Asphalt Emulsions 101: Proper Handling, Storage, and Sampling

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Asphalt Company

- 5 Asphalt Terminals in 3 States
  - Catoosa, OK
  - Artesia, Albuquerque, Rosario, NM
  - Glendale, AZ
- At one time...22 Grades of Asphalt Emulsions in 6 States
  - NM, TX, AZ, CO, CA, KS
- QC labs and personnel in all terminals
  - All labs AMRL accredited

Who are those guys?
Topics for Today

- Background
- Emulsion Applications
- Composition and Manufacturing
- Classification
- Sampling and Testing
- Handling and Storage
Main Goal - Learn & Have Fun

Fun!

Less fun!
References

TRB
E-C102

Asphalt Emulsion Technology

Asphalt Institute
MS-19
Types of Asphalt

- Paving Asphalt for Building Roads (~86%)
  - Asphalt Cement (77%)
  - Cutback Asphalt (1%)
  - Emulsified Asphalt (8%)
- Roofing Asphalt (13%)
- Specialty Asphalt (1%)

Source: Asphalt Institute
Asphalt Cements for Paving

- Straight run from refinery
- Terminal manufactured
- Blend of refinery products
- Produced to meet PG purchase specification
  - PG specs in the US
  - PG variants (aka “PG Plus”)

Gotta have heat
Cutback Asphalts

- **Rapid Cure (RC)**
  - high volatility solvent (e.g., naphtha)
  - chip seals, tack coat
- **Medium curing (MC)**
  - moderate volatility (e.g., kerosene)
  - patching mix or prime coat
- **Slow Curing (SC)**
  - low volatility (diesel or something else)
  - patching mix

*Gotta have solvent*
Emulsified Asphalt

- Made fluid by suspending droplets in water with and emulsifying agent
  - agent imparts charge to droplets
  - this is way cool!
  - ambient up to about 200 F
- Cationic (CRS, CSS, etc.)
  - positive charge on droplets
  - works best with gravels?
- Anionic (RS, SS, HF, etc.)
  - negative charge on droplets
  - works best with limestone?

Gotta have water and soap
Asphalt Emulsion Definition

When asphalt is milled into microscopic particles and dispersed in water with a chemical emulsifier, it becomes an asphalt emulsion.

Asphalt Institute MS-19
Asphalt Emulsion History

- Developed in 1900-1920
  - spray applications (e.g. dust palliatives)
- Early growth limited by grades available
- Steady growth since WWII
  - ~ 10% of paving asphalt usage
  - primarily maintenance applications
Emulsion Expectations

- Fluid enough to spray and cover a surface but not run off
- Viscous enough to wet and coat aggregate
- Develop adhesion quickly
- Hold aggregate tightly to roadway surface
- Not bleed or ravel under traffic or with changing weather conditions
Applications

- Surface Treatments
  - Chip seals, etc.
- Cold Mixes
- Asphalt Recycling
- Miscellaneous
  - prime coat, tack coat
  - crack fill
  - others
Reasons for Using Asphalt Emulsions

- Uses less heat, less solvent...energy savings
- Fewer hydrocarbon emissions
- Coat damp aggregate, reduces heating, energy requirements
- Large variety of applications
- Ability to use cold materials at remote sites
- Most useful in maintenance applications, extend pavement life
What happened to Dale?
Composition of Emulsions (%BWE)

- Asphalt (50 - 70%)
  - including diluents
- Soap Solution
  - water (30 - 50%)
  - emulsifying agent (0.15 - 3%)
- Other stuff (1-4%)
  - polymers
  - antistrips/adhesion promoters
  - extenders
  - rejuvenators
Emulsifying Agents

- **Anionic (-)**
  - fatty acids
  - wood product derivatives
  - react with caustic to make soap

- **Cationic (+)**
  - fatty amines
  - animal derived
  - react with acid to make soap

- **Nonionic**
  - e.g., ethoxylated nonylphenyls
  - don’t have to be reacted
  - usually used as SS, very stable

*Good info at: James, TRB E-C102*
Emulsion Manufacture
(Colloid mill)

Asphalt, soap go in

Emulsion comes out

Source: Dalworth Machine Products
Mill Parameters

- Temperatures
  - Asphalt ~ 300 F (binder ~ 250 cP)
  - Soap ~ 90 F
  - Emulsion 170-200 F
- Pressure ~ 5-60 psi (10-30 normal)
- Production Range 3,000-30,000 gph

\[
\text{[(AC wt\% \times AC temp \times 0.5) + (Soap wt\% \times Soap temp \times 1.0)] = Emulsion Temp}
\]

\[
\text{[(AC wt\% \times 0.5) + (Soap wt\%)]}
\]

Good info at: Baumgardner, TRB E-C102
Asphalt Emulsion Classification

- Soap chemistry determines classification
  - Anionic (-)
    - includes high float
  - Cationic (+)
  - Nonionic

- Oil soluble tail
- Water soluble head
Emulsion “Breaks”

- Droplets “coalesce” as water leaves the emulsion system
- Speed of coalescence indicates classification
  - determined by type and amount of emulsifier

- **Fast**
  - Rapid Set
  - Spray Grade Emulsions

- **Less Fast**
  - Medium Set
  - Mixing Grade Emulsions

- **Less Slow**
  - Quick Set

- **Slow**
  - Slow Set
Asphalt Emulsion Classification

- Viscosity of emulsion
  - important for constructability
  - “1” or “2” indicates emulsion vis

- Hardness of base asphalt
  - important for long term performance
  - “h” indicates hard, lower pen base
Asphalt Emulsion Classification

- **High Float Emulsions** - special characteristics imparted by emulsifier to asphalt
  - tall oil soap creates gelled asphalt

- **Gelled Asphalt aka “High Float” Asphalt (HF)**
  - better adherence to dusty aggr
  - better high temp performance
  - resistance to aging
  - more forgiving construction ops
  - wide variety of grades
  - work well with polymers
High Float Emulsions
Asphalt Emulsion Classification

- Presence of other stuff
  - polymers (P)
  - latex (LM)
  - rubber (R)
  - recycling/rejuvenating agents
Residue Properties

Elastic Recovery

- **Purpose**
  - detect presence of stretchy polymer dissolved in asphalt
  - ability of asphalt to snap back to original shape
Emulsion Types
(*ASTM/AASHTO* Specs)

- SS-1  CSS-1
- SS-1h CSS-1h
- CRS-2  CRS-1
- CRS-2 CRS-2P CRS-2L
- HFRS-2 HFRS-2P
- HFMS-2 HFMS-2P
Emulsion Types

(Selection)

- SS-1  CSS-1
- SS-1h CSS-1h
- CSS-1P
- QS-1h CQS-1h
- CRS-2 CRS-1
- CRS-2 CRS-2P CRS-2L
- HFRS-2 HFRS-2P
- HFMS-2 HFMS-2P

- Fog seal, tack coat, mixing, scrub seal
- Slurry, microsurfacing
- Chip Seal
- Mixing
Popular Urban Legend

Chupacabra?
Popular Urban Legend

“For chip seals you must use cationic (+) emulsions with siliceous aggregate (-) and anionic (-) emulsions with calcareous (+) aggregate!”
Judge Judy

Rule of Thumb

“If it doesn’t make sense it probably isn’t true.”

- Judge Judy
Successful chip seal?

SOME PEOPLE DREAM OF ZERO CLAIMS
WHILE OTHER PEOPLE LIVE TO CRUSH THOSE DREAMS
Anatomy of an Asphalt Emulsion Specification (e.g., AASHTO M316, CRS-2P)

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity @ 122 F, sfs</td>
<td>100-400</td>
</tr>
<tr>
<td>Sieve Test, %</td>
<td>0.10 max</td>
</tr>
<tr>
<td>Storage Stab (24 hr), %</td>
<td>1.00 max</td>
</tr>
<tr>
<td>Demulsibility, %</td>
<td>30 min</td>
</tr>
<tr>
<td>Asphalt Residue, %</td>
<td>65 min</td>
</tr>
<tr>
<td>Penetration, dmm</td>
<td>90 min</td>
</tr>
<tr>
<td>Ductility @ 77 F, cm</td>
<td>125 min</td>
</tr>
<tr>
<td>Ductility @ 39.2 F cm</td>
<td>30 min</td>
</tr>
<tr>
<td>Elastic Recovery, %</td>
<td>50 min</td>
</tr>
<tr>
<td>Solubility, %</td>
<td>97.5 min</td>
</tr>
</tbody>
</table>

Properties of emulsion

Properties of base asphalt
Residue Recovery (Distillation)
Sampling

No metal sample cans!

Plastic is good, allow to cool
Sample Handling

*(Which way is best?)*
## Handling Rules of Thumb

<table>
<thead>
<tr>
<th>Product to be Loaded</th>
<th>Asphalt Cement</th>
<th>C/B, Heavy Fuel Oils</th>
<th>Cationic Emulsion</th>
<th>Anionic Emulsion</th>
<th>Crude Oil</th>
<th>Other Stuff</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cationic Emulsion</strong></td>
<td>Empty</td>
<td>Empty to no meas quantity</td>
<td>Okay to load</td>
<td>Empty to no meas quantity</td>
<td>Empty to no meas quantity</td>
<td>Clean tank</td>
</tr>
<tr>
<td><strong>Anionic Emulsion</strong></td>
<td>Empty</td>
<td>Empty to no meas quantity</td>
<td>Empty to no meas quantity</td>
<td>Okay to load</td>
<td>Empty to no meas quantity</td>
<td>Clean tank</td>
</tr>
</tbody>
</table>

1 consider flush with non-ionic

Source: Asphalt Institute
Emulsion Transport
References

TRB E-C102

Asphalt Institute MS-19
Thank You!
Thanks for your Participation

Please complete the evaluation to provide your feedback on this session and suggest topics for future events.

Remember to mark these upcoming events on your calendar!

March 7-11, 2017
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