Control of Air Flow as Part of Thermal Insulation

Manufacturer’s Instructions to Achieve Energy Efficiency of Any Building
Air Infiltration & Insulation

Today’s Presentation

Address the role of insulation in a home

Review common types of insulation used in homes

Discuss “air infiltration and where it typically occurs in a home

Summarize recent research conducted by the NAHB Research Center
Insulation is installed first, and foremost, to retard the flow of heat.

Insulation:
➤ Is a primary contributor to an energy efficient home.
➤ Adds to the comfort of a home. Homes are warmer in the winter and cooler in the summer because they are insulated.
➤ Provides noise control – a benefit that is becoming a highly sought after feature in new homes.
“R-value” is the measure of resistance to heat flow. The higher the R-value, the better the insulation material’s ability to resist the flow of heat.

The FTC requires R-value claims be based on the specific ASTM test methods listed in 16 CFR 460.

The FTC recognizes R-value as the single major performance property for consumers to compare insulation products that perform the same function.

Any claims that insulation R-value can be discounted or enhanced due to air infiltration capabilities are misleading. R-value and “air infiltration” are two separate and distinct issues that must be addressed in different steps by the builder.
Common Types of Insulation Used in Today’s Homes

- Fiber Glass Batt Insulation
- Fiber Glass Blown-in Insulation
- Cellulose Spray Applied Insulation
- Spray Foam Insulation
Research consistently demonstrates that **insulation alone does not stop air infiltration into the home**. Insulation may **reduce** air movement through the wall cavity, but most air infiltration occurs in other areas.

Building scientists recognize that just having an air impermeable insulation does not make a home air tight.
Air Infiltration Happens!

➤ Leaks occur in many places in buildings

➤ Most of the air leakage happens around or through penetrations

➤ Most air does not pass through insulated wall cavities. Testing has shown that only 14% of the air infiltration in a home occurs through the wall cavity.

EPA: www.energystar.gov
Air Infiltration of Wood Frame Walls

NAHB Research Center

May 2009
Air Infiltration of Wood Frame Walls

Purpose:
➤ To compare the air infiltration through a common stud wall...
➤ With different types of insulation
➤ With and without house wrap...
➤ And on a stud wall that included a band joist
Air Infiltration of Wood Frame Walls

➤ R-13 fiber glass batts
➤ R-15 fiber glass blown-in insulation
➤ R-13 cellulose - damp spray
➤ R-13 spray foam insulation
Air Infiltration & Insulation

Air Infiltration of Wood Frame Walls – Test Details

➤ ASTM E1677-05
   *Standard Specification for an Air Retarder Material or System for Low-Rise Framed Building Walls*

➤ 8’ x 8’ wall • 2 x 4 framing • 16” o.c.

➤ Single bottom plates • double top plates

➤ Single gang electrical box with wiring holes through studs

➤ OSB with 1/8” gap, nailed per IRC

➤ Drywall installed on the interior with paper tape and a “skim” coat of joint compound
Air Infiltration & Insulation

Air Infiltration of Wood Frame Walls

Additional Wall Test with Band Joist
# Air Infiltration & Insulation

## Insulation Installation Details

### Control Wall

<table>
<thead>
<tr>
<th>R-value</th>
<th>Insulation System</th>
<th>Test Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>None</td>
<td>No house wrap</td>
</tr>
<tr>
<td>N/A</td>
<td>None</td>
<td>House wrap-taped</td>
</tr>
</tbody>
</table>

- **Fiber Glass Batt**
- **Fiber Glass Blown-in**
- **Cellulose Spray-Applied**
- **Spray Foam**
# Fiber Glass Insulation Wall

<table>
<thead>
<tr>
<th>R-Value</th>
<th>Insulation System</th>
<th>Test Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-13</td>
<td>Inset Stapled Batt</td>
<td>No house wrap</td>
</tr>
<tr>
<td>R-13</td>
<td>Inset Stapled Batt</td>
<td>House wrap</td>
</tr>
<tr>
<td>R-13</td>
<td>Inset Stapled Batt</td>
<td>House wrap-taped</td>
</tr>
<tr>
<td>R-13</td>
<td>Face Stapled Batt</td>
<td>House wrap-taped</td>
</tr>
<tr>
<td>R-15</td>
<td>Blown-in/FG</td>
<td>House wrap-taped</td>
</tr>
</tbody>
</table>
# Cellulose Insulation Wall

<table>
<thead>
<tr>
<th>R-value</th>
<th>Insulation System</th>
<th>Test Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-13</td>
<td>Damp Spray</td>
<td>No house wrap</td>
</tr>
<tr>
<td>R-13</td>
<td>Damp Spray</td>
<td>House wrap</td>
</tr>
<tr>
<td>R-13</td>
<td>Damp Spray</td>
<td>House wrap-taped</td>
</tr>
</tbody>
</table>
## Spray Foam Insulation Wall

<table>
<thead>
<tr>
<th>R-value</th>
<th>Insulation System</th>
<th>Test Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-13</td>
<td>0.5 pcf spray foam</td>
<td>No house wrap</td>
</tr>
<tr>
<td>R-13</td>
<td>0.5 pcf spray foam</td>
<td>House wrap</td>
</tr>
<tr>
<td>R-13</td>
<td>0.5 pcf spray foam</td>
<td>House wrap-taped</td>
</tr>
</tbody>
</table>
Air Infiltration & Insulation

Maximum Permissible Air Leakage Rate

➤ ASHRAE 90.1 has proposed requirements of 0.04 cubic feet per minute per square foot (cfm/ft²) for an air barrier assembly when tested in accordance with ASTM E 1677 at 75 Pascal (0.3” of water).

➤ Assuming an 8’ by 8’ test sample wall area, the maximum permissible air leakage rate would be 2.52 cubic feet per minute (0.04 cfm/sf x 64 sf).

➤ The following slides depicting the NAHB Research Center test results have a dashed line at 2.52 cubic feet per minute mark to show which assemblies would meet this requirement.

➤ NOTE – The NAHB Research Center report does not state that walls with less than 2.52 cubic feet per minute are considered air tight. This is simply a reference mark showing which assemblies would meet the proposed ASHRAE 90.1 requirements for an air barrier assembly.
Air Infiltration & Insulation

Results: Control Wall

- No house wrap
- House wrap taped

<table>
<thead>
<tr>
<th>Insulation Type</th>
<th>cfm@0.1</th>
<th>cfm@0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>House wrap</td>
<td>6.2</td>
<td>12.3</td>
</tr>
<tr>
<td>House wrap taped</td>
<td>0.26</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Air Infiltration & Insulation

Results: Fiber Glass Insulation Wall

- Inset Stapled, no wrap
- Inset Stapled wrap, no tape
- Inset Stapled wrap+tape
- Faced Stapled wrap+tape
- Blown-in-wrap+tape

<table>
<thead>
<tr>
<th></th>
<th>cfm@0.1</th>
<th>cfm@0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inset Stapled, no wrap</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Inset Stapled wrap, no tape</td>
<td>1.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Inset Stapled wrap+tape</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Faced Stapled wrap+tape</td>
<td>0.26</td>
<td>0.4</td>
</tr>
<tr>
<td>Blown-in-wrap+tape</td>
<td>0.04</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Fiber Glass Face Stapled
Inset Stapled
Blown-in
Air Infiltration & Insulation

Results: Cellulose Insulation Wall

- **cellulose-no wrap**
- **cellulose + wrap**
- **cellulose+wrap+tape**

<table>
<thead>
<tr>
<th></th>
<th>cfm@0.01</th>
<th>cfm@0.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damp Spray No House wrap</td>
<td>1.29</td>
<td>2.7</td>
</tr>
<tr>
<td>Damp Spray House wrap</td>
<td>0.41</td>
<td>0.08</td>
</tr>
<tr>
<td>Damp Spray House wrap - taped</td>
<td>0.08</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Air Infiltration & Insulation

Results: Spray Foam Wall

- 0.5 pcf-no wrap
- 0.5 pcf + wrap
- 0.5 pcf +wrap+tape

<table>
<thead>
<tr>
<th>cfm@0.1</th>
<th>cfm@0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No house wrap</td>
<td>0.0</td>
</tr>
<tr>
<td>House wrap</td>
<td>0.0</td>
</tr>
<tr>
<td>House wrap - taped</td>
<td>0.0</td>
</tr>
</tbody>
</table>
All Inclusive - Test Wall Results

8x8 Wall – With and Without House Wrap

- No Insulation
- Fiber Glass Batt Inset-no wrap
- Fiber Glass Batt Inset+wrap
- Fiber Glass Batt Inset+wrap+tape
- Fiber Glass Batt Face Stapled+wrap+tape
- Fiber Glass Batt Blown-in+wrap+tape
- Cellulose spray-applied-no wrap
- Cellulose spray-applied+wrap
- Cellulose spray-applied+wrap+tape
- Foam spray-applied-no wrap
- Foam spray-applied+wrap
- Foam spray-applied+wrap+tape

Air Infiltration & Insulation

- cfm@0.1
- cfm@0.3
Importance of Sealing All Air Infiltration Paths

The air infiltration results in the next slide showing walls insulated with fiber glass and spray foam were done with 2 different wall frame/floor joist assemblies. Therefore it is incorrect to conclude that fiber glass walls with band joists are tighter than foam walls.

This only shows that this one fiber glass wall was tighter than the foam wall tested.

Because these were 2 different frame assemblies it is likely the untreated joint between the wall frame and the floor sheathing in the foam wall allowed more air infiltration than that in the fiber glass wall.

These test results demonstrate the importance of air sealing all air infiltration paths - regardless of the type of insulation used in the wall cavities and band joist assemblies.
Air infiltration rate exceeded the 15 cfm measurement capability of the system.
### Does Caulking Make A Difference?

8x8 Wall - With and Without House Wrap - Caulked OSB

<table>
<thead>
<tr>
<th>Insulation</th>
<th>Test Details</th>
<th>No Caulk cfm@0.1” Low pressure</th>
<th>Caulked cfm@0.1” Low pressure</th>
<th>No Caulk cfm@0.3” High pressure</th>
<th>Caulked cfm@0.3” High pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>FG Inset</td>
<td>No house wrap</td>
<td>3.6</td>
<td>0.83</td>
<td>7.9</td>
<td>1.2</td>
</tr>
<tr>
<td>FG Inset</td>
<td>House wrap -taped</td>
<td>0.40</td>
<td>0.16</td>
<td>0.4*</td>
<td>0.0*</td>
</tr>
<tr>
<td>FG Face stapled</td>
<td>House wrap -taped</td>
<td>0.26</td>
<td>0.16</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Blown-In FG</td>
<td>House wrap -taped</td>
<td>0.04</td>
<td>0.00</td>
<td>0.1*</td>
<td>0.2*</td>
</tr>
</tbody>
</table>

* Data is not consistent due to tolerance of measurement equipment
Air Infiltration & Insulation

Does Caulking Make A Difference?

Air Infiltration is significantly reduced simply by caulking and sealing penetrations and construction gaps prior to and during the installation of the insulation package.
Conclusion

Air sealing using taped house wrap or caulk effectively reduced air infiltration to near zero for the air permeable insulated wall specimens tested.