Understanding and Using Asphalt Emulsion

Emulsion 101 by Jack Dougherty

Rocky Mountain West Pavement Preservation

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PARAMOUNT ASPHALT

a subsidiary of ALON USA

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

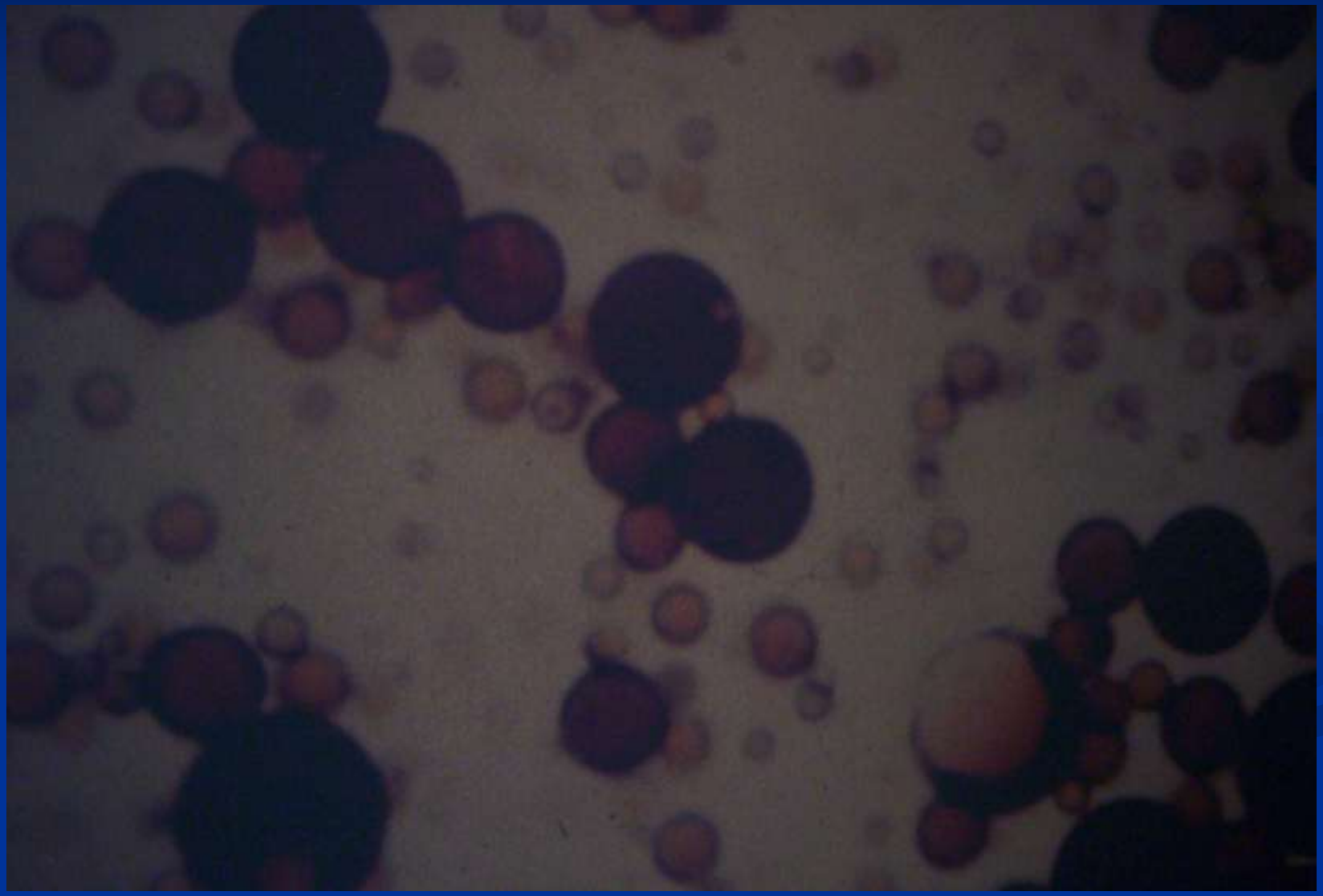
Type of Emulsions

- 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

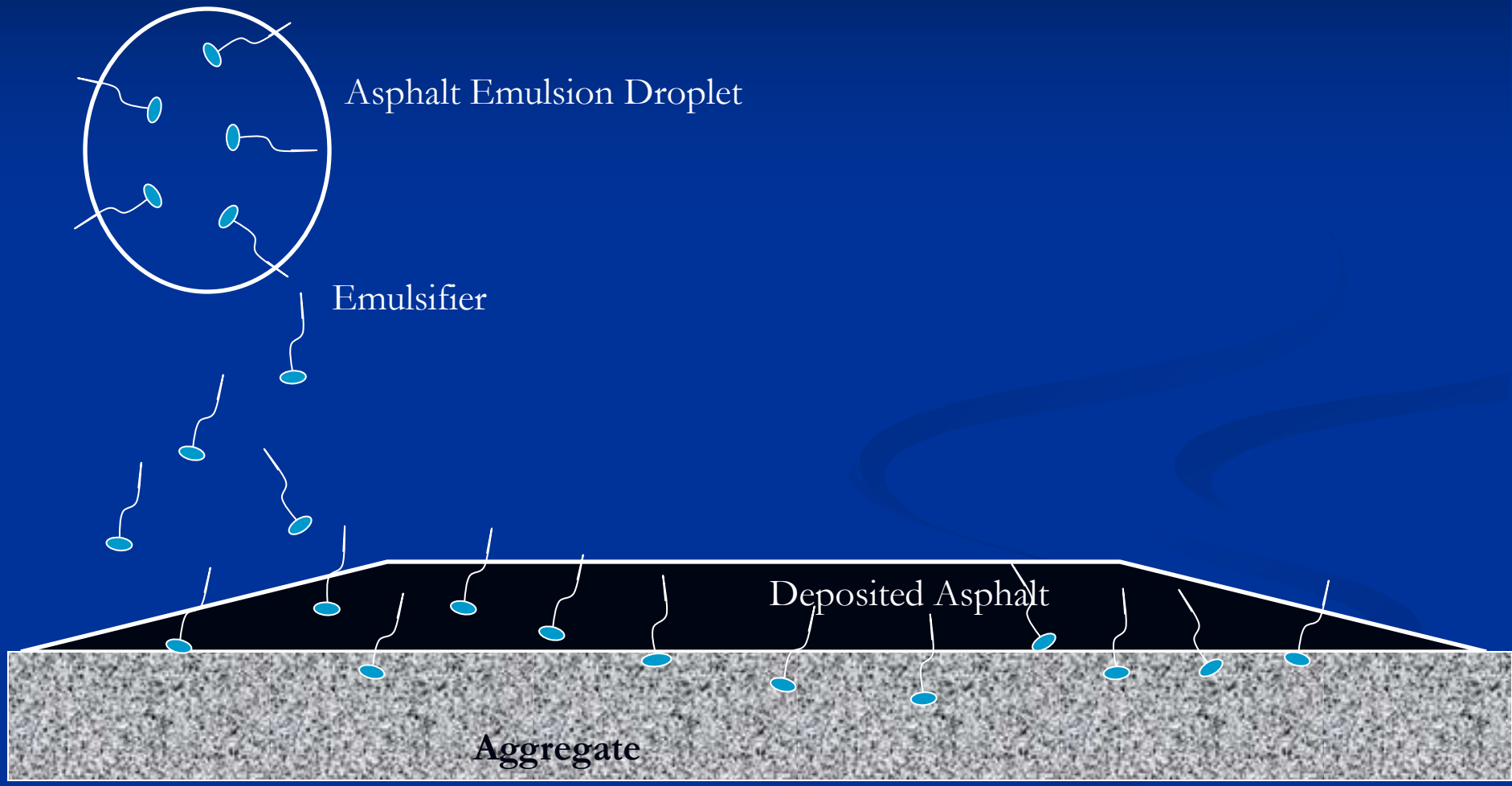
Chemistry of Asphalt Emulsions



Emulsion Breakage

- Evaporation
- Chemical
- Surface contact
- Temperature

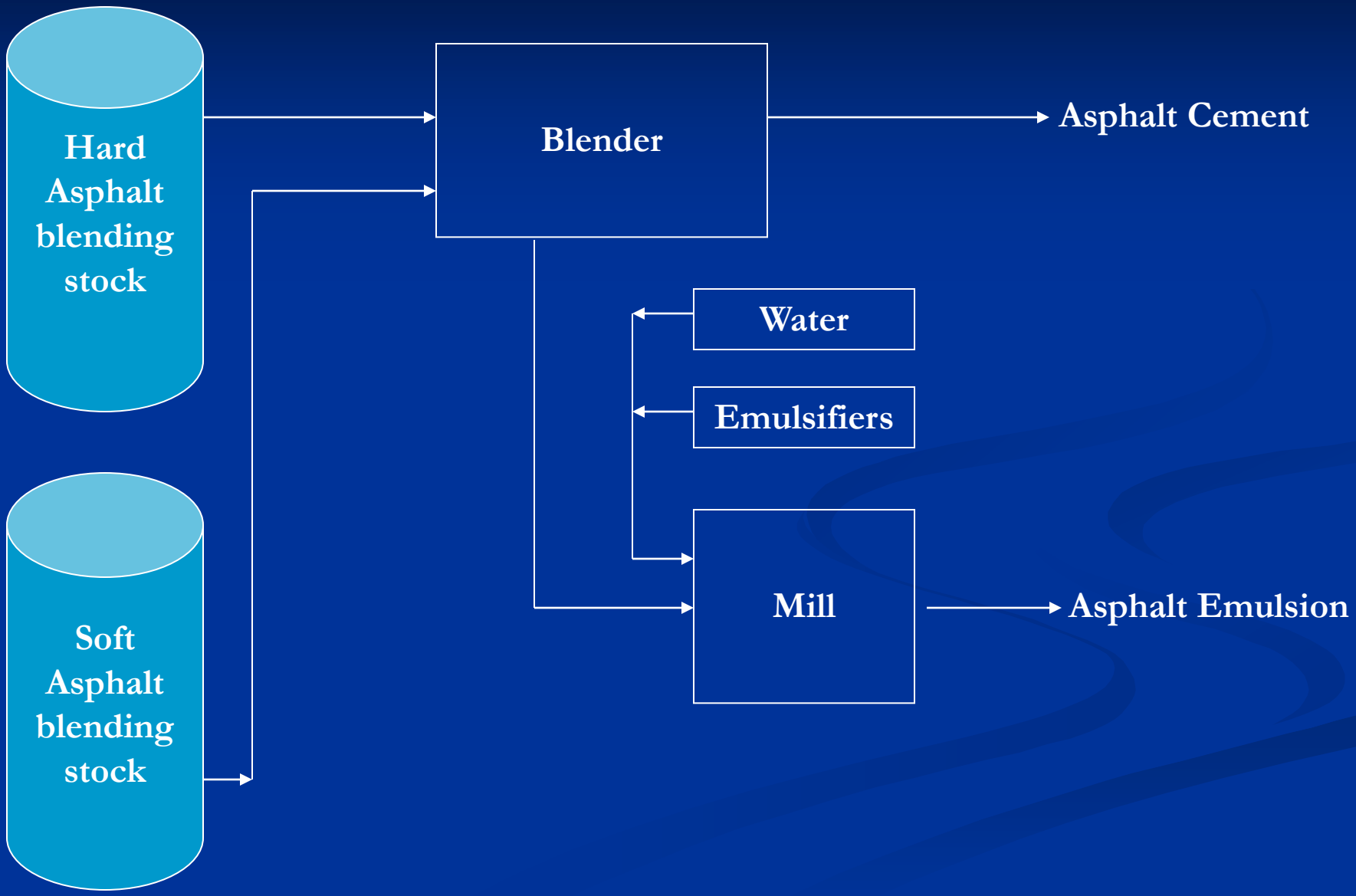
Emulsion Deposition



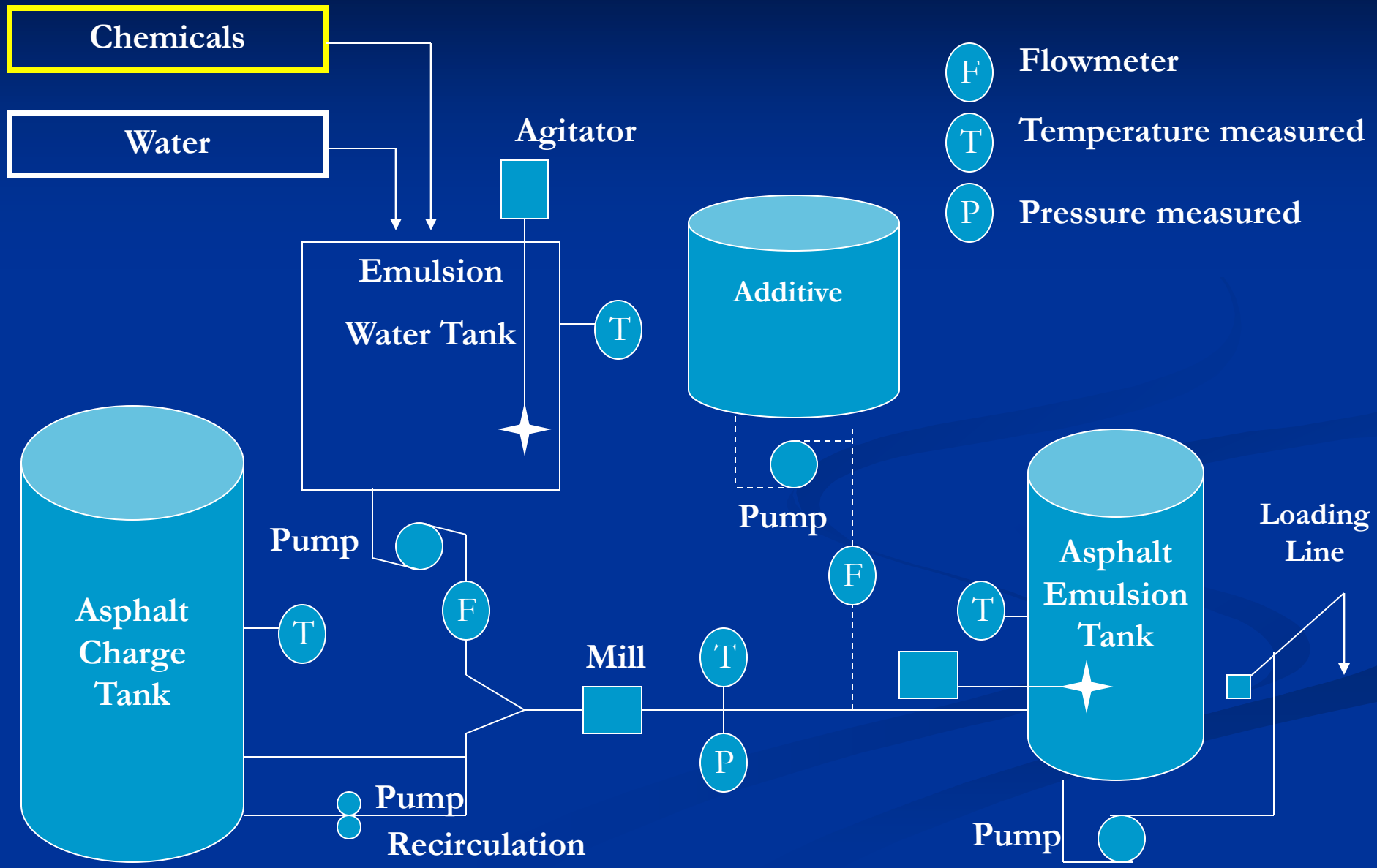
The Manufacture Of Asphalt Emulsions

- Liquid State:
  - Possess the handling and ecological advantages of water
- Cured State:
  - Possess the adhesive durability and water resistant properties of a paving asphalt

Emulsion Plant



Process Flow Diagram



CHARLOTTE® COLLOID MILLS FOR ASPHALT EMULSIONS

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

Industrial head (2 pieces)

Siefer Emulsion Mill

Lab Mill

Factors That Affect Emulsification

- Asphalt (caustic treated-Recycled lube oil treated0
- 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
  - CRS, CMS, CQS emulsifier
  - CSS emulsifier
  - Create soap
  - Reduce emulsion viscosity

Emulsion Grades

Grade	Cationic	Anionic
Rapid Setting	CRS	RS
Mixing	CMS	MS
Slow Setting	CSS	SS
High Float		HFRS HFMS
Control Setting	CQS	QS

Typical Asphalt Emulsion Formulation

- CRS-2:
  - Asphalt: 67%
  - F.A. Diamine: 0.2%
  - HCL: 0.1%
  - Water: 32.7%
- RS-2:
  - Asphalt: 65%
  - Tall Oil: 0.2%
  - NaOH.: 0.04%
  - Water: 34.76%
- CMS-2S:
  - Asphalt: 62%
  - F.A. Diamine: 0.4%
  - HCL: 0.2%
  - Naphtha: 12%
  - Water: 25.4 %
- SS-1h:
  - Asphalt: 60%
  - Vinsol Resin: 0.75%
  - Na Ligno-SO_4: 0.75%
  - NaOH: 0.09%
  - Water: 38.41 %

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