Joining the Pieces Together
A New Weatherbarrier Sealant to Ensure Energy Retention of Commercial Buildings

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OUTLINE

• Codes and Standards
• Air Barriers as a Substrate
• The Importance of Sealant Performance
• A New Type of Sealant
• Conclusion
Codes and Standards

- Buildings account for 39% of all energy use in the US*.  
  - 21% of energy is lost through the walls  
  - 22% of energy is lost through windows  
  - 18% of energy use is due to offsetting heating and cooling of air infiltrating the building envelope

- This led to building codes requiring the use of air barriers.

* Data from US DOE EERE
## Codes and Standards

<table>
<thead>
<tr>
<th>Standard or Code</th>
<th>Section Containing Requirements on Air Infiltration</th>
<th>Examples of Jurisdictions Adopted</th>
<th>Air Leakage Rates at 0.3 in. w.g. (1.57 lb/sqft, 75 Pa)</th>
<th>Tests Cited</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 90.1-2010</td>
<td>Section 5.4</td>
<td>Massachusetts IECC-2012</td>
<td>Material: 0.004 cfm/sqft Assembly: 0.04 cfm/sqft</td>
<td>ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283</td>
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<tr>
<td>ASHRAE 90.1-2007</td>
<td>Section 5.4</td>
<td>LEED® 2010</td>
<td>N/A</td>
<td>ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283</td>
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<tr>
<td>ASHRAE 189.1-2009</td>
<td>Subsection 7.4.2.10, Normative Appendix B</td>
<td>IgCC-2012</td>
<td>Material: 0.004 cfm/sqft Assembly: 0.04 cfm/sqft Building: 0.4 cfm/sqft</td>
<td>ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283, ASTM E 977</td>
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<tr>
<td>IECC - 2012</td>
<td>Section 502</td>
<td>None</td>
<td>Material: 0.004 cfm/sqft Assembly: 0.04 cfm/sqft</td>
<td>ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283</td>
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<tr>
<td>IgCC-v2, 11-2011</td>
<td>Section 606.1.2</td>
<td>None</td>
<td>Envelope: 0.25 cfm/sqft</td>
<td>ASTM E 977</td>
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<tr>
<td>USACE</td>
<td></td>
<td></td>
<td>Envelope: 0.25 cfm/sqft</td>
<td></td>
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<tr>
<td>Executive Order #13514</td>
<td>Energy Efficiency</td>
<td>All Federal Buildings planned after 2020</td>
<td>Reduce energy cost of ASHRAE 90.1-2004 by 30%</td>
<td></td>
</tr>
</tbody>
</table>
The Challenge of Air Barriers

- Self-adhered flashings typically have high-density polyethylene (HDPE) backings
  - HDPE is a very low surface energy material
  - Very difficult for traditional sealants to adhere

- Spun-bound polyolefin sheets are fibrous wrap materials which are mechanically attached to the building
  - Also low surface energy

- Sealants need to be able to adhere to both the air barrier and traditional substrates in order to provide an air tight building envelope.
More than just adhesion…

- ASHRAE 189.1-2009 Normative Appendix B subsection B1.b: “The air barrier component of each assembly shall be joined and sealed in a flexible manner to the air barrier component of the adjacent assemblies, allowing for the relative movement of these assemblies and components.”

- Subsection B1.c: the continuous air barrier “shall not displace adjacent materials under full load.”

- Section 606.1.2.1 of the IgCC v2.0, 11-2011 requires that “the building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.”
System Performance

• Does a sealant that adheres to the substrates really make a difference?
• Tested a system to ASTM E283-04

3 Cases
• Sealant that adheres to the membrane
• Sealant that “adheres” until stressed
• Same sealant after it has seen cyclical movement and lost adhesion
## Adhering Sealant Results – ASTM E283

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Air Infiltration</th>
<th>Air Exfiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installation</td>
<td>Window</td>
</tr>
<tr>
<td></td>
<td>Net (cfm)</td>
<td>Net (cfm)</td>
</tr>
<tr>
<td>25 Pa (0.52 psf)</td>
<td>0.05</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>50 Pa (1.04 psf)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>75 Pa (1.57 psf)</td>
<td>0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>100 Pa (2.09 psf)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>150 Pa (3.13 psf)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>250 Pa (5.22 psf)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>300 Pa (6.27 psf)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
## With and Without Adhesion

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Initial Tare (cfm)</th>
<th>Infiltration</th>
<th>Exfiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With Sealant Adhered</td>
<td>Without Sealant Adhered</td>
</tr>
<tr>
<td>25 Pa (0.52 psf)</td>
<td>0.11</td>
<td>&lt;0.01</td>
<td>0.12</td>
</tr>
<tr>
<td>50 Pa (1.04 psf)</td>
<td>0.22</td>
<td>&lt;0.01</td>
<td>0.19</td>
</tr>
<tr>
<td>75 Pa (1.57 psf)</td>
<td>0.33</td>
<td>0.01</td>
<td>0.27</td>
</tr>
<tr>
<td>100 Pa (2.09 psf)</td>
<td>0.42</td>
<td>&lt;0.01</td>
<td>0.34</td>
</tr>
<tr>
<td>150 Pa (3.13 psf)</td>
<td>0.61</td>
<td>&lt;0.01</td>
<td>0.45</td>
</tr>
<tr>
<td>250 Pa (5.22 psf)</td>
<td>0.94</td>
<td>&lt;0.01</td>
<td>0.67</td>
</tr>
<tr>
<td>300 Pa (6.27 psf)</td>
<td>1.08</td>
<td>&lt;0.01</td>
<td>0.74</td>
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</table>
Solution to air infiltration concerns

• Sealant that is…
  – Designed to adhere to low energy surfaces
  – Remains flexible under long-term loading
  – Does not tear apart the fragile air barrier materials

• Looked beyond traditional silicone polymers to the world of resins

• A mixture of a traditional silicone polymer with a trimethylated silica resin.
Adhesion Performance of Polymer-Resin Sealant to Low Energy Substrates

- Low-Density Polyethylene
- Weather Barrier Mfr. 1 (polyolefin)
- Weather Barrier Mfr. 2 (polyethylene)
- Weather Barrier Mfr. 3 (polyethylene)
- Weather Barrier Mfr. 4 (polyethylene)

7 Day Peel Strength (pli)
Adhesion to Traditional Substrates

- Anodized Aluminum
- PVC
- Vinyl
- Polyester Powder Coating
- Acrylic Coating
- Mica Flake Fluoropolymer Coating
- Galvanized Steel

7 Day Peel Strength (pli)

- Silicone Resin/Polymer Mix Sealant
- Low modulus silicone sealant
- Polyurethane
- Silane-Terminated Polyether
- Acrylic

Graph showing comparison of peel strength for different substrates.
## Both Before and After QUV Exposure

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>7 Day RT</th>
<th>1000 Hr RT</th>
<th>1000 Hr QUV</th>
<th>5000 Hr RT</th>
<th>5000 Hr QUV</th>
<th>10,000 Hr RT</th>
<th>10,000 Hr QUV</th>
<th>Reference traditional sealant value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel Strength on Glass (pli)</td>
<td>62</td>
<td>69</td>
<td>70</td>
<td>83</td>
<td>60</td>
<td>85</td>
<td>62</td>
<td>20-50</td>
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<tr>
<td>Durometer (A Scale)</td>
<td>NA</td>
<td>55</td>
<td>53</td>
<td>57</td>
<td>53</td>
<td>63</td>
<td>60</td>
<td>30-40</td>
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<tr>
<td>Tensile Strength (psi)</td>
<td>NA</td>
<td>399</td>
<td>334</td>
<td>459</td>
<td>332</td>
<td>424</td>
<td>301</td>
<td>150-250</td>
</tr>
</tbody>
</table>

*RT = Room Temperature
Weathering

Silicone Polymer Resin Blend Sealant after 2 years in Phoenix Desert Outdoor Weathering Site. No cleaning or special preparation of the sealant. Substrate is a common SAF weather barrier membrane.

Organic technology sealant after 2 years in Phoenix Desert Outdoor Weathering Site. No cleaning or special preparation of the sealant. Substrate is a common SAF weather barrier membrane.
Weathering + Adhesion

Adhesion of polymer/resin blend sealant (left) and a common silicone sealant (right) after 2 years in Phoenix Desert Outdoor Weathering Site, to a common peel and stick weather barrier membrane with a high density polyethylene top sheet.

Adhesion of polymer/resin blend sealant (right) and a common silicone sealant (left) after 2 years in Phoenix Desert Outdoor Weathering Site, to a common spun bound polyolefin weather barrier membrane
Polymer/resin blend sealant joint after being tested for +/- 25% movement (left) and standard silicone sealant joint after being tested for +/- 25% movement (right). Substrates are anodized aluminum and HDPE.
## Performance in Shear

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Sealant/Primer</th>
<th>Cure Conditions</th>
<th>Peak Shear Force (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anodized Aluminum/HDPE</td>
<td>Polymer/resin blend sealant/No Primer</td>
<td>21 days standard lab conditions</td>
<td>65</td>
</tr>
<tr>
<td>Anodized Aluminum/HDPE</td>
<td>Traditional silicone sealant/No Primer</td>
<td>21 days standard lab conditions</td>
<td>42</td>
</tr>
</tbody>
</table>
“Results of testing at an independent laboratory showed that the sealant we intended to use did not adhere as intended to the membrane and thus could not provide the performance and durability we required.”

– Jim Curry, Sr. PM, CBO Glass Inc.

Independent testing confirmed that this sealant provided excellent air and water penetration in a mockup of the Kaleida Health building.
Conclusion

• Building codes are adopting standards to address energy loss through a building envelope

• Most common solution is to reduce air infiltration using air barriers that have a low surface energy

• Curtain wall and window installations currently rely on organic flashing materials

• Sealant chemistry and adhesion performance will affect air infiltration performance of a curtain wall or window installation

• Unique sealant chemistry with a resin component designed to adhere to low surface energy materials assures long term adhesion and low air infiltration performance of a whole installation
Thank You!

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