Materials that Improve the Cost-Effectiveness of Air Barrier Systems

Oak Ridge National Laboratory
China Academy of Building Research

Dow Chemical
3M Company
China Academy of Building Research
Kelong Insulation

Presented By
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Purpose and Objectives

• Air leakage is responsible for 4% of the energy consumed in the US

![US Primary Energy Consumption](image)

- Transportation: 27 Quads
- Industrial: 30 Quads
- Buildings: 40 Quads
- Infiltration: 4 Quads

Office of Energy Efficiency and Renewable Energy
2011 Energy Data Book

• Reduce energy penalty by simplifying installation of air barrier systems
  • Dow Chemical → sprayable liquid flashing (LF)
  • 3M → primer-less self-adhered membrane (PSAM)
Purpose and Objectives
Dow’s Sprayable Liquid Flashing

Current Technologies

Liquid flashing
Needs bridging materials

Peel & stick
Time consuming and prone to error

Backer rod bridging gap

Sprayable Liquid Flashing

- Serves as air and liquid water sealant
- Applied with regular professional paint sprayer
- Bridges gaps up to ¼” wide without supporting materials
- Four times faster to install than tape
- Water-based → low VOC emissions, reduces cleaning time
- Adheres to:
  - Concrete masonry blocks
  - Exterior grade gypsum board
  - Rigid foam insulation
  - Concrete
  - Steel
  - Wood
  - Aluminum
- Anticipated installed cost is lower than current technologies
Purpose and Objectives
3M’s Primer-Less Self-Adhered Membrane

Current Technologies

Typical asphalt-based self-adhered membrane
Primer required over substrate

Failure can occur if primer is not adequately dried

Primer-Less Self-Adhered Membrane

- Serves as air, liquid water and water vapor barrier
- Does not need a primer → decreases installation time by ½
- Can be applied at -18°C
- Adheres to:  - Concrete masonry blocks  - Concrete
  - Exterior grade gypsum board  - Steel
  - Rigid foam insulation  - Wood
  - Aluminum
- Anticipated installed cost is lower than current technologies
Approach

Improve product specifications and installation guidelines to ensure reduced installation time while maintaining or improving the performance of air barrier systems.

Development of durability test protocol

Large-scale lab test

Estimates of potential energy savings and CO₂ reductions
Durability Test

Pass Criteria

- Air leakage <0.2 L/(s·m²) at 75 Pa

- No water leakage at ∆P= 137 Pa

- Air leakage <0.2 L/(s·m²) at 75 Pa at
  - Warm conditions: \( T_{in} = 22°C (72°F) \) \( T_{out} = 43°C (110°F) \)
  - Cold conditions: \( T_{in} = 22°C (72°F) \) \( T_{out} = -18°C (0°F) \)

- Air leakage <0.2 L/(s·m²) at 75 Pa after aging through pressure cycles that simulate 15-year wind loads

- Air leakage <0.2 L/(s·m²) at 75 Pa after aging through temperature cycles ranging between 66°C (150°F) and -12°C (10°F)

- No water leakage when pressure cycles between 240 and 720 Pa
Sprayable Liquid Flashing (LF)
Dow
LF on Polyisocyanurate Boards

- LF used to seal gaps around penetrations and board joints
- Successfully completed durability test
- Lessons learned
  - Special attention to be paid when LF is applied to the underside of penetrations
• LF used to seal gaps around penetrations and board joints, and served as the water-resistant barrier over exterior grade drywall
• Successfully completed durability test
LF: Field Tests

Substrates: foil-faced polyisocyanurate board insulation and steel

China Academy of Building Research (CABR)
Beijing, China

Concrete window sill
Installed liquid flashing
**Dow’s Target Outcomes**

<table>
<thead>
<tr>
<th>Target Outcomes</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generate technical product planning roadmap in 2014</td>
<td>On schedule</td>
</tr>
<tr>
<td>Launch the LF in the US in 2014</td>
<td>On schedule</td>
</tr>
<tr>
<td>Initiate lab and field tests</td>
<td>On schedule</td>
</tr>
<tr>
<td>Generate economic value proposition in 2014</td>
<td>On schedule</td>
</tr>
<tr>
<td>Present benefits from the LF at major trade conferences</td>
<td>On schedule</td>
</tr>
</tbody>
</table>

**Key accomplishment**

Patent awarded to Dow’s liquid flashing: US20130042961A1
Primer-Less Self-Adhered Membrane (PSAM)
3M
PSAM: Lab Tests

- Selected material layout
  - Steel framing
  - Wall 1 exterior substrate: exterior grade drywall
  - Wall 2 exterior substrate: concrete boards
- Tests will begin in September 2014
PSAM: Field Tests

Substrates: exterior grade drywall and steel

China Academy of Building Research (CABR)
Beijing, China

Concrete window sill
Membrane as flashing
PSAM: Whole-Building Tests

- DOE’s Emerging Technologies / Commercial Building Integration Lab Call
- ORNL and 3M were awarded funds for multi-year project
  - Conduct whole-building tests: air leakage will serve as the main variable
  - Build, instrument and monitor ten test facilities
  - Quantify energy savings due to improvements in airtightness
- Test site: Cottage Grove, MN
- Project to begin in October, 2014
## 3M’s Target Outcomes

<table>
<thead>
<tr>
<th>Target Outcomes</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generate product planning roadmap in 2015 based on results from 2014 lab and field tests</td>
<td>On schedule</td>
</tr>
<tr>
<td>Initiate lab and field tests</td>
<td>On schedule</td>
</tr>
<tr>
<td>Launch PSAM in China in 2014</td>
<td>On schedule</td>
</tr>
<tr>
<td>Present benefits from the PSAM at major trade conferences</td>
<td>On schedule</td>
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</tbody>
</table>

**Key accomplishment**

Secured funds from ET/CBI lab call to quantify energy savings from improvements in airtightness
## Remaining 2014 Tasks

### ORNL
- Test two walls with PSAM
- Coordinate air barrier system with the Kelong design team
- 2014 funds requested: $240K
- 2014 funds received: $115K
- 2014 funds remaining: $10K

### Dow and 3M
- Continue working on target outcomes

### CABR
- Conduct air and water penetration tests on windows with LF and PSAM
- Report results

### Kelong Insulation
- Share drawings with ORNL, Dow and 3M
Appendix

- 2015 requested budget: $220K
- Quarterly plan

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Main Tasks</th>
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<tbody>
<tr>
<td>1</td>
<td>Test 1 wall</td>
</tr>
<tr>
<td>2</td>
<td>Test 2 walls</td>
</tr>
<tr>
<td></td>
<td>Coordinate installation of LF and PSAM in Kelong building</td>
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<tr>
<td>3</td>
<td>Test 1 wall</td>
</tr>
<tr>
<td></td>
<td>Estimate energy savings and reductions in CO$_2$ emissions</td>
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<tr>
<td>4</td>
<td>Issue final report</td>
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<tr>
<td></td>
<td>Dow and 3M meet target outcomes</td>
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