Asphalt Innovations

- Involved in asphalt industry for more than 50 years
- 3 development centers in Europe, Asia, and U.S.
- 30 technical resources
Asphalt Innovations

Products include
• Emulsifiers & Stabilizers
• Liquid anti-strips
• Polymer modifiers
• Warm-mix additives
Why Warm Mix Asphalt?

- IARC
- Stack & Job Site Emissions
- Kyoto Treaty
US Regional Kyoto Commitments

911 as of 2/23/09

Mayors Climate Protection Center
Why Warm Mix Asphalt?

- IARC
- Stack & Job Site Emissions
- Kyoto Treaty
- Energy Costs
- Odors

- Higher Temperature Trends
- Regulatory & Permitting Trends
- Increased Activism

Lower Temperatures are Needed!
Evotherm
What is it?

• Comprehensive chemical package
• Optimized to deliver
  – Mixing
  – Coating
  – Workability
  – Compaction
  – Adhesion
• Evotherm DAT
  – Chemical concentrate solution directly injected into asphalt line at plant
  – 85 - 100°F cooler than HMA

• Evotherm 3G
  – Water-free version, suitable for both terminal-add and plant-add
  – 65 - 85°F cooler than HMA
Evotherm Mix Temperatures

- HMA
- 320°F
- 250°F
- 200°F
- Evotherm 3G
- Evotherm DAT
How does it work?

- Delivered at 0.4 to 0.7% by asphalt weight
- Effective temperature range
  - Mix temperature
    - 250 – 180°F
  - Compaction temperature
    - 240 - 160°F
Advantages of Evotherm

- Easy to use
- Proven performance
- Low temperature
Advantages of Evotherm

• Easy to use
  – Can be produced in any mix plant
  – Same production & lay down equipment as conventional mix
  – Minimal to no plant modifications
  – Metering equipment provided for evaluations
Evotherm DAT
Evotherm DAT Injection
Advantages of Evotherm

• Proven performance
  – More than 200 projects
  – 9 independent studies
  – 13+ DOT & MT evaluations
  – Projects in 22+ states, 5 provinces, 8 countries
  – 10+ million ESAL’s on NCAT’s Test Track
NCAT Performance

1.4 mm average
Advantages of Evotherm

• Low temperature
  – 85 - 100°F cooler than conventional mix
  – Large compaction window
  – Major reductions in fuel & emissions
  – Reduced binder oxidation
  – Reduced thermal segregation
  – Extended hauls & paving season
Typical Application Temperature

Conventional Hot Mix
Advantages of Evotherm

• Improved compaction
Improved Compaction

Roadway & Lab Densities @ 4.6% PG76-22

- **WMA**
  - Rdwy Density: 94.0
  - Lab Density: 96.3

- **HMA Control**
  - Rdwy Density: 93.1

- **HMA Project**
  - Rdwy Density: 97.2
  - Lab Density: 97.0

**Note:**
- WMA HMA Control HMA Project
- Rdwy Densities vs. Lab Molded Densities
TxDOT Specification Bonus

Roadway Densities
TxDOT Specification % Bonus

- 5% Bonus: Evotherm
- 3.2% Bonus: HMA Control
- 2.0% Bonus: HMA Project

Averages
NCAT Test Track
Pavement Densities

<table>
<thead>
<tr>
<th>Evotherm Base</th>
<th>HMA Base</th>
<th>Evotherm Binder</th>
<th>HMA Binder</th>
<th>PG 67-22 Evotherm Surface</th>
<th>PG 67-22 HMA Surface</th>
<th>PG 76-22 Evotherm Surface</th>
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<tbody>
<tr>
<td></td>
<td>% Density</td>
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<tr>
<td>96</td>
<td>96.0</td>
<td>92.8</td>
<td>96.0</td>
<td>92.2</td>
<td>92.1</td>
<td>93.3</td>
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<td>226</td>
<td>311.0</td>
<td>225.0</td>
<td>328.0</td>
<td>225.0</td>
<td>260.0</td>
<td>205.0</td>
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</table>

[Graph showing density and compaction temperature for different materials and surfaces]
NCAT Test Track
Evotherm PG 67-22
Thermal Segregation
HMA

62°F Difference
Thermal Segregation

Evotherm

24°F Difference
Advantages of Evotherm

- Improved compaction
- Extended hauls & paving season
HMA at 50°F

16 minutes
Evotherm at 50°F

26 minutes
Cold Weather Paving

- 350°F production
- 240°F delivery

- 280 mile, 8 hour haul
- 10°F air temperature
- Bridge resurfacing
Advantages of Evotherm

- Improved compaction
- Extended hauls & paving season
- Increased usage of RAP
### High RAP Warm Mix Asphalt

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>20% RAP</th>
<th>28% RAP</th>
<th>35% RAP</th>
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<tr>
<td>Pen</td>
<td>29</td>
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<tr>
<td>Viscosity</td>
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<td>DSR 70</td>
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<td>BBR -12</td>
<td>0.394</td>
<td>0.437</td>
<td>0.406</td>
<td>0.393</td>
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Source: D. Williams - MoDOT
Advantages of Evotherm

- Improved compaction
- Extended hauls & paving season
- Increased usage of RAP
- Reduced fuel consumption and emissions
200 °F Evotherm, 310°F HMA control
Reduced Emissions

Hot Mix

EvoTherm
Fume Exposure vs. HMA

- Total Organics:
  - Evotherm: Below Detectable Limits
  - HMA: 41% lower than Evotherm

- Benzene Solubles:
  - Both Evotherm and HMA are below detectable limits.
Advantages of Evotherm

- Improved compaction
- Extended hauls & paving season
- Increased usage of RAP
- Reduced fuel consumption and emissions
- No odor
Advantages of Evotherm

• Improved compaction
• Extended hauls & paving season
• Increased usage of RAP
• Reduced fuel consumption and emissions
• No odor
• Longer binder life
Binder Aging

Bar chart showing the Pen values for Virgin AC, Recovered AC, and 2 years AC for Hot Mix and Evotherm.

- Virgin AC: Hot Mix (120) and Evotherm (110)
- Recovered AC: Hot Mix (70) and Evotherm (100)
- 2 years AC: Hot Mix (60) and Evotherm (80)

Legend:
- Hot Mix
- Evotherm
TxDOT Cores After 1 Year

Hot Mix Control
TTI Overlay Tester Results

HMA GRANITE
EVOTHERM GRANITE

* Test stopped at 841 cycles without failure
** Test stopped at 634 cycles without failure
TTI Overlay Tester Results

<table>
<thead>
<tr>
<th>CYCLES TO FAILURE</th>
<th>HMA LIMESTONE</th>
<th>EVOTHERM LIMESTONE</th>
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<tbody>
<tr>
<td>SAMPLE</td>
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<tr>
<td>1</td>
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<td>MEAN</td>
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Contact information:

1-800-458-4034
evootherm@meadwestvaco.com