ASPHALT EMULSION BASICS for Pavement Preservation

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ncpp
National Center for Pavement Preservation
MICHIGAN STATE UNIVERSITY

AASHTO TSP2 PAVEMENT PRESERVATION
ROCKY MOUNTAIN WEST PAVEMENT PRESERVATION PARTNERSHIP
SOUTHEAST PAVEMENT PRESERVATION PARTNERSHIP
MIDWESTERN PAVEMENT PRESERVATION PARTNERSHIP
NORTHEAST PAVEMENT PRESERVATION PARTNERSHIP

OVERVIEW

- Properties of an Emulsion
- Components and Production of Asphalt Emulsions
- Asphalt Emulsifiers Explained
- Desired Emulsion Properties
- Classification of an Emulsion
- Pavement Preservation
  - Types of Applications
  - Desirable Emulsion Properties
- Summary

THREE GROUPS OF ASPHALT?

Asphalt Cement

- Use heat to pump mix and coat

Asphalt Cutback

- Use diluent to reduce viscosity for mixing and coating at lower temperature

Asphalt Emulsion

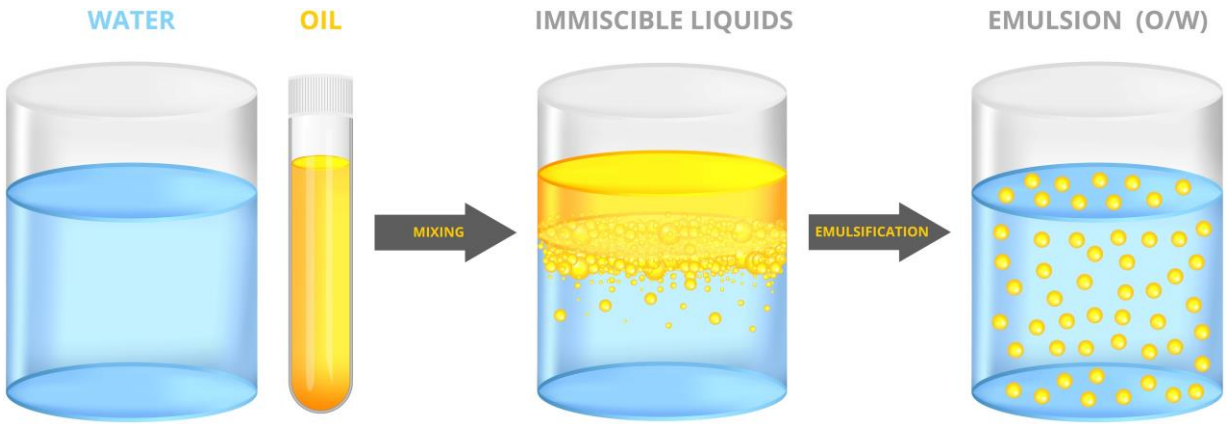
- Suspend asphalt in a water phase for ease of use, chemical control

ASPHALT EMULSION
What is an Emulsion?

- Combination of two liquids that don't mix (immiscible)
- Droplets in a continuous phase

- Two basic types:
  - Oil in water O/W
    - Water is continuous phase
  - Water in Oil W/O
    - Oil is continuous phase

- Surface active agent
  - Surfactant
  - Chemical
  - *Emulsifier*
  - Soap



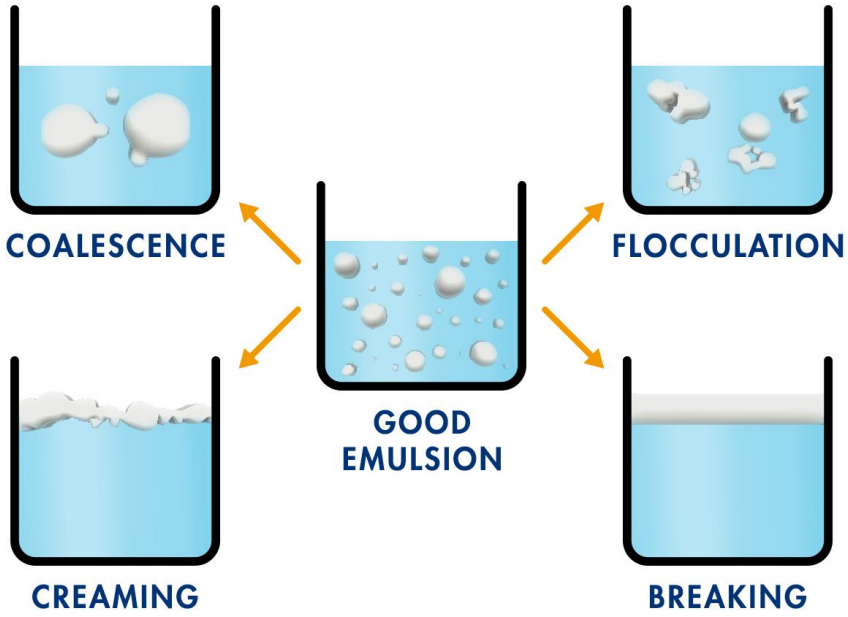
ASPHALT EMULSION
Stable vs. Unstable

Stable

- Droplets are evenly suspended
- Droplets have a uniform, narrow size range

Unstable

- Droplets able to agglomerate, stick together
  - Flocculation, creaming, coalescence, breaking
- When the system is out of balance
- Mechanical, Thermal, Chemical



ASPHALT EMULSION
Stable vs. Unstable

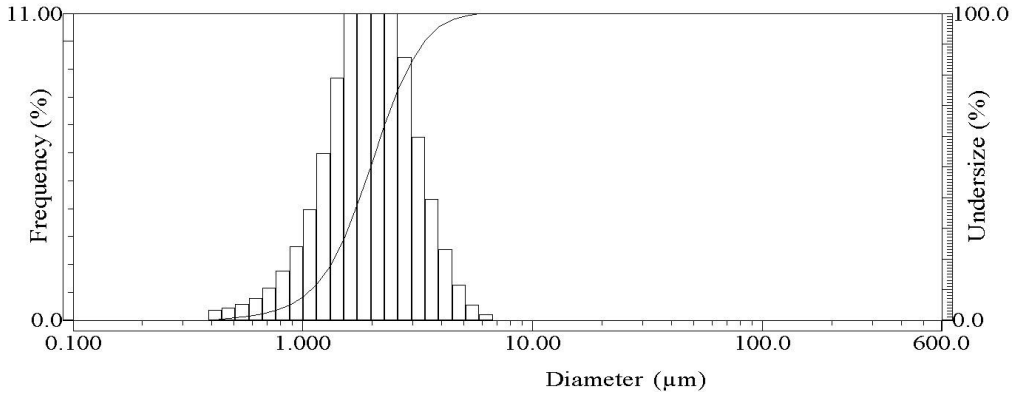
Stable

Unstable

ASPHALT EMULSION
Stable vs. Unstable

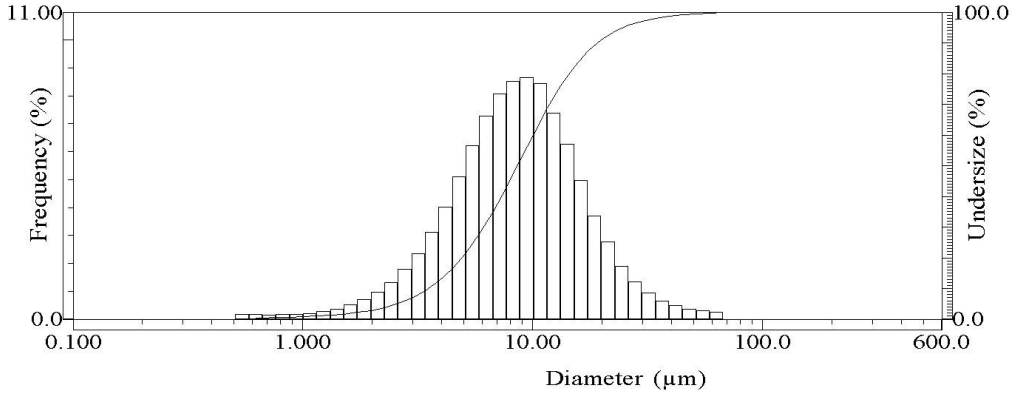
Stable Emulsion

- Narrow distribution
- Small median size



Unstable Emulsion

- Broad distribution
- Larger median size



ASPHALT EMULSION Components

Components

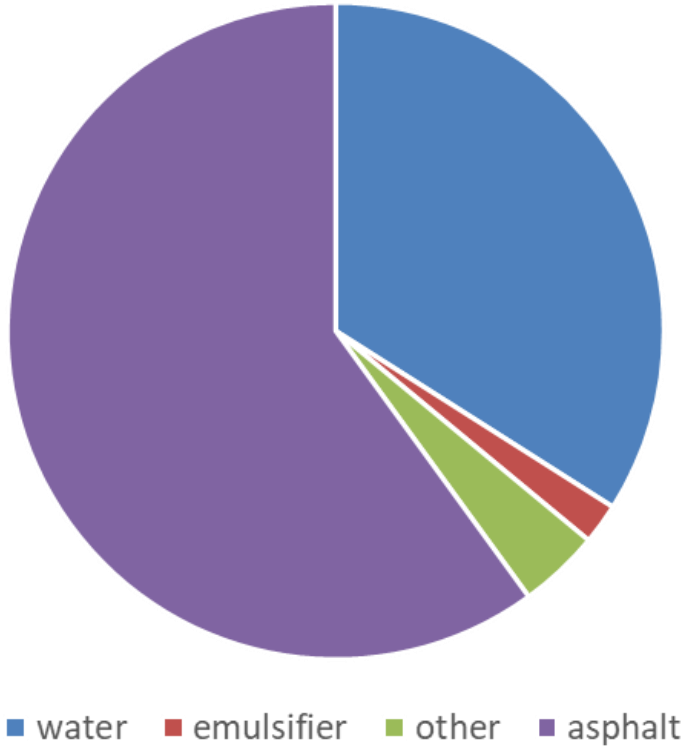
Asphalt

Water

Emulsifier

Other

Polymer
Diluent
Salt
Thickeners



ASPHALT EMULSION Production

Treated Water “Soap”

- Emulsifier
- Acid or Caustic (pH)
- Latex, salt
- Temp and mixing

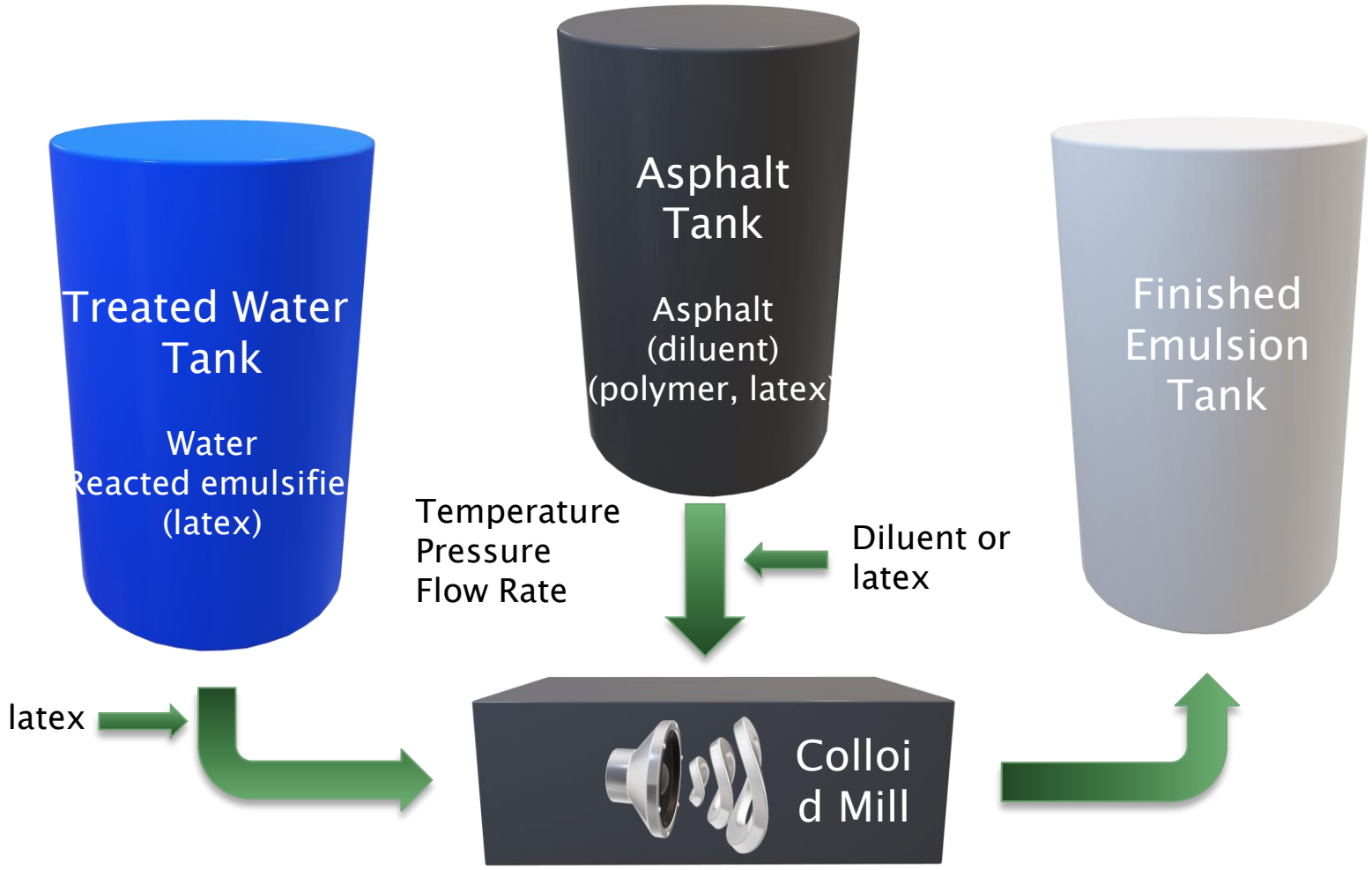
Asphalt

- Diluent
- Polymer
- Temp

Soap and Asphalt Introduced to the Mill

- Temperature
- Flow Rate
- Pressure

ASPHALT EMULSION Production



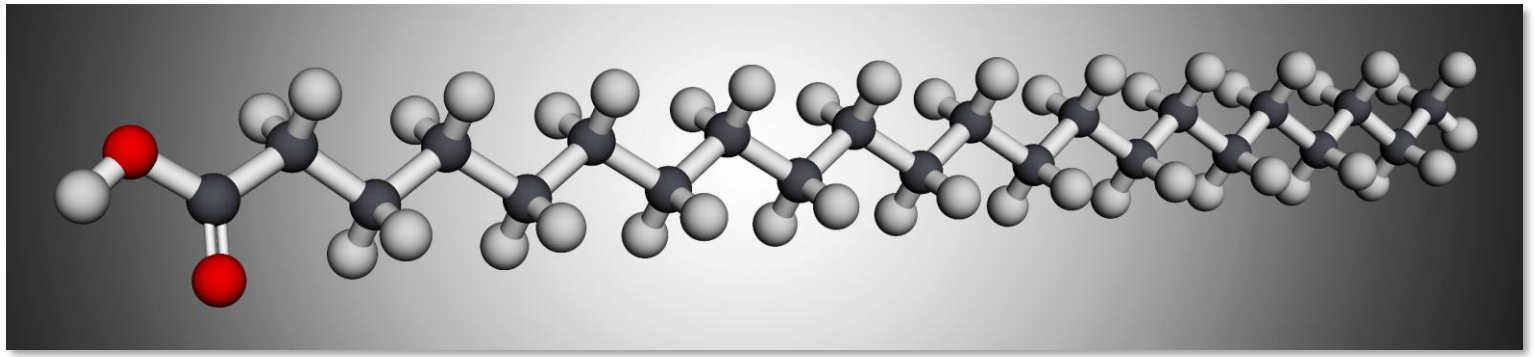
ASPHALT EMULSION
Emulsifiers

“Head”

- Hydrophilic
- Water-loving
- Polar, ionic

“Tail”

- Hydrophobic
- Oil-loving
- Long chain hydrocarbon



ASPHALT EMULSION
Emulsifiers

Cationic

- Low pH, (+) positive charge, acidic

Anionic

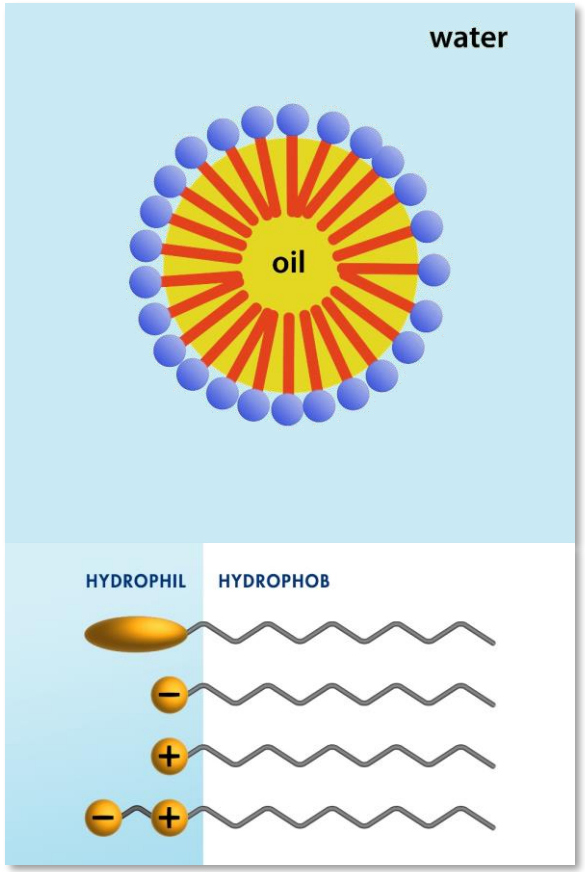
- High pH, (-) negative charge, basic

Amphoteric

- High or low pH, (+/-) positive or negative

Nonionic

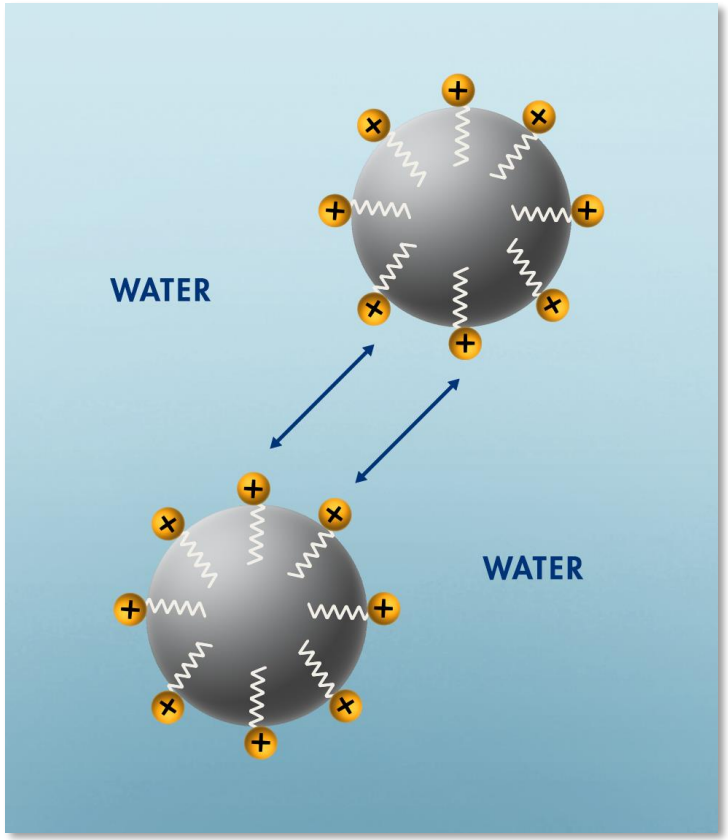
- pH near 7, neutral charge, polar head



ASPHALT EMULSION
Emulsifiers

Stabilized Emulsion

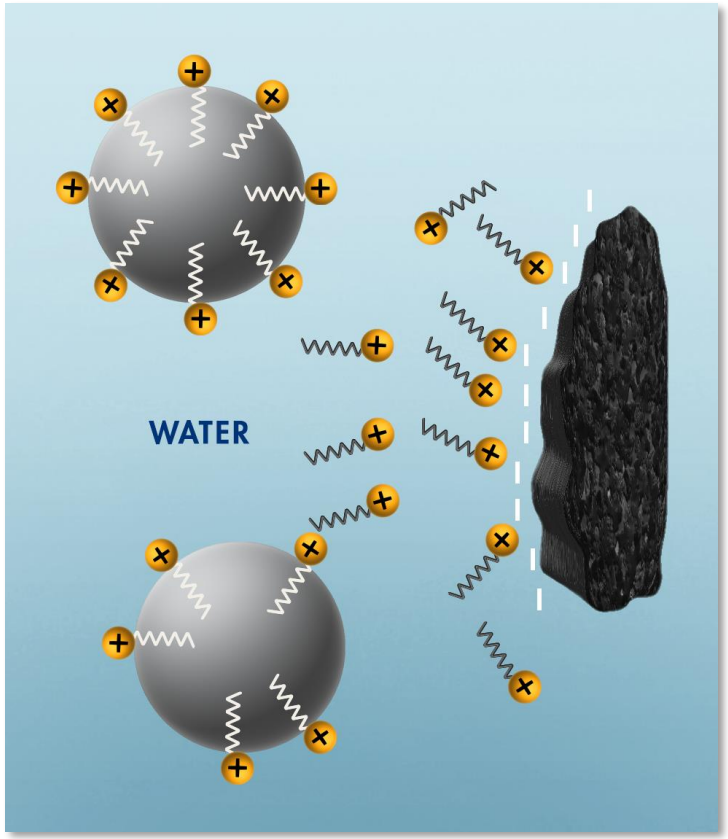
- Tail in asphalt droplet
- Head in water phase
- Like repels like (magnet)



ASPHALT EMULSION
Emulsifiers

Emulsifier Dosage

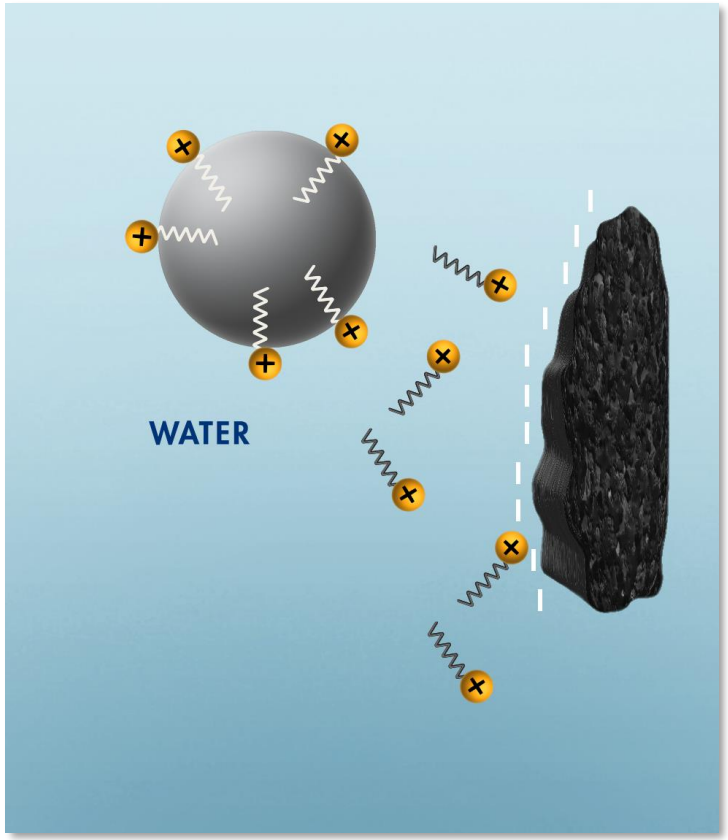
- Excess emulsifier coats asphalt droplet
- More stable, promotes adhesion



ASPHALT EMULSION
Emulsifiers

Emulsifier Dosage

- Less emulsifier, no excess in water phase
- More rapid migration to aggregate surface
- Less stability, rapid break



ASPHALT EMULSION Classification

SET	ANIONIC (–)	CATIONIC (+)
RAPID	RS	CRS
MEDIUM	MS	CMS
QUICK	QS	CQS
SLOW	SS	CSS

ASPHALT EMULSION Classification

PROPERTY	DESIGNATIONS
LATEX, POLYMER	LM–, PM–, –P Latex modified
VISCOSITY	–1 (thin < 100 SFs) –2 (thick >100 SFs)
HARDNESS	–h (hard <100 pen) –s (soft >100 pen)
HIGH FLOAT– HARDNESS	HF250, HF500, etc. High float penetration

ASPHALT EMULSION Classification

APPLICATION	CATIONIC EMULSION	ANIONIC EMULSION
FOG SEAL	CSS-1(h), CQS-1(h) PMRE	SS-1(h)
TACK and PRIME COAT	CSS-1(h), CQS-1(h), CRS-1(h)	SS-1(h)
CHIP and SCRUB SEAL	CRS-2(h), PMCRS-2(h), CRS-2P, PMRE, CHFRS-2	HF-100P
SLURRY and MICRO SURFACING	PMCQS-1h, CQS-1hP, LMCQS-1h, MSE	AQS-1(h)
COLD MIX	CMS-2(h), Engineered Emulsion	HF-350s, HF-500M, HF-1000M

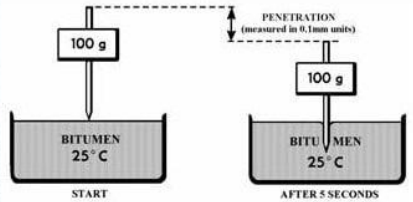
ASPHALT EMULSION Testing

- Liquid Emulsion
  - Handling
  - Pumpability
  - Mixability, film thickness
  - Stability/ storage
  - Adhesion
  - Set time/breaking
  - Composition
- Emulsion Residue
  - Hardness
  - Polymer
  - Crack resistance
  - Flow under traffic
- Performance
  - Mix design

ASPHALT EMULSION Testing

- Emulsion
  - Viscosity
  - Demulsibility
  - Sieve
  - Coating and water resistance
  - Miscibility in water
  - Freezing stability
  - Storage stability
  - Cement mixing
  - Distillation (residue/oil portion)

- Emulsion Residue
  - Penetration
  - Apparent viscosity
  - Elastic recovery
  - Toughness and tenacity
  - Torsional Recovery

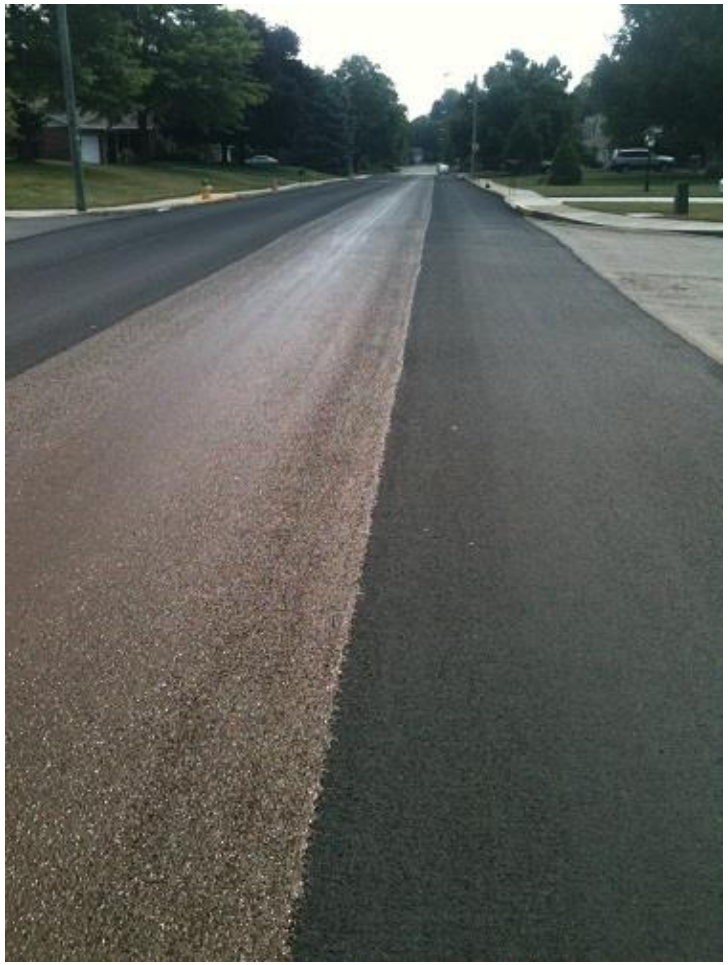


ASPHALT EMULSION
Desired Properties

Stability
- Pumping
- Storage
- Mixing

Controlled Break
- Timely separation of oil and water phase
- Tailored to the application

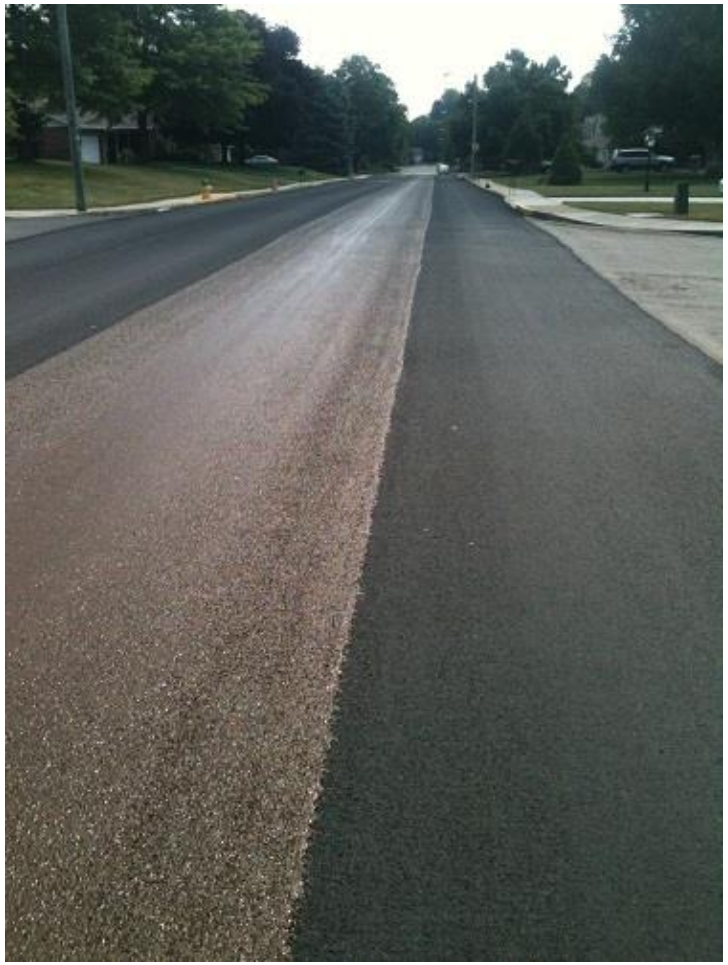
Coalesced Residue
- Properties of original binder
- Enhanced properties (polymer)
- Adhesion/cohesion



ASPHALT EMULSION
Desired Properties

Emulsion Break

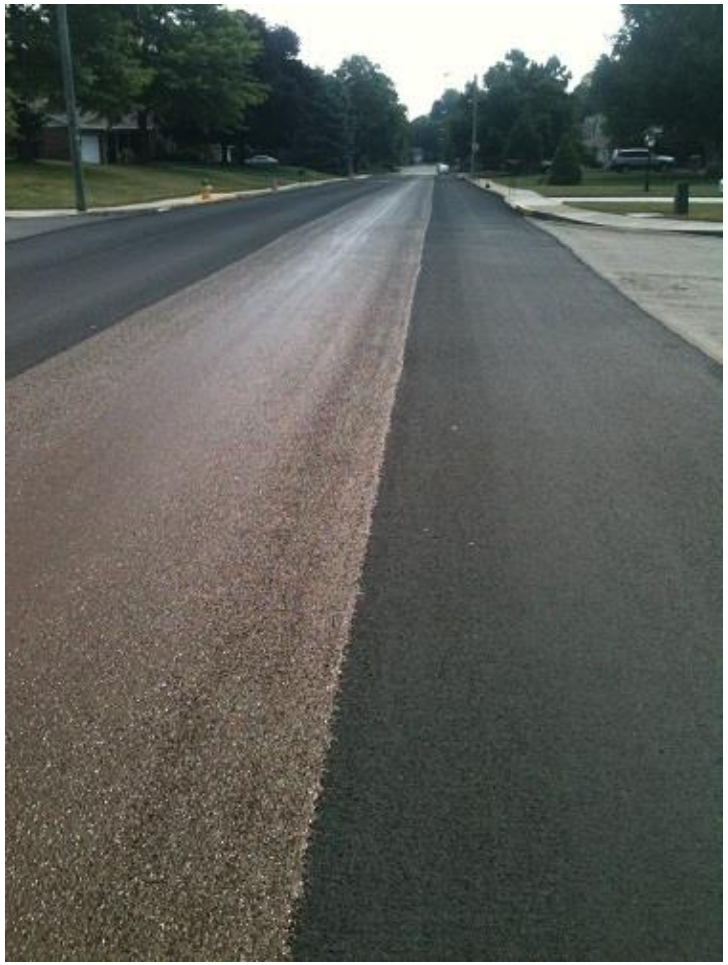
- When asphalt and water separate
- Emulsifier balance is upset
- Contributing factors:
  - Over-shearing
  - Over-heating
  - pH change
  - Mixing with aggregate
  - Evaporation
- Make sure you are in control



ASPHALT EMULSION
Desired Properties

Controlling Emulsion Break

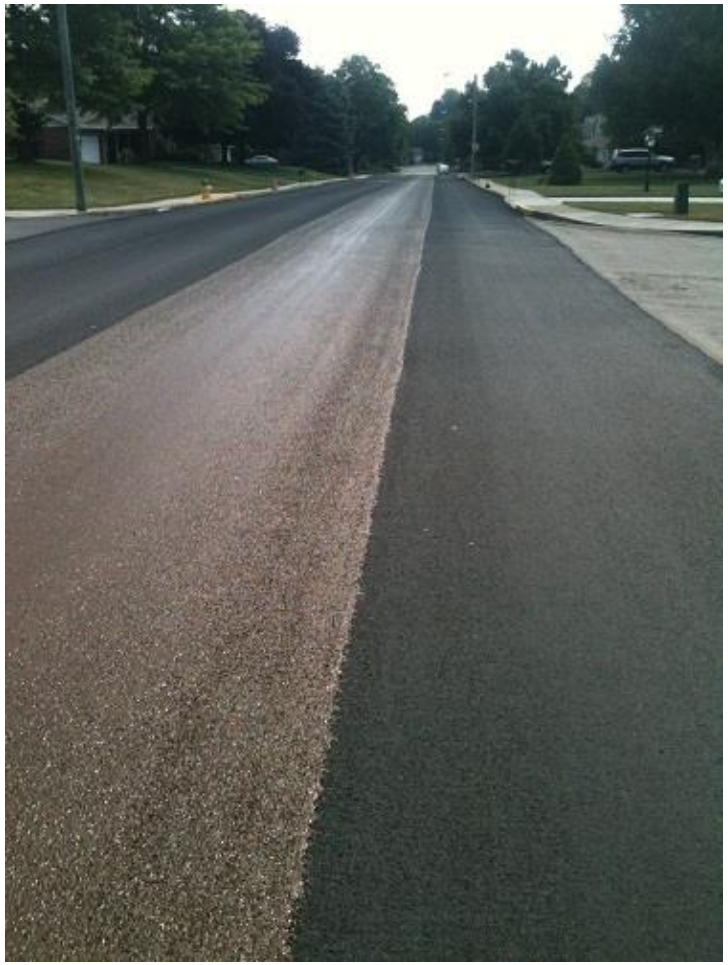
- Chemical
  - Emulsifier dosage
  - pH of emulsion
  - Aggregate surface chemistry
  - Mineral fillers, additives
- Thermal
  - Emulsion temperature
  - Environment, evaporation
- Mechanical
  - Mixing
  - Shear
  - Compaction, rolling
- Make sure you are in control



ASPHALT EMULSION Desired Properties

Emulsion Set and Cure

- Set
  - pH change
  - Emulsifier migrates to aggregate surface
  - Asphalt follows emulsifier
    - Begins to coalesce on surface
  - Irreversible
- Cure
  - Asphalt binder adhesion to surface
  - Evaporation of water
- Make sure you are in control

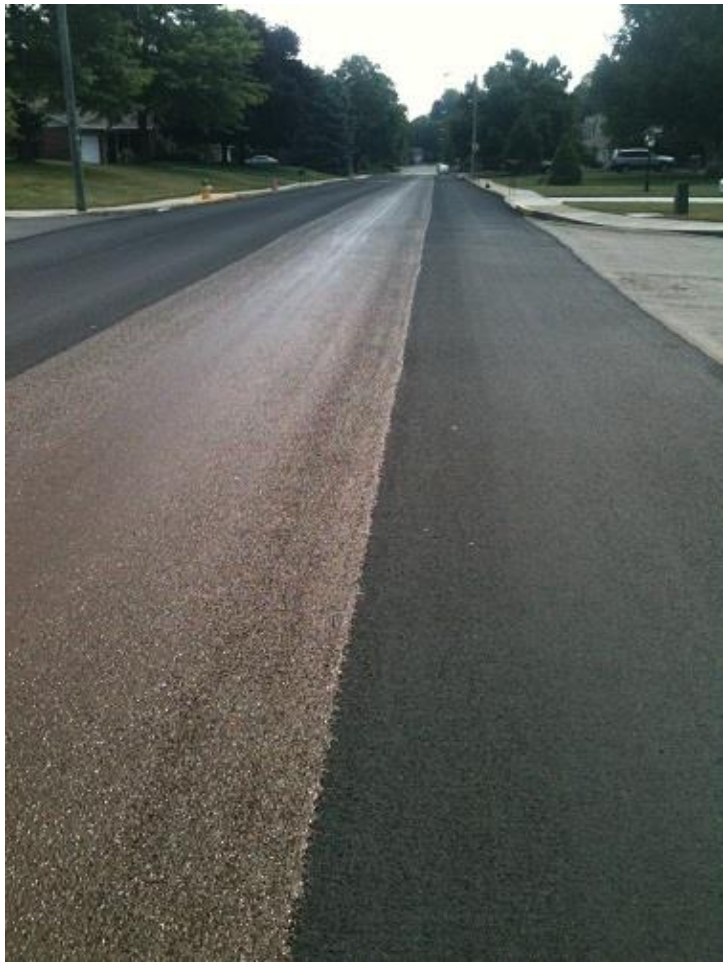


ASPHALT EMULSION
Desired Properties

Controlling Emulsion Cure

- Emulsion pH
- Emulsifier content
- Particle size
- Mineral filler
- Mix time
- Water content
- Environment

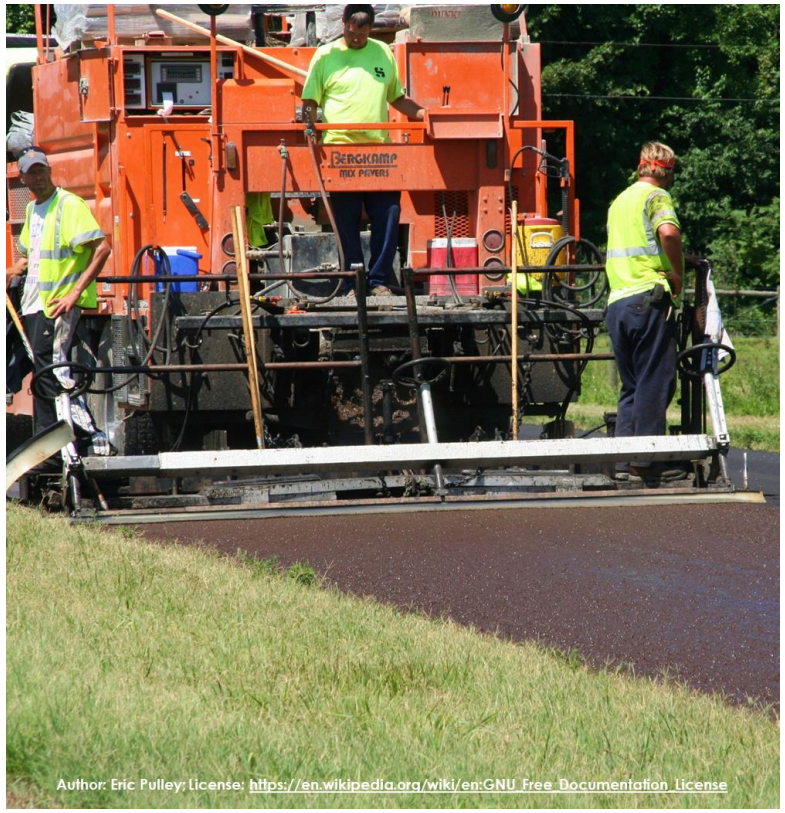
- Make sure you are in control



PAVEMENT PRESERVATION Applications

Preservation Systems

- Crack Mitigation
- Spray Applied Seal
- Spray Applied Chip Seal
- Slurry Surfacing
- Cold Mix



PAVEMENT PRESERVATION Applications

Crack Mitigation

- Crack Fill
- Crack Seal
- Crack Fill/Seal

Emulsion Properties

- Adhere to crack wall
- Resist traffic abrasion/ pick-up
- Elastic properties
- Stable for compounding
- SS, CSS

PAVEMENT PRESERVATION
Applications

Spray Applied Seal

- Fog Seal
- Tack Coat
- Prime Coat
- Dust Control
- Sand Seal

Emulsion Properties

- Able to dilute
- Pump/ sheer stability
- Penetrate surface
- Coating/ Adherence
- Rejuvenation
- Application 0.05 – 0.3 gal/sq.yd.
- SS, CSS, CQS
- Usually, no polymer

PAVEMENT PRESERVATION Applications

Spray Applied Chip Seal

- Conventional Chip Seal
- Scrub Seal

Emulsion Properties

- Good flow for even spray pattern
- Viscous enough not to run
- Wet and adhere to aggregate
- Begin to break on contact with aggregate
- Grip aggregate in place
  - Stand up to sweeping
- Not bleed or strip
- RS, CRS, HFRS, PMRE

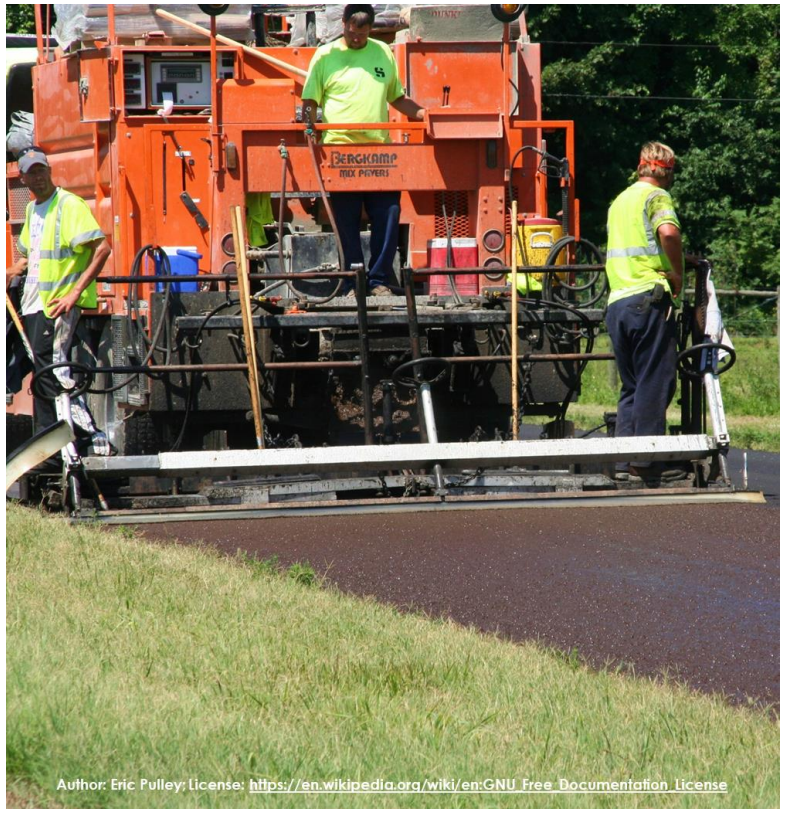
PAVEMENT PRESERVATION Applications

Slurry Surfacing

- Slurry Seal
- Polymer Modified Slurry Seal
- Micro Surfacing

Emulsion Properties

- Aggregate compatibility
- Controlled Mix time
  - Break, set, sure
- Quick cohesion build up
- Resists displacement and Bleeding
- Smooth, excellent particle size
- CQS, PMCQS, MSE



PAVEMENT PRESERVATION Applications

Cold Mix

- Open grade, Dense grade
- Virgin aggregate, RAP
- Stockpile
- Mixed in place, travel or central plant

Emulsion Properties

- Excellent coating
- Adhesion under wet conditions
- Good mixing and compaction
- Tolerate aggregate variability
- Workability
  - Stockpile life

SUMMARY

- A quality emulsion with the right emulsifier package offers flexibility
  - Application
  - Variability in raw materials
  - Environmental conditions
- Emulsions can be formulated to tailor desired properties and meet specific application needs
- Asphalt emulsions for pavement preservation provide:
  - Ease of handling and storage
  - Broader application
  - Flexibility addressing changing raw materials
  - Ability to improve binder properties
  - Low/no emissions
  - Bigger toolbox
  - Cost effective treatments
  - Long-term cost savings

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QUESTIONS:

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