Warm Mix Asphalt – What is it and how can we benefit?

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WMA - What is it?

- Plant mix asphalt produced at lower temperatures while maintaining the workability required to be successfully placed
Thermometer reads 228.1°F
How does it work?

• Although there are several different WMA technologies and products, the basic function is to reduce the viscosity of the binder at lower temperatures to allow for sufficient coating of the aggregates, maintain good workability and durability.

• A variety of additives and/or processes have been developed to make this possible.
Several ways to classify WMA technologies

- One is by temperature reduction
  - Hot Mix Asphalt > 275 °F (135 °C)
  - Warm Mix Asphalt > 212 °F (100 °C)
  - Half-Warm asphalt mixtures < 212°F (100 °C)
Classification by Temperature

- Cold Mix
- Half-Warm Asphalt
- WMA
- HMA

Temperature, °F

BTU/Ton

- Heating
- Vaporization
- Drying
WMA Technologies

Classifying WMA by technology:

- Processes that use some form of additive
- Processes that use water
- Processes that use both water and additive
  - or -
- Processes that foam the asphalt
- Processes that chemically modify the asphalt
A partial list of technologies

Foaming Methods

• Advera – PQ Corp.
• Double-Barrel Green - Astec
• Green Machine - Gencor
• AQUABlack - Maxam
• WMA System – Terex
• Low Emission Asphalt – Suit-Kote

Chemical Modifiers*

• Evotherm - MeadWestvaco
• Rediset – Akzo-Nobel
• Revix – Mathy-Ergon
• Sasobit - Sasol
Processes that introduce small amounts of water

- May be injected via a foaming nozzle
- Or may use a hygroscopic material such as zeolite
  - Blended with the dry aggregate
  - Releases water at elevated temps over time
  - Creates a controlled foaming effect which lasts until the temperature drops below 212°F (100°C)

- When the water turns to steam:
  - It expands by a factor of 1,673
  - Expands & cools the asphalt
  - Reduces the viscosity.
  - Amount of expansion varies depending
    - amount of water added
    - temperature of the binder
Plant modifications for foaming

Maxam AQUABlack

Terex Warm Mix Asphalt

Gencor Green Machine

Astec Double Barrel Green

StanSteel Accu-Shear
Additives for foaming

PQ Corporation - Advera Zeolite Powder

Eurovia / Hubbard Group Aspha-Min Zeolite Powder
L.E.A’s sequential mixing

PHASE 1
- 120°/150°C
- Hot asphalt
- Dry, hot coarse aggregates

PHASE 2
- 170°C
- Coarse aggregates are coated by all the asphalt

PHASE 3
- Moisture from fine aggregates triggers asphalt foaming

PHASE 4
- Foamed asphalt encapsulates fine aggregates
- 100°C

PHASE 5
- Thermal equilibrium reached
- All aggregates uniformly coated
- 90°C

Foaming Process - LEA
Emulsion Based

- **Evotherm™ – MeadWestvaco**
  - Emulsion mixed with hot aggregates
  - Mix temperature between 185 to 240 °F
  - The emulsion uses a chemical package
    - to enhance coating, adhesion, and workability.
  - Water in the emulsion flashes off as steam
  - A new process has been developed called DAT,
    - Same chemical package
    - Diluted with a small amount of water
    - Injected in-line just before the mixing chamber.
Chemical Process - Evotherm

Additive

Volumetric Pump

Asphalt Line Injection Point
Chemical Process - Sasobit

Wax Based

- Sasobit® Technology – Sasol Wax
  - Sasobit wax melts at 212°F
  - Completely soluble in binder
  - Reduces the viscosity of the binder
  - Increases the resistance to deformation throughout the operating temperature range
  - Does not affect the low temperature properties of the binder
Chemical Process - Rediset

- Added to binder at about 1 kg per ton of mix
- No plant modifications required
- Does not introduce moisture into mix
- Includes anti-stripping adhesion promoter
- Improves cohesive strength
- Does not affect the temperature properties of the binder
How can we benefit?
Lower energy consumption (~30%)
Lower fumes and emissions (~30-90%)
Areas of the country where air pollution levels persistently exceed the national ambient air quality standards may be designated "nonattainment."

Counties Designated "Nonattainment"
for Clean Air Act's National Ambient Air Quality Standards (NAAQS) *

Legend **
- County Designated Nonattainment for 3 NAAQS Pollutants
- County Designated Nonattainment for 2 NAAQS Pollutants
- County Designated Nonattainment for 1 NAAQS Pollutant

* The National Ambient Air Quality Standards are health standards for lead, carbon monoxide, sulfur dioxide, ground level 8-hr ozone, and particulate matter (PM-10 and PM2.5). There are no nitrogen dioxide nonattainment areas.
Environmental Advantages

Every WMA technology reduces emissions compared to HMA

• Figures specific to Evotherm:
  - Reduces job site emissions by up to 97%
  - Reduces greenhouse gasses at least 60%
  - Nearly 75% reduction in photochemical smog emissions
  - > 80% drop in acid rain causing sulfur dioxide
Better Working Conditions for Workers (Lower Fumes, Temperature)

HMA Control Section

WMA Section
Makes obtaining proper roadway compaction easier

Most specifications heavily weight Density, e.g. AASHTO R 42

Combined Pay Factor =

\[0.20PF_{\text{BINDER}} + 0.35PF_{\text{VOIDS}} + 0.10PF_{\text{VMA}} + 0.35PF_{\text{DENSITY}}\]
Decreased binder aging, light oils never reach boiling point (285°F)

Pavement stays blacker, longer
Extended paving season / night paving / longer hauls
Absorbs less into the aggregate, allowing for a greater effective binder content.
What about moisture susceptibility?

TSR Data from I-70 WMA Project in Colorado

- Control Mixture TSR = 85%
  (Dry ITS = 67 psi, Wet ITS = 57 psi)
- Advera Mixture TSR = 81%
  (Dry ITS = 69 psi, Wet ITS = 56 psi)
- Sasobit Mixture TSR = 84%
  (Dry ITS = 76 psi, Wet ITS = 64 psi)

*Other projects have experienced lower TSRs on WMA, however
What about rutting susceptibility?

Hamburg Rut Test Data* from Same Project

- Control Mixture – 3.9 mm rut
- Advera Mixture – 3.5 mm rut
- Sasobit Mixture – 2.9 mm rut

* Specimens run under water at 40 °C, values after 20,000 passes
TxDOT Hamburg Rut Specimens – HMA vs. WMA after 1 year of service
Allows for increased usage of RAP
Eliminates bump when paving over crack sealant
Questions?