Understanding and Using Asphalt Emulsion

Emulsion 101 by Jack Dougherty

Rocky Mountain West Pavement Preservation

Peppermill, Reno 10-5-2011
Why is emulsion used?

- Liquid
- Saves Energy
- Aggregate coating
- No fire hazard
- Environmentally clean
Asphalt Emulsion Advantages

- Low Storage and application temperature
- Construction versatility
- Reduced energy requirement
- Reduce air pollution
- High mix production rate
- High seal coat stone retention (min. bleeding)
- High natural adhesion
- Wide grade selection
Disadvantages

- Lack of freeze resistance
- Some types may suffer early rain damage
- Need curing period to develop tensile strength
Artists’ Perspective

- Oil Base: Type of oil and quantity
- Lacquers: solvent/evaporation rate
- Latex: Water
Asphalt Technology Perspective

- HOT APPLIED      Visco-elastic / VGO
- CUTBACKS        Solvents / Evaporation rate
- EMULSIONS       Surfactants / water
Asphalt Cement Can Be Liquefied By:

- Heat
- Blending With a petroleum Solvent
- Emulsifying with water (and an Emulsifying Agent)
Emulsified Asphalts - Production & Use

- What are emulsified asphalts?
- How is emulsified asphalt manufactured?
- Uses of emulsified asphalts
  - Construction
  - Maintenance
Chemistry Of Asphalt Emulsions

- Emulsified asphalt is a dispersion of asphalt cement particles in water with the aid of an emulsifying agent (or “system”)

- The asphalt cement is dispersed in the liquid medium in the form of tiny droplets ranging from about one to ten microns in diameter

- In the manufacturing process agitation and surface active agents are required for emulsification
Type of Emulsions

- **Cationic:**
  - Asphalt droplets having a positive (+) charge

- **Anionic:**
  - Asphalt droplets having a negative (-) charge

- **Nonionic:** Neutral Charge on asphalt particles

- Emulsion type determined by emulsifier chemical
Specifications

- **Emulsified Asphalt**
  - AASHTO M140
  - ASTM D977
    - Anionic
    - Nonionic
    - Some Cationic

- **Cationic Emulsified Asphalt**
  - AASHTO M208
  - ASTM D2397
    - Cationic only
Chemistry of Asphalt Emulsions
Emulsion Breakage

- Evaporation
- Chemical
- Surface contact
- Temperature
Emulsion Deposition

Asphalt Emulsion Droplet

Emulsifier

Deposited Asphalt

Aggregate
The Manufacture Of Asphalt Emulsions

- **Liquid State:**
  - Possess the handling and ecological advantages of water

- **Cured State:**
  - Possess the adhesive durability and water resistant properties of a paving asphalt
CHARLOTTE® COLLOID MILLS
FOR ASPHALT EMULSIONS

G100 25 tph with 100 HP motor
G125 40 tph with 125 HP motor

Industrial head (2 pieces)
Factors That Affect Emulsification

- Asphalt (caustic treated-Recycled lube oil treated)
- Soap Type / Soap Content
- pH
- Asphalt Temperature
- Soap Temperature
- Mill Gap
- Back Pressure
- Discharge Temperature
- Water hardness
Factors effecting particle size

- Temperature of components
- Type and quantity of surfactant
- Mill clearance
- Mill “dwell time”
  - Back pressure
- Ionic strength of water phase
Adjusting Emulsion Viscosity

- Low Viscosity
  - Increase Mono-amine
  - Increase Residue
  - Use Thickener
  - Decrease mill gap
  - Rise Asphalt Temp
  - Rise Soap Temp
  - Check pH

- High Viscosity
  - Use Amido Amine
  - Use CaCl / NaCl
  - Increase mill gap
  - Use “Durco”
  - Lower Residue
  - Lower Asphalt Temp
  - Lower Soap Temp
  - Check pH
Factors Effecting Sieve

- Recycled Lube Oil in asphalt
- Inadequate saponification or not enough surfactant
- Shear sensitive emulsifiers
- High shearing mixers
- High shear pumps
- Mill Gap
- Boiling on Discharge
- Hard water
- Hot spots in tank or live steam
Factors Effecting Storage

- High settlement
  - Low Residue
  - Excess or insufficient Acid or caustic
  - Too much salt
  - Large particle size
  - Insufficient surfactant – particle charge

Storage Temperature
- Hot spots
- Too cold

Surface area
Factors Effecting Setting / Breaking Rate

- More surfactant longer break longer setting time
  - Coating reduced with lower surfactant but increase set and break.
- Non ionics slow breaking and setting time
- Lignosulfonates and Aminated lignums slow breaking and setting time.
Keys to making “Good Soap”

- Lignins (Indulin SAL, Indulin C, Polyphon, W-5 W2 etc)
  - If in powder form add to warm water Then add Acid

- Tall Oils
  - Add half of the caustic Then add to 130F Water The TO . Then the remaining caustic

- Fatty Amines
  - Same as Tall Oil

- Nonionics
  - Many inactive above 140 F

- Correct pH
  - 3.5 pH Minimum for Amines (except Quats)
  - 10+ for Anionic Tall Oil or Tallow – excess critical in High Floats
Anionic Materials

Materials
- Tall Oil
- Sodium Hydroxide
- Potassium Hydroxide
- Sodium Chloride
- Methyl Oleate
- Tallow
- Vinsol Resin
- Sodium Lignosulfonate
- Alpha Olefin Sulfonate
- Clay

Function
- RS/MS/HF emulsifier
- Create soap
- Create soap
- Reduce emulsion viscosity
- HFRS-2 additive
- HFRS-2 additive
- Emulsifier/stabilizer for MS & SS
- Stabilizer for SS
- QS-h emulsifier
- Reduces settlement
# Cationic Materials

## Materials
- Amines, Mono- or di-
- Amidoamine
- Quaternary ammonium salts
- Ligniamine
- Hydrochloric acid
- Calcium chloride

## Function
- CRS, CMS emulsifier
- CRS, CMS, CQS emulsifier
- CSS emulsifier
- Create soap
- Reduce emulsion viscosity
Emulsion Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cationic</th>
<th>Anionic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Setting</td>
<td>CRS</td>
<td>RS</td>
</tr>
<tr>
<td>Mixing</td>
<td>CMS</td>
<td>MS</td>
</tr>
<tr>
<td>Slow Setting</td>
<td>CSS</td>
<td>SS</td>
</tr>
<tr>
<td>High Float</td>
<td>CQS</td>
<td>HFRS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HFMS</td>
</tr>
<tr>
<td>Control Setting</td>
<td>CQS</td>
<td>QS</td>
</tr>
</tbody>
</table>

Different grades have different usage in highway construction.
## Typical Asphalt Emulsion Formulation

<table>
<thead>
<tr>
<th></th>
<th>CRS-2:</th>
<th>RS-2:</th>
<th>SS-1h:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asphalt: 67%</td>
<td>Asphalt: 65%</td>
<td>Asphalt: 60%</td>
</tr>
<tr>
<td></td>
<td>F.A. Diamine: 0.2%</td>
<td>Tall Oil: 0.2%</td>
<td>Vinsol Resin: 0.75%</td>
</tr>
<tr>
<td></td>
<td>HCL: 0.1%</td>
<td>NaOH.: 0.04%</td>
<td>Na Ligno-SO₄: 0.75%</td>
</tr>
<tr>
<td></td>
<td>Water: 32.7%</td>
<td>Water: 34.76%</td>
<td>NaOH: 0.09%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Water: 38.41%</td>
</tr>
<tr>
<td>CMS-2S:</td>
<td>Asphalt: 62%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F.A. Diamine: 0.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HCL: 0.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Naphtha: 12%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water: 25.4 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Emulsion Tests

- **Emulsion Property**
  - Emulsion handling
  - Emulsion stability
  - Emulsion type
  - Emulsion grade
  - Asphalt grade
  - Asphalt content

- **Test Procedure**
  - Viscosity
  - Sieve, storage stability
  - Particle charge
  - Classification, mixing test, cement mixing
  - Penetration, Original DSR (ADOT)
  - Distillation or Evap

- **Plus specification**
  - Softening pt
  - Torsional Recovery
  - Latex/Polymer %
  - Other per agency specification
Why surface treat

- To seal
- To rejuvenate
- To reinforce
- To provide skid resistance
- To provide demarcation
- To provide improved visibility
General Uses of Asphalt Emulsions

- Rapid setting (RS, CRS, or HFRS)
  - Chip seals
  - Surface treatments
  - Sand seals
  - Penetration treatments
General Uses of Asphalt Emulsions

- Medium setting (MS, CMS, or HFMS)
- Plant mix (cold or hot)
- Seal coat and surface treatments
- Tack coat
- Crack sealing
- Road mix
- Patching mix (for immediate use)
General Uses of Asphalt Emulsions

- Slow setting (SS, CSS)
- Cold Plant mix
- Road mix
- Tack coat (diluted)
- Fog seal (diluted)
- Dust palliative
- Mulching
- Slurry seal coat
**QS slurry seal**

- **Types:**
  - Cationic
    - Emulsion Plus Mix Aid = QS slurry
    - Fast set
    - No mixing stability
    - Retards Set
  - Anionic
    - Emulsion Plus Setting Agent = QS slurry
    - Long Mixing Cycle without Setting agent
    - Control Set