EMULSION BASICS

Midwestern Pavement Preservation Partnership

Adam Redman
Heritage Research Group

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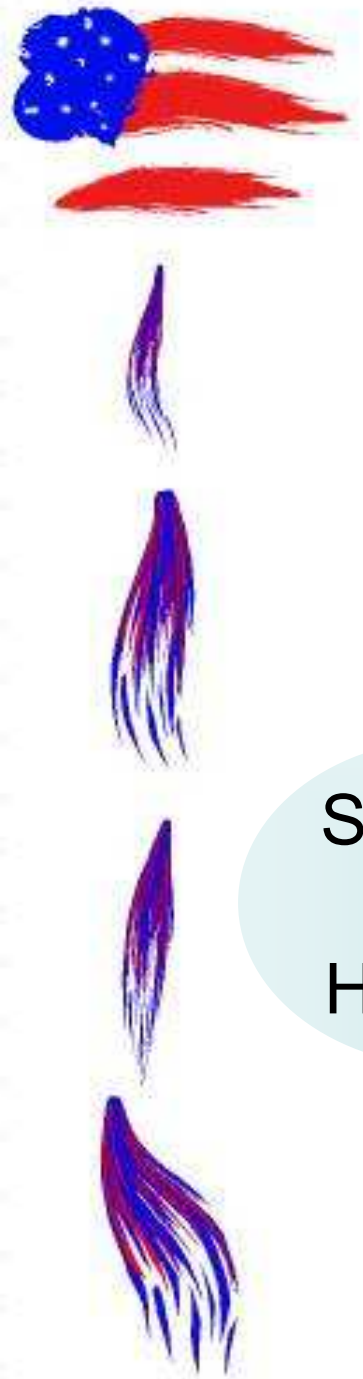
Des Moines, Iowa

OVERVIEW


History
Testing
Description
Performance
Storage and Handling
Composition
Production
Classifications

HISTORY OF ASPHALT EMULSIONS

- First developed in the 1900's
- In the 20's asphalt emulsions came into general use for paving applications
- Early use was in spray applications and dust control.

HISTORY OF ASPHALT EMULSIONS

- Interest picked up in the 50's for farm to market roads

HISTORY OF ASPHALT EMULSIONS

- The environmental movement in the 1970's prompted the increase in emulsion manufacturing due to concerns about pollution from cutback asphalts (VOC's)

HISTORY OF ASPHALT EMULSIONS

- New formulations have increased performance for many applications

WHAT IS AN ASPHALT EMULSION?

- Two liquids or components with one dispersed continuously through the other
- The immiscible materials are held together in a stable suspension with the aid of a surfactant
- Examples of common emulsions are shampoo, milk, mayonnaise and paint

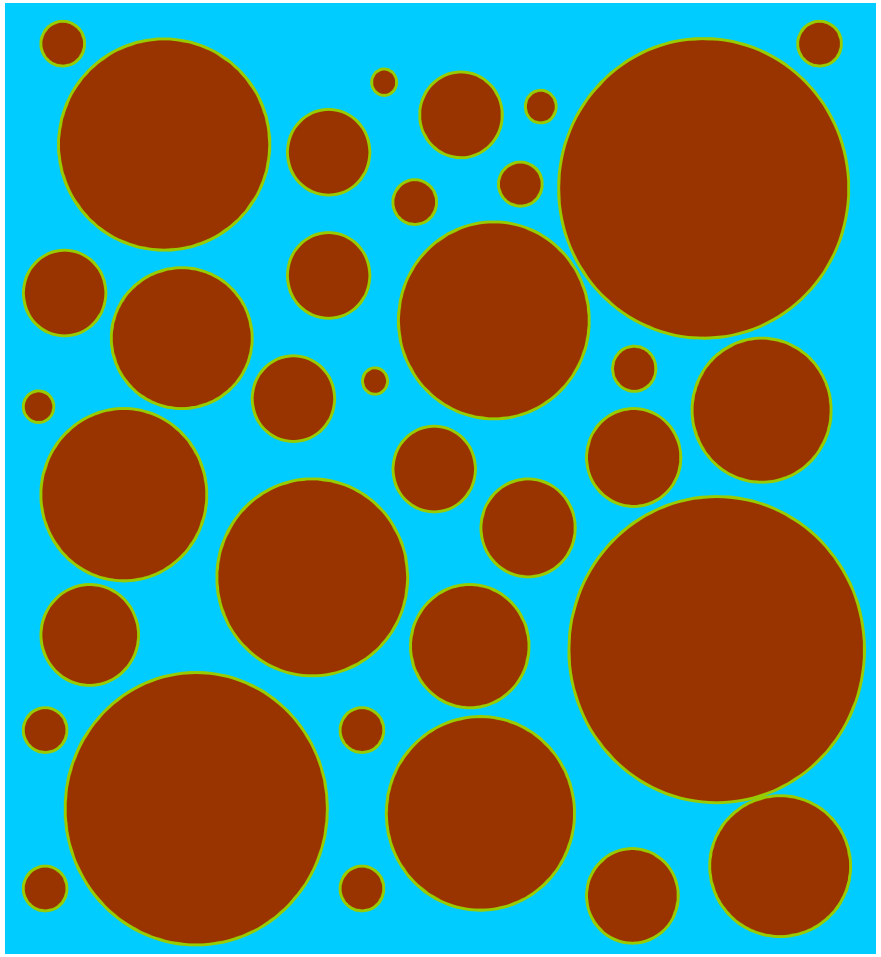
OIL & WATER EMULSION NOT STABILIZED

- Unstable emulsion.
- Not an emulsion.

WHICH WILL COME OUT ON TOP?

OIL & WATER EMULSION STABILIZED

- Oil and water can be emulsified (stabilized) when a surfactant is added.

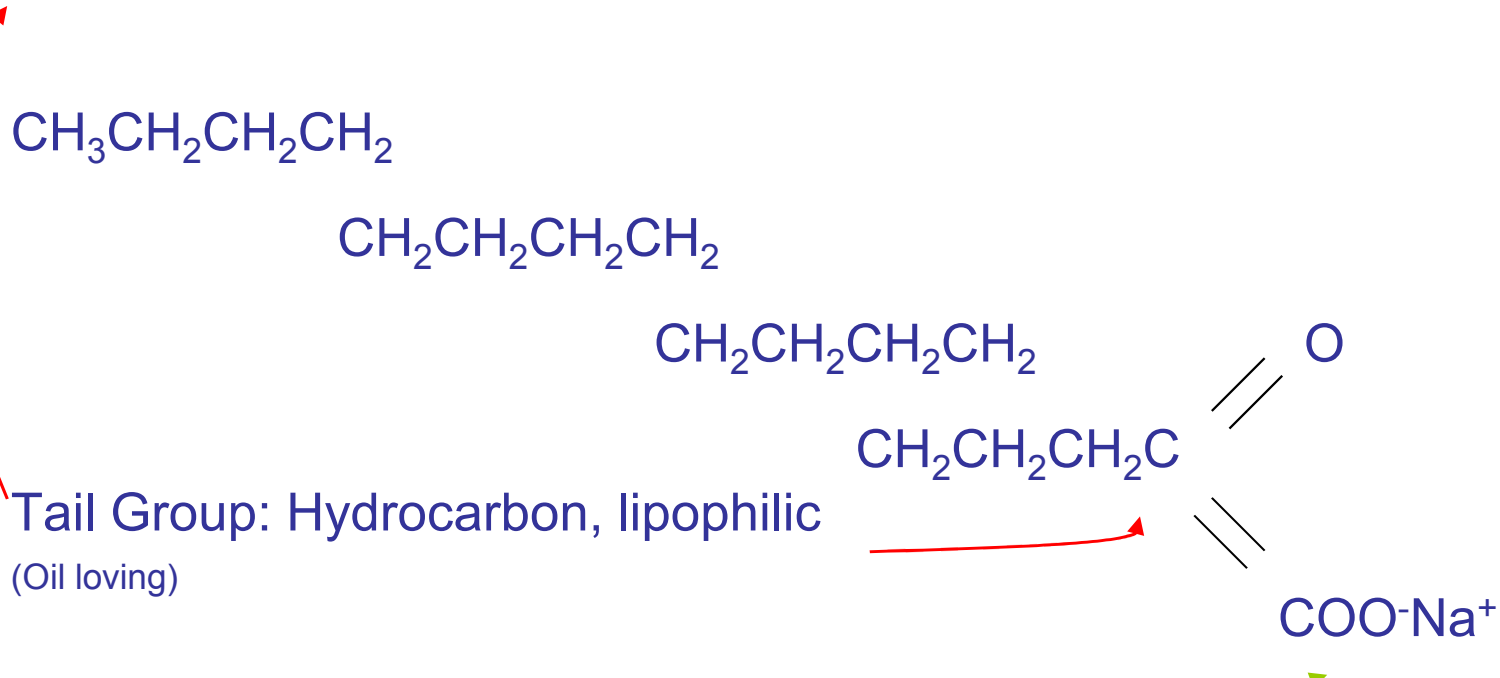


HOW EMULSIFIERS WORK

- Both cationic and anionic emulsifiers are surfactants (soaps)

  - Gives stability to the emulsion
    - Does not allow the Oil (asphalt) to separate from the water.
  - Gives a charge
    - Cationic vs. Anionic (Positive vs. Negative)
  - Imparts setting characteristics
    - Slow Set, Medium Set and Quick Set

ANIONIC EMULSIFIER STRUCTURE



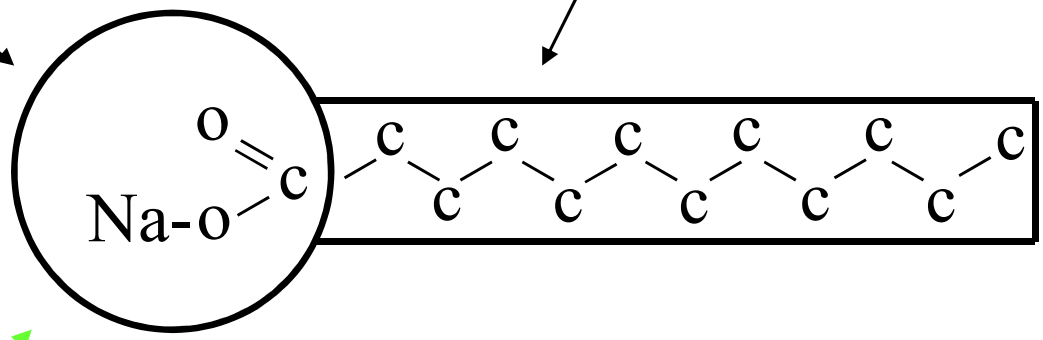
Tail Group: Hydrocarbon, lipophilic
(Oil loving)

Head Group: Polar, hydrophilic (Water loving)

SURFACTANT MODEL

Sodium Hydroxide

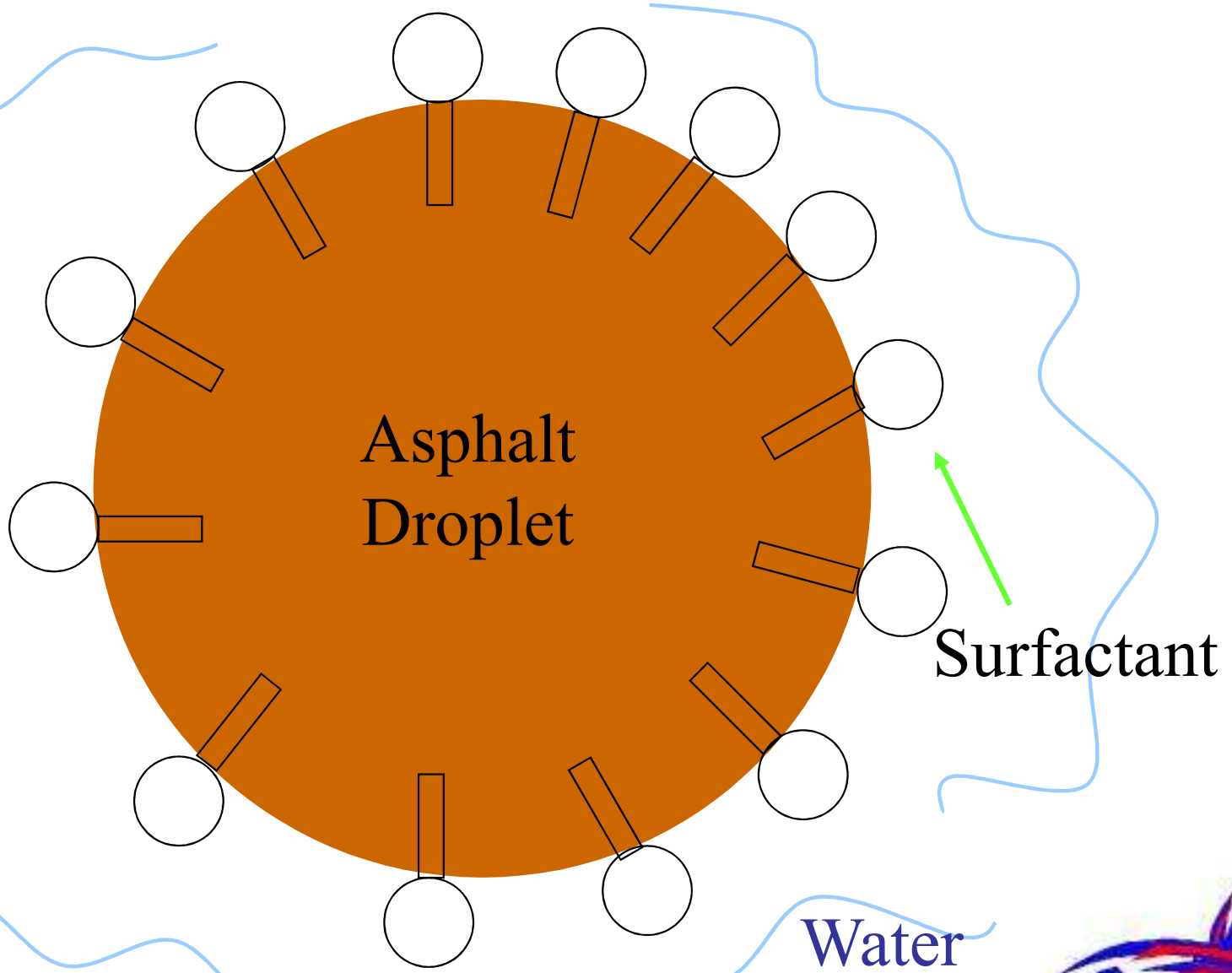
Tall Oil



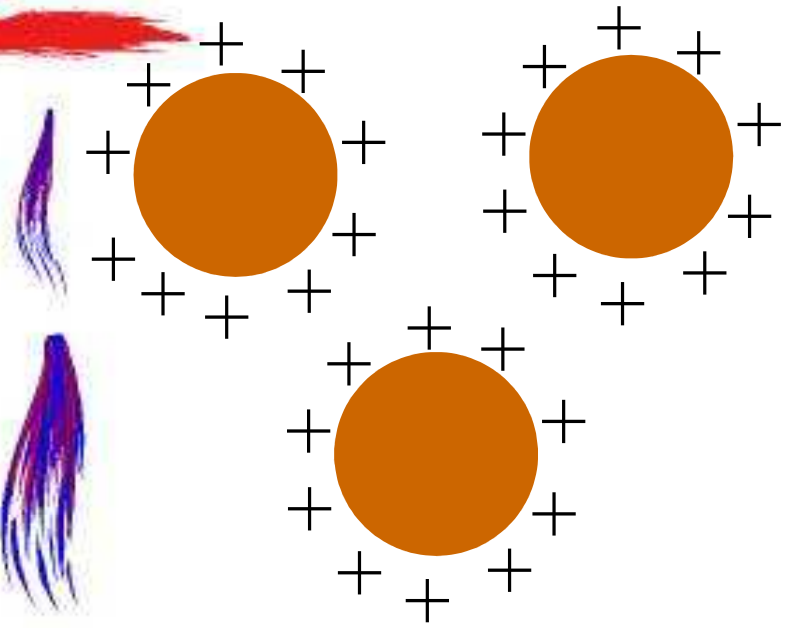
Polar Head
(Water Loving)

Non-Polar Tail
(Oil Loving Hydrocarbon)

ASPHALT EMULSION MODEL



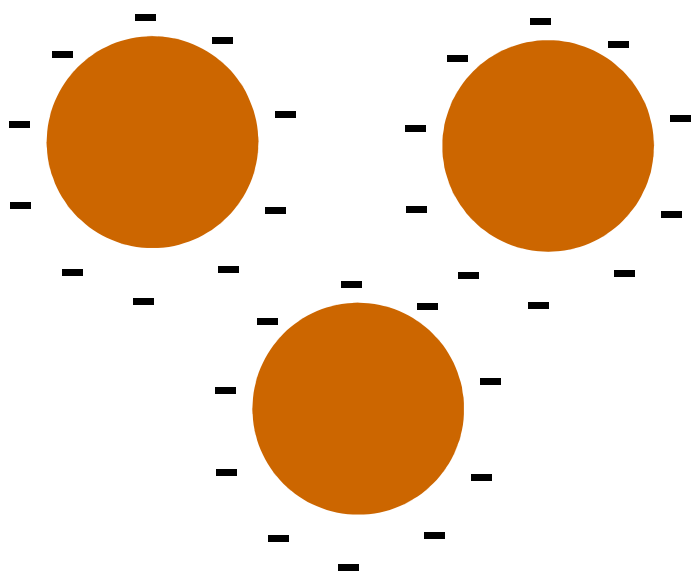
Cationic



+ +

Repulsion

Anionic



- -

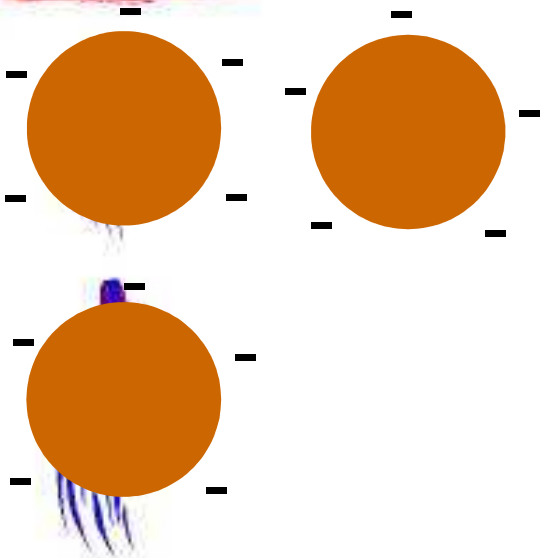
Repulsion

Never Mix Emulsions

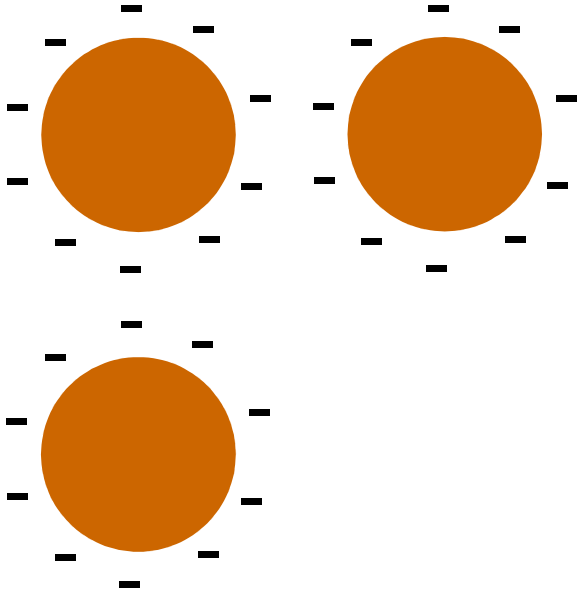
+ -

Attraction

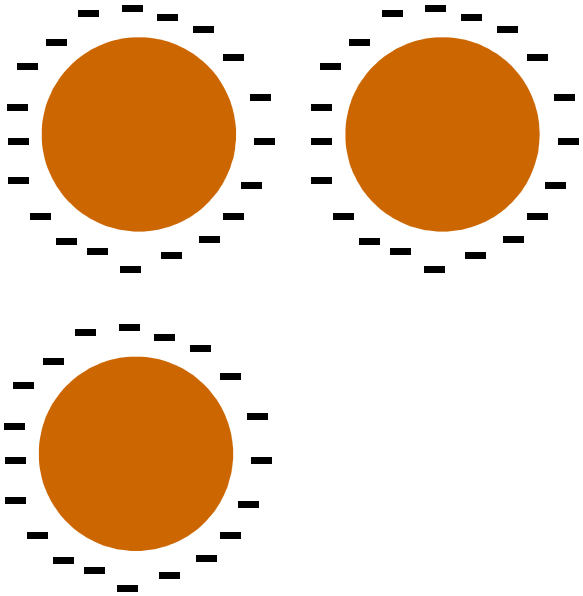
CHEMICAL SET



Rapid



Medium



Slow

NAMING THE EMULSIONS

- Prefix
  - RS = rapid set
  - SS = slow set
  - QS = quick set
  - MS = medium set
  - HFRS = high float rapid set
  - C = Cationic
  - AE = anionic emulsion
- Suffix
  - 90,150, or 300 = penetration ranges
  - h = hard penetration
  - P,M or L = modified with polymer or latex
  - 1 = low viscosity, stored @ cooler temps
  - 2= high viscosity, stored @ higher temps

NOMENCLATURE

HFRS-2 ← High Viscosity

High Float

Rapid Setting

CRS-2P ← High Viscosity, Polymer Modified

Cationic

Rapid Setting

CSS-1h ← Low Viscosity, hard asphalt

Cationic

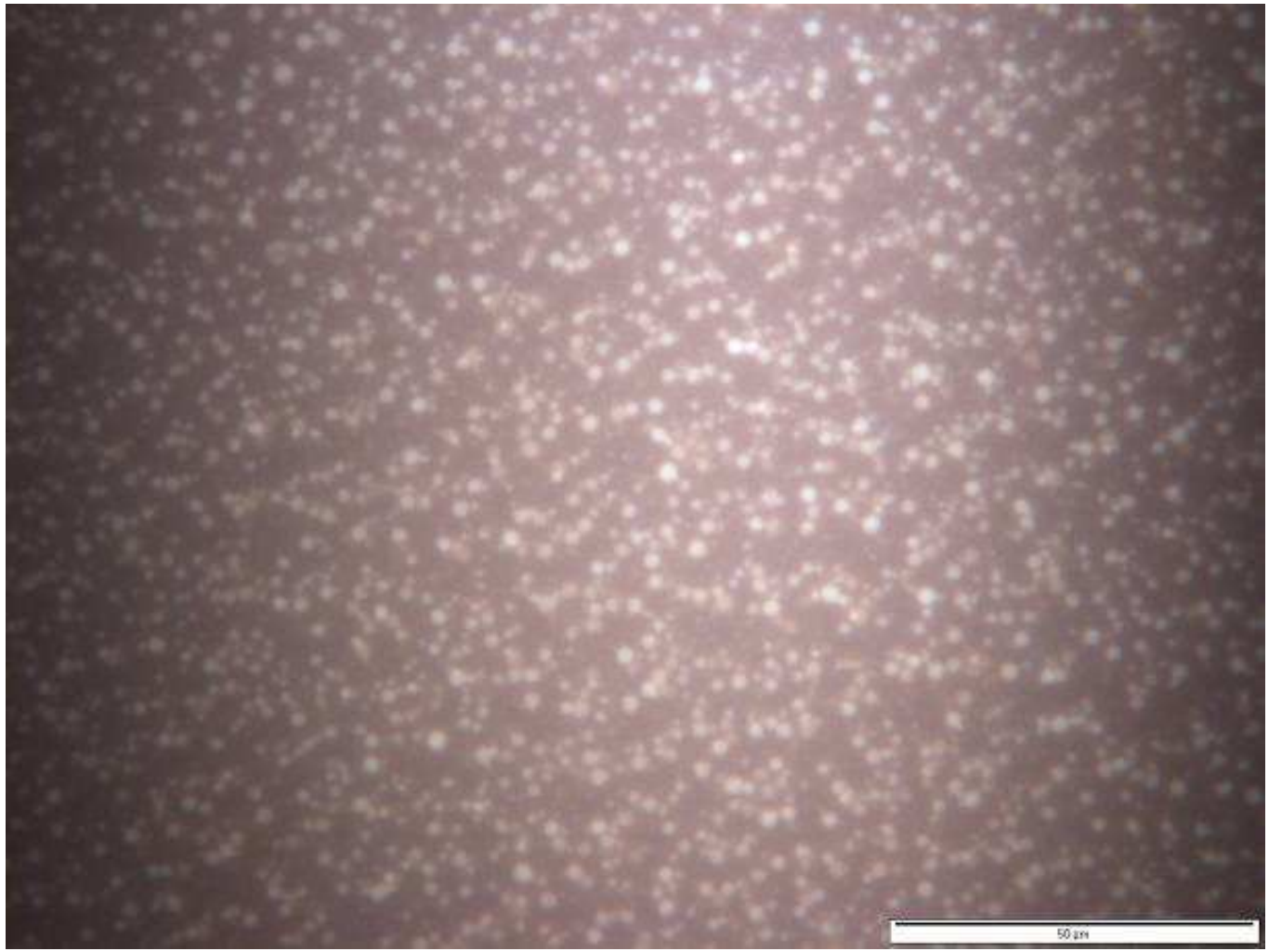
Slow Setting

MODIFICATIONS

- Polymers
  - SBS & SBR
    - Large Molecules

  - Increase Service Life of the Project
    - Early Chip Retention
    - Flexibility
    - Elasticity

FLUORESCENCE OPTICAL MICROSCOPE



4% SBS in Asphalt

GENERAL CLASSIFICATION

- Rapid-Setting
- Medium-Setting
- Slow-Setting
- Quick-Setting and Micro-Surfacing

RAPID SETTING EMULSION

- Designed to react quickly with aggregate and revert from the emulsion to the asphalt.
- Primarily used for spray applications.
  - RS-2, HFRS-2, MWS-90, and CRS-2

SURFACE TREATMENT APPLICATION

MEDIUM SETTING EMULSION

- Designed for mixing with graded aggregate.
- Formulated not to break immediately upon contact with aggregate and will remain workable for a few minutes to several months depending upon the formulation.
- Primarily used in pugmills.
  - MS-2, CMS-2, HFMS-2, MWS-150 & 300

COLD CONSTRUCTED ASPHALT PAVEMENTS

SLOW-SETTING EMULSION

- Designed for mixing stability.
- Primarily used with high fine content aggregates, tack coats, fog seals and dust palliatives.
  - SS-1h, Dustlay, Dust Control

QUICK-SETTING & MICRO SURFACING

- Designed specifically for slurry and micro-surfacing emulsions.
- Allows quicker opening to traffic times.
- Micro-surfacing emulsions are polymer modified and allow mixes to be placed at greater thickness than slurry seals.
  - CSS-1h, CQS-1h and CQS-1hM

MICRO SURFACING / SLURRY

EMULSION PRODUCTION

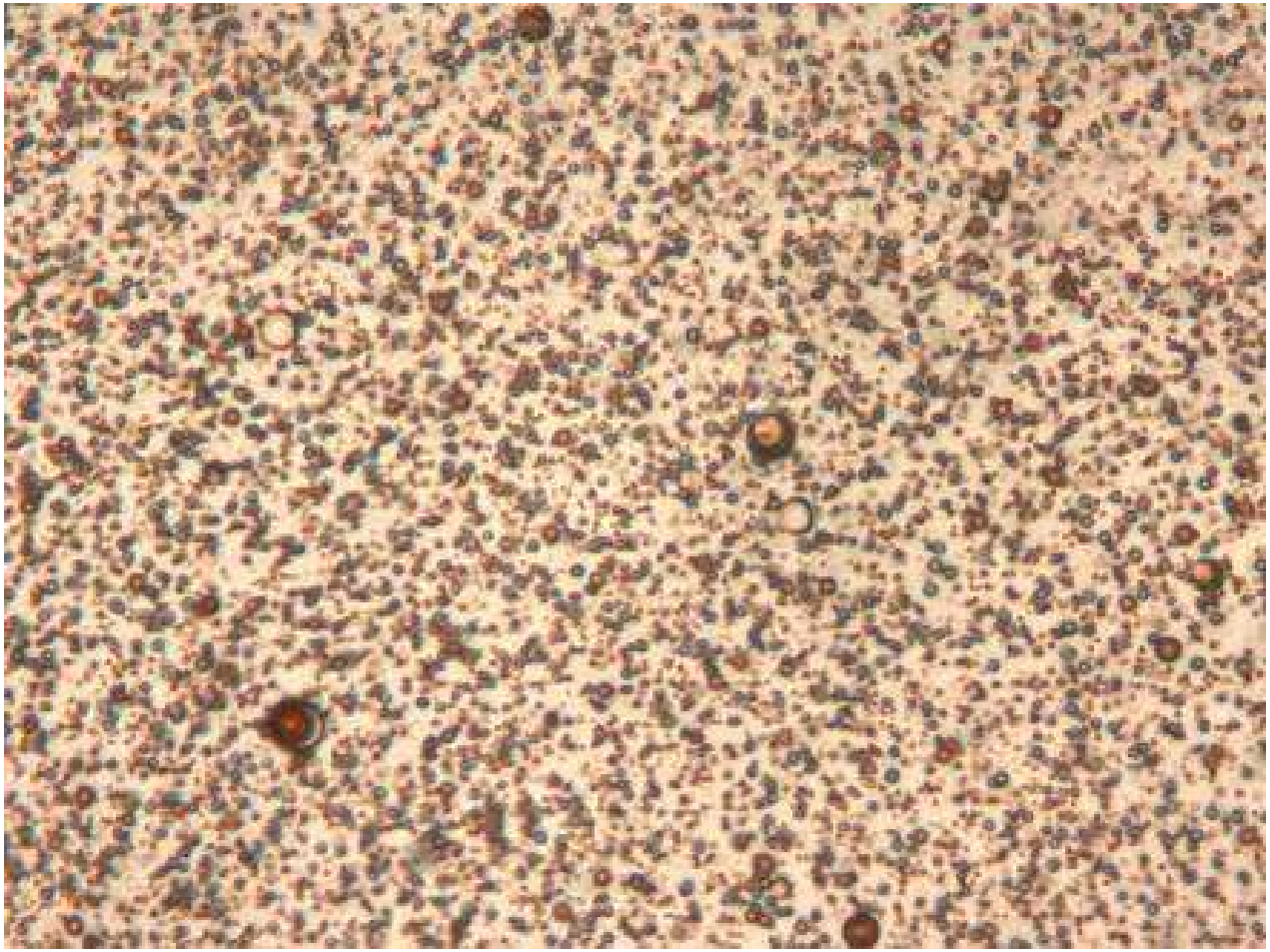
EMULSION MILL

- Colloid Mill

- Rotor & Stator

EMULSION PARTICLE SIZE

- Asphalt emulsion 1-10 Microns in size
- Human Hair 70-100 Microns in size



VERTICAL TANKS

- Vertical storage tanks are recommended.
- Tanks should be insulated to protect the emulsion from freezing.
- There is less surface area which means there is less exposure of the emulsion to air.
- These tanks are easier to put into place, heat, insulate and keep track of inventory.

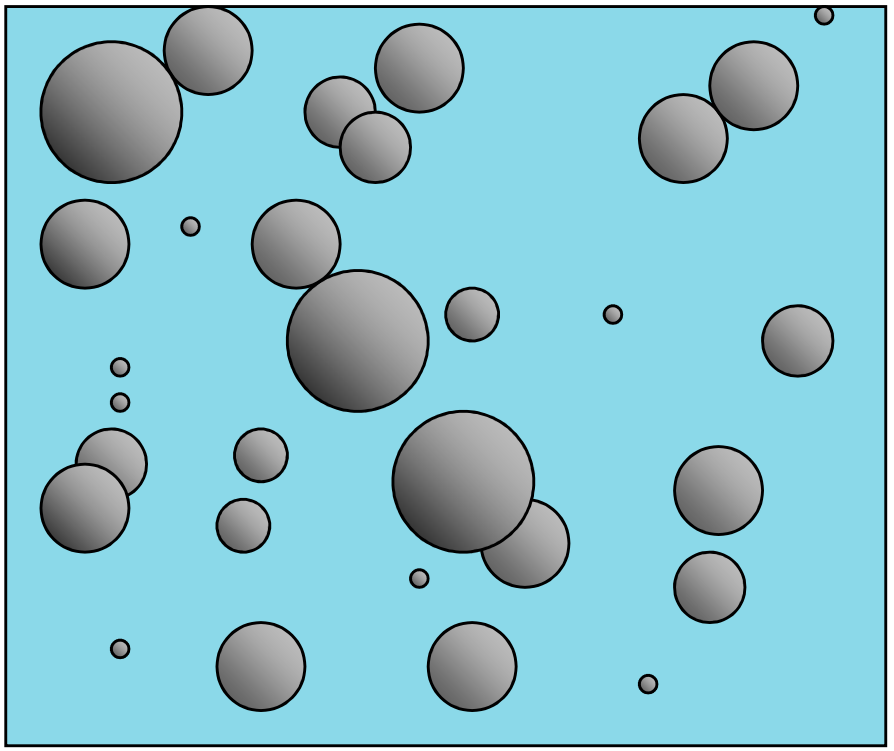
STORAGE TEMPERATURES

- Recommended Storage Temperatures
- Always consult the manufacture for their recommended storage temperatures

Emulsion	MIN°F	MAX°F
RS-1	70	140
RS-2	125	185
HFRS-2	125	185
SS-1h	50	140
AE-90	125	185
MS-2	125	185
CQS-1h	50	140
CSS-1hM	50	140
CRS-2	125	185
CRS-2P	125	185

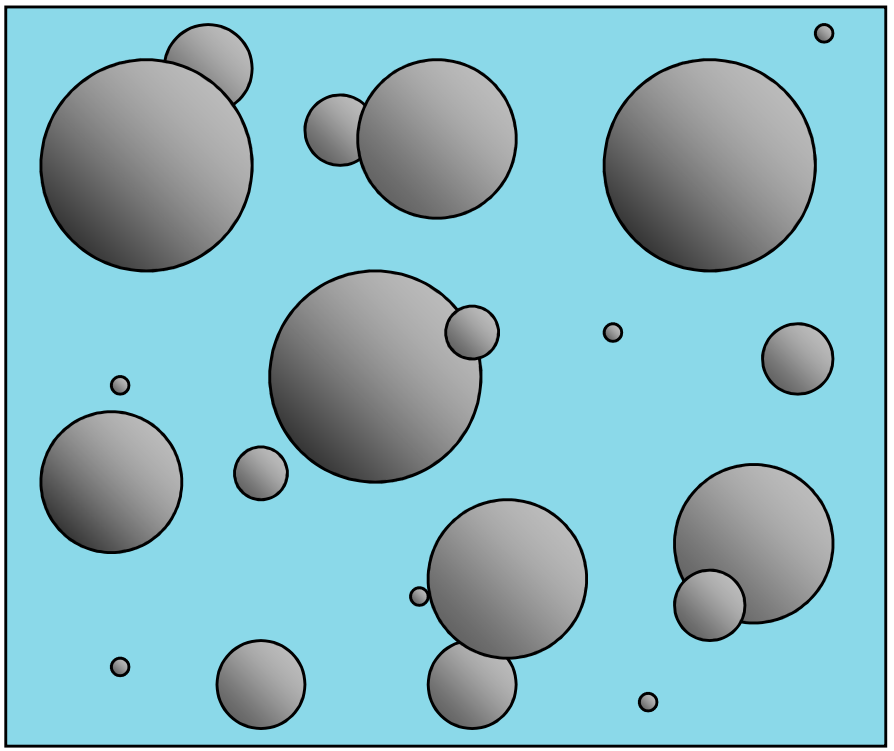
STORAGE AND HANDLING

- **<u>Flocculation</u>** – when the particles stick together.
- Reasons for this maybe due to a low chemical load, thermal shock, and prolonged storage.



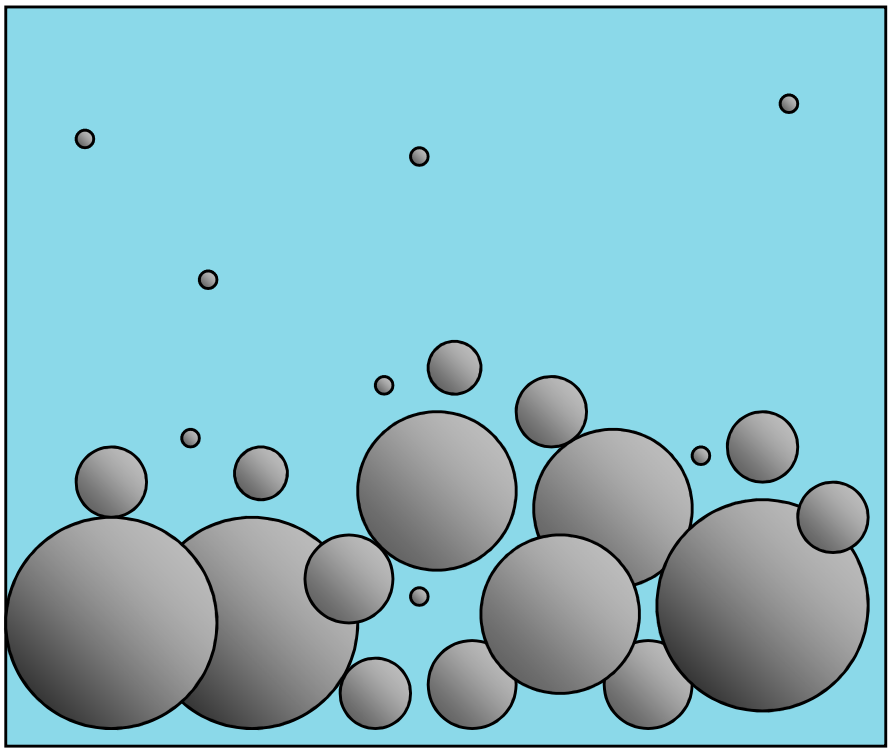
STORAGE AND HANDLING

- **<u>Coalescence</u>** – particles that stick together become larger.
- Reasons for this maybe due to flocculation.

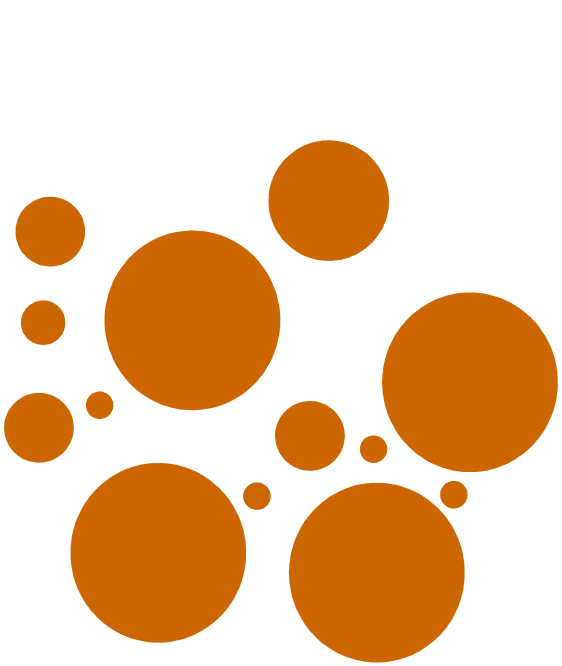


STORAGE AND HANDLING

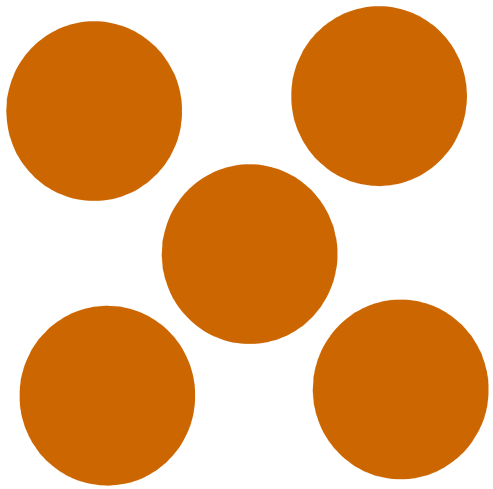
- **<u>Settlement</u>** – the heavier asphalt particles settle to the bottom of the tank.
- Reasons for this maybe prolonged storage, lack of mixing, problems with asphalt compatibility or wrong chemical load.



PARTICLE SIZE AFFECTS EMULSION BREAKDOWN



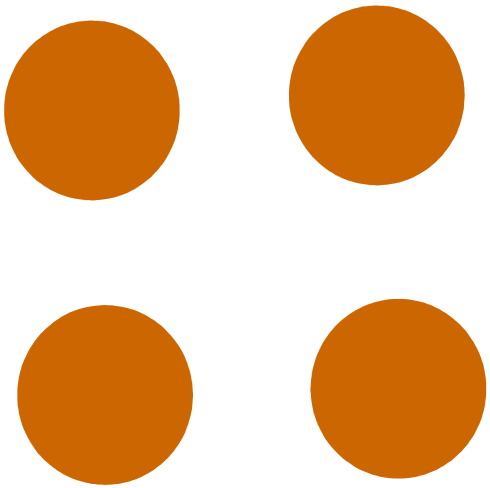
Variable Size
Pack Efficiently



Same Size
Pack Poorly

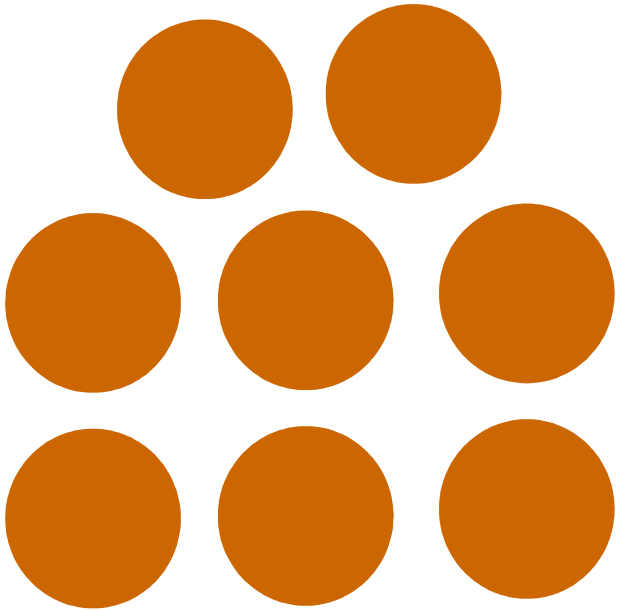
Poor Packing is More Stable
and Produces Higher Viscosity

VISCOSITY IS RELATED TO QUANTITY OF EXTERNAL PHASE AND PACKING



Low Asphalt Content

Low Viscosity



High Asphalt Content

High Viscosity

STORING ASPHALT EMULSIONS

- DO store as you would water – between 50ºF and 185ºF, depending on the intended use and specific product.
- DO store at the temperature specified for the particular grade and application.
- DO NOT permit the asphalt emulsion to be heated above 185ºF. Elevated temperatures evaporate water, changing the characteristics of the asphalt emulsion.
- **DO NOT let the emulsion freeze**. This breaks the emulsion, separating the asphalt from the water. The result will be two layers in the tank, neither of which will be suited for the intended use.
- DO NOT allow the temperature of the heating surface to exceed 212ºF. This will cause premature breakdown of the emulsion on the heating surface.
- DO NOT use forced air to agitate the emulsion. It may cause the emulsion to break.

- Chapter Three from the Basic Asphalt Emulsion Manual. The Asphalt Institute

HANDLING EMULSIFIED ASPHALTS

- DO when heating emulsified asphalt agitate it to eliminate or reduce skin formation.
- DO protect pumps, valves, and lines from freezing in winter. Drain pumps or fill them with anti-freeze according to the manufacture's recommendations.
- DO blow out lines and leave drain plugs open when they are not in service.
- DO use pumps with proper clearances for handling emulsified asphalt. Tightly fitting pumps can cause binding and seizing.
- DO use a mild heating method to apply heat to the pump packing or casing to free a seized pump. Discourage the use of propane torches.
- DO warm the pump to about 150ºF (65ºC) to ease start-up
- DO when a pump is to be out of service for even a short period of time, fill it with fuel oil to ensure a trouble free start-up.
- DO before dilution grades of emulsified asphalt, check the compatibility of the water with emulsion (not the emulsion to the water).
- DO if possible, use warm water for dilution and always add the water slowly to the emulsion (not the emulsion to the water).
- **DO avoid repeated pumping and recycling**, if possible, as the viscosity may drop and air may become entrained, causing the emulsion to be unstable.

- Chapter Three from the Basic Asphalt Emulsion Manual. The Asphalt Institute

HANDLING EMULSIFIED ASPHALTS

- DO guard against mixing different classes, types, and grades of emulsified asphalt in storage tanks, transports, and distributors. For example, if cationic and anionic emulsified asphalts are mixed, the blend will break and separate into water and coagulated asphalt that will be difficult to remove. Because it is hard to determine visually the difference between various emulsified asphalts, always make a trial blend of the newly-delivered emulsion and the stored emulsion before pumping off. Check the trial blend for compatibility.
- DO place inlet pipes and return lines at the bottom of tanks to prevent foaming.
- DO pump from the bottom of the tank to minimize contamination from skinning that may have formed.
- **DO remember** that emulsions with the same grade designation can be very different chemically and in performance.
- DO haul emulsion in truck transports with baffle plates to prevent sloshing.
- DO mix by circulation, or otherwise, emulsions that have been in prolonged storage.

- Chapter Three from the Basic Asphalt Emulsion Manual. The Asphalt Institute

HANDLING EMULSIFIED ASPHALTS

- DO NOT use tight-fitting pumps for pumping emulsified asphalt; they may seize or shear the asphalt emulsion.
- DO NOT apply severe heat to pump packing glands or pump casing. The pump may be damaged and the asphalt may become even harder.
- DO NOT dilute rapid-setting grades of emulsified asphalt with water. Medium and slow setting grades may be diluted, but always add water slowly to the asphalt emulsion. Never add the asphalt emulsion to a tank of water when diluting.
- DO NOT re-circulate emulsified asphalts for too many cycles. They tend to lose viscosity when subjected to excessive pumping. Also, air bubbles may become entrained which would render the emulsion unstable.
- DO NOT load emulsified asphalt into storage tanks, tank cars, tank transports, or distributors containing remains of incompatible materials.

- Chapter Three from the Basic Asphalt Emulsion Manual. The Asphalt Institute

WHY IS PROPER STORAGE AND HANDLING SO IMPORTANT?

- Quality of the emulsion
- Performance and application of the emulsion.
- COST!!!

TESTING OF EMULSIONS

- Composition
  - Particle Charge
  - Density
  - Distillation
- Storage and Handling
  - Storage Stability
  - Sieve
  - Saybolt Viscosity
- Reactivity
  - Demulsibility
- Residue Tests
  - Float Test
  - Penetration
  - Dynamic Shear Rheometer

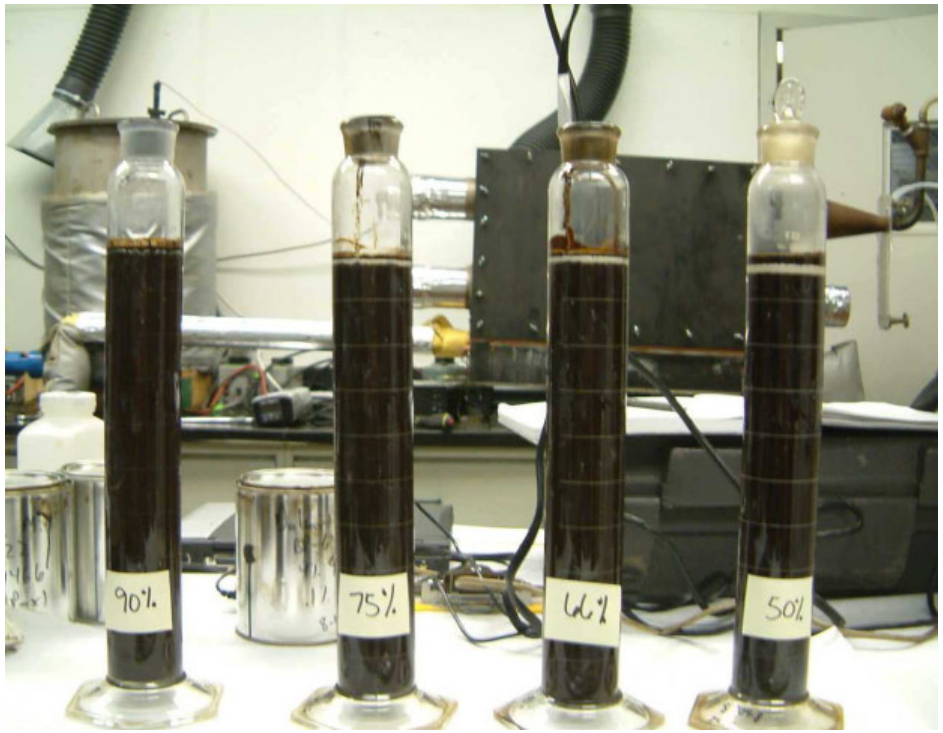
PARTICLE CHARGE TESTER

- Used to identify the charge of the emulsion.
- Cationic (positive)
- Anionic (negative)
- Non-ionic (no charge)
- ASTM D 244

SAYBOLT FUROL VISCOSITY

- Measure the viscosity of the emulsion.
- Test temperatures are 25ºC and 50ºC.
- Viscosity is defined as a fluid's resistance to flow.
- ASTM D 244

STORAGE STABILITY



- Indicates an emulsion's stability in storage.
- Sample is taken from the top and bottom after 24hrs.
- Residues can only differ by less than 1.0%.
- ASTM D 6930

OVERSIZED PARTICLES IN EMULSIFIED ASPHALT (Sieve Test)

- Test to measure the quality of an emulsion
- Excessive amounts of sieve (>0.1%) indicate emulsion instability.
- ASTM D 6933

DEMULSIBILITY

- Test indicates the relative rate at which the colloidal asphalt particles in an emulsion will break when mixed or spread on aggregate.
- Determines if the emulsion is rapid or slow setting.
- ASTM D 6936

EMULSION DENSITY

- Determines the density or weight per gallon on the emulsion.
- Emulsion's densities change depending on the asphalt content.
- Used for billing and inventory purposes.
- ASTM D 6937

DISTILLATION

- Used to separate the water from the asphalt.
- Measures the amount of asphalt in the emulsion.
- Additional tests are run on the residue that is recovered.
- ASTM D 6997

Float Test

- Measures the resistance to flow at elevated temperatures (140ºF).
- Float test is used for high float emulsions.
- ASTM D 139-95

PENETRATION

- Used to determined the hardness of the asphalt.
- ASTM D 5-05

RING and BALL

- Measures the softening point properties of an asphalt or emulsion residue.
- First developed for the roofing and waterproofing industry.
- ASTM D 36

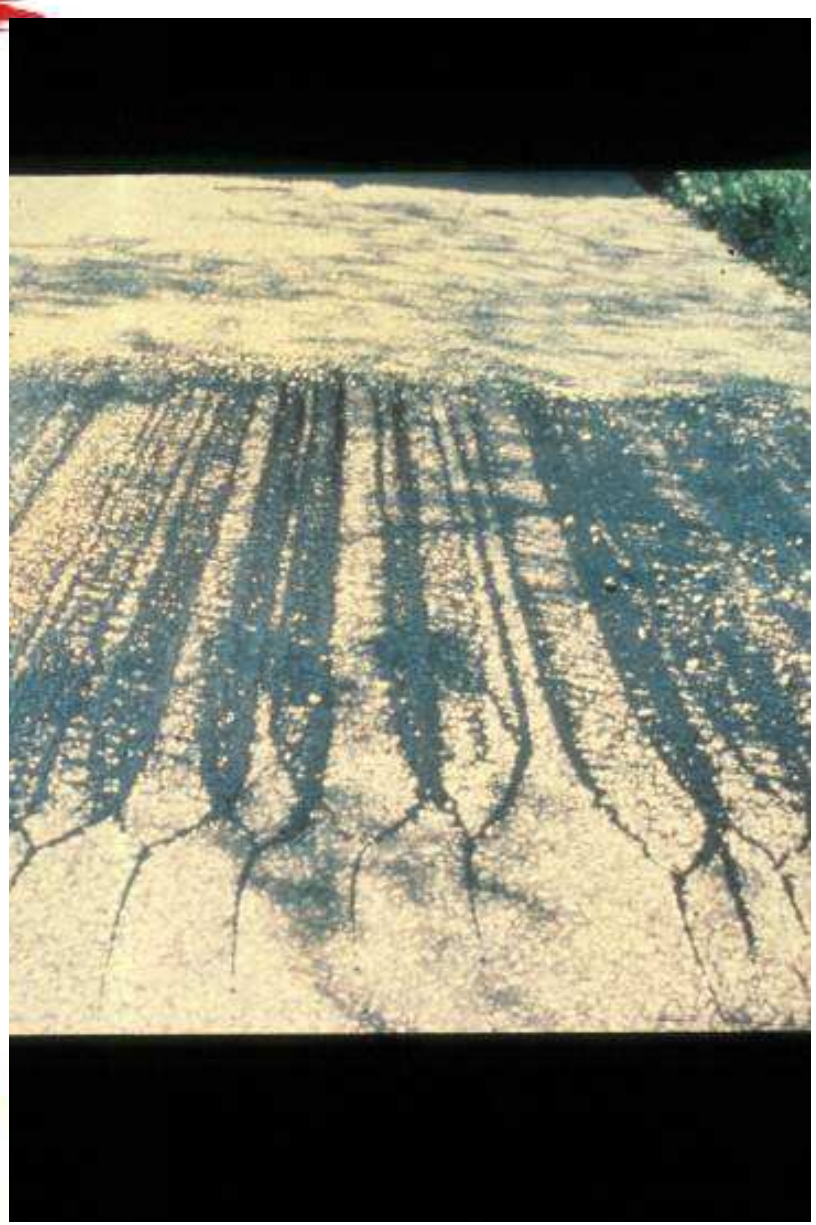
DYNAMIC SHEAR RHEOMETER

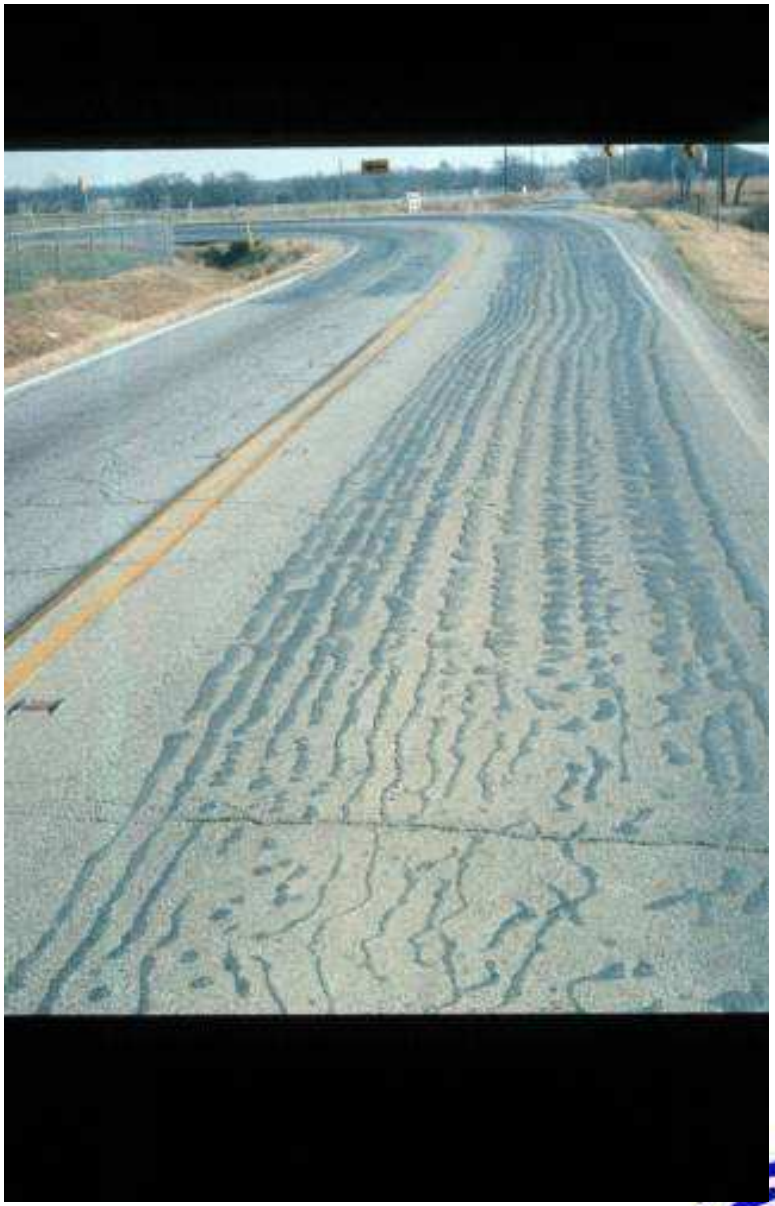
- Measures the rheological properties of an asphalt or emulsion residue.
- Developed for PG testing of asphalt binders

SUMMARY – WHY USE EMULSIONS

- Emulsions reduce apparent viscosity of product
- Allow application temperature to be reduced
- Reduces application rate necessary to achieve coating on a surface
- To improve adhesion by chemically attracting emulsion droplets to surface using charge

DON’T WANT FAILURES





WANT SUCCESSFUL PROJECTS

CONCLUSION

- The better that the materials are understood the better they can be used for their intended purpose
- Proper application is critical to success in pavements
- Use the resources of your emulsion supplier to achieve success in roads

THANK YOU

Adam Redman

Heritage Research Group

7901 W Morris Street

Indianapolis, IN 46231

adam.redman@heritage-enviro.com

(317) 390-3631