Benton County Preservation Round Table

February 16th 2016

UNDERSTANDING THE DIFFERENCES IN EMULSIONS AND THE MANUFACTURING PROCESS.

KEVEN HEITSCHMIDT

ALBINA ASPHALT

Topics.

- What is an asphalt emulsion?
- Emulsion classifications and common uses
- Emulsion chemistry
- Emulsion specifications and performance
- Emulsion Stability.

ALBINA ASPHALT

What is a emulsion?

- Solution
  - A homogeneous mixture of two substances
  - Individual molecules of one substance (solute) are surrounded by molecules of the other substance (solvent)
  - Examples:
    - Water (humidity) in air
    - Table salt in water
    - Metal alloys

ALBINA ASPHALT

What is an emulsion?

- Colloid or emulsion
  - A homogeneous mixture of two insoluble substances
  - Particles of one substance (dispersed phase) are surrounded by molecules of the other substance (continuous phase)

ALBINA ASPHALT

What is a emulsion?

- Colloid or emulsion
  - A homogeneous mixture of two insoluble substances
  - Particles of one substance (dispersed phase) are surrounded by molecules of the other substance (continuous phase)
  - Examples:
    - Smoke or fog (ash particles or water droplets)
    - Milk, butter, mayonnaise (fats)
    - Asphalt!

ALBINA ASPHALT

What is a emulsion?

- Asphalt
  - Composed of crystalline particles generally classified as “asphaltenes”
  - Asphaltenes are suspended in an oily liquid continuous phase generally classified as “maltenes”
  - The balance of composition determines asphalt physical properties such as rheology

What is a emulsion?

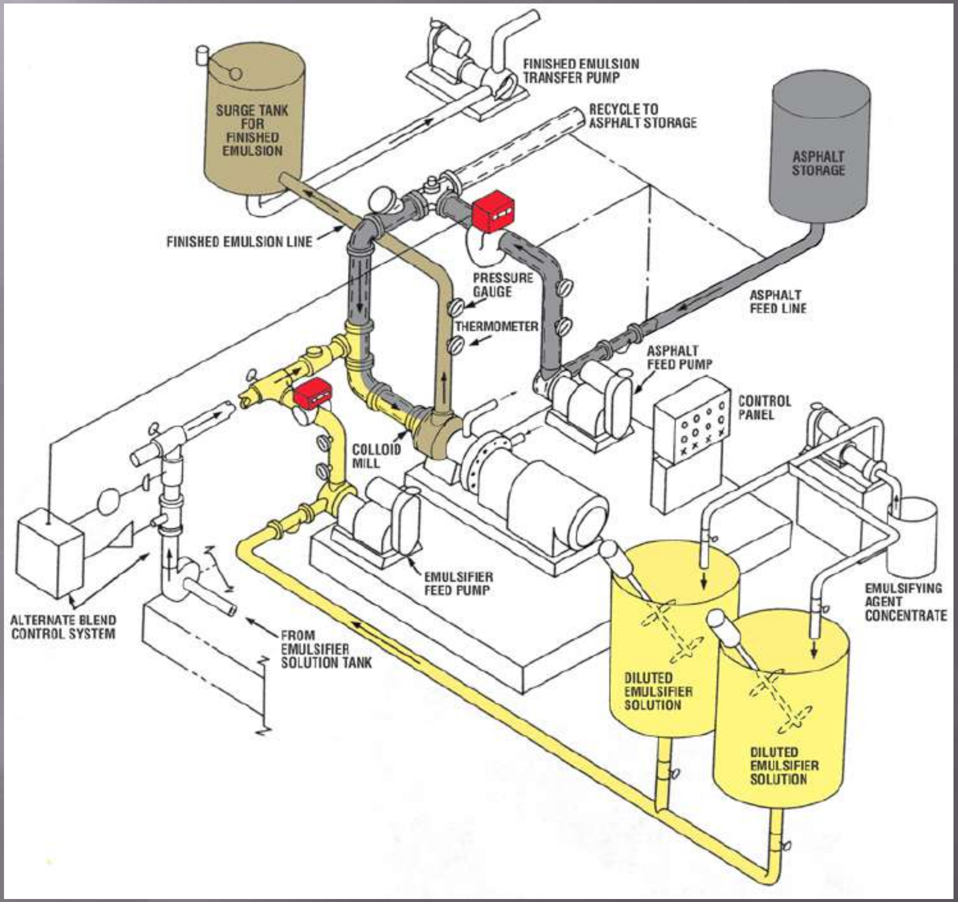
- Why emulsify asphalt?
  - Viscosity reduction and safer use at lower temperatures
  - Change from “oil based” to “water based” system
  - Reduced energy use, worker exposure, burn hazard and job site odor
  - Properly formulated emulsion systems provide long term performance benefits

ALBINA ASPHALT

What is a emulsion?

- Asphalts Soft pen, Hard pen
- Emulsifiers
- Chemical Activators
- Additives
- Polymers

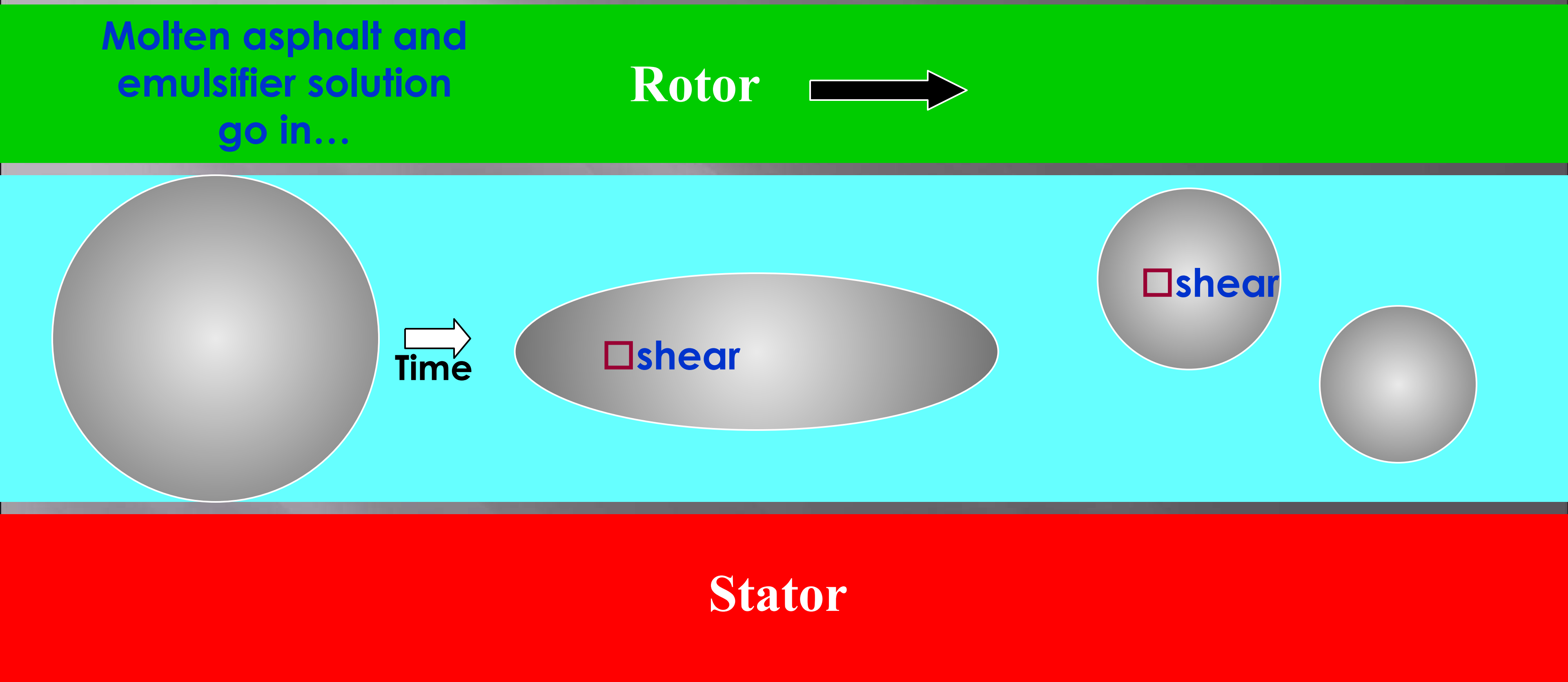
What is a emulsion?



ALBINA ASPHALT

What is a emulsion?

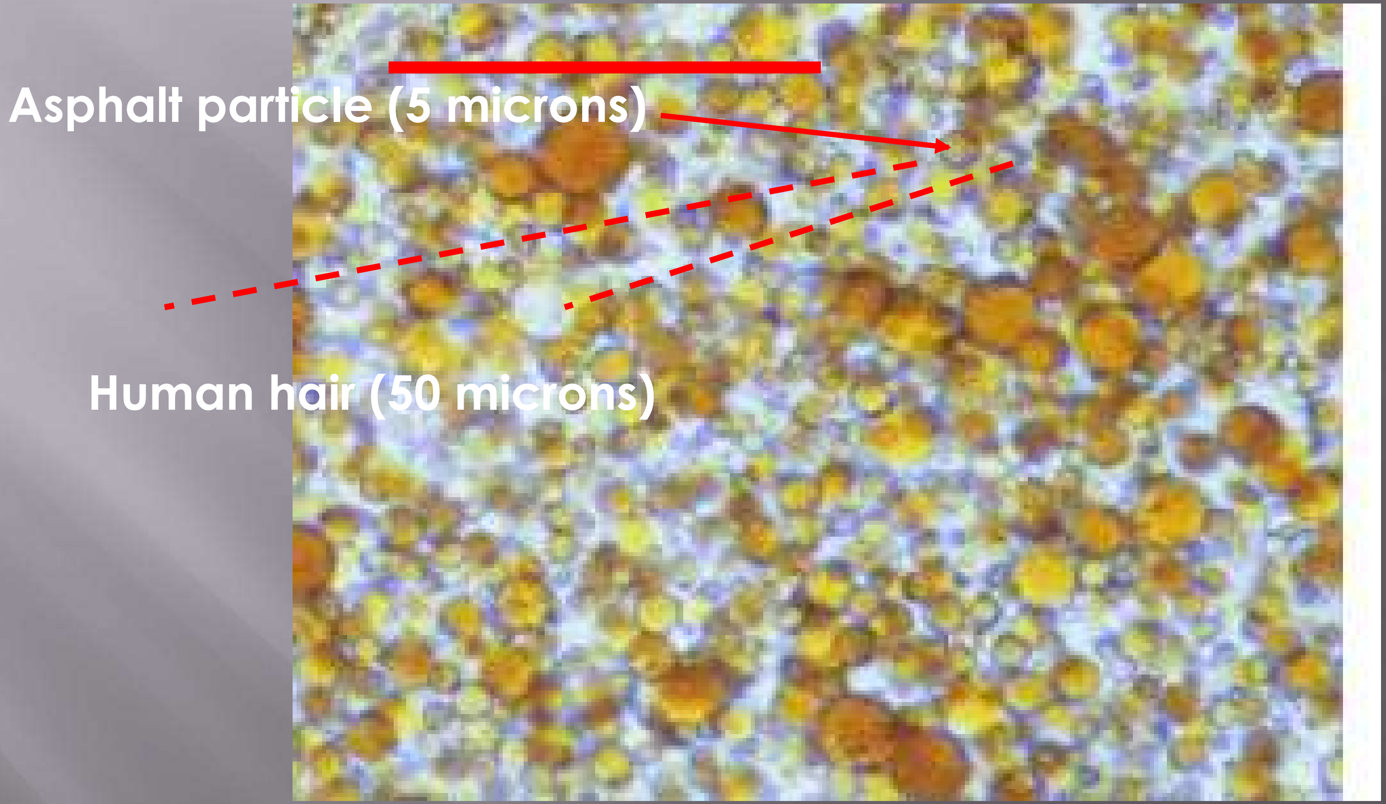
What is a emulsion?



What is a emulsion?

What is a emulsion?

What is a emulsion?



What is a emulsion?

- Average 3-7 microns diameter
- Asphalt is usually 57-70% of the emulsion
- 1 gram of asphalt will form more than 10 billion particles
- The total surface area of 1 gram of asphalt is 1-2 m^2
- One drop of emulsifier would stabilize as much as 100 billion particles or 10-20 m^2 of asphalt particle surface area

ALBINA ASPHALT

Emulsion Classifications

- Cationic
- Anionic
- Nonionic (usually treated as a subset of the anionic classification)

ALBINA ASPHALT

Emulsion Classifications

- Each classification is based on the electrical charge on the asphalt particles' surface
- The particle charge is determined by the emulsifier and the water pH

Emulsion Classifications

- Cationic
  - Definition - having a positive electrical charge
  - The emulsifier has a positive charge
  - Since the emulsifier coats the asphalt particle surface, all of the particles have a positive charge

Emulsion Classifications

- Anionic
  - Definition - having a negative electrical charge
  - The emulsifier has a negative charge
  - Therefore, all of the asphalt particles have a negative charge

ALBINA ASPHALT

Emulsion Classifications

- Nonionic
  - Definition - having no electrical charge
  - The emulsifier has very little or no charge
  - The asphalt particles also have little or no charge
  - Particles are protected by a viscous layer formed by the emulsifier

ALBINA ASPHALT

Emulsion Classifications

- Common Cationic Classifications
- CRS, CMS, CQS, and CSS
- Each classification will have a suffix such as "-1" or "-2" (emulsion viscosity) and/or an "h" (asphalt base hardness)
- Examples: CRS-2, CQS-1h, CSS-1
- Other designations: P=polymer (solid or latex) LM=latex polymer, s=solvent, many others…

ALBINA ASPHALT

Emulsion Classifications

- Common Anionic Classifications
- RS, HFRS, MS, HFMS, QS, and SS
- Each classification will have a suffix such as "-1" or "-2" (emulsion viscosity) and/or an "h" (asphalt base hardness)
- Examples: HFRS-2, SS-1h
- Other designations: P=polymer (solid or latex) LM=latex polymer, s=solvent, many others…

ALBINA ASPHALT

Emulsion Classifications

- Why do we have different classifications?
  - Producing an emulsion that is stable for storage or handling is easy…
  - …but emulsions must be designed to break at exactly the right time in the construction process and perform well over the long-run

ALBINA ASPHALT

Emulsion Classifications

Rapid Set | Medium Set | Quick Set | Slow Set

Spray Grade Emulsions

Mixing Grade Emulsions

Emulsion Classifications

- Spray grade emulsions (rapid and medium sets)
- Designed to be marginally stable
- The chemical additives and dosages are chosen to allow reasonable handling stability, but easy destabilization
- Break with mild destabilizing effects
- Environmental exposure and/or on contact with flat surfaces

ALBINA ASPHALT

Emulsion Classifications

- Spray grade applications
- Chip seals
- Cape seals (the chip portion only)
- Tack coats
- Fog seals
- Prime coats

ALBINA ASPHALT

Emulsion Classifications

- Mixing grade emulsions (medium, quick and slow sets)
- Designed to be significantly more stable
- The chemical additives and dosages are chosen to allow good handling stability and designed destabilization
- Break with strong destabilizing effects
- Exposure to high aggregate fines, pH shifts, or challenging environment

ALBINA ASPHALT

Emulsion Classifications

- Mixing grade applications
- Slurry seals
- Micro-surfacing
- Cape seals (the slurry portion only)
- Cold mixes (solvent and solventless)
- Base stabilization, full depth reclamation, recycling, virgin aggregate intermediate and wearing courses, and patch mixes
- Emulsion based warm mixes

ALBINA ASPHALT

Emulsion Classifications

- Mixing grade emulsions in spray applications
- Tack coats and fog seals – diluted for weeks, pumped multiple times
- Chip seals – where dense graded or dusty aggregates are used
- Prime coats – emulsion stability needed to allow penetration into the base

Emulsion Classifications

- General emulsifier chemical structures
- "Salt" formation
- Surface activity of emulsifiers

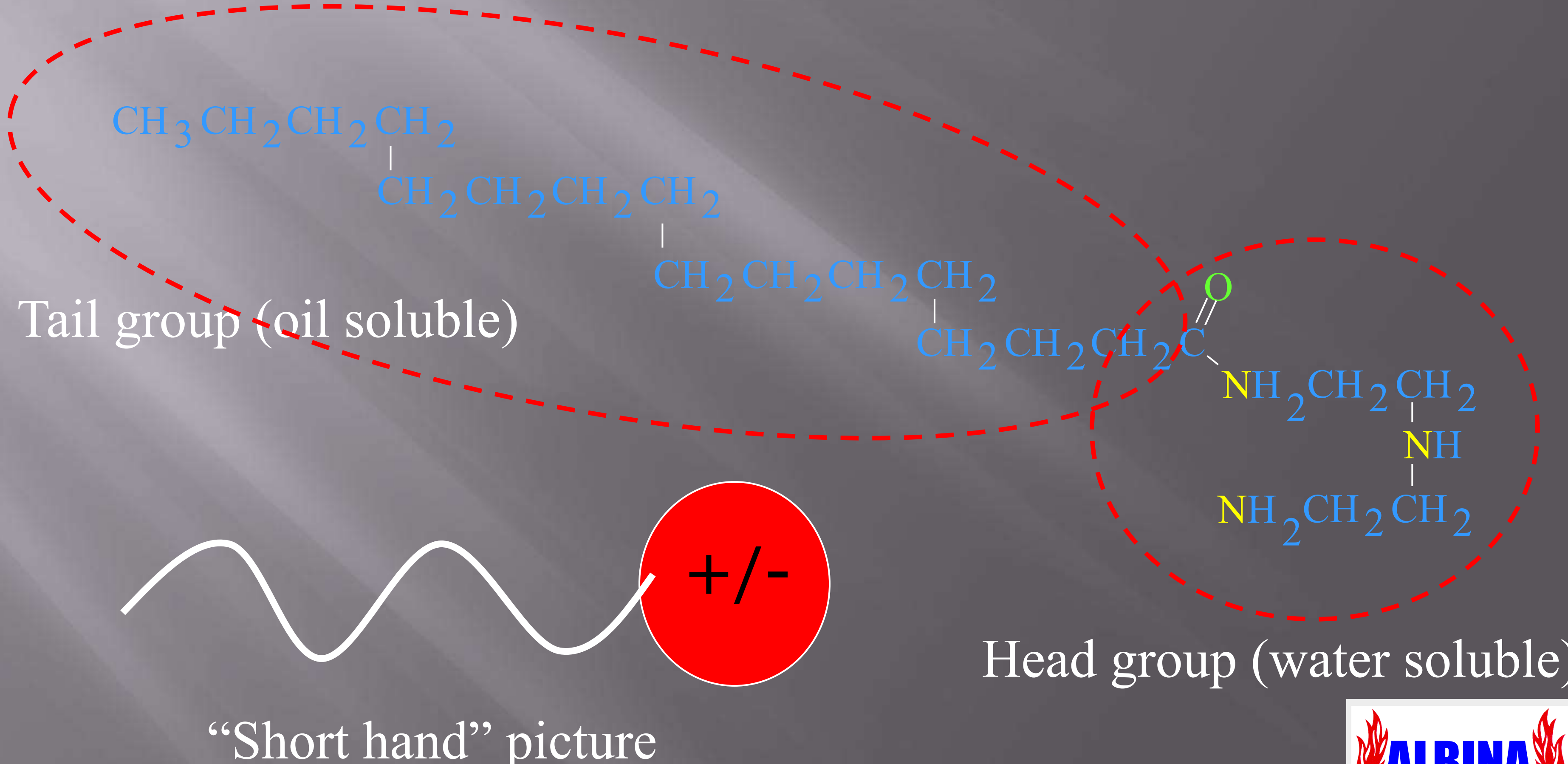
ALBINA ASPHALT

Emulsifier

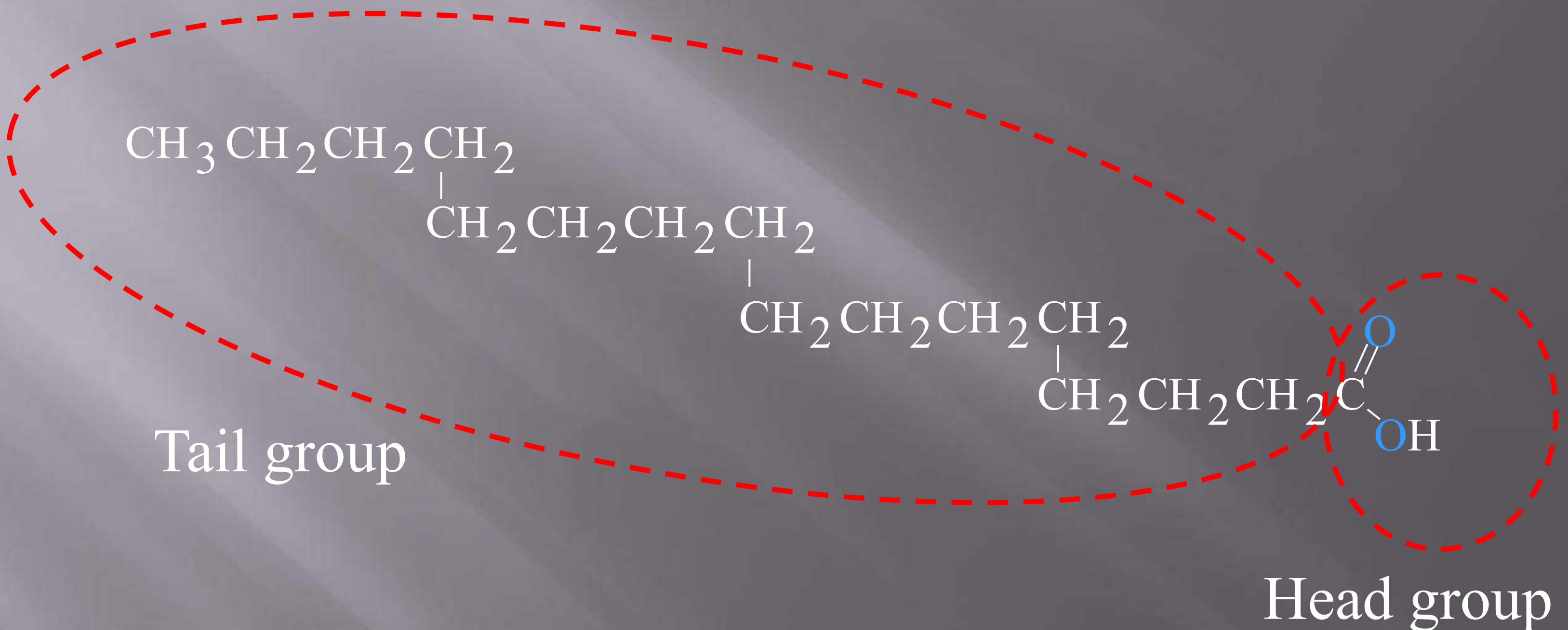
- An oil soluble part (Lipophilic)
- A water soluble part (Hydrophilic)
- Some characteristic that allows the molecule to protect the surface of the asphalt droplet
- Electrical charge…
- …or no charge, but large size

ALBINA ASPHALT

Emulsifier

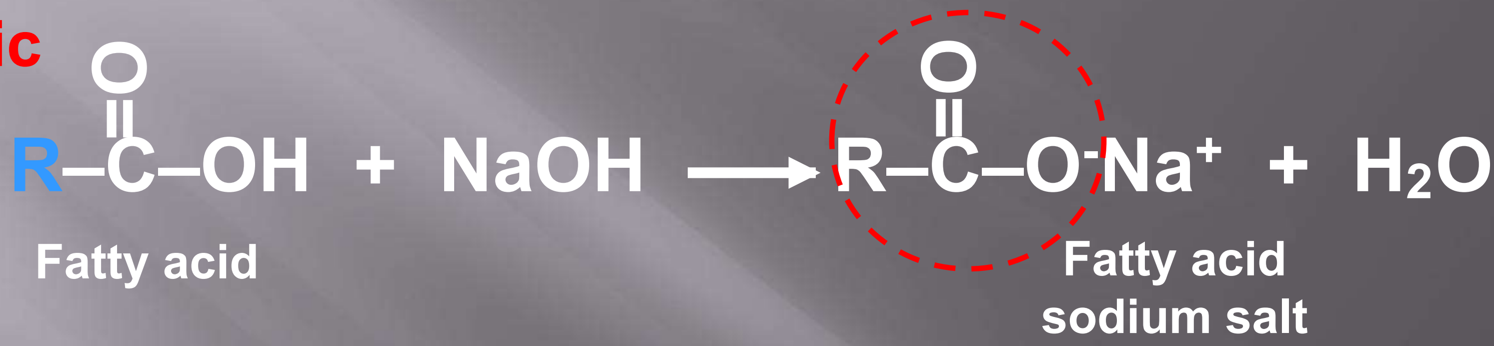

CH3 CH2 CH2 CH2
CH2 CH2 CH2 CH2
CH2 CH2 CH2 CH2
CH2 CH2 CH2 C
O
NH2 CH2 CH2
NH
NH2 CH2 CH2
Tail group (oil soluble)
Head group (water soluble)
+/-
"Short hand" picture

Anionic Emulsifier Molecule



Salt Formation

Anionic

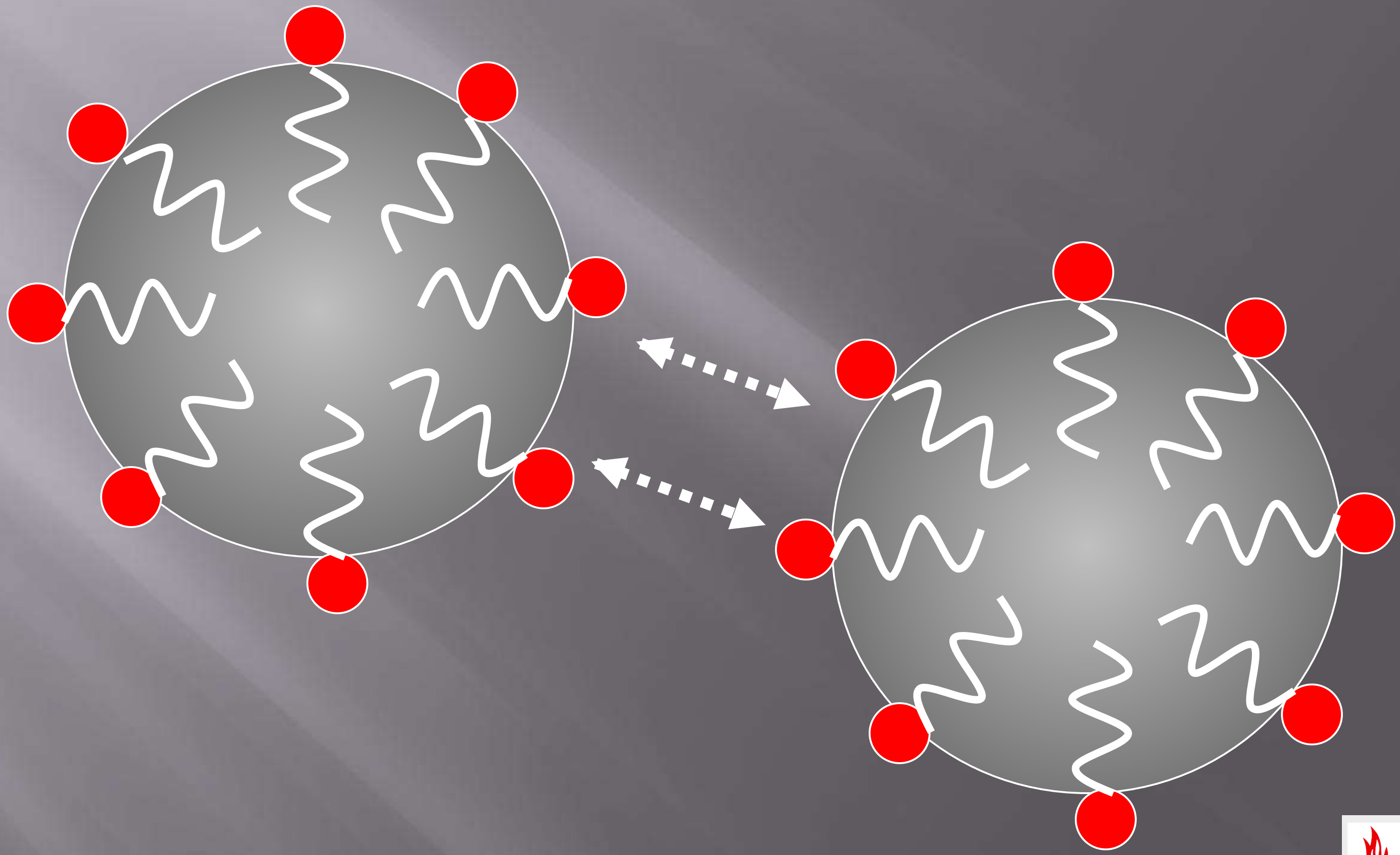


"R" = Hydrocarbon tail

Cationic

ALBINA ASPHALT

Emulsifier



Emulsifier

- "Application" usually refers to spraying the emulsion onto surfaces or mixing them with aggregates
- To understand emulsion performance, we need to know more about aggregate or other surfaces

ALBINA ASPHALT

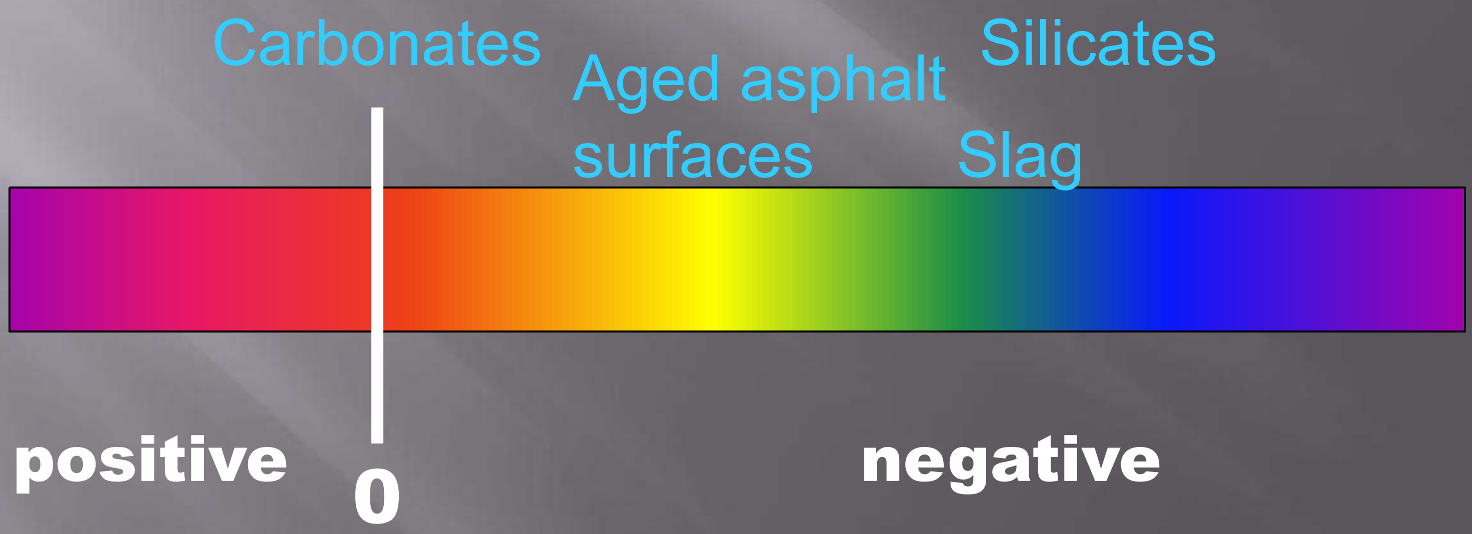
Aggregate

- Minerals have surface charges
- The charges on the asphalt particles interact with the stone's charges
- "Opposites attract" – longer life
- Silicates and slag – generally "–"
- Limestones – generally 0 or "+"

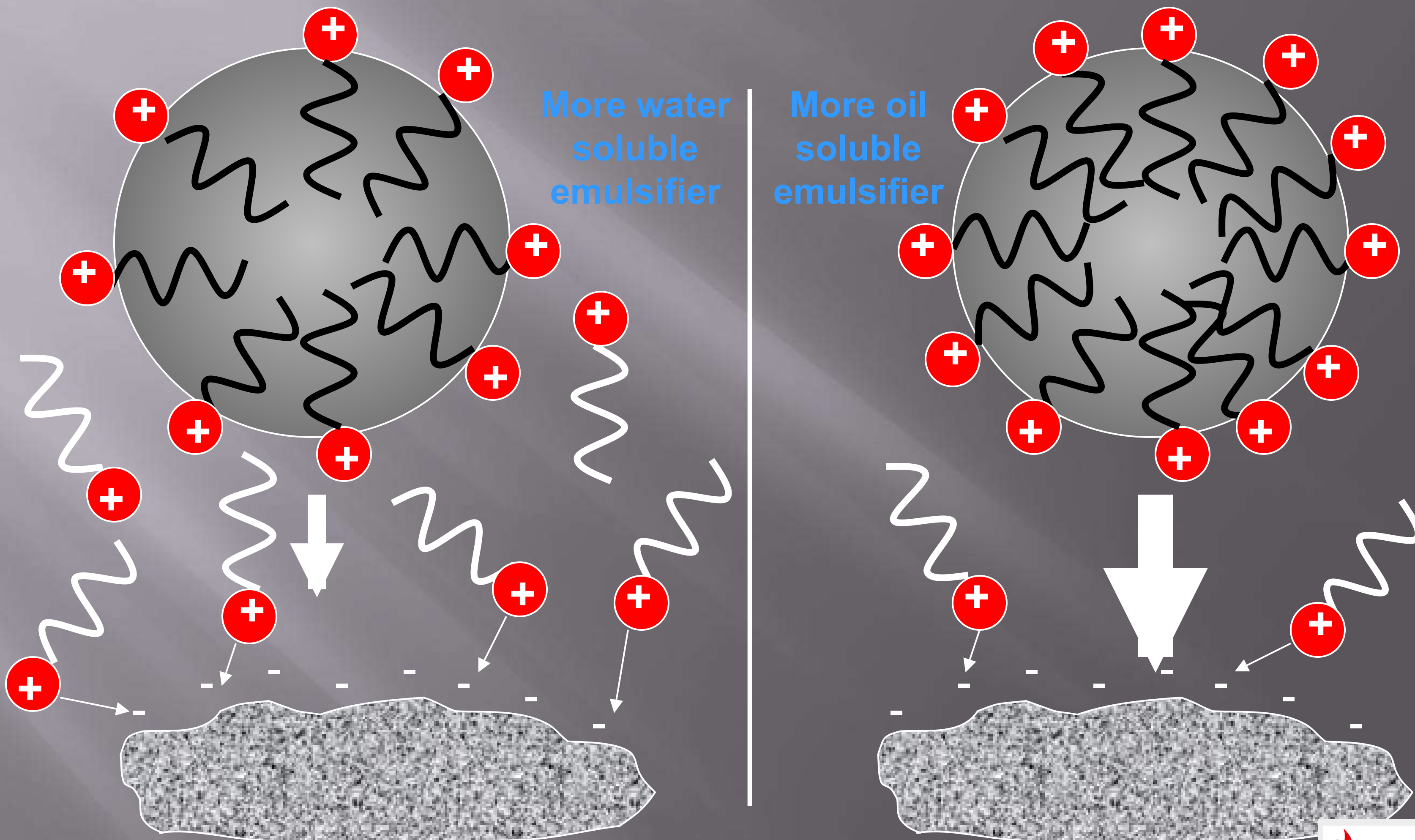
ALBINA ASPHALT

Surface Properties of Rocks

- Surface charge measurements (Zeta potential) show that general mineral categories fall in two zones
- This affects the rock's interaction with asphalt emulsions



The Emulsifier - Performance

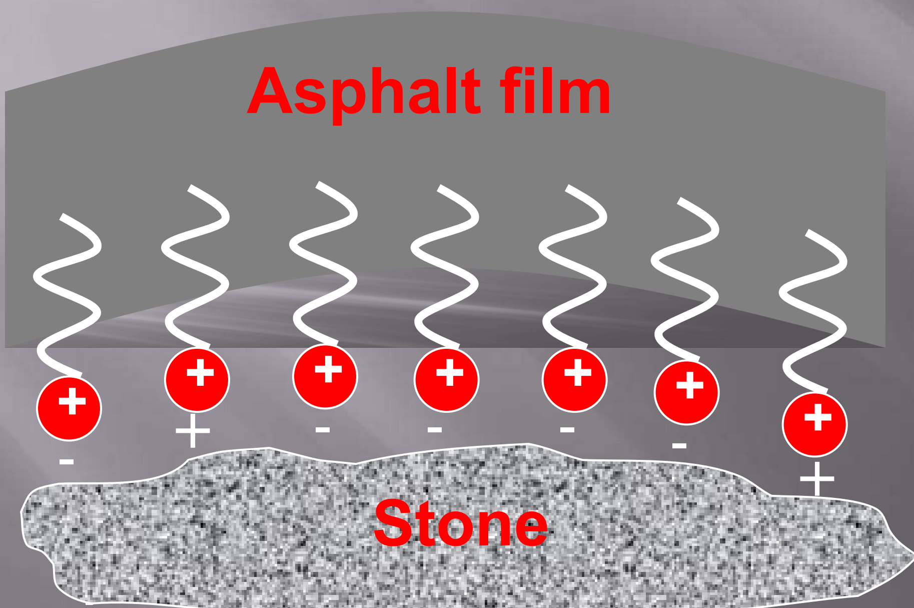


ALBINA ASPHALT

Adhesion – Silicate Mineralogy (Granite, Trap Rock, Basalt, Slag…)

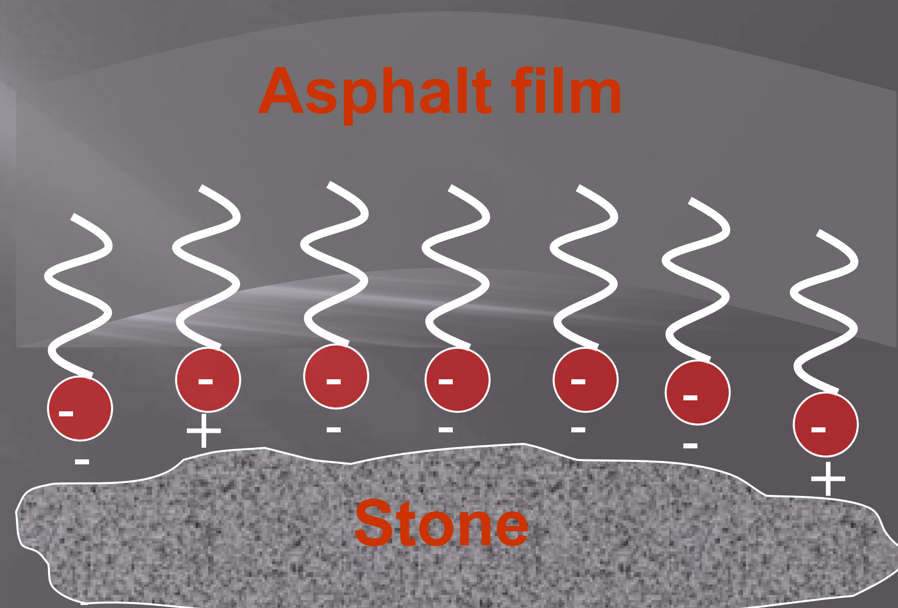
Cationic Emulsion

Opposite charge interaction produces a tight bond



Anionic Emulsion

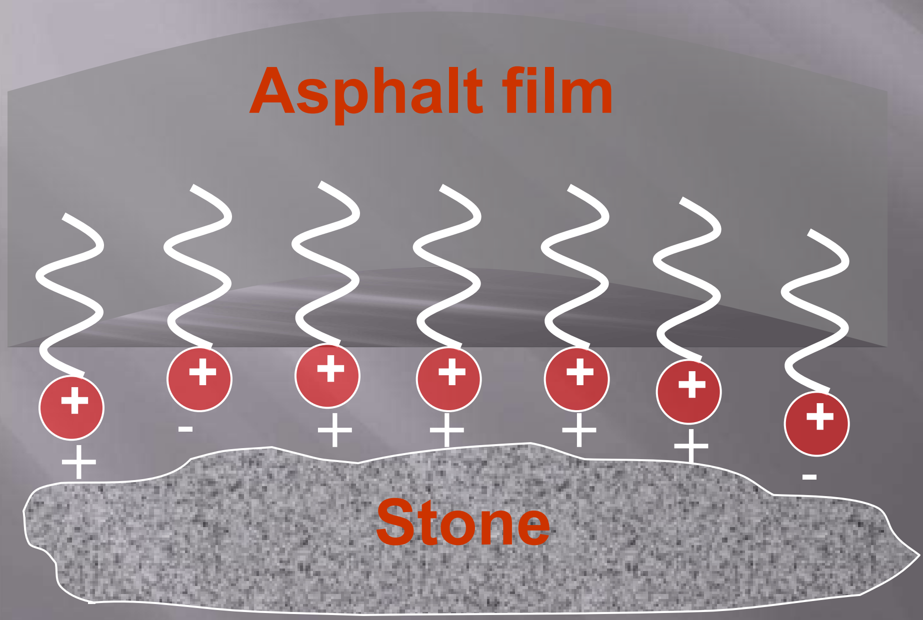
Similar charge interaction produces a weak bond



Adhesion – Carbonate Mineralogy (Limestone, Dolomite…)

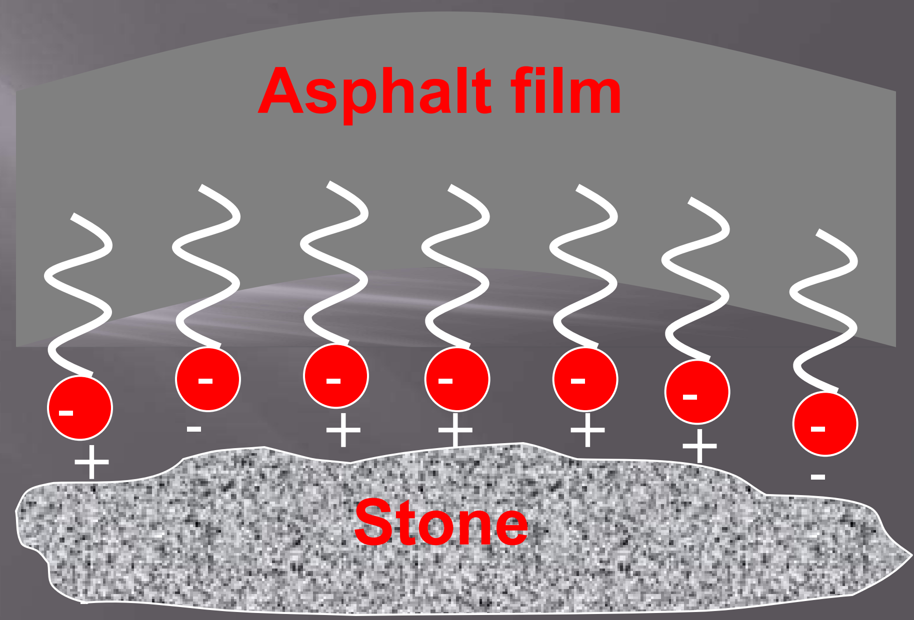
Cationic Emulsion

Similar charge interaction produces a weak bond



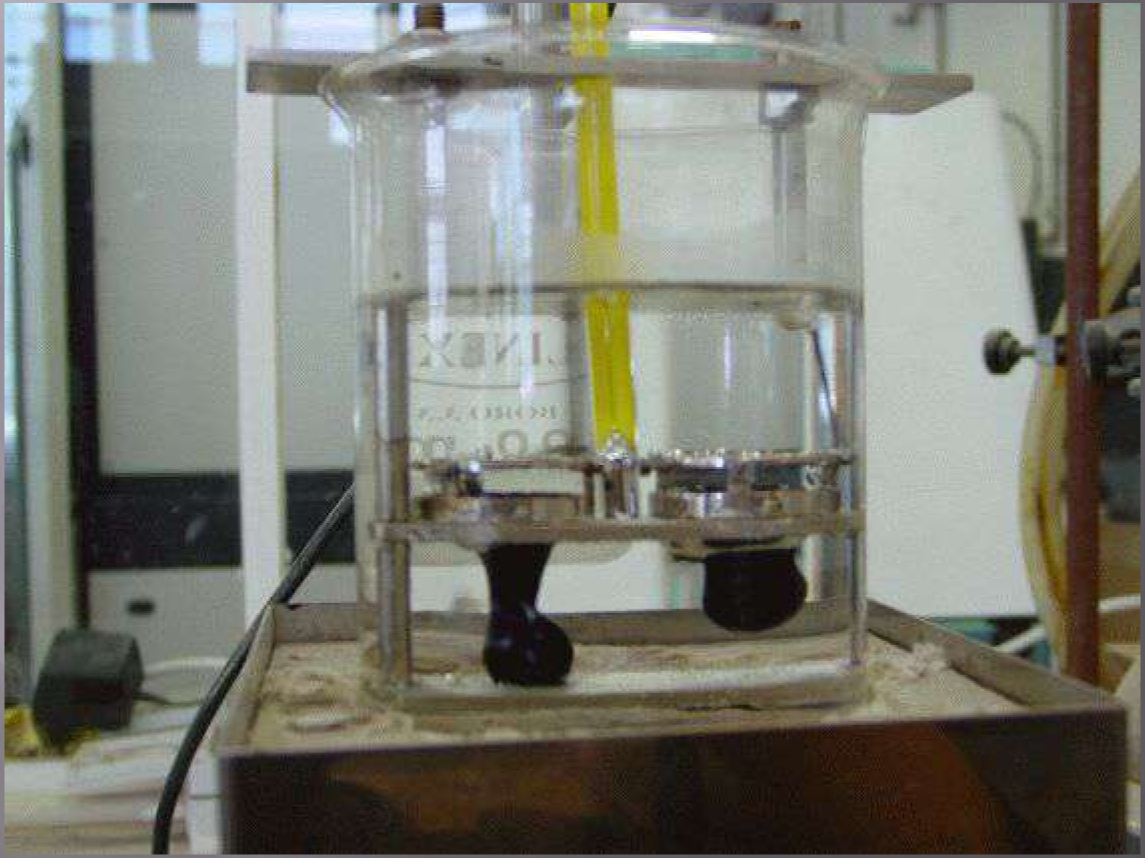
Anionic Emulsion

Opposite charge interaction produces a tight bond



ALBINA ASPHALT

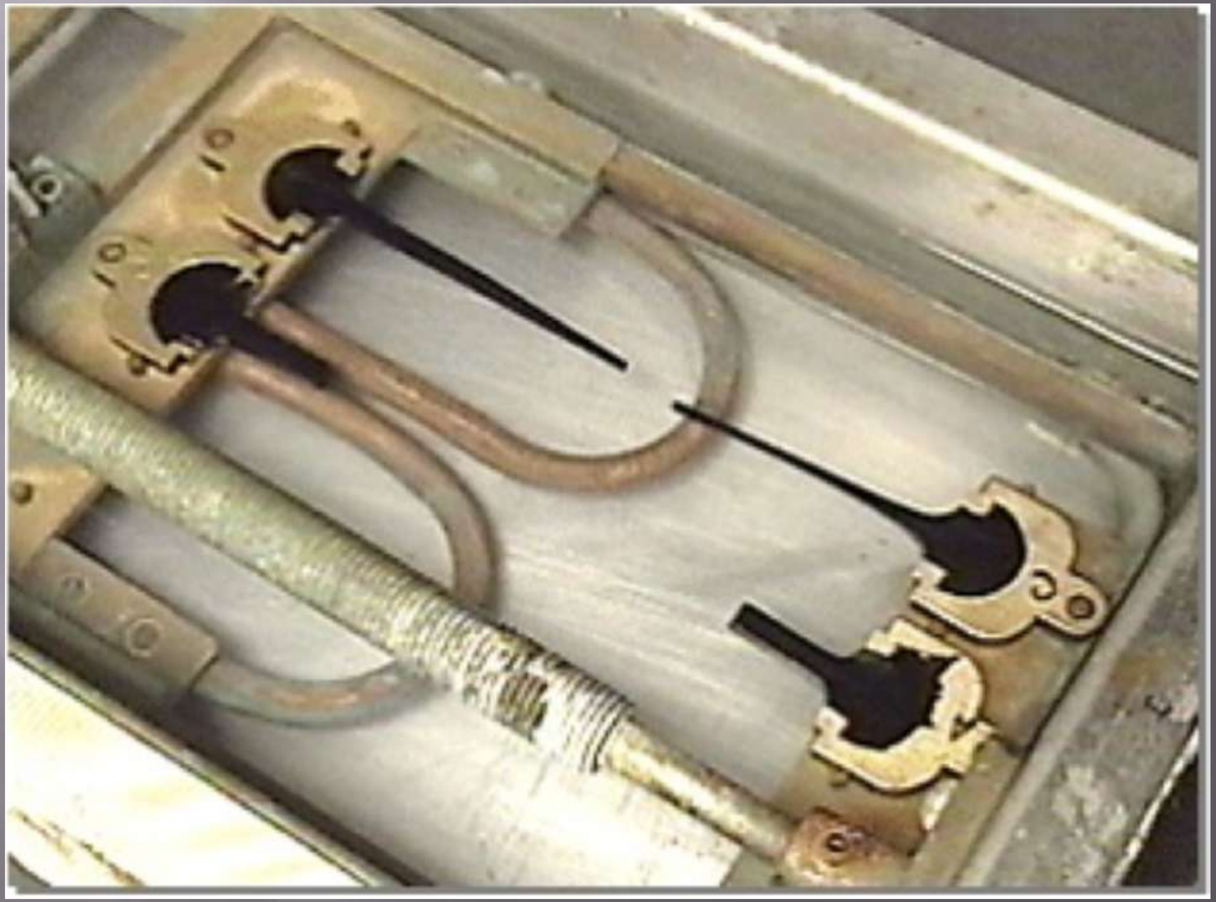
Softening Point Test



ALBINA
ASPHALT

Penetration Test

Elastic Recovery Test



Possible Future Test?

ALBINA ASPHALT

Emulsions

Emulsion	90-1S	CSS	CRS-2	CRS-2P	CQS	MSE
Orig Properties						
Viscosity @77°F SFS		30-90			30-90	30-90
Viscosity @122°F SFS	390		100-400	100-400		
20 Mesh Sieve	1.0 Max	1.0 Max	1.0 Max	1.0 Max	1.0 Max	1.0 Max
Cement Mixing		Max 2.0%			Max 2.0%	
Particle charge	Negative	Positive	Positive	Positive	Positive	Positive
Demulsibility	Min 40%		Min 40%	Min 40%		
Distillation						
Res by Distillation %	67	62	67	67	62	65
Pen 77°F	125	105	115	110	60	48
Float Test	1300 sec					
Ductility at 77°F	Min 40	Min 40	Min 40	Min 40	Min 40	Min 40
Elastic Recovery @50°F	30%		0	55%	0	65%
Softening point °F	123	100	100	115	105	143
% Torsional Recovery	18	0	0	23	0	35

Thank You!

Questions??

ALBINA ASPHALT