Warm Mix Asphalt

Gary L. Fitts, P.E.
Asphalt Institute
Garden Ridge, Texas
• US-based, international association of petroleum asphalt producers, manufacturers, and affiliated businesses, established in 1919
• Promotes the use, benefits and quality performance of petroleum asphalt through engineering, research and educational activities.
• HQ office-Lexington, KY
• Local office-Garden Ridge (San Antonio), Texas
  – Six other regional engineering offices scattered about the US
MEMBER COMPANIES

AFFILIATE MEMBERS

www.asphaltinstitute.org
Warm Mix Asphalt-Definition

Hot Mix Asphalt designs that are modified to be produced, placed and compacted at 50-100°F less than typical HMA

http://www.warmmixasphalt.com/
Potential Benefits of WMA

• Improved workability
  – Easier compaction, allows for extended hauls and construction season
  – Facilitates night work, especially thin-lift applications using polymer modified asphalt binders

• Reduced binder aging

• Reduced heating/energy requirements
  – Lower emissions during production
    • Visible and non-visible
  – Less fumes during handling

• Less plant wear
Ground level ozone is considered to be a respiratory irritant. It is caused by chemical interaction between sunlight, nitrous oxides (NOx) and volatile organic compounds (VOC’s).
Global Increase in CO₂
WMA Benefit: Reduced Emissions

Table 4. Reported reductions in plant emissions (percent) with WMA.\(^{10, 11, 12}\)

<table>
<thead>
<tr>
<th>Emission</th>
<th>Norway</th>
<th>Italy</th>
<th>Netherlands</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO(_2)</td>
<td>31.5</td>
<td>30–40</td>
<td>15–30</td>
<td>23</td>
</tr>
<tr>
<td>SO(_2)</td>
<td>NA</td>
<td>35</td>
<td>NA</td>
<td>18</td>
</tr>
<tr>
<td>VOC</td>
<td>NA</td>
<td>50</td>
<td>NA</td>
<td>19</td>
</tr>
<tr>
<td>CO</td>
<td>28.5</td>
<td>10–30</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>NO(_x)</td>
<td>61.5</td>
<td>60–70</td>
<td>NA</td>
<td>18*</td>
</tr>
<tr>
<td>Dust</td>
<td>54.0</td>
<td>25–55</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Reported as NO\(_2\)
NA—not available

From: Warm-Mix Asphalt: European Practice

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We’re driven.
HMA vs WMA

Hot Mix (155 °C) 311 °F

WAM (110 °C) 230 °F
Warm Mix Asphalt-Approaches

- Chemical binder additives
- Chemical mixture additives
- Foaming admixtures
- Plant modifications/foaming

www.warmmixasphalt.com
WMA Technologies

- Chemical binder additives:
  - Cecabase RT®
  - Evotherm™
  - Rediset™WMX
  - REVIX™

- Chemical mixture additives:
  - Asphaltan®
  - Sasobit®

- Foaming admixtures:
  - Advera®
  - Aspha-Min®
  - Low Energy Asphalt

- Plant modification:
  - Double-Barrel® Green
  - Terex® WMA System
  - WAM-Foam

www.warmmixasphalt.com
Chemical Binder Additives

- Examples:
  - Cecabase RT®
  - Evotherm™
  - Rediset™WMX
  - REVIX™

- Make the asphalt “wetter” so it more readily coats and lubricates aggregate particles

- Added directly to the asphalt binder
• Chemical structure developed & optimized for warm mix performance
  – Coating
  – Workability
  – Strength
  – Adhesion
• Dispersed Asphalt Technology (D.A.T.) delivery system
  – ~5% by weight of asphalt binder
• Mix & compaction temperatures from 110-60C (230-140F)
• No plant modifications required
• No unit operations problems encountered
• Reduced dust generation
• Mixes can be stored in a silo
Evotherm Injection Method

Injection Point into AC line feeding the drum
Evotherm™ Field Trials

Superpave and conventional mixes, using standard production, laydown, & compaction methods

Immediate release to traffic
Evotherm™ Demo: September 2006
San Antonio

230-235F
Chemical Mixture Additives

- May be added to mixture or to the asphalt binder
- Waxes provide fluidity (workability) above their melting point
- Types of waxes
  - Fischer-Tropsch
  - Montan
Sasobit®

• Product of Sasol Wax GmbH (Germany)
  – Used in Germany since 1997
• Fischer-Tropsch (synthetic) wax
  – Byproduct of Fischer-Tropsch process used to create liquid fuels from coal or natural gas feedstock
  – Different chemical and physical characteristics than petroleum waxes
  – Sasobit is a food-grade material used in packaging
• Available in beads, flakes or powdered form
  – 2, 5, 20, and 600 kg bags
• Normal dosage: ~1.5% by weight of asphalt binder
  – About 1½ lbs per ton of mixture
Fischer-Tropsch Waxes

• Different than naturally occurring petroleum waxes in structure and physical properties
  – Higher molecular weight
  – Higher melting point (~98°C)
    • Above melting point temp-lower viscosity than asphalt binder
    • Below melting point temp-higher viscosity

• Allows mixture to remain workable until the wax solidifies
Pneumatic feed
Sasobit®

Prills (5 mm/0.25”)
Small Prills (1 mm)
Flaked

Photos from Sasol
Sasobit®

• Airports
  – Frankfurt Airport -Frankfurt, Germany
  – Doha airport, Qatar
  – Svalbard Airport—Most northern commercial airport in the world
  – Logan Airport, Boston, MA

• Container Ports
  – Heavy duty paving in some of the worlds busiest ports

• Race Tracks
  – Talladega, Homestead and Watkins Glen

• Extra long hauls
  – 750 kilometers (466 miles) in Australia

Port of Hamburg, Germany
Frankfurt Airport

- Asphalt mixture laid at low temperature
- Better compactability
- Increased resistance to deformation at high temperatures
Frankfurt Airport, Germany

- Worked in strips, removing and replacing ~20 inches of material each night
  - Used Sasobit® WMA technology
- When the entire length was completed, milled and resurfaced w/SMA
Foaming Admixtures

• Release small amounts of steam at temperatures above 212°F (100°C), foaming the asphalt binder

• Admixtures include synthetic zeolites or moistened fine aggregates
  – Zeolites: Advera®, Aspha-Min®
  – Moistened fine aggregates: Low energy asphalt
Synthetic Zeolites

- Synthetic particles consisting of crystalline hydrated aluminum silicate containing a latticed internal void structure (~20%)
- Water is stored in the internal voids, gradually released as steam
- Only 0.25-0.3% by weight of total mixture is typically used

From Wikipedia
Aspha-min®

Advera®
Plant Modifications - Foaming

- Two-stage mixing
  - Used in Norway (WAM-Foam) where it is common for plants to have different (hard and soft) asphalt binders available for blending
  - First, soft binder is mixed with aggregates, followed by coating with foamed hard asphalt

- Provide water injection system, mixing chamber to foam the asphalt binder before it contacts the aggregates
  - Examples: Astec “Double Barrel® Green,” Terex WMA System
Schematics of the typical process conditions

**TRADITIONAL HOT MIX ASPHALT**

- 90% AGGREGATE
- DRYER (390 °F)
- MIXER (320 °F)
- SILO (300-350 °F)
- LAYING (270-320 °F)
- 6% ASPHALT
- 5% FILLER 20 °C

**WAM Foam ASPHALT MIX PROCESS**

- 90% AGGREGATE
- DRYER (260 °F)
- MIXER (225 °F)
- SILO (180-220 °F)
- LAYING (175-200 °F)
- 1.8 % SOFT
- 4.2 % HARD COMPONENT
- 5% FILLER 20 °C
Plant Modifications-Astec
Plant Modifications, Astec

TOP VIEW

SIDE VIEW

DB GREEN MANIFOLD
<table>
<thead>
<tr>
<th>WMA Technology</th>
<th>Process Type</th>
<th>Decreases Production Temperatures by 30 to 50 F° (17 to 28 C°)</th>
<th>Decreases Production Temperatures by More Than 50 F° (28 C°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Barrel® Green Green</td>
<td>Foaming</td>
<td>XX¹</td>
<td>X²</td>
</tr>
<tr>
<td>Evotherm™</td>
<td>Chemical Additive</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>(LEA) Low Energy Asphalt</td>
<td>Foaming</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>Rediset™ WMX</td>
<td>Chemical Additive</td>
<td>XX</td>
<td>X</td>
</tr>
<tr>
<td>REVIX™</td>
<td>Chemical Additive</td>
<td>X</td>
<td>XX</td>
</tr>
<tr>
<td>Sasobit</td>
<td>Organic Additive</td>
<td>XX</td>
<td>X</td>
</tr>
<tr>
<td>Synthetic Zeolite</td>
<td>Foaming</td>
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<td>X</td>
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<tr>
<td>WAM-Foam</td>
<td>Foaming</td>
<td>XX</td>
<td>XX</td>
</tr>
</tbody>
</table>

¹Frequently observed; ²Observed

Courtesy Brian Prowell, PhD, PE
Questions about WMA

• Performance
  – Moisture sensitivity
  – Early resistance to deformation

• Economics
  – Do cost savings in fuel, equipment, labor overcome increased costs?

• Specifications
  – Binder qualities
  – Laboratory procedures
  – Sampling/conditioning methods

These are promising technologies that we can expect to see more of in the future!
WMA Trials & Demos
• NCHRP 09-43, Mix Design Practices for Warm Mix Asphalt
  – Advanced Asphalt Technologies, LLC
  – PI: Dr. Ramon Bonaquist
  – 3-year project, anticipated completion in March 2010
• NCHRP 09-47, Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies
  – Asphalt Institute
  – PI: Mike Anderson
  – 3-year project, anticipated completion in March 2011
NCHRP 9-47 Research Team

- Asphalt Institute (Mike Anderson, Phil Blankenship, Earl Arp, Wayne Jones)
- MTE Services (Gerald Reinke, Erv Dukatz, Stacy Glidden)
- Paragon Technical Services (Gaylon Baumgardner, Mike Hemsley)
- Kentucky Transportation Center
- University of California-Davis (Dave Jones)
- Consultants (Jim Scherocman, Gary Blackburn, Gavin Braithwaite)
Evaluation of the Environmental and Performance Properties of Warm Mix Asphalt Technologies

- Evaluate the type and level of emissions from WMA during production and placement compared with those from HMA
- Compare initial field performance of pavements constructed with WMA with that of conventional HMA
- Correlate the engineering properties of WMA technologies with their field performance
Warm-mix asphalt: The wave of the future

Warm-mix asphalt is the generic term for a variety of technologies that allow the producers of hot-mix asphalt pavement material to lower the temperature at which the material is mixed and placed on the road. Reductions of 50 to 100 degrees Fahrenheit have been documented. Such drastic reductions have the obvious benefits of cutting fuel consumption and decreasing the production of greenhouse gases. In addition, potential engineering benefits include better compaction on the road, the ability to haul paving mix for longer distances, and the ability to pave at lower temperatures.

Read more about the benefits of Warm Mix Asphalt

Upcoming Events

- July 16-18 - 2008 Pavement Performance Prediction Symposium, Laramie, WY
  The symposium, presented by Western Research Institute in cooperation with the Federal Highway Administration, is dedicated to the topic of recycled and warm mix asphalt pavements. For more information, contact Steve Salmon at WRI, or call 307-721-2305. Visit website.

- July 27-30 - NAPA’s Midyear Meeting
  The inaugural meeting of NAPA’s Warm-Mix Asphalt Task Force will take place at NAPA’s Midyear Meeting in Colorado Springs, Colorado. Learn more.

- November 11-13 - International Conference on WMA
  The International Conference on Warm Mix Asphalt will be held in Nashville, Tennessee. View the flyer.
Warm Mix Asphalt: Best Practices

- NAPA Quality Improvement Series (QIP) 125
  - Stockpile Moisture Management
  - Burner Adjustments and Efficiency
  - Aggregate Drying and Baghouse Temperatures
  - Drum Slope and Flighting
  - Combustion Air
  - RAP usage
  - Placement Changes
• Summary of scanning tour visit of European countries in May 2007
  – Reviewed processes, mix design and construction practices, performance, limitations, and benefits
  – Belgium, France, Germany, Norway
  – Included industry & government engineers

• PDF available at no charge from:

http://www.warmmixasphalt.com/
Asphalt is the sustainable material for constructing pavements.

From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction, low emission of greenhouse gases, and conservation of natural resources help to make asphalt the environmental pavement of choice. More...
Thanks!