Building Envelope Applications for Reinforced Flexible Aerogel Insulation Blankets

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What Is An Aerogel?

• Aerogels are nanoporous solids invented in the 1930’s
  – Aerogels are created when silica is gelled in a solvent
    • *When the solvent is removed, what remains is “puffed-up sand”, with up to 99% porosity*
  – Nanopores cage the air molecules, retarding heat flow
  – Long molecular chains increase the solid path-length through the silica, reducing thermal conductivity

• Twin innovations helped move aerogels from lab curiosity to industrial product
  – Supercritical CO₂ extraction reduces cycle times from months to hours
  – Casting the wet gel into a fibrous batting provides mechanical integrity

The Aerogel Advantage:
Superinsulation performance in a flexible blanket form
Aerogel Thermal Performance – With the Flexibility of a Blanket

• Start with a non-woven blanket
  – Typically polyester, glass, carbon, or ceramic fiber
• Fill that blanket with a wet gel
• Remove the solvents via supercritical CO₂ extraction
• Roll the blanket onto a spool

**Step 1:**
Fill fibrous batting with a liquid-solid solution

**Step 2:**
Extract solvents with supercritical carbon dioxide

**Step 3:**
Resulting dry, fiber-reinforced aerogel blanket
Aspen’s Aerogel Manufacturing Process

Silica Sol | Catalyst | Dopants

Casting

Dry fiber blanket

Gelation

Supercritical extraction

Dry fiber blanket

Drying

Rolls packed for shipment

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Heath and Safety Aspects of Aerogels

• Aerogels are an amorphous (non-crystalline) silica with 97% of particles larger than 45μm
  – Only the pores are nano-scale (~0.01 μm)
  – Aerogel particles are much larger

• Amorphous silicas have been studied by OSHA, EPA, and the OECD, concluding:
  – “Demonstrated lack of toxicity, mutagenicity.”
  – “Is not expected to pose a carcinogenic risk.”
  – “Silicas are inert when ingested, and unlikely to be absorbed through the skin.”
  – “No concerns for human health.”

• Typical dust loading in fab-shop is <5 mg/m³
  – OSHA limit for amorphous silica is 80 mg/m³

Recommended PPE is paper dust mask, work gloves, and safety glasses
## Spaceloft Technical Specifications and Sustainability

<table>
<thead>
<tr>
<th>Test Procedure</th>
<th>Property</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM C 518</td>
<td>Thermal Conductivity</td>
<td>0.094 BTU-in/hr-sqft-F</td>
</tr>
<tr>
<td></td>
<td>R-value</td>
<td>R-10 installed @ 1“</td>
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<tr>
<td></td>
<td></td>
<td>R-4 @ 0.4” (10 mm)</td>
</tr>
<tr>
<td>ASTM E 84</td>
<td>Flame Spread &amp; Smoke Development</td>
<td>Class A: FSI &lt;5 SDI 20</td>
</tr>
<tr>
<td>ASTM C 165</td>
<td>Compressive Strength</td>
<td>8psi @ 10% compression</td>
</tr>
<tr>
<td>ASTM E 96</td>
<td>Water Vapor Transmission Rate</td>
<td>79 perm</td>
</tr>
<tr>
<td>ASTM E 2178</td>
<td>Air Permeability</td>
<td>0.043 L / s-sqm</td>
</tr>
<tr>
<td>ASTM C 1338</td>
<td>Mold and Fungal Growth</td>
<td>0 growth</td>
</tr>
<tr>
<td></td>
<td>Embodied Energy</td>
<td>22.8 kBTU / lb</td>
</tr>
<tr>
<td></td>
<td>Embodied CO2</td>
<td>4.2 lb CO2 / lb</td>
</tr>
</tbody>
</table>

### Material Attributes
- High thermal resistance per thickness
- Durable while flexible
- Stable thermal conductivity
- Prevents bulk water passage
- Readily passes water vapor
- Contains no ozone depleting substances
- >30% recycled content
- Recyclable
Interior Wall Application – Full Wall Coverage

Delta T = 2-3 degrees
Cooler Exterior Wall = Less Heat Loss
Exterior Wall Application - Residential

Project: MA Housing Authority
Multi-Family renovation
Spaceloft insulation installed over new sheathing with new plank siding applied over the top
  • Weather Resistive Barrier
  • Continuous Insulation

Project: Canadian Residential New Build
Spaceloft Insulation Applied over sheathing with WRB and new brick façade applied over the aerogel
  • Continuous Insulation
  • Energy Efficiency
Exterior Wall Application – “Façadetomy” & Stucco / EIFS
Cathedral Ceiling Application

Project: TX Cathedral Ceiling

Spaceloft insulation installed over ceiling framing drywall installed over aerogel

- High R value
- Space Savings
Spaceloft insulation strips applied to all exterior framing on residential new construction.
• Energy Efficiency
• Thermal Bridging

**Project: CO Low Energy House**

Spaceloft insulation strips applied to all exterior framing on residential new construction.
• Energy Efficiency
• Thermal Bridging

**Project: MA Farmhouse Renovation**

Spaceloft Insulation strips applied to all exterior framing on second story renovation
• Energy Efficiency
• Thermal Bridging
Passive House Application

Project: Portland Everhart Passive House Retrofit
Spaceloft insulation installed on framing and in walls
- Thermal Bridging
- Walls

Project: California O’Neill Passive House Retrofit
This is the first Passive House in California and the first retrofit Passive House in the entire country.
- Under floor
- Thermal Bridging
Specialty Applications

• Radiant Flooring
  – Thin profile
  – Improved Response Time

• Radiators & Convectors

• CurtainWall and Window Framing
  – Thermal Break improvement

• Heat Protection
  – High Temperature Capability

• Distributed Energy
  – System Efficiency improvement
  – Maintenance Project EE opportunity

Ambient conditions = 75°F, no wind, 0.1 emissivity
For Further Information:

http://www.aerogel.com

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