Thin Insulation Solutions for Thermal Performance Challenges

Thermal Analysis Using DOWSIL™ Building Insulation Blanket
New Solutions for Improving Thermal Performance

Meeting the challenges of energy efficiency and new energy regulations – including concerns over thermal bridging – has been difficult to accomplish with traditional insulation technology. An innovative technology from Dow High Performance Building solutions is providing architects and contractors with a solution that improves thermal performance while expanding design options.

DOWSIL™ Building Insulation Blanket – which provides high-performance insulation in challenging, space-limited situations – features significantly improved thermal resistance as compared to conventional insulation products. Its thin profile, superb flexibility and compression resistance allow for thermal protection in hard-to-insulate spaces. It can be easily cut and conformed to complex shapes and tight curvatures and adhered to most common construction substrates. It is an ideal solution for providing insulation in challenging transition conditions in building envelopes, such as where glazing systems meet cavity walls, where below-grade systems meet above-grade systems and where parapets meet roofs. DOWSIL™ Building Insulation Blanket also is fire-resistant, is hydrophobic and does not settle over time when appropriately adhered or fastened to the substrate.

DOWSIL™ Building Insulation Blanket is based on silicon aerogel technology. Aerogel is a lightweight silica solid derived from gel in which the liquid component of the gel has been replaced with gas, creating an extremely low-density solid with several remarkable properties, including fire resistance, moisture permeability and – most notably – its effectiveness as a thermal insulator.

Evaluation by Thermal Modeling

To effectively predict thermal performance of a building design, including the effects of thermal bridging, insulation materials are better evaluated as part of the overall system rather than on their R-value alone. Using thermal modeling software, DOWSIL™ HPI-1000 Building Insulation Blanket was evaluated in a variety of details using a steady-state conduction model based on ASHRAE 1365-RP. In each case, the details were analyzed with and without DOWSIL™ HPI-1000 Building Insulation Blanket to compare relative heat loss. A sampling of these results is shared here.

Comparative R-value per Inch

Thermal conductivity varies by specific grade of insulation for any given material family. Values shown represent typical values and are only provided for general comparison of families.

<table>
<thead>
<tr>
<th>Material</th>
<th>R-value per Inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOWSIL™ HPI-1000 Building Insulation Blanket</td>
<td>9.6</td>
</tr>
<tr>
<td>Polyisocyanurate</td>
<td>6</td>
</tr>
<tr>
<td>Extruded Polystyrene (XPS)</td>
<td>5.3</td>
</tr>
<tr>
<td>Mineral Wool</td>
<td>4.2</td>
</tr>
<tr>
<td>Expanded Polystyrene (EPS)</td>
<td>3.8</td>
</tr>
<tr>
<td>Fiberglass Batts</td>
<td>3.5</td>
</tr>
</tbody>
</table>

*Average R-values per ASTM C518 at 100°F and 2 psi compression, shown in hr-ft²-F/BTU; USI-values shown in W/m²K.
Summary – Detail-level Thermal Modeling of DOWSIL™ HPI-1000 Building Insulation Blanket

<table>
<thead>
<tr>
<th>Transmittance Description</th>
<th>Linear Transmittance, BTU/hr·ft·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Insulation Blanket</td>
<td>With 10 mm DOWSIL™ HPI-1000 Building Insulation Blanket</td>
</tr>
<tr>
<td>Curtainwall to interior/exterior insulated steel stud wall transition</td>
<td>0.069</td>
<td>0.019</td>
</tr>
<tr>
<td>Window-wall at floor slab</td>
<td>0.556</td>
<td>0.264</td>
</tr>
<tr>
<td>Curtainwall to at-grade slab transition</td>
<td>0.495</td>
<td>0.370</td>
</tr>
<tr>
<td>Curtainwall to roof parapet transition</td>
<td>0.614</td>
<td>0.513</td>
</tr>
</tbody>
</table>

U-Value Results

<table>
<thead>
<tr>
<th>Curtainswall spandrel section incorporating DOWSIL™ HPI-1000 Building Insulation Blanket as a mullion wrap</th>
<th>Spandrel U-Value, BTU/hr·ft²·°F/BTU</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spandrel Height, ft</td>
<td>Curtainwall Backpan Insulation, hr-ft²·°F/BTU</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>R 16.8</td>
</tr>
</tbody>
</table>

Modeling – Detail-level use of DOWSIL™ HPI-1000 Building Insulation Blanket

Curtainwall to Interior/Exterior Insulated Steel Stud Wall Transition

Linear Transmittance Calculations for Steel Stud Wall Transition

<table>
<thead>
<tr>
<th>Transmittance Description</th>
<th>Linear Transmittance, BTU/hr·ft·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Insulation Blanket</td>
<td>With 10 mm DOWSIL™ HPI-1000 Building Insulation Blanket</td>
</tr>
<tr>
<td>Curtainwall jamb to an interior and exterior insulated steel stud assembly</td>
<td>0.069</td>
<td>0.019</td>
</tr>
</tbody>
</table>
Window-wall at Floor Slab

Linear Transmittance Calculations for a Window-wall Spandrel Section Slab Face

<table>
<thead>
<tr>
<th>Transmittance Description</th>
<th>Linear Transmittance, BTU/hr·ft·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Insulation Blanket</td>
<td>With 10 mm DOWSIL™ HPI-1000 Building Insulation Blanket</td>
</tr>
<tr>
<td>Window-wall spandrel section</td>
<td>0.556</td>
<td>0.264</td>
</tr>
</tbody>
</table>

Curtainwall to At-Grade Slab Transition

Perimeter Heat Loss for Curtainwall At-Grade by Varying U-Values

<table>
<thead>
<tr>
<th>Depth of Insulation, inches</th>
<th>Below-Grade Insulation, hr·ft²·°F/BTU</th>
<th>Slab Perimeter Heat Loss, BTU/hr·ft·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Without Insulation Blanket</td>
<td>With 10 mm DOWSIL™ HPI-1000 Building Insulation Blanket</td>
</tr>
<tr>
<td>24</td>
<td>R 10</td>
<td>0.495</td>
<td>0.370</td>
</tr>
</tbody>
</table>
Curtainwall to Roof Parapet Transition

**Wall U-Value for Curtainwall at Parapet**

<table>
<thead>
<tr>
<th>Curtainwall Height, ft</th>
<th>Curtainwall Backpan Insulation, hr·ft²·°F/BTU</th>
<th>Overall Opaque Wall U-Value, BTU/hr·ft²·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Without Insulation Blanket</td>
<td>With 10 mm DOWSIL™ HPI-1000 Building Insulation Blanket</td>
</tr>
<tr>
<td>2</td>
<td>R 16.8</td>
<td>0.500</td>
<td>0.449</td>
</tr>
<tr>
<td>3</td>
<td>R 16.8</td>
<td>0.397</td>
<td>0.363</td>
</tr>
<tr>
<td>4</td>
<td>R 16.8</td>
<td>0.346</td>
<td>0.321</td>
</tr>
</tbody>
</table>

**Linear Transmittance Calculations for Parapet Detail**

<table>
<thead>
<tr>
<th>Transmittance Description</th>
<th>Linear Transmittance, BTU/hr·ft·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtainwall parapet</td>
<td>0.614</td>
<td>16</td>
</tr>
</tbody>
</table>

**Curtainwall Spandrel Vertical Mullion Wrap**

**U-Value Results for Curtainwall Spandrel Section**

<table>
<thead>
<tr>
<th>Spandrel Height, ft</th>
<th>Curtainwall Backpan Insulation, hr·ft²·°F/BTU</th>
<th>Spandrel U-Value, BTU/hr·ft²·°F</th>
<th>% Reduction in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>R 16.8</td>
<td>0.169</td>
<td>0.153</td>
</tr>
</tbody>
</table>
Whole-building Energy Modeling

Additionally, two whole-building energy models were developed to demonstrate the effect of using DOWSIL™ HPI-1000 Building Insulation Blanket with conventional and higher-performance assemblies to minimize thermal bridging:

### 100% Façade Glazing

Building with the glazing system covering 100% of the façade area, modeled with DOWSIL™ HPI-1000 Building Insulation Blanket within conventional and higher-performance assemblies in a Chicago climate.

<table>
<thead>
<tr>
<th>Building Description</th>
<th>Assembly Performance</th>
<th>Annual Heating Energy Use, MMBTU (GJ)</th>
<th>% Reduction in Heat Loss</th>
<th>% Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Without Insulation Blanket</td>
<td>With DOWSIL™ HPI-1000 Building Insulation Blanket</td>
<td>Absolute MMBTU (GJ)</td>
</tr>
<tr>
<td>Façade with glazing system covering 100% of the façade area</td>
<td>Conventional assemblies</td>
<td>6,123 (6,460)</td>
<td>5,905 (6,230)</td>
<td>218 (230)</td>
</tr>
<tr>
<td></td>
<td>Higher-performance assemblies</td>
<td>4,421 (4,665)</td>
<td>4,275 (4,511)</td>
<td>147 (155)</td>
</tr>
</tbody>
</table>

### Curtainwall Glazing and Steel Stud Wall Assembly

Building with a façade of curtainwall glazing and a steel stud wall assembly, modeled with DOWSIL™ HPI-1000 Building Insulation Blanket within conventional and higher-performance assemblies in a Chicago climate.

<table>
<thead>
<tr>
<th>Building Description</th>
<th>Assembly Performance</th>
<th>Annual Heating Energy Use, MMBTU (GJ)</th>
<th>Savings Due to DOWSIL™ HPI-1000 Building Insulation Blanket Details</th>
<th>% Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Without Insulation Blanket</td>
<td>With DOWSIL™ HPI-1000 Building Insulation Blanket</td>
<td>Absolute MMBTU (GJ)</td>
</tr>
<tr>
<td>Façade with curtainwall glazing and a steel stud wall assembly</td>
<td>Conventional assemblies</td>
<td>4,545 (4,796)</td>
<td>4,279 (4,515)</td>
<td>266 (281)</td>
</tr>
<tr>
<td></td>
<td>Higher-performance assemblies</td>
<td>3,340 (3,524)</td>
<td>3,114 (3,285)</td>
<td>227 (239)</td>
</tr>
</tbody>
</table>
3-D Thermal Modeling – Isotherms

3-D thermal modeling is an enabler of more informed design choices – for system selection and for detail development for visual impact. One of the outputs of 3-D thermal modeling is the isotherms – a depiction of material surface temperatures showing the variation as one reads them from the exterior of the building towards the interior. This variation is expressed in different colors: blue for cold and red for hot.

Using an interior temperature of 69.8°F and an exterior temperature of 5.8°F, 3-D thermal modeling of one of the typical thermal bridging conditions shows the impact that using DOWSIL™ HPI-1000 Building Insulation Blanket has on the surface temperatures of the system. The below summarizes the modeled results of interior surface temperatures of selected window-wall components at that interface – both when there is no insulation at the slab edge and when DOWSIL™ HPI1000 Building Insulation Blanket covers the slab edge.

<table>
<thead>
<tr>
<th>Detail Description – Window-Wall Spandrel Section</th>
<th>Minimum Temperature, °F (°C)</th>
<th>% Improvement in Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Insulation Blanket</td>
<td>With DOWSIL™ HPI-1000 Building Insulation Blanket</td>
</tr>
<tr>
<td>T₁ – minimum temperature on glazing</td>
<td>34.1 (1.2)</td>
<td>37.7 (3.2)</td>
</tr>
<tr>
<td>T₂ – minimum temperature on frame</td>
<td>36.8 (2.6)</td>
<td>41.7 (5.4)</td>
</tr>
<tr>
<td>T₃ – minimum temperature on concrete</td>
<td>40.2 (4.5)</td>
<td>46.3 (7.9)</td>
</tr>
</tbody>
</table>

Outside minimum temperature indices without DOWSIL™ HPI-1000 Building Insulation Blanket:
- T₁ = 34.1°F (1.2°C)
- T₂ = 36.8°F (2.6°C)
- T₃ = 40.2°F (4.5°C)

Inside minimum temperature indices with DOWSIL™ HPI-1000 Building Insulation Blanket:
- T₁ = 37.7°F (3.2°C)
- T₂ = 41.7°F (5.4°C)
- T₃ = 46.3°F (7.9°C)

DOWSIL™ HPI-1000 Building Insulation Blanket along slab face and vertical and horizontal mullions
For More Information

Dow is collaborating with industry professionals around the world to improve the energy efficiency of buildings, offer long-lasting solutions and provide excellent technical support. Taking a holistic approach, Dow brings together expertise from across the company to help customers find solutions to a wide range of high performance building challenges. Dow High Performance Building solutions include proven materials for structural and protective glazing, weatherproofing, insulating glass, window and door fabrication, and building materials protection, as well as innovations for high efficiency insulation, LED lighting, thermal management systems, and the incorporation of photovoltaic cells and solar panels into building design. Learn more about our full range of building and construction solutions, including service and support, at consumer.dow.com/construction.

Dow has sales offices, manufacturing sites, and science and technology laboratories around the globe. Find local contact information at consumer.dow.com/contactus.

For the most up-to-date information about DOWSIL™ HPI-1000 Building Insulation Blanket, visit the High Performance Insulation webpage at consumer.dow.com/HPInsulation.

To satisfy Seattle’s requirements for both continuous insulation and thermal-bridging management at the Stadium Place, West Tower (“The NOLO”), in downtown Seattle, Washington, USA, thin-profile DOWSIL™ HPI-1000 Building Insulation Blanket was cut to fit, then installed around window jambs to insulate the area where brick returns to meet the window wall. (Case study available.)

To meet stringent Passive House standards required controlling losses from thermal bridging at the Kiln Apartments in Portland, Oregon, USA. DOWSIL™ HPI-1000 Building Insulation Blanket was added as a thermal isolator to a stainless steel sunshade support to minimize these losses. (Case study available.)