Arctic Sealant Technology & Innovation

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The Commercial Sealant Market - $3.5 Bio

USA Building & Construction Demand (2020)

(USA Size: 1.2 billion pounds valued at $3.5 billion)

- On-site Applications [new, repair]: 857, $2,425
- Civil Engineering: 265, $808
- Off-Site applications: 84, $281

Source: ChemQuest
The Sealant Market – Global Trends

### Several global trends across a diverse range of markets

<table>
<thead>
<tr>
<th>Trend</th>
<th>Innovation</th>
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<tr>
<td>Shift from mechanical fasteners to adhesives</td>
<td>- Bonding/softening dissimilar materials of design</td>
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<td>- NVH Corrosion protection, crackworthiness (load management and distribution)</td>
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<td>Increased use of composites, plastics, and light metal alloys</td>
<td>- Aerospace (Boeing Dreamliner 787)</td>
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<td>- Automotive (2025 CAPE Standards)</td>
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<td>- Implementation of carbon fiber and bonding dissimilar materials</td>
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<td>- Resilient veneer-laminated wood flooring</td>
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<td>Demand for alternative, sustainable energy sources</td>
<td>- Wind Energy</td>
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<td>- Long-term, durable solar panels</td>
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<td>Globally aging population</td>
<td>- Comfortable adult incontinence products</td>
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<td>Electric vehicles and vehicle light-weighting</td>
<td>- Engineered Structural Adhesives</td>
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<td>- Thermally-conductive encapsulants; lightweight adhesives</td>
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<td>Demand for energy efficient buildings</td>
<td>- Highly durable, easy-to-apply insulating adhesives and tapes</td>
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<td>- Adhesive fastening via Direct Glazing</td>
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<td>Micro-electronics and electronic light-weighting</td>
<td>- Shock-resistant component assembly</td>
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<td>- Waterproof and lighter weight next-generation smartphones</td>
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<td>E-commerce and demand for sustainable packaging</td>
<td>- Automated, lower-cost, more sustainable packaging solution for online retailers</td>
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<td>- Flexible packaging innovations substituting rigid packaging</td>
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<tr>
<td>Emergence Of New Adhesive Types</td>
<td>- The various types of adhesives being developed are dual-stage pressure-sensitive adhesives, pre-cut layered adhesive films and stick-to-skin adhesives</td>
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<td>- Stick-to-skin adhesives are used in monitoring and drug delivery devices</td>
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<td>Building &amp; Construction</td>
<td>- Consumer trend away from U.S brick and mortar retail stores to e-commerce. More warehouse and distribution center construction, less retail.</td>
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<td>- Life Cycle Assessment and demands from end uses and identification community</td>
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<td>- Complex new corrosion challenges</td>
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<td>Increased penetration by meeting previously unmet needs</td>
<td>- Reduce asset out-of-service time during repair</td>
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<td>- Improved manufacturing through productivity</td>
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<td>- Joining mixed materials – Enables joining composites, plastics and metal alloys</td>
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<td>- Enable low-temperature curing</td>
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<td>- Customized packaging options for precision dispensing, remanufacturing waste</td>
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Enable Low-Temperature Curing!
Problem To Be Solved

- Greater demand for faster project completion – time pressure.
- Pressure to use existing available products/technology in conditions not meant for.
- Risk for everyone!
CONTRACTORS THAT WANT TO WORK THROUGH THE COLDER MONTHS AND KEEP EMPLOYEES RETAINED.

THIS MEANS WORKING IN WEATHER CONDITIONS THAT ARE NOT IDEAL.
The Decision

• Decision to work on a 2-component polyurethane sealant:
  
  • Better fit for the construction projects that would desire to continue to work during winter months.
  
  • Wider range of colors (i.e. on-site color tinting)
2-component PU Sealants
2-component PU Sealants
How Contractors Worked Previously

- Existing sealants must be used above 40F and rising temperatures.
- When material gets too cold or is not conditioned properly it cannot be applied.
- Delays and work stoppages.
Arctic Sealant Project Objective

• Develop a Sealant that:

  • Can be mixed down to 15F – just as regular sealant mixes as room temperature.

  • Can gunned and tooled down to 15F – similar to room temp application of standard product.

  • Will cure down to 15F.
Let’s start with the basics
PU Sealants and Cold Weather

1 Component
• Low temperature
  • Viscosity increase
  • Difficult to gun and tool
• Low moisture
  • Slow adhesion development
  • Slow tensile strength development

2 Component
• Low temperature
  • Viscosity increase
  • Difficult to mix, gun and tool
• Low moisture
  • Slow adhesion development
  • Slow tensile strength development
Important factors – Sealing at Low T

Installation ease
• Mixing (2 component)
• Applying
• Tooling

Cure speed
• Adhesion strength development
• Tensile strength development

Performance in the joint
• Movement during cure
• Compression as Temperature rise
Solution
Cold Temperature Sealing – Patented Solution for 2 C PU

A two-component composition is described which comprises: A) an isocyanate component comprising an isocyanate-terminated polyol polyol or polyether polyol and B) a water component comprising water. At least one of the isocyanate component is component A) and/or component B).

This two-component composition of the adhesive is suitable as a sealant in particular as a joint sealant. Particular advantages are that it is resistant against frost and provides good adhesion, even at temperature variations, such as 0.4°C or below. The substrate to be sealed must have moisture-resistant substrates.
Installation Ease

Extrusion Force Part A

- Newton
- Temperature:
  - 75F
  - 40F
  - 10F
- Comparison:
  - 2C
  - 2c Arctic

Viscosity Comparison Part B

- Centipoise
- Temperature:
  - 75F
  - 40F
  - 10F
- Comparison:
  - 2C
  - 2C Arctic
Installation Ease

✓ Mixing (2 component)  ✓ Gunning  ✓ Tooling
## Cure speed – Adhesion Development

<table>
<thead>
<tr>
<th>Adhesion development on unprimed concrete</th>
<th>Standard 2-component Sealant</th>
<th>2-component Arctic Sealant</th>
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</thead>
<tbody>
<tr>
<td>3 days @5°F</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>7 days @ 5°F</td>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>3 days @15F</td>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>7 d@15F</td>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>1 day @73°F</td>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>2 days @73°F</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

- **RED** = not cured, no adhesion development
- **ORANGE** = not fully cured, adhesion development on substrate
- **GREEN** = cohesive failure on substrate
Cure Speed – shore A development
Cure Speed – Tensile Development

- Tensile Strength
- Elongation at break
- Modulus @100%

Comparisons between 7 days and 21 days:
- 60% Tensile Strength
- 90% Tensile Strength
- 90% Elongation at break
- 60% Modulus @100%
Cure Speed

- Adhesion built up at low temperatures
- Tensile strength development at low temperatures
Movement capability

Installation ease – safer installation as
- ✓ Mixing (2 component)
  - ✓ No pre-heat needed
- ✓ Gunning
  - ✓ Guns easy at 15°F
- ✓ Tooling
  - ✓ Tools easy at 15°F

Cure speed – development at low T
- ✓ Adhesion strength built up
  - ✓ Fully developed in 3 days @ 15°F
- ✓ Tensile strength built up
  - ✓ 0% of ultimate strength reached after 7 days at 15°F
Movement capability

- Externally tested
- +/-35% movement on unprimed mortar
Field Testing Phase – Establish Success

• Two full winter seasons for field testing.

• Market feedback helped adjust to get a final desired product.

• Practical applications and monitoring helps with skeptics.

• Full release with resounding success and acceptance.
Field Testing Phase – Mixing and Applying
Arctic Sealant Application

• Sound, well prepared substrate – just as with any other sealant application.

• No Frost.

• Watch the Dew Point.

• Dry Surface
Where Arctic Sealant is Being Used
Helping Contractors Work Through the Winter
Distribution Center Construction
Warehouse Construction
Questions?

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