POLYISO INSULATION: THE FOUNDATION FOR 21ST CENTURY ROOF SYSTEMS

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Firestone Building Products
Agenda

1. Insulation Overview
2. Energy Efficiency & Higher R-Values
3. Energy Efficiency & The Reroofing Challenge
4. Environmentally Friendly Polyiso
5. Enhanced Understanding and Testing of Dimensional Stability
6. High Density Polyiso Cover Boards
7. Conclusions
Insulation Overview

- High prices of energy
  - Insulation never more important
- Saves Money
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- Reduces a Country’s Dependence on Foreign Oil / National Security Issues
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- Energy Efficiency is Key
- Ultimate Goal: “Passive Building”!? 
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- Saves Money
- Reduces a Country’s Dependence on Foreign Oil / National Security Issues
- Energy Efficiency is Key
- Ultimate Goal: “Passive Building”!
- Today’s Commercial Roof Requirements for Insulation are More Demanding and Complex
  - High R-Values / Minimize Thickness
  - More Durable
  - More Environmentally Friendly
Energy Efficiency – Higher R-Values

- ASHRAE 90.1 – 2007
  - Approx. 35% higher than ASHRAE 90.1 - 2004
Energy Efficiency – Higher R-Values

- **ASHRAE 90.1 – 2007**
  - Approx. 35% higher than ASHRAE 90.1 - 2004

  - **35%** higher than ASHRAE 90.1 – 2007
  - **80%** higher than ASHRAE 90.1 – 2004
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Million Sq. Ft.

- New Construction 500 MM sq ft (20%)
- Roof Recover 700 MM sq ft (28%)
- Roof Replacement 1,300 MM sq ft (52%)
Energy Efficiency – The Reroofing Challenge

- Reroofing Constitutes the Largest Portion of Commercial Roofing
- Roof Recover is Exempt from 2012 IECC
- Huge Opportunity
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- Cost Barrier
Exempt Roof Recover

Typical R-12 Roof
Exist. Membrane / Insulation (Remain)
Existing Roof Deck

New Roof Membrane
New Roof Cover Board (R-2 to R-6)

$5.00 / Sq. Ft.

Non-Exempt Roof Recover

Typical R-12 Roof
Exist. Membrane / Insulation (Remain)
Existing Roof Deck

New Roof Membrane
New Roof Insulation (R-8 to R-23)

New R-20 to R-35 Roof

$6.00 / Sq. Ft.
(20% Increase)
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- Cost Barrier
- Include all commercial roofs in the energy code
Environmental Friendly

- Recycling Status
  - Std 2” Polyiso
    - 24% Post Consumer Recycled Content
    - 15% Post Industrial Recycled Content
  - Preliminary Work Recycling Foam into Raw Materials
  - Reusing Polyiso Boards in Reroofing Jobs
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- Carbon Dioxide Reduction
  - McKinsey Report
  - Insulation is cost effective
THE COST CURVE PROVIDES A “MAP” OF ABATEMENT OPPORTUNITIES

Cost of abatement, 2030, €/tCO₂e*

Abatement Gt CO₂e/year

* Cubic feet of carbon equivalents.
Source: McKinsey and Vattenfall analysis
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- **Life Cycle Analysis**
  - Environmental payback in approx. 4 weeks
Understanding Dimensional Stability

- Dimensional Stability is an Important Physical Property
  - Problems are rare but when they happen they can be frustrating, time consuming and expensive
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  - 12” by 12” Samples
  - Focus is on Overall Sample Dimensional Stability
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- Why are the 8-foot Edges the Most Susceptible Part of the Board to Dimensional Stability Problems?
Understanding Dimensional Stability

- Back To Basics
  - $PV = nRT$ (Ideal Gas Law)
Understanding Dimensional Stability

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  - \( P_m = T_m \quad P_{2w} = T_{2w} \)
  - Foam / Bundle Temperature is Greater than 300 F
  - Formation of Key Reaction (Trimerization) is Most Effective at 160 F (71 C)
Understanding Dimensional Stability

- **Back To Basics**
  - $PV = nRT$ (Ideal Gas Law)
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- **Edges of the Board Don’t Reach this Temperature**
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  - At Manufacture & 2 Weeks After Manufacture
  - \( P_m = T_m \quad P_{2w} = T_{2w} \)
  - Foam / Bundle Temperature is Greater than 300 F
  - Formation of Key Reaction (Trimerization) is Most Effective at 160 F (71 C)

- **Edges of the Board Don’t Reach this Temperature**

- **Measure of the Strength of the Foam in the Cross Machine or Z Direction Correlates to Amount of Reaction and Crosslinking**
Relation of Edge Collapse to Foam Compressive Strength
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Continuous Monitoring During Manufacture

- Continuously Measure Compressive Strength in the Cross Machine Direction (Z-Direction) called in-line ZCS.
- Operator adjust equipment and/or formulation to maintain high ZCS numbers.
- Continuous monitoring of Boards 2” and Greater.
Dimensional Stability as a Function of Time & Temperature

- Is it possible for a board with edge collapse to recover?
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- Anecdotal example
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  - Samples Three Weeks at 100 F or 150 F
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- Laboratory Studies
  - Samples Three Weeks at 100 F or 150 F
- Survey of Old Roofs
High Density Polyiso Cover Boards

- Need for a Lighter Weight, Tougher, Higher R-Value, Dimensionally Stable Cover Board
- Higher Density, Specially Modified Polyiso foam
- Combined with Coated Fiberglass Mat Facers
- Toughness: Approximately 6000 Passes on the RLE at 20 psi
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- Higher Density, Specially Modified Polyiso foam
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- Toughness: Approximately 6000 Passes on the RLE at 20 psi
- Good fire performance but not quite as good as the fiberglass mat gypsum based board
- Cold Applied Asphalt but No Hot Asphalt
<table>
<thead>
<tr>
<th>Property</th>
<th>Fiberglass Mat Faced Polyiso (HD)</th>
<th>Fiberglass Mat Facer Gypsum</th>
<th>Woodfiber</th>
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<tr>
<td>Thickness, mm (in)</td>
<td>25.4 – 50.8 (¼ - ½)</td>
<td>25.4 (¼)</td>
<td>50.8 (½)</td>
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<tr>
<td>R-Value</td>
<td>0.176 – 0.44 (1.0 – 2.5)</td>
<td>0.049 (0.28)</td>
<td>0.246 (1.4)</td>
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<td>Board Weight 1.2 m X 2.4 m (4’ X 8’), Kg (lb)</td>
<td>5.44 (12)</td>
<td>17.41 (38.4)</td>
<td>9.29 (20.5)</td>
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<tr>
<td>Ease of cutting*</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mold resistance (D 3273)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>&lt;3%</td>
<td>10%</td>
<td>10%</td>
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<tr>
<td>Dimensional Stability</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent; poor if wet</td>
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*Contractor’s comments
Conclusions

- The IECC 2012 Code: Approximately 80% Higher R-Values Compared to ASHRAE 90.1 – 2004
- Polyiso Insulation is an Environmentally Friendly Product
Conclusions

- The Physics of Polyiso Dimensional Stability was Elucidated and Innovative Tests Developed to Ensure Boards are Dimensionally Stable in the Field

- High Density Cover Boards Offer the Roofing Professional
  - Light Weight
  - Higher R-Value
  - High Performance and Strength
  - Mold Resistance
  - Toughness and Durability