASTM E-2178 at 0.0001 L/s/m² @ 75 Pa.

It should be noted that open-cell foams used for insulation have approximately 60 percent open-cell content and have far greater air and vapor transmission characteristics, with an R-value of 3.5 per inch. Although open-cell foams tend to be slightly less expensive to install than closed-cell formulations, this cost advantage is often lost due to the need to apply over four times as much material when using an open-cell foam as an air barrier.

Unlike traditional insulation materials that do not offer native air leakage control and therefore require an additional air barrier (polyethylene, airtight drywall, etc.) to be installed, with COMFORT FOAM, your outlay of $1.25 to $2.25 per square-foot gives you two integral systems—insulation and air barrier—in one. That means a much faster installation—an average crew can complete a 1200-ft² house in less than a day—for a substantial reduction in labor costs. It also means you're not shelling out even more money for additional materials.

LOWER ENERGY, INSTALLATION AND LIFECYCLE COSTS

Because insulating air barrier systems combine superior insulation with total air leakage control, they allow HVAC requirements to be reduced at the design phase. Lower installation labor costs and a lifecycle that lasts throughout the structure's life expectancy combine to make the COMFORT FOAM insulation and air barrier one of the most cost-effective solutions available today.

A residential study by ADVANCED CERTIFIED THERMOGRAPHY shows that COMFORT FOAM installations can help reduce energy costs by as much as 60 percent each year compared to traditional insulation systems. With escalating energy costs, realized savings may be even greater.

COMFORT FOAM insulation and air barrier can also contribute to obtaining energy-efficiency incentives under the Federal Energy Policy Act of 2005. Under the Act, builders of site-built or manufactured homes are eligible for a rebate of $2,000 for energy-efficiency measures that achieve 50 percent savings over the 2004 IECC Standard.

Existing homes can also benefit from using COMFORT FOAM insulation and air barrier, as well as ZERODRAFT® insulating air seal materials under the Energy Policy Act. Envelope improvements to existing homes that meet the 2003 IECC and supplements are eligible for a rebate equal to 10 percent of the cost of improvements, up to $500.

The DOE offers financial assistance opportunities through the Office of Energy Efficiency and Renewable Energy (EERE) and other incentives are available through more than 60 ENERGY STAR® incentive programs. In addition, special mortgages for energy efficient homes are offered by more than 40 different agencies across the United States.

BASF Polyurethane Foam Enterprises LLC is associated with the ENERGY STAR Insulation Program and an ally in the ENERGY STAR Homes Builder Program. This program offers Energy Efficiency Mortgaging (EEM) that

	COMFORT FOAM®	Glass Fiber	Wool	Blown Cellulose	Open-Cell Foam
R-Value	6.0	3.0	3.5	3.0	3.5
Approved Air Barrier System	Yes Air leakage <0.001 L/s/m² @ 75 Pa at 1.5" thickness	No	No	No	Yes Air leakage 0.005 L/s/m² @ 75 Pa at 5.5" thickness
Seamless Construction	Yes	No	No	No	Yes
Rigid	Yes	No	No	No	No
Fully Adhered	Yes	No	No	No	Yes
Adds Structural Strength	Yes	No	No	No	No
Long Service Life	Yes	No	No	No	Yes
Absorbs Water	<4% v/v	Yes	Yes	Yes	>40% v/v
Allows Moisture Vapor In	No	Yes	Yes	Yes	Yes

may help borrowers to qualify for additional mortgage dollars.

WHAT ABOUT DURABILITY?

Because the BASF Polyurethane Foam Enterprises air barrier materials are seamless and fully adhered, they actually add structural strength and will not settle or sag over time, unlike traditional insulation systems.

Testing conducted by the National Association of Home Builders (NAHB) Research Center shows spray-applied polyurethane foam insulation between wood- and steel-stud wall panels increased rack and shear two to three times over standard stick-built components and glass fiber insulation when sprayed onto gypsum wallboard or vinyl siding, and increased racking strength by 50 percent when sprayed onto oriented strandboard (OSB).

Results from testing conducted by the National Research Council (NRC) of the Canadian Construction Materials Centre (CCMC) show spray-applied polyurethane foam air barriers offering long-term durability greater than or equal to the building's expected life span[3]. They also show that 16-inch centered studs incorporating closed-cell polyurethane foam may be moved out to 48 inches and still maintain racking and structural loads according to Code.

HEALTH, SAFETY AND ENVIRONMENTAL RESPONSIBILITY

COMFORT FOAM insulation and air barrier uses ZONE3® zero-ozone-depleting blowing agent technology, contains no urea formaldehyde and emits no volatile organic compounds (VOCs). Also, the award-winning BASF Eco-Efficiency Analysis assesses total cost and ecological impact over the product lifecycle to benchmark current performance and get insight for future improvements.

The COMFORT FOAM system is accepted by all major building codes, including the International Code Council encompassing both commercial and residential applications. Accredited third-party testing of the COMFORT FOAM system using ASTM E 283-(04)[4] and E 2178 proves that COMFORT FOAM insulation is a Building Code-recognized air barrier material.

PERFORMANCE ATTRIBUTES

Typical applications for COMFORT FOAM spray-applied polyurethane foam material in the building envelope system include:

- Wood framing
- Metal framing
- Foundations
- Slab on grade
- Walls
- Floors
- Crawl spaces
- Attics
- Garages
- Cathedral ceilings
- Rim/band joists
- Bonus rooms

Rising energy costs are fueling a demand among educated homebuyers for energy-efficient, sustainable, comfortable houses. Incentives from all levels of government, as well as local utilities, help raise awareness, desirability and affordability of energy efficient homes. Is it any wonder that developers, architects and contractors are actively seeking cost-effective, environmentally responsible ways to build homes with reduced energy demands?

1 TOOLBASE™ TECHSPECS: Alternative Insulation Materials, Partnership for Advancing Technology in Housing.
2 Home Performance Brochure, 1999, sponsored by Home Energy Magazine, Affordable Comfort Institute and US Department of Energy.
3 Canadian Construction Materials Centre (CCMC), Evaluation Report 12932-R, National Research Council (NRC) of Canada.
4 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.

ZERODRAFT® Insulating Air Sealants Play a Key Role in the BASF Near-Zero Energy Home-Paterson, N.J.

ZERODRAFT® single- and plural-component insulating air sealants are making a key contribution to the building envelope system of the BASF Near-Zero Energy Home-Paterson, N.J.

Built as part of the BASF Better Home, Better Planet Initiative, the BASF Near-Zero Energy Home-Paterson, N.J., features a high performance building envelope, or exterior wall system. Fast-curing ZERODRAFT® insulating foam sealants are used to join the Structural Insulating Panels (SIPs) and Insulating Concrete Forms (ICFs) together and create complete air barrier continuity between all the components of the building envelope of the BASF Near-Zero Energy Home-Paterson, N.J.

Plural-component polyurethane insulating air sealants and single-component polyurethane foam sealants are installed from within the building structure to seal and insulate 'hard-to-build' areas, such as windows, doors, penetrations, parapets and soffits to create insulating air barrier system continuity from the foundation up through the walls and across the roof.

The BASF Near-Zero Energy Home-Paterson, N.J., recently achieved a HERS rating of 95.5—more than 78 percent better than the Model Energy Code.

By sealing gaps, cracks, leaks and holes within the building envelope and creating air barrier continuity, ZERODRAFT foam sealants have helped lower energy demand and consumption in all types of commercial, institutional, multi-unit and single-family residential buildings—both new construction and retrofit—across North America.

Are All Spray Foam Insulations Created Equal?

No. And the reason is chemistry.

You probably don't spend a lot of time thinking about chemistry when you choose insulation to improve energy efficiency. Yet one popular insulation material—spray-applied polyurethane foam (SPF)—relies entirely on chemical cleverness.

Spray-applied polyurethane foam is a two-component product that is manufactured on-site, but engineered in the molecular level to optimize performance for a specific application.

Currently, three types of spray-applied polyurethane foam are commonly used within the construction industry:

- medium-density (MD) 24 kg/m^3 to 48 kg/m^3 (1.5 pcf to 3 pcf)
- low-density (LD) 8 kg/m^3 to 12 kg/m^3 (0.5 to 0.7 pcf)
- sealant foams

The most important distinction is whether the formulation produces an open-cell or closed-cell foam. MD foams are formulated to have a closed-cell content of greater than 90 percent, combined with an effective R-value of over 6.0 per inch. LD, open-cell foams have approximately 60 percent open-cell content and offer an R-value between 3.0 and 3.6 per inch.

But R-values are only the beginning when it comes to energy efficiency. The air permeability capabilities are the true differentiator.

To make a building truly energy efficient, it needs an effective, continuous air barrier system, as well as insulation. Without it, conditioned air escapes through the building envelope, and the HVAC system has to work harder to keep the indoor environment comfortable.

Most open-cell foams have not been tested for the function and, therefore, do not qualify as air barrier systems in 'typical thickness' of less than four inches. One open-cell foam manufacturer's product requires an application of 5.5 inches (its maximum allowable thickness) to pass the minimum requirements of ASTM International E 2178, Standard Test Method for Air Permeance of Building Materials (air leakage rate of 0.02 L/s/m^2 @ 75 Pa).

Compare this with closed-cell foams, some of which provide air leakage rates of <0.001 L/s/m^2 @ 75 Pa at 1.5-inch thickness.

Because the systems are spray-applied, fully-adhered and seamless, they also eliminate connective loops behind the insulation and, therefore, eliminate moisture. And since mold requires three things to grow—moisture, warm temperatures and a food source—and closed-cell foams do not provide any of these things, MD, closed-cell SPF can help to prevent dangerous mold growth.

Both closed-cell SPF systems and open-cell foams have low environmental impact, have no adverse effect on the ozone layer and do not emit volatile organic compounds.

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