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### Foam Home

#### Factors like dew points and air changes give higher-priced insulation fresh appeal

All other factors being equal, traditional fiberglass batts remain the most economical choice to meet energy code standards in the West. Unfortunately, the other factors aren't always equal. Over the past decade, in response to concerns over moisture and mold, walls have become one of the most complex parts of residential construction. Builders have re-examined many long-standing details and adopted new ones where necessary, including drainage planes, vented rain screens, flashing, housewrap, vapor retarders, and various sealants, tapes and caulks.

Insulation, too, is under scrutiny, and it's no longer just a matter of R-value per dollar. Several more expensive materials are gaining attention for what else they can offer—notably, help with air infiltration and condensation inside walls, which are major sources of callbacks and litigation.

"If you build a wall to code in Washington, with R-19 fiberglass in 2x6 framing and OSB sheathing, the dew point will fall inside the wall cavity—period," says Wes Wilson of Eagle Energy Systems, Vancouver, WA.

Foam is hardly a new concept in insulation, but two different systems deserve a closer look from builders. Both offer advantages that go beyond mere R-value.

#### Low-density soft foam

Spray polyurethane foams (SPF) are liquid-applied systems consisting of two parts, isocyanate and polyol resins, that react to form polyurethane foam as they are sprayed into wall cavities. In its high-density, closed-cell form (typically 1.5 or more pounds per cubic foot), SPF has an R-value up to 6 per inch, and is used for roofing insulation and commercial applications, including refrigerated buildings.

More appropriate for residential wall insulation are the low-density "soft" foams, which weigh in at a half pound per cubic foot. A good spray job fills wall cavities, with the excess trimmed off with a knife. The foam is easily cut away if any work needs doing inside foamed walls.

The light foam remains flexible and won't pull away from expanding and contracting framing members. This plays to its strongest suit: the ability to provide a superior air seal while remaining vapor-permeable. Icynene-brand SPF, for instance, has an air leakage rate a bit tighter than plywood; vapor permeance for a 3-inch wall is 16 perms, comparable to

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many housewraps.

The bottom line is that warm, moisture-laden air won't condense inside the cavity. "The dew point temperature falls within the wall, but there's nothing for moisture to condense on," says Wilson. SPF foams also don't support organic growth if they do get wet.

The air barrier is far more important for reducing condensation than vapor barriers, which reduce vapor drive. "A typical vapor differential across a 4x8 sheet of drywall can bring one-third quart of water into a wall over the course of a heating season," says Wilson. "A 3/4-square inch hole in that wall can bring 30 quarts. That's where you really get mold."

Spray foam alone isn't enough to achieve a low air change rate. Sill plates need to be gasketed; and annular seams, such as lengthwise stud joints, should be caulked. But spray foam expands to fill most voids, and so eliminates the need for a lot of the tricky sealing details around fixtures and openings.

As for measured insulation value, low-density SPF doesn't offer much more than fiberglass—about R-3.5 to 3.8 per inch. But the R-numbers don't tell the true story, says Wilson. "I once replaced fiberglass insulation in a home in Alaska that was supposed to be R-100. We put in five inches of SPF and their heating bills went way down."

Its proponents say that foam won't lose R-value from air movement like fiberglass and loose fill insulations. "Foam eliminates the convection currents that you get in fiberglass insulation," says Joe Swinford of Bio-Based Systems, an SPF manufacturer. "An SPF can cut heating and cooling bills by 35% to 50%." Fiberglass, on the other hand, depends on perfect installation for its effectiveness since a 5% void in insulation can reduce R-value by 15%.

Application costs per square foot range from \$1.00 to \$1.75, depending on the manufacturer. Several manufacturers are confident that their costs will continue to fall. "We're always looking for less costly catalysts, polyols, surfactants," says Dan Helton of Specialty Product, a manufacturer based in Tacoma. "There's a lot of new molecules out there to look at."

Unlike the urea-formaldehyde foam insulations from two decades ago, SPFs don't off-gas dangerous substances. While high-density foams are struggling to reduce ozone-depleting chemicals CFCs from their processes, low-density foams use water as a blowing agent.

In recent years several companies have begun using soybean oil for the polyol resin instead of petroleum. Soy SPFs received a number of endorsements from environmental building groups, and have generated consumer interest as "green" products. The actual percentage of plant-derived components remains fairly low, at about 15% of the resin, but Swinford hopes Bio-Based SPF will be at 50% soy soon. He also hopes the stable pricing for soybeans will give it the edge when oil prices rise.

Spray foam's consumer recognition is also working in its favor. "Homeowners are becoming increasingly inclined to request SPF insulation," says Steve Loftis supplier for North Carolina Foam Industries. He credits the product's exposure on TV shows such as This Old House and the Internet for generating consumer interest. Icynene was also used in the NAHB's 2003 The New American Home project in Las Vegas.

Helton thinks SPFs are at a tipping point and expects to quadruple his soft foam sales this year. "In the last year or two it's really been taking off," he says.

### **Rigid foam**

Any insulation limited to wall cavities has a weakness: the thermal bridging of wood studs. A 2x6 on end has an R-value of about 4, and with 16-inch on-center framing this can lower the whole-wall R-value of R-13 insulation by 25%. Rigid foam boards installed over framing provide a continuous thermal break that virtually eliminates the bridging effect.

Rigid foam comes in three types: polyisocyanurate; expanded polystyrene (EPS), which forms the core of structural insulated panels (SIPs); and extruded polystyrene (XPS). Because it encloses low-convecting gases, polyiso boasts the highest R-value per inch (6.5-7), though its R-value is currently changing as manufacturers transition to new blowing agents. Enclosed gases can also transpire, over time, lowering its insulation bonus relative to XPS. XPS costs more than the crumbly EPS but has lower moisture absorbency and is easier to work with, so is more popular with builders.

Polyiso is often foil-faced, making it a near-perfect vapor barrier if taped. If an air gap is allowed between foil and siding, the low-emissive foil forms a radiant energy break that can

increase its effective R-value.

XPS has a nominal R-value of about 5 per inch, compared to about .5 for half-inch OSB. By blocking the bridging effect of wood framing, however, they contribute more than that to the whole-wall R-value, and can also provide excellent sound dampening. Depending on the climate and thickness, rigid board will keep the dew point outside most walls for all but the coldest days.

To keep costs down, many builders use XPS or polyiso on walls in place of OSB or plywood, and use wood sheathing only for required corner bracing. XPS and polyiso are usually twice the cost of wood sheathing, but with OSB flying high in recent months at \$20 or more per sheet, the price can be a wash.

XPS is commonly used over light-gauge steel framing and in highly efficient homes; several custom home builders in the Northwest combine spray foam with rigid foam and achieve phenomenally low heating and cooling costs, but the full system adds nearly 5% to the construction cost. But it is also common on new homes that use one-coat stucco. According to Dow's Dan Kitts, nearly 80% of such homes in Northern California use rigid foam over 2x4 framing with OSB for required corner bracing.

The most benefit can come from engineering each home design to minimize structural sheathing, rather than following prescriptive framing practices. Jim Chapman of Legend Homes, Portland, follows this method, using 1-inch rigid XPS boards over 2x4 walls with R-13 unfaced fiberglass batt insulation, rather than the customary 2x6 frame required for fiberglass batts to reach the area's R-21 requirement.

Chapman's primary motivation is to prevent condensation, "even if it only happens once in ten years," he says. But he's noted some other bonuses. He's built townhouses with the different wall designs on either side of a busy highway, and says the rigid-over-2x4 walls are noticeably quieter. The assembly also gives him an extra 2 inches along interior walls. "It adds up, especially in bathrooms and kitchens, where you're trying to fit fixtures and tubs," he says. According to Dow, an average-sized home can gain 28 square feet by making the substitution.

Between the downsized framing and less OSB, Chapman doesn't fret over the added cost of XPS. "I don't know if it's saving us money or not," he says. "But our customers' heating bills are down, and I don't worry about condensation." Of course, re-engineering the plans makes a big difference. "You couldn't just take a house plan and do this," he says.

The ICC also recently accepted taped foam board as a substitute for a secondary moisture and air barrier, so builders can save on housewrap if desired.

One important caution: XPS has a low permeance (1.2 perms per inch), so don't use it on the exterior with an interior vapor retarder, like vapor-barrier paint, asphalt-impregnated faced fiberglass batts, or visqueen/poly on the interior—or you'll end up with a wall that can't dry out.