Building Science 101

If you don’t make yourself obsolete . . . someone else will . . .

Anonymous
Fiberglass and cellulose insulation are not air barriers therefore they do not solve the problem of convective heat loss/gain. The EPA and the U.S. Department of Energy have concluded that convection accounts for up to 60% of energy loss/gain in houses in the U.S.

In addition, Oak Ridge National Laboratories found that fiberglass insulation performs at 1/2 of its labeled R-value during periods of extreme cold or hot outdoor conditions. This means that when you need it most, fiberglass fails as an effective thermal insulator to stop conductive heat loss/gain.

Convection and conduction together account for 90% of total energy gain/loss through the building envelope.

**Building Science Facts: Vented Attic Assembly Problems**
- In summer attic temps soar upwards or 130°F as roof vents allow hot outside-air unrestricted entrance and the sun pours in radiant/conductive heat.
- Cooling the structure down to 75°F creates a 55°F ΔT across the ceiling boundary, causing heat from the attic to pour into the interior of the structure.
- All duct-leakage goes to the outside and duct efficiency drops as cool, conditioned air gains heat as it travels through a HOT attic.
- Attic vents allow humidify to enter the attic causing a build up of condensation on metal ducts carrying cool conditioned air. This condensation will soak into the insulation reducing its insulation R-value to zero and eventually causing mold, mildew, and other moisture related building failures.
- Conversely, in winter, attic temps drop to ambient temperature sucking heat from the duct system and from within the house to the outdoors causing comfort problems and increasing energy bills.

**35%**
35% of your home’s energy loss is due to air infiltration through the ceiling penetrations. - EPA

**25%**
25% of your home’s energy loss is due to air infiltration through the walls. - EPA

**THIS HOUSE:**
- Monthly Payment: $1657.00
- Monthly Utility Bill: $287.00
- Total Monthly Cost: $1944.00

Read on and see how spray foam insulation can turn these energy losses into **GREEN SAVINGS** every month and improve comfort, reduce noise, increase indoor air quality.
Fiberglass - a product with a well established track record of failure...
- Fiberglass is listed as a known class-one carcinogen - EPA
- Fiberglass acts as a filter, capturing dust, dirt, pollutants as air moves through it.
- Fiberglass R-value drops by more than 50% when compressed or when ambient temperature rises above 85°F, or drops below 45°F - Oak Ridge National Laboratories
- Air-infiltration through the building envelope accounts for approximately 40% of the total energy loss of homes in the US - EPA

Building Science 101
Traditional Building Envelope
Moisture & Air Movement During Winter

NO Air-Seal & Reduced R-value
Fiberglass does not stop air movement, nor does fiberglass does conform around wiring, electrical boxes, or plumbing pipes in the wall without being compressed to fit. According to Oak Ridge National Laboratories, fiberglass insulation loses over 28% of its labeled R-value when "commonly installed" with gaps, voids, and compressed. In addition, a study done by the California Energy Commission in 2002 showed that 100% of the sample homes with improperly installed ("commonly installed") fiberglass. The primary problems cited were gaps at the tops, bottoms, and edges of the wall cavities and compression of batts when squeezed into cavities behind wiring and plumbing.

Dew Point Temperature
**Exposed to warm, humid air from inside the home promoting condensation and potential mold growth**

House Wrap/Drainage Plane
Exterior Sheeting

Humidity
In Winter, humidity from your house is driven into your walls 24/7 through every crevice and crack in the building envelope creating the potential for condensation and mold.

OUTSIDE BUILDING
25°F 10% RH

Fiberglass Insulation

1/2" Gypsum Wallboard
(Vapor Permeable Latex Paint)

typical outlet box or switch box

Heat
In Winter, warm air in your house is lost to the outside 24/7 as it leaks through every crack in the building envelope. As warm air leaves, it is replaced by cold Winter drafts. In 2004 a Midwest based HERS rating firm, Cenergy, LLC, recorded in numerous blower-door tests that the cumulative square inches of air-leakage in a fiberglass insulated home is equivalent to leaving a window open approximately 6 inches year-round. Imaging how much MORE energy it would take to heat and cool your home if you left a window open!
Fiberglass - a product with a well established track record of failure.

- Fiberglass is listed as a known class-one carcinogen - EPA
- Fiberglass acts as a filter, capturing dust, dirt, pollutants as air moves through it.
- Fiberglass R-value drops by more than 50% when compressed or when ambient temperature rises above 85°F, or drops below 45°F - Oak Ridge National Laboratories
- Air-infiltration through the building envelope accounts for approximately 40% of the total energy loss of homes in the US - EPA

Building Science 101
Traditional Building Envelope
Moisture & Air Movement During Summer

**Exposed to warm, humid air from inside the home promoting condensation and potential mold growth**

- NO Air-Seal & Reduced R-value

  Fiberglass does not stop air movement, nor does fiberglass does conform around wiring, electrical boxes, or plumbing pipes in the wall without being compressed to fit. According to Oak Ridge National Laboratories, fiberglass insulation loses over 1/2 of its labeled R-value when compressed. In addition, a study done by the California Energy Commission in 2002 showed that 100% of the sample homes had improperly installed fiberglass. The primary problems cited were gaps at the tops, bottoms, and edges of the wall cavities and compression of batts when squeezed into cavities behind wiring and plumbing.

- Humidity

  In Summer, humidity from the outdoors is constantly driving its way into our homes through every little crack and gap in the building envelope. This can lead to condensation inside your walls and mold growth.

  **Outside Building**

  95°F  80% RH

  **Temperature (ΔT) & Pressure (ΔP) Gradient**

  **Inside Building**

  72°F  40% RH

  **Heat**

  In Summer, heat from outside is constantly driving its way into our homes through every nook and cranny, increasing energy costs and decreasing comfort. In 2004 a Midwest based HERS rating firm, Cenergy, LLC, recorded in numerous blower-door tests that the cumulative square inches of air-leakage in a fiberglass insulated home is equivalent to leaving a window open approximately 6 inches year-round. Imaging how much MORE energy it would take to cool your home if you left a window open!
"Of all the environmental conditions, moisture poses the biggest threat to structural integrity and durability, accounting for up to 89% of damage in building envelopes."

-- Bomberg, M. and W. Brown, Construction Canada

**Building Science 101**

Traditional Building Envelope

Moisture Transfer Due to Air Infiltration

---

**AIR LEAKAGE**

This famous building science study demonstrates the immense amount of water that gets through the building envelope as a result of air-infiltration. This moisture is responsible for a vast array of building failure including structural damage, rot, mold, mildew and poor indoor air quality.

---

**standard 4x8 sheetrock**

---

30 Quarts of water provides mold spores more than adequate moisture for germination and growth. The paper backing on drywall can provide an adequate food source.

---

**One Heating Season . . . 70°F / 40% RH**

Under normal conditions 30 quarts of water passes through a 3/4 inch hole in a solid 4x8 sheet of gypsum board via air-infiltration.
Is the performance and installation of fiberglass really that bad??

What do the experts say?

If you don't make yourself obsolete . . . someone else will . . .

Anonymous
Surprisingly, the study showed that 100% of the test homes contained fiberglass batt insulation that was installed improperly with voids, gaps and compression. More surprising was the fact that, upon close examination, in many cases it was not practical and/or possible to install the fiberglass batt product properly due to the nature of the product itself combined with challenging structural design elements in the homes and the presence of numerous obstacles in the wall cavities.

-- California Energy Commission Study Summary

About 50% of all wall cavities in residential construction are non-standard in width and height or obstructed with wiring, pipes, and other things. Any void or compressed area in conventional batt insulation can reduce the R-value significantly.

-- Guardian Fiberglass

The thermal performance (R-value) of fiberglass can be reduced up to 28% due to compression when installed in the typical fashion.

-- Oak Ridge National Laboratories

Fiberglass loses up to 40% of its labeled R-value when outside temperatures fall to 20° F and loses 50% of its labeled R-value when outside temperatures exceed 85° F.

-- LEEDS Research Study in conjunction with the Canadian Research Council

Air infiltration accounts for 40% or more of a home's heating and cooling costs and contributes to problems with moisture, noise, dust, and the entry of pollutants, insects, and rodents. Fiberglass insulation does not act as a sufficient air barrier by itself.

-- U.S. Department of Energy

If you don't make yourself obsolete . . . someone else will . . .

Anonymous
Spray foam insulation serves two purposes by insulating and air-sealing a building's thermal envelope. Therefore it prevents both convective and conductive heat loss/gain in a building.

By sealing as well as insulating, spray foam can reduce energy costs by up to 60% over fiberglass and cellulose insulation products, which do not have the ability to seal the building envelope and lose their ability to insulate during periods of hot and cold.

Building Science Facts: Sealed Attic Assembly Advantages:
- attic stays within 3'-5' F of interior temp because hot outside-air and the sun's radiant heat energy are locked out in summer, and warm air is held in the winter.
- In summer humidity is locked out of the attic preventing condensation, mold and mildew, and in winter, interior humidity levels are easily maintained increasing comfort and indoor air-quality.
- air distribution improves because all duct-leakage is retained inside the building envelope and not allowed to escape to the outside.
- heat loss/gain in the duct system is eliminated as the conditioned air travels through an attic environment that is neither extreme hot nor cold.

Convective heat loss/gain through the building envelope is virtually eliminated as air infiltration is cut by over 90% and conductive heat/loss is reduced to a snail's pace because of spray foam's all-weather-stable R-value and superior insulating ability.

THIS HOUSE:
Monthly Payment: $1657.00
Monthly Utility Bill: $148.00
Total Monthly Cost: $1840.00

The foam insulation saves you more than it costs you.

increase mortgage cost: $35.00
energy savings per month: $139.00
net monthly savings: $104.00

Spray foam insulation is the upgrade that pays for itself in the first month.

- improves whole-house comfort
- stops unwanted noise intrusion
- reduces air-borne dust and allergens
- increases fire protection
- allows smaller HVAC equipment
- eliminates the conditions that cause mold and mildew
UP TO 70% MORE ENERGY EFFICIENT
Foam It Spray Foam Insulation seals your home so that the conditioned air stays inside your house resulting in vast energy savings.

MOLD & MOISTURE PROTECTION
Foam It Spray Foam Insulation is not a food source for mold. Foam It Spray Foam Insulation creates an effective barrier that keeps warm humid air safely away from the dew point so that condensation can not form in the wall cavity.

MORE HEALTHY, COMFORTABLE & QUIET
Foam It Spray Foam Insulation completely seals the building envelope so that conditioned air is held comfortably inside your home while the heat of summer and the cold of winter are locked out, along with noise and pollutants.

Building Science 101
Improved Building Envelope
Moisture & Air Movement During Winter

Air-Seal
Foam It Spray Foam Insulation expands 100x filling EVERY void and penetration virtually eliminating air-infiltration.

Humidity
The air-seal created by Foam It Spray Foam Insulation keeps indoor humidity inside where it belongs maintaining indoor comfort, and eliminating the possibility of condensation inside the wall cavity.

OUTSIDE BUILDING 25° F 10% RH Temperature Gradient 73°F 40% RH INSIDE BUILDING

Foam It Spray Foam Insulation System (Air Perm Rating: .0049L/S-m @75Pa for 5.25in)
1/2" Gypsum Wallboard (Vapor Permeable Latex Paint)
typical outlet box or switch box

up to 70% ENERGY SAVINGS compared to old fiberglass and cellulose insulation technology. Ask your Foam It Building Consultant about how to get foam insulation and guaranteed energy bills!!

Heat
Foam It Spray Foam Insulation seals the cracks and crevices that allow warm air inside to be lost to the outside. By sealing and insulating your home, Foam It Spray Foam Insulation reduces energy costs by 30%-50%.
Building Science 101
Improved Building Envelope
Moisture & Air Movement During Summer

UP TO 70% MORE ENERGY EFFICIENT
Foam It Spray Foam Insulation seals your home so that the conditioned air stays inside your house resulting in vast energy savings.

MOLD & MOISTURE PROTECTION
Foam It Spray Foam Insulation is not a food source for mold. Foam It Spray Foam Insulation creates an effective barrier that keeps warm humid air safely away from the dew point so that condensation can not form in the wall cavity.

MORE HEALTHY, COMFORTABLE & QUIET
Foam It Spray Foam Insulation completely seals the building envelope so that conditioned air is held comfortably inside your home while the heat of summer and the cold of winter are locked out, along with noise and pollutants.

Air-Seal
Foam It Spray Foam Insulation expands 100x filling EVERY void and penetration virtually eliminating air-infiltration. Stopping the free-flow of air in your wall cavities is a critical first step in keeping your home comfortable, your energy bills low, and your house healthy.

Foam It Spray Foam Insulation System
made of 45% bio-renewable content

72° F 40% RH
95° F 80% RH

INSIDE BUILDING

Humidity
Heat

Temperature Gradient

OUTSIDE BUILDING

up to 70% ENERGY SAVINGS compared to old fiberglass and cellulose insulation technology. Ask your Foam It Building Consultant about how to get foam insulation and guaranteed energy bills!!
Diffusion is the migration of moisture by means of vapor drive caused by vapor pressure differential ($\Delta P$). It occurs in either direction as dictated by the season and climate of a particular geographic region. Coastal areas with higher relatively humidity will spend a greater portion of the year with vapor diffusion occurring toward the interior of the building and dryer climates will see the opposite. Vapor diffusion occurs naturally and constantly through nearly all building products year-round. According to ASHRAE the amount of water transferred through the building envelope due to vapor diffusion is insignificant and does not contribute to building failure.

Building Science 101
Improved Building Envelope
Moisture Transfer Due to Vapor Diffusion

One Heating Season . . . $70^\circ$ F / 40% RH

Under normal conditions $\frac{1}{3}$ quart of water passes through a solid 4x8 sheet of gypsum board via vapor diffusion. Stopping air-infiltration drastically reduces the amount of moisture moving into your walls; thereby reducing your chances of having moisture related building failure such as mold, mildew or rot.
Spray foam has been around for over 60 years and is in many products you use every day. It is used in hot tubs, jet fighters, space shuttles, travel mugs, seat cushions, beds, theme park attractions, TV and movie sets, sound stages, and etc. It has one of the widest range of applications of any product produced today.

The chart below demonstrates why spray foam is also the preferred choice for sealing and insulating buildings.

### Insulation Comparison Chart

<table>
<thead>
<tr>
<th>Feature or Benefit</th>
<th>Fiberglass Batts</th>
<th>Wet Sprayed Cellulose</th>
<th>Closed Cell, Rigid Spray Foam</th>
<th>Open-Cell, Semi-rigid Spray Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect fit and conformity to cavity size/shape</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Meets vapor barrier requirements</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Meets air barrier requirements</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Does not distort framing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Does not wick or absorb water</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Contains no formaldehyde</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Does not settle or sag over time</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Remains adhered to vertical substrate such as walls</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Remains adhered to horizontal substrate such as floors</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Remains adhered to angled substrate such as roof decks</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Will not support combustion</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Provides additional structural strength</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Is fire-resistant</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Will not shrink</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Does not require drying time</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>No food value for pests or rodents</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Does not emit harmful gasses or dust particles</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maintains R-value in extreme cold/hot conditions</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Significantly reduces sound transmission</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Contains no ozone depleting chemicals</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Helps maintains good indoor air quality</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Will NOT become a habitat for dirt, allergens, and dust mites</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Total Score**

<table>
<thead>
<tr>
<th></th>
<th>Fiberglass Batts</th>
<th>Wet Sprayed Cellulose</th>
<th>Closed Cell, Rigid Spray Foam</th>
<th>Open-Cell, Semi-rigid Spray Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Score</strong></td>
<td><strong>5</strong></td>
<td><strong>7</strong></td>
<td><strong>17</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>