# Evolution of Oil – Where Did the Cutbacks Go?

North  Dakota Asphalt Conference

2019

# Role of Asphalt Binder in Chip Seal

**Asphalt acts as an adhesive**

**To allow aggregate to adhere to the road**

# Role of Asphalt Products in Surface Treatment (Chip Seal)

**Primary Role**

- Adhere the aggregate to the road
- Provide waterproofing to reduce incursion of water into lower pavement layers

**Additional considerations of sealcoat binder selection**

- Tolerant of variations of conditions and materials during placement
- Durability from a mechanical and moisture resistance standpoint
- Practical – asphalt product must work with equipment and crew practice

# What choices do you have for Chip seal Binder ?

**Forms of Asphalt**

- Asphalt Cutbacks
- Asphalt Emulsions
  - Chemically formulated to meet aggregate or application needs

**Similarities**

- Both asphalt cutback and asphalt emulsion are made with asphalt cement
  - Example - PG 58-28
  - Because they do not go through a hot plant the asphalt is not subjected to oxidation and hardening during the construction process

# Historical Application of Cutback Asphalt

- Cutbacks developed prior to asphalt emulsion
- Solvent "cutter / diluent"
  - Reduces asphalt viscosity during placement
  - Evaporates
- Decreased viscosity allows for easier handling and spray application
- Provides asphalt with ability to coat aggregate to promote adhesion
- Volatility of solvent provides initial workability but a transition to stiffer asphalt as the cutback cures on the road

# Cutback Asphalt Components

- Cutback- asphalt addition of cutter / diluents
- Cutback product grades differentiated based on cure time and viscosity. The more cutter the lower the viscosity

<u>Grade</u>

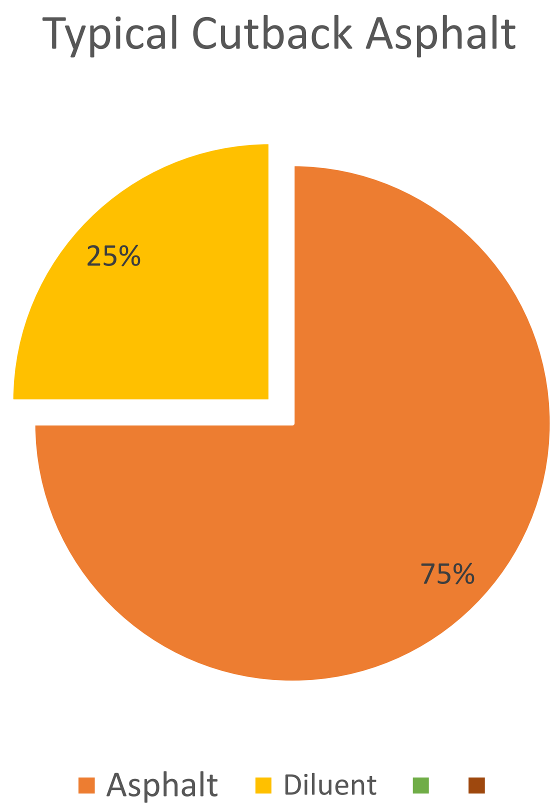
- ~~Rapid Cure (RC)~~
- Medium Cure (MC)
- Slow Cure (SC)

<u>Cutter / diluent</u>

- Naphtha
- Kerosene
- Heavy Fuel oil

# The Disadvantages of Cutback Asphalt

- Subject to expanding environmental regulations
- Safety factors
- Cost of fuel – refined products are used
- Damp conditions can negatively affect performance
  - Wet aggregate
  - Wet pavement surface
- Lengthy cure times
- Lack of performance improvements provided by current technologies



# Chip Seals Asphalt Binders

- Cutbacks
  - MC-3000
  - MC-800
- Emulsions
  - Cationic Emulsions
    - Fast cure positively charged chemistry
    - Polymer modification options
      - CRS (cationic rapid set)
      - CHFRS (cationic high float rapid set)
  - Anionic Emulsions – generally not employed in North Dakota due to mineralogy

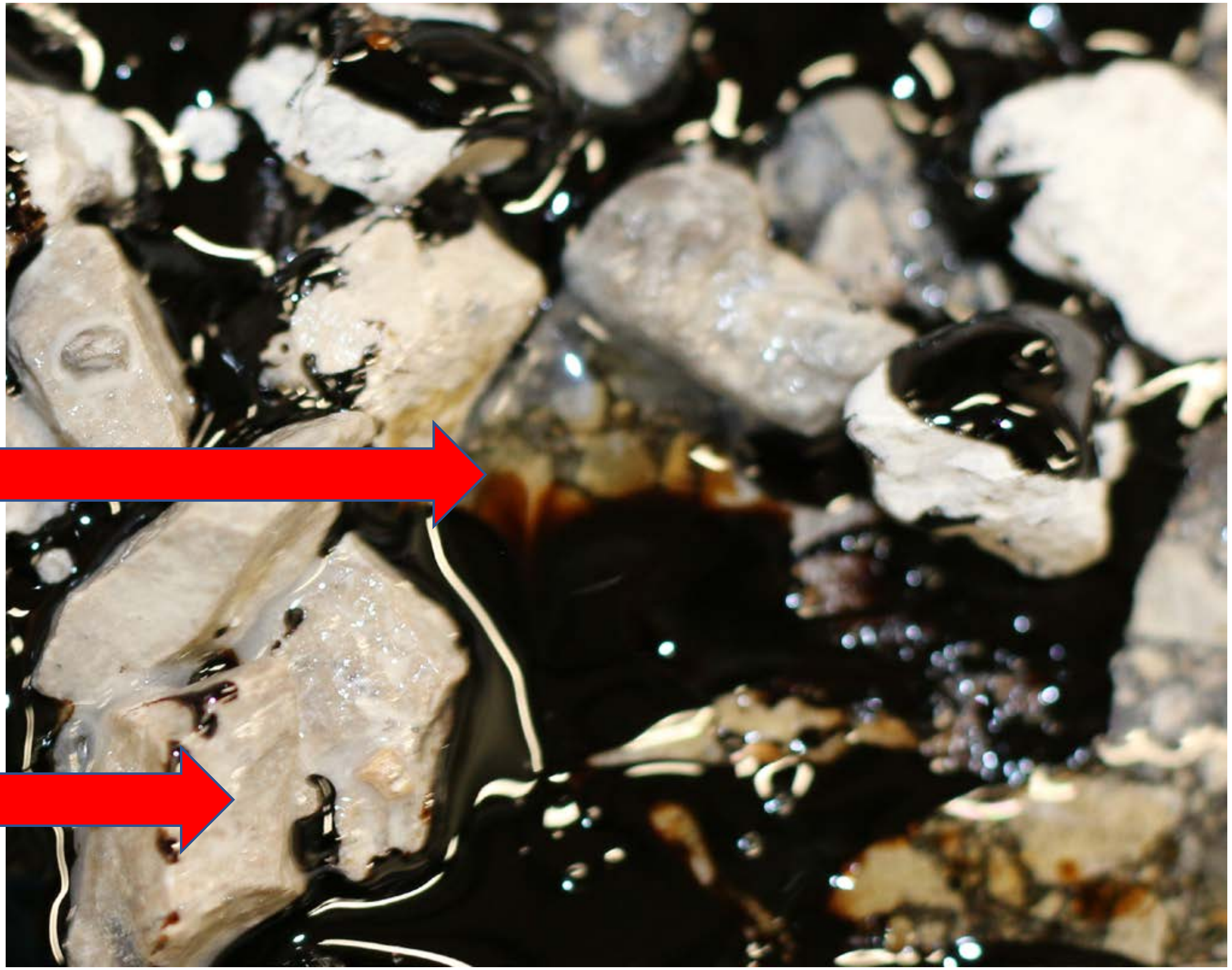
# Dry  Aggregate and Surface with Cutback

- MC-3000 or MC-800 can work well with dry pavements and dry aggregates
- MC-3000 or MC-800 can work well slightly dirty or pit run aggregates

# Wet Aggregate and Surface with Cutback prevents good adhesion

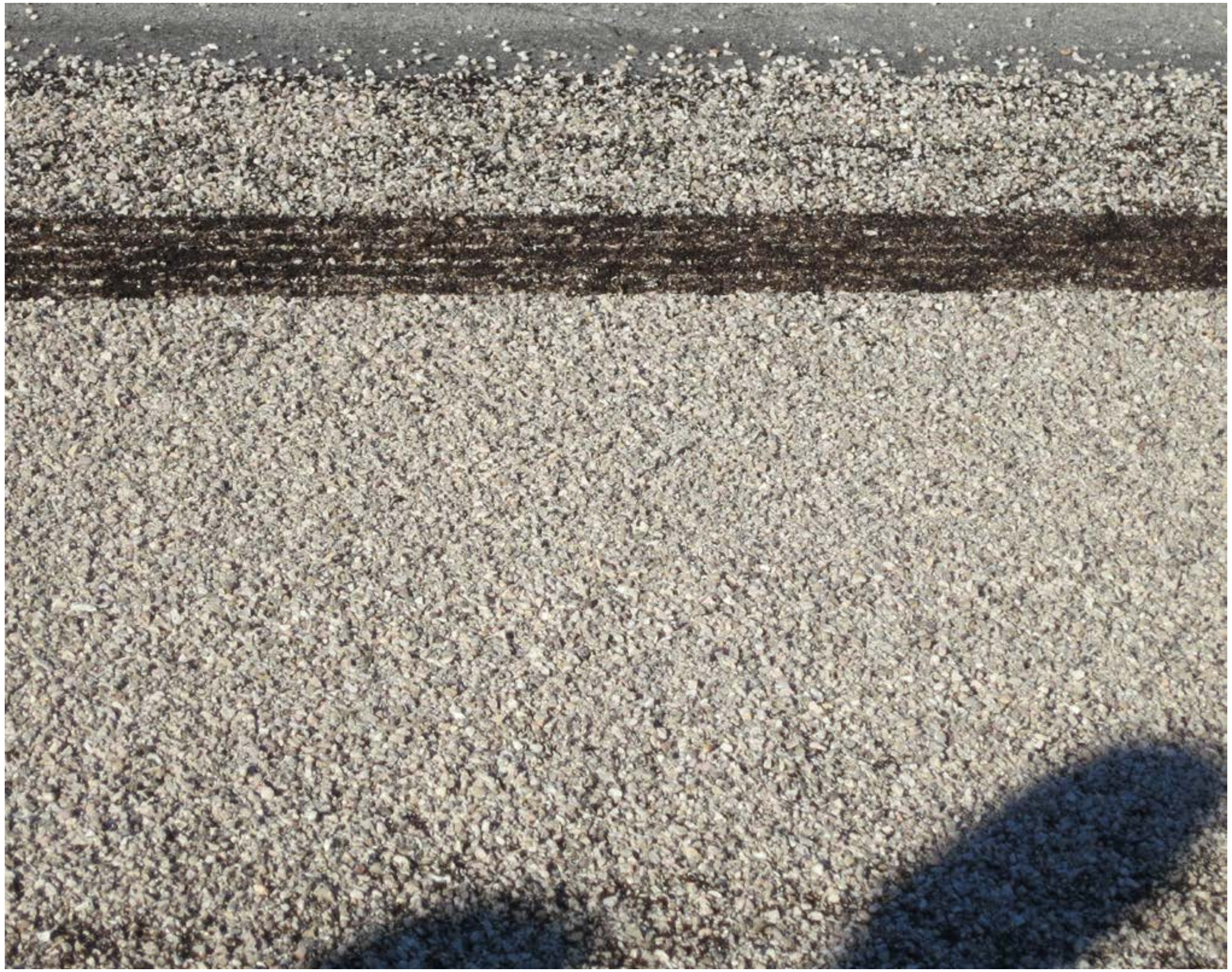
MC-3000 is prevented from bonding to the surface if the pavement or aggregate is wet

Note uncoated pavement and minimal adhesion to aggregate



# Asphalt Cutbacks

- Stay soft a long period of time
- Subject to tracking and bleeding



# ASPHALT EMULSIONS

- Asphalt emulsions were developed in the early 1900's
- Asphalt emulsions are a stabilized dispersion of asphalt droplets in water
- Reduction in asphalt viscosity achieved through incorporation of water (rather than solvent in cutbacks)
  - Safer handling
  - Allows application at much lower temperatures

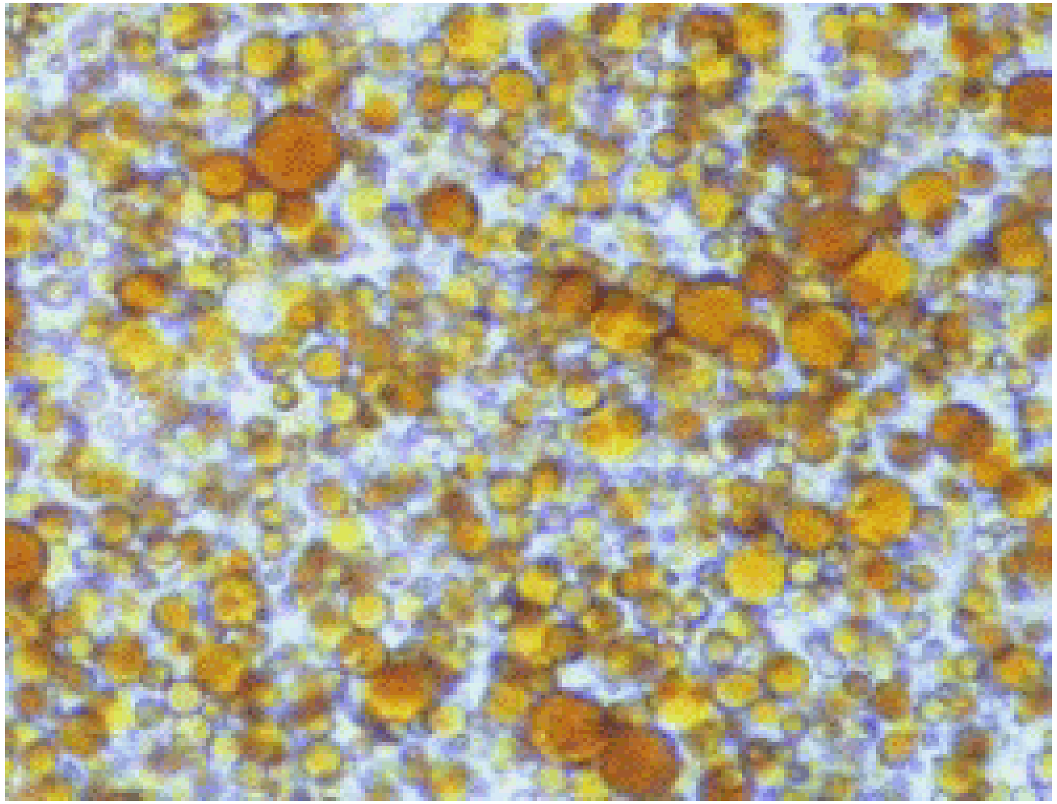
# What is an Asphalt Emulsion?

## Production and Components

- Liquid asphalt and water are introduced to a high shear milling process

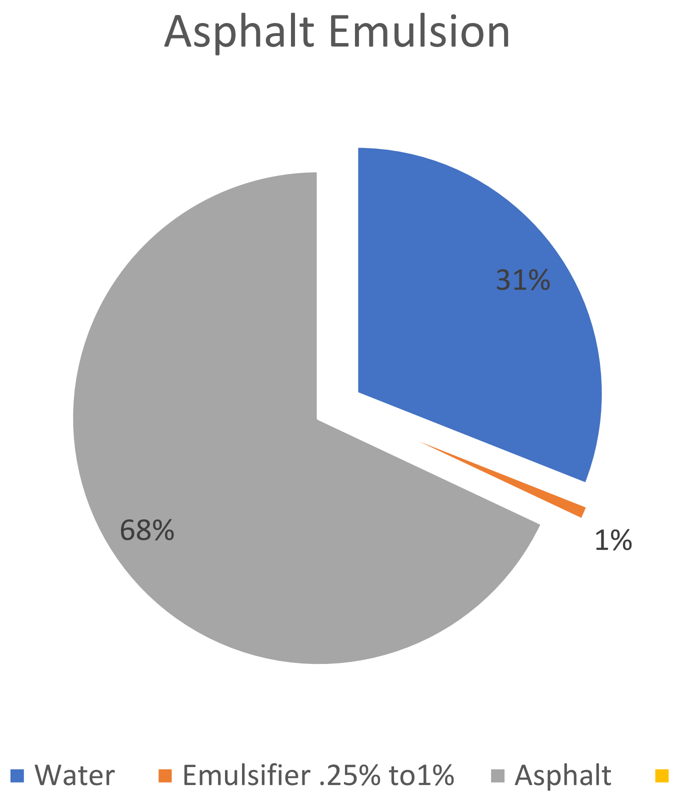
- Hydrophobic asphalt becomes the dispersed phase, and water the continuous phase

- Chemical surfactants introduced with water and asphalt stabilize the resulting emulsion



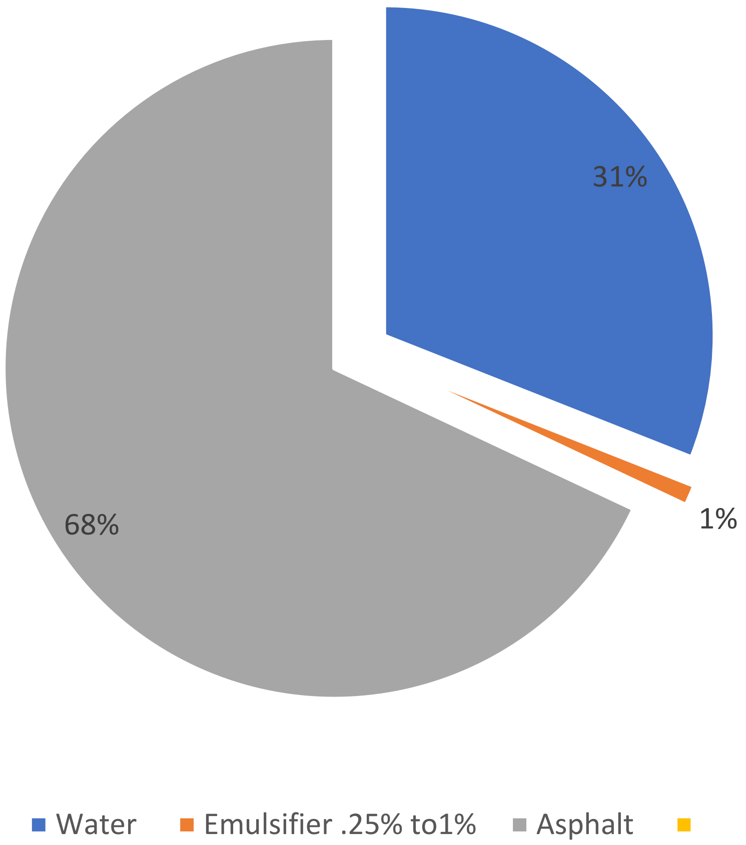
- TRB circular E-C102

# Asphalt Emulsion Components

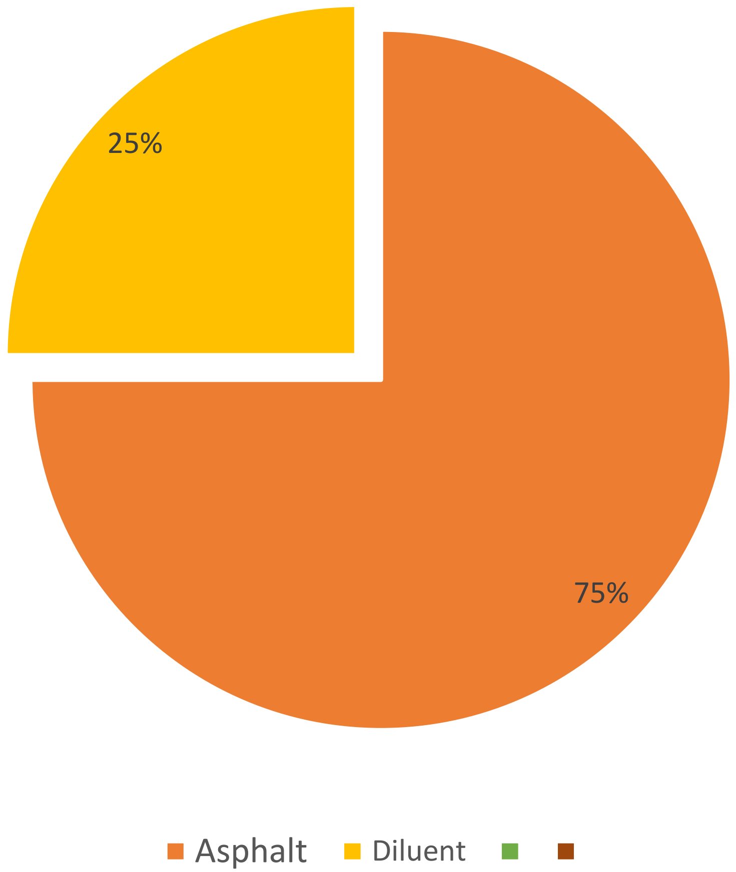



- Emulsion: a mixture of immiscible liquids
- Asphalt Emulsion
- Other common emulsions
  - Milk (fat in water)
  - Vinaigrette (oil and vinegar)
  - Fog (water in air)
  - Latex Paints (polymer in water)
- Emulsifiers add stability

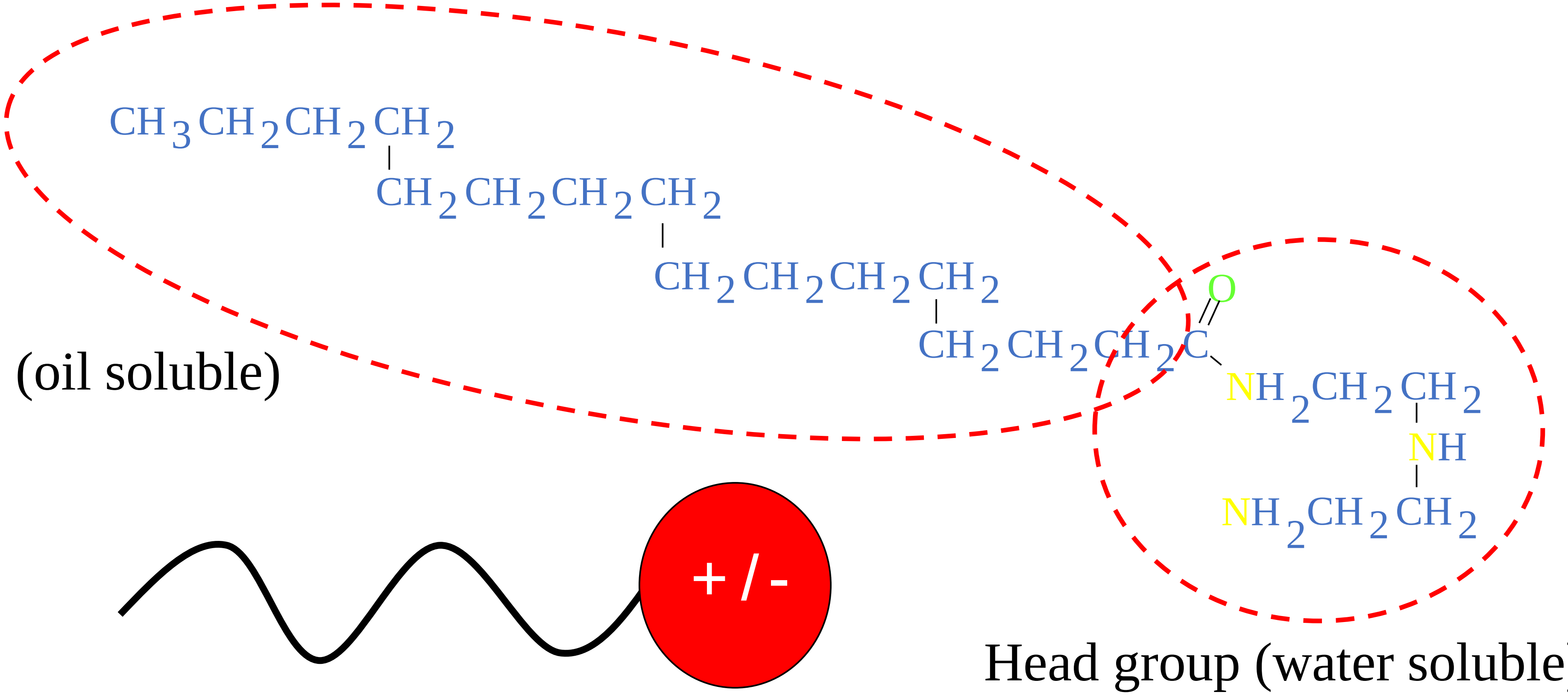
# Example Asphalt Emulsion




# Example Cutback Asphalt



# Emulsifiers or Surfactants

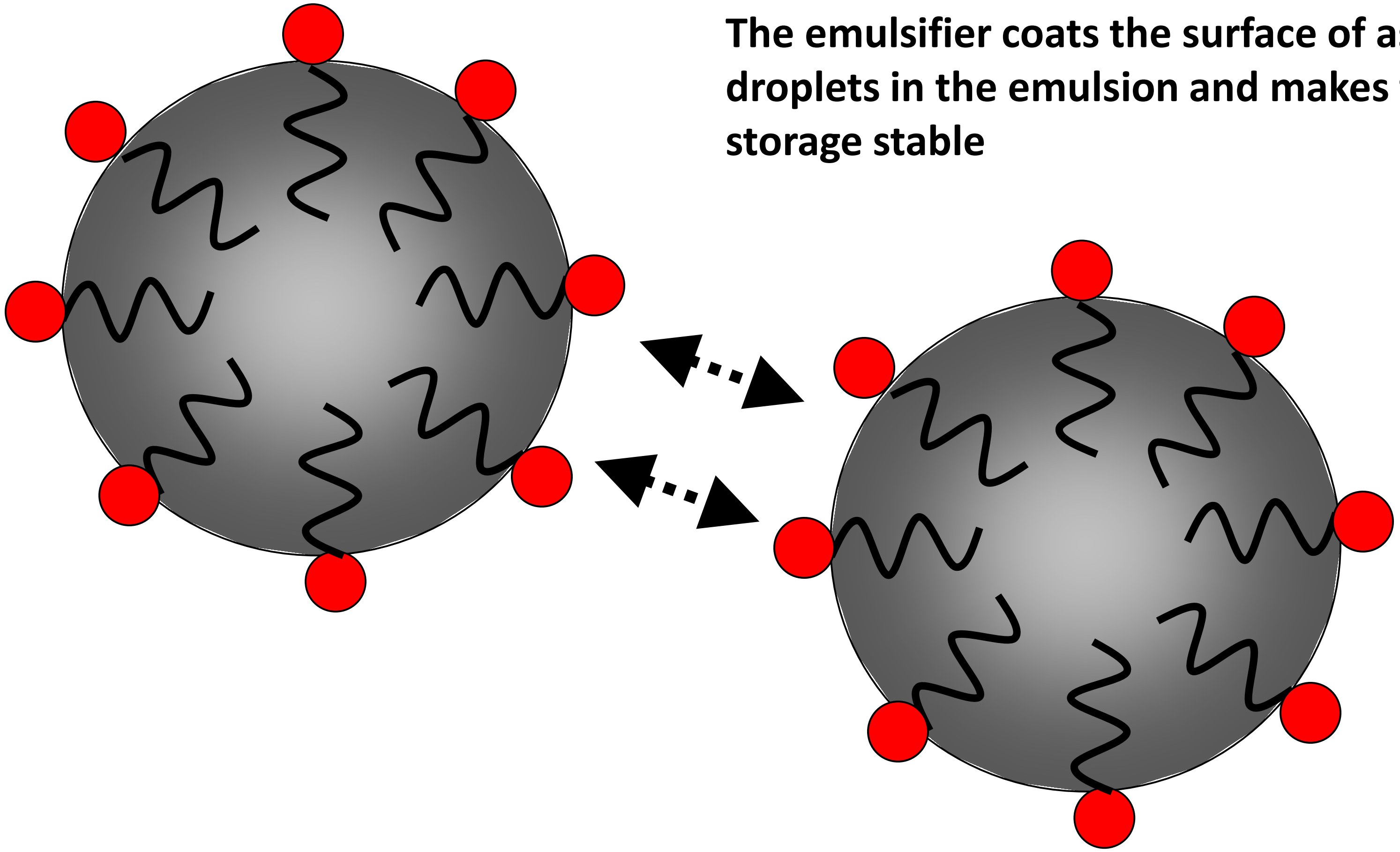



Tail group (oil soluble)

Head group (water soluble)

“Short hand” picture

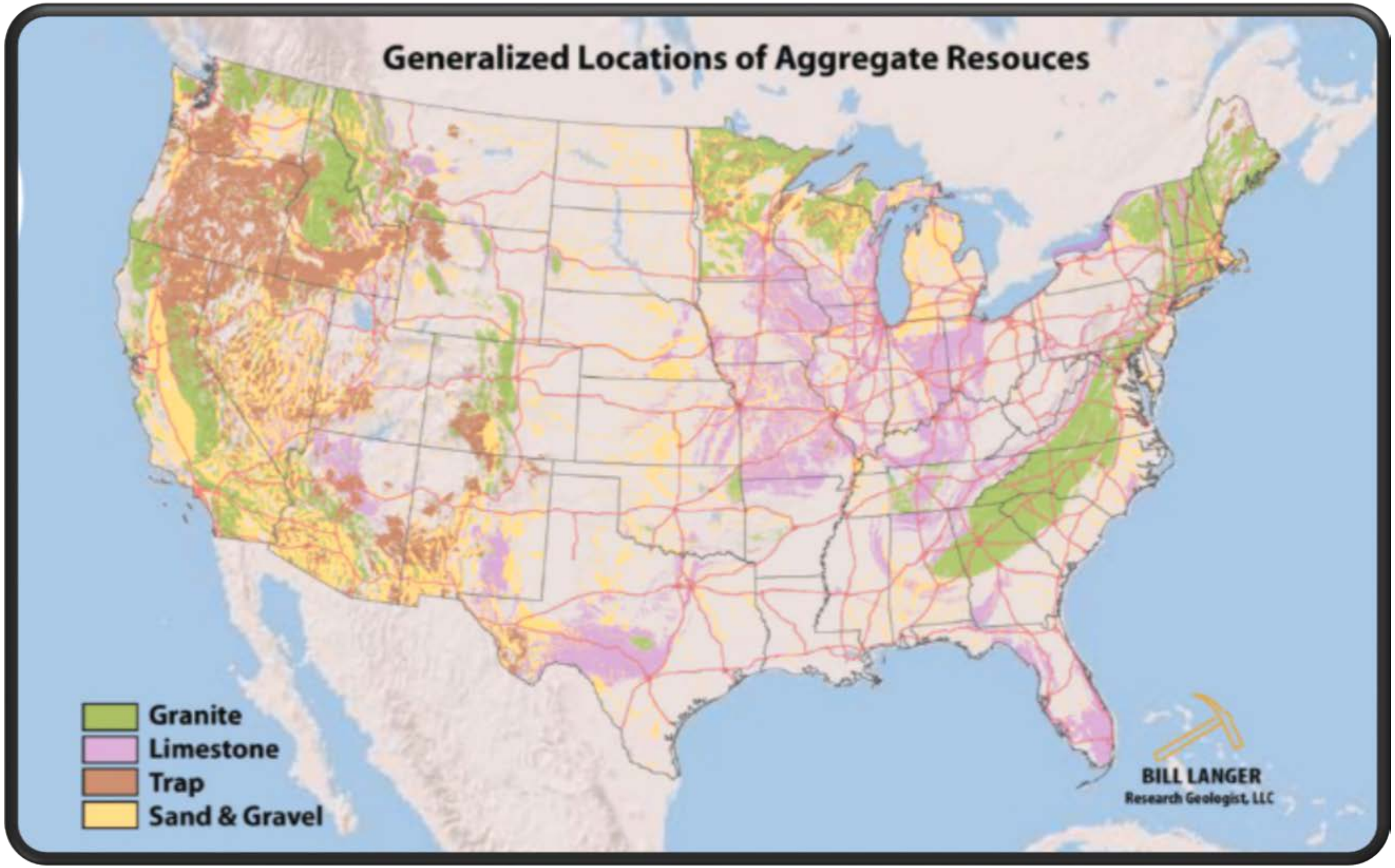
# Emulsifiers, Surfactants



**The emulsifier coats the surface of asphalt droplets in the emulsion and makes them storage stable**

# AGGREGATE COMPONENT

- Aggregate makes up a significant proportion of the applied weight of any surface treatment
- Emulsion choices are driven by:
- Mineralogy
- Construction Practices
- Availability



# Emulsifiers, Surfactants

## Aggregate

- A simple theory based on particle surface charge can be used to conceptualize emulsion performance
  - Zeta potential
  - Charge (+ or -) and quantity

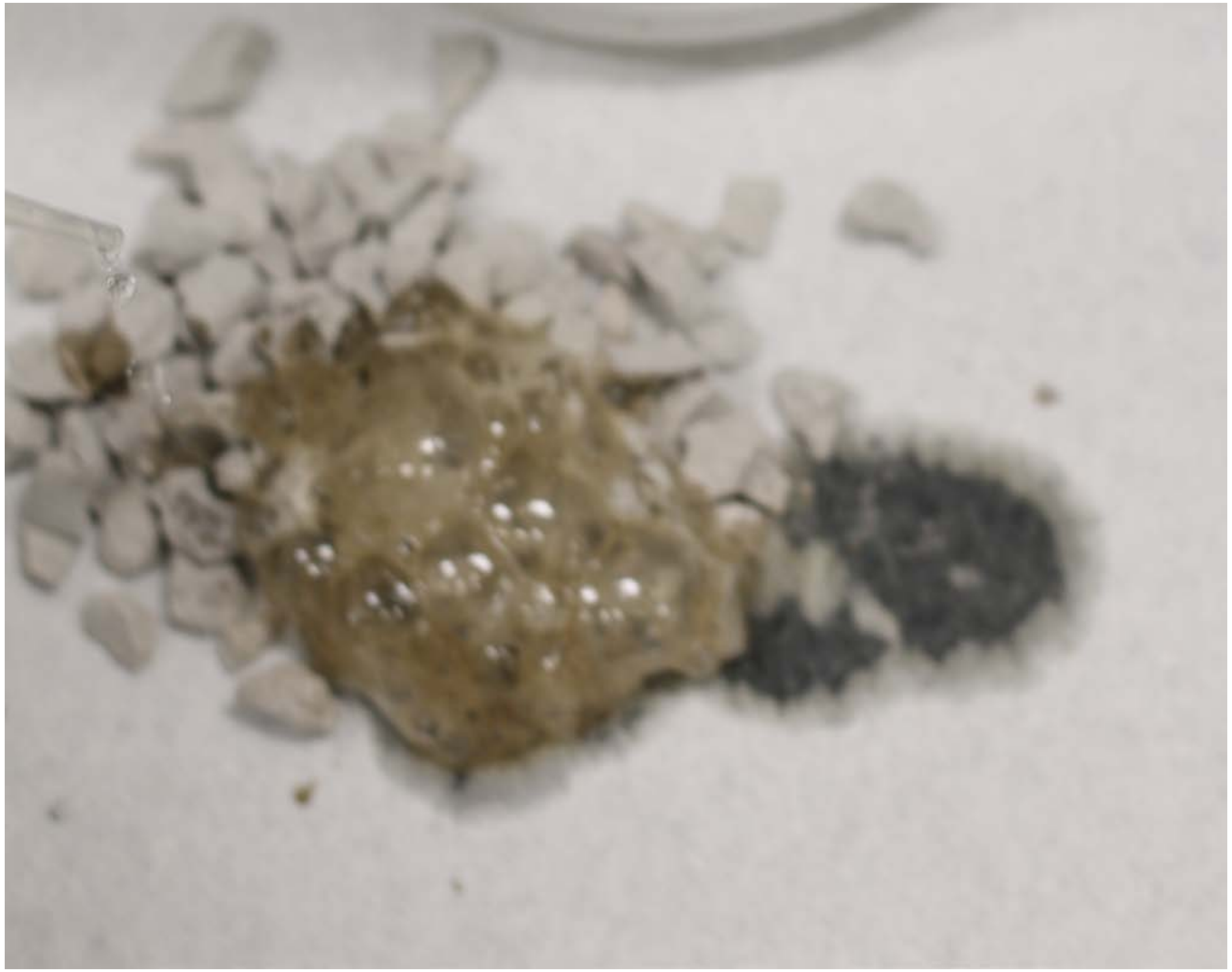

  - Examples:
    - Carbonates = limestone, dolomite
    - Silicates = Granite, basalt

## Gravel & Quartzite Siliceous aggregate

- Most gravel & quartz have a high proportion of silica based minerals - Quartz
- If clean may work well with Cationic Asphalt Emulsion - CRS-2 include
- Usually will not react with HCl

**Carbonate aggregates - Limestone Dolomite**

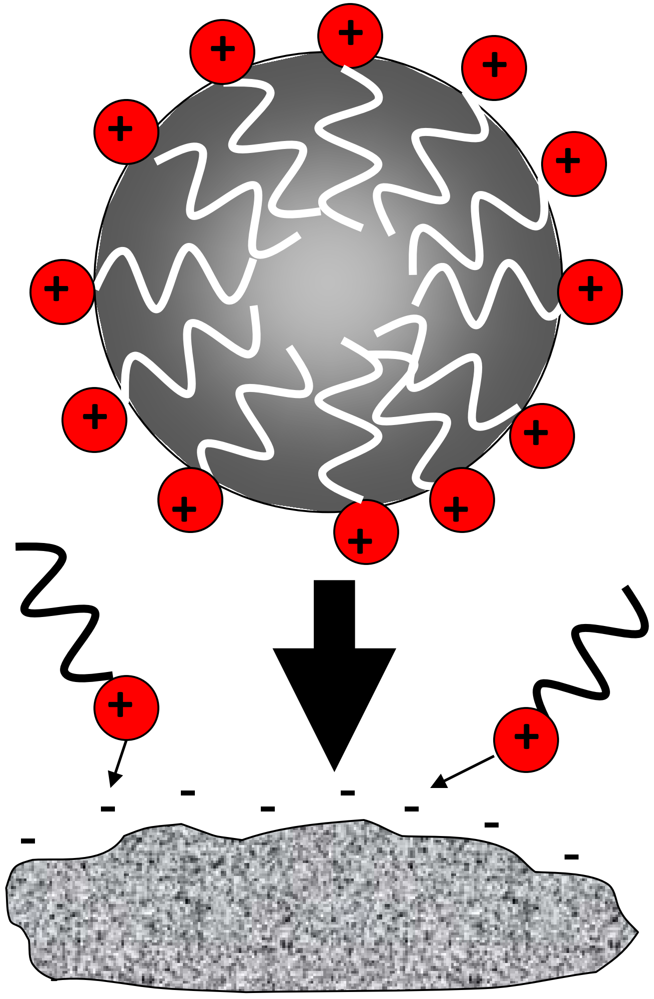
- May be dusty
- Often work well with High Float Emulsion
- Usually reacts strongly with HCl (foams and bubbles)



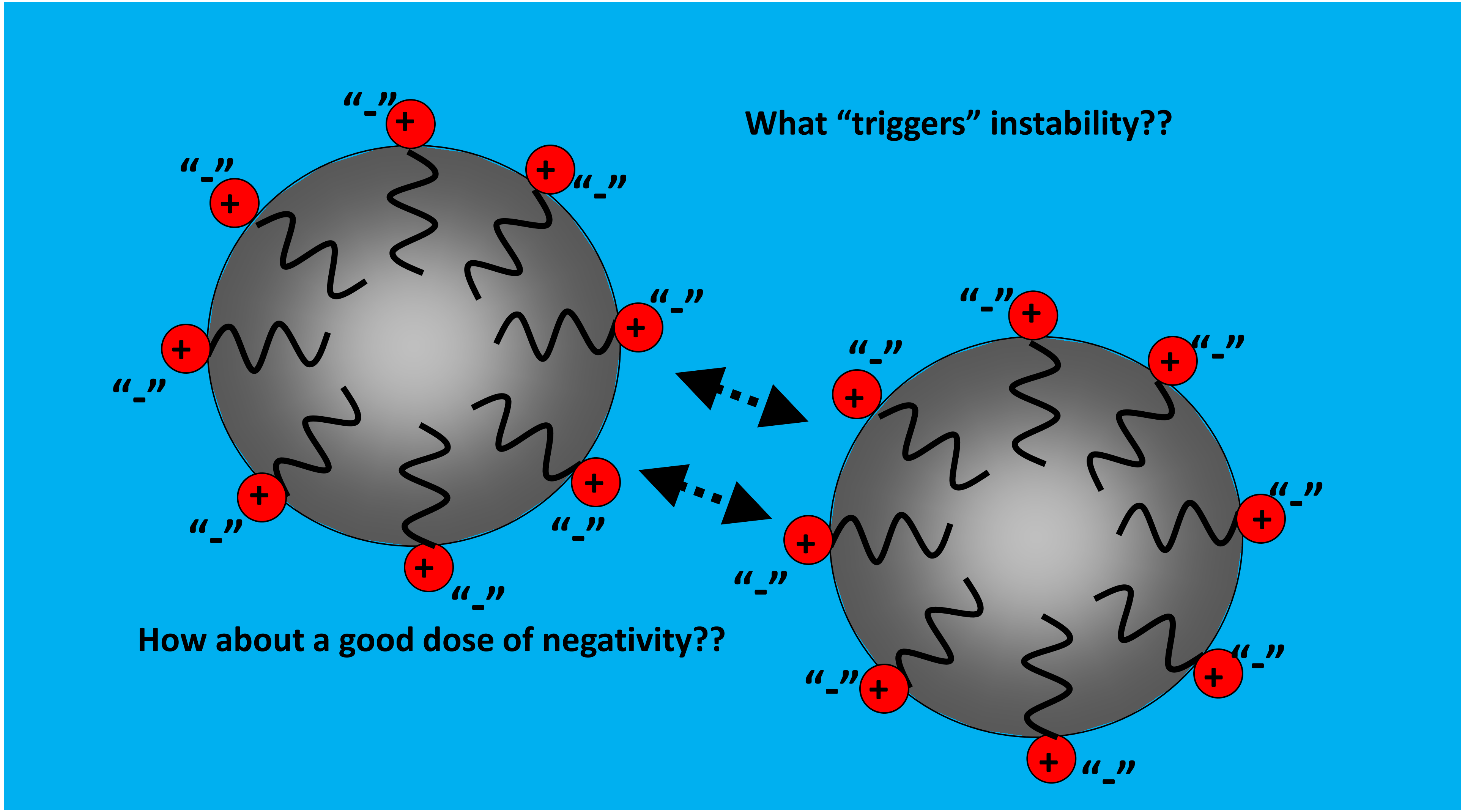
# Emulsifiers, Surfactants

## Emulsion performance

- Light weight, fast moving surfactants interact with aggregate
- Asphalt particle attracted to surface
- Opposite charges neutralize each other and emulsion breaks



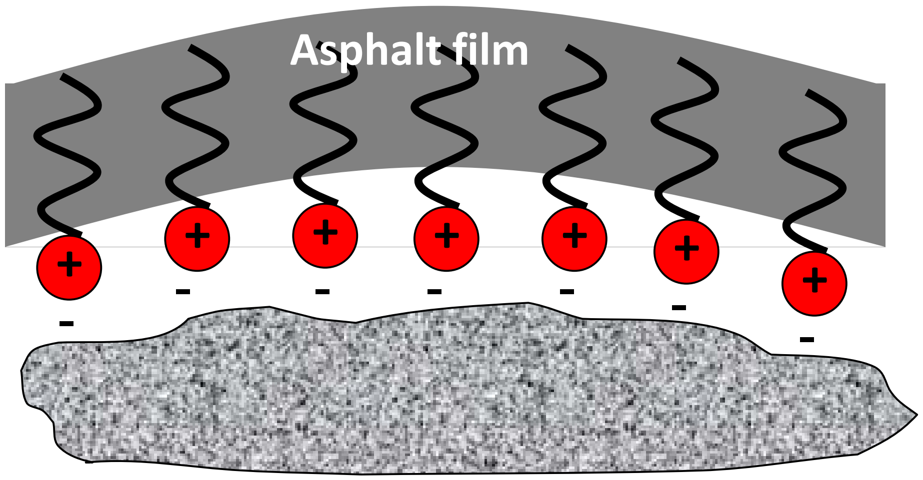
# Destabilization or “Demulsification”



# Emulsifiers, Surfactants

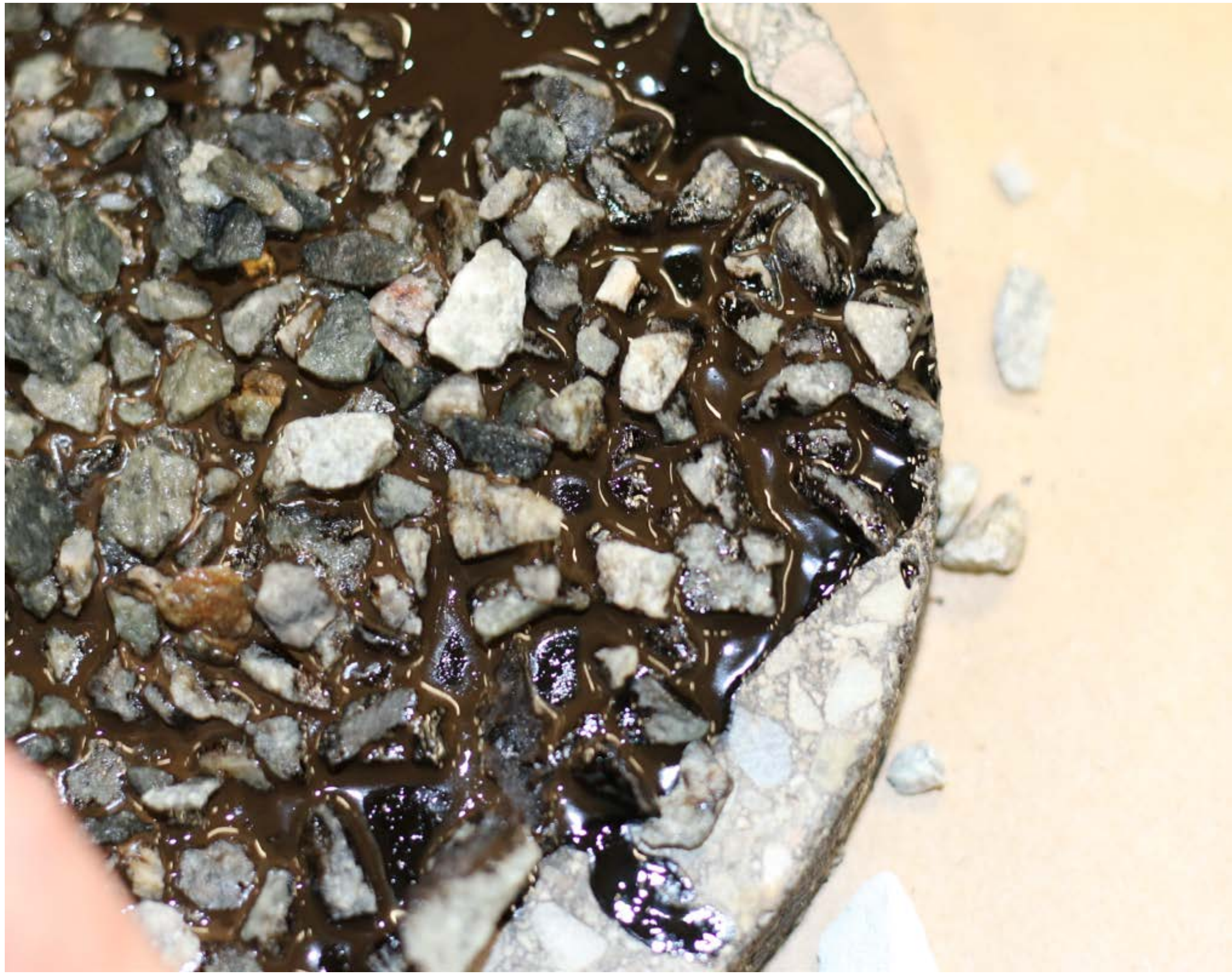
## Emulsion performance

- Light weight, fast moving surfactants interact with aggregate
- Asphalt particle attracted to surface
- Opposite charges neutralize each other and emulsion breaks
- Asphalt particles stick to each other and to the aggregate



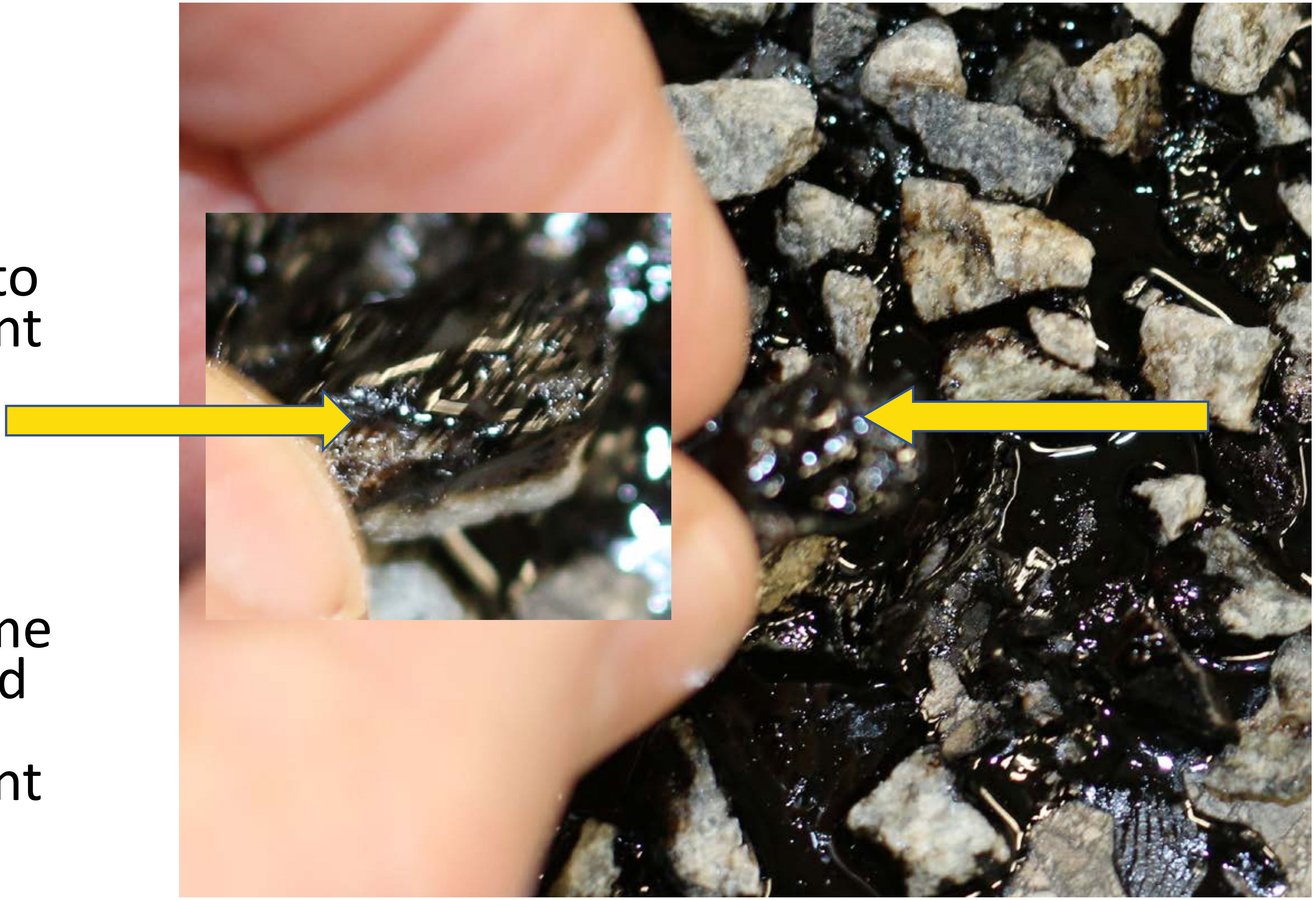
# Asphalt emulsions tolerate damp aggregate and surfaces

Having the aggregate slightly damp can improve adhesion



# Fast Emulsion Clean Aggregate

- Asphalt emulsion particles are attracted to aggregate and pavement surface
- Asphalt particle chemistry pushes the water out of the way.
- Asphalt particles become attached chemically and physically to the aggregate and pavement surface



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# APPLICATIONS OF CUTBACK AND ASPHALT EMULSION

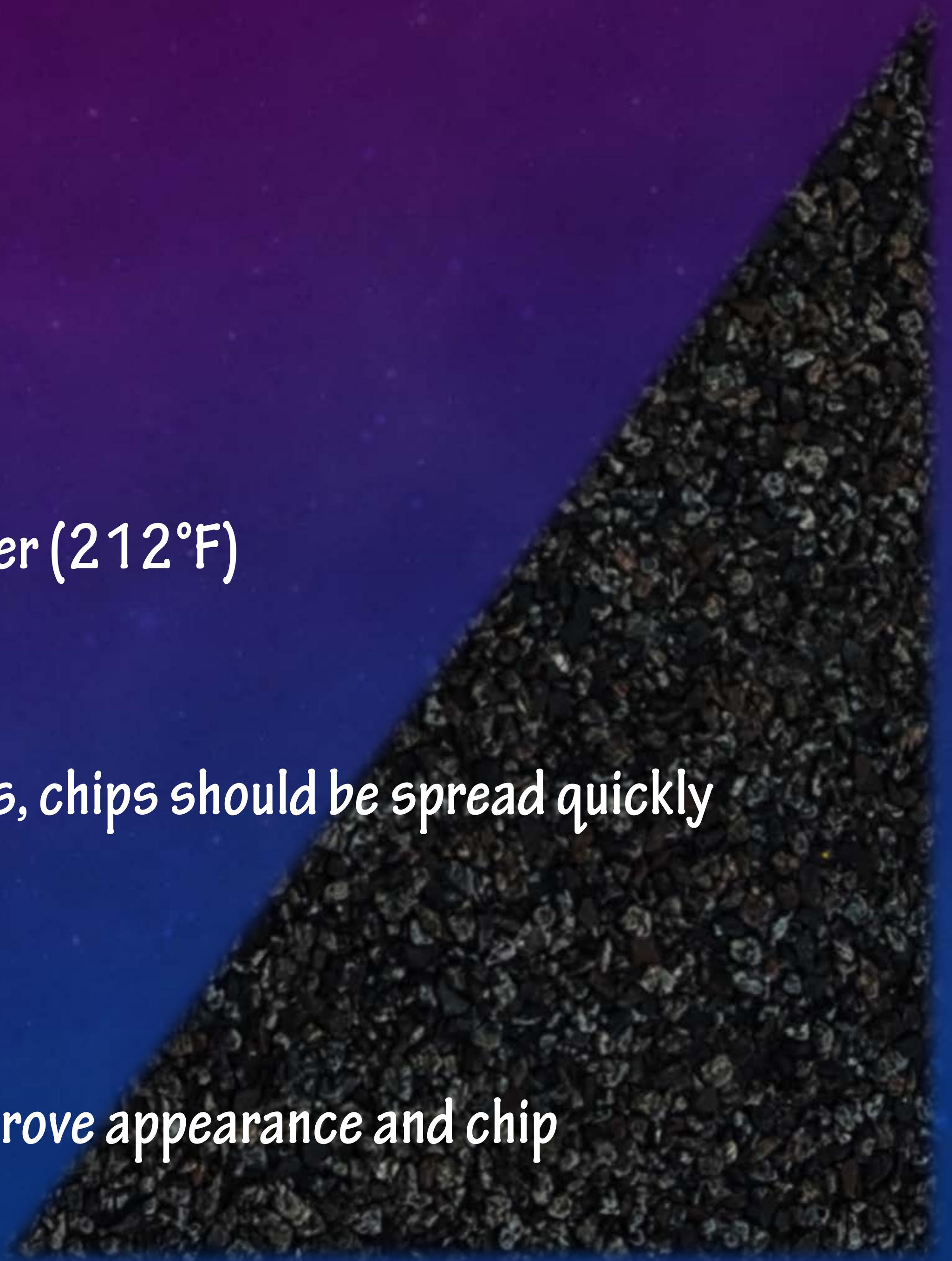
- Emulsions may be used in place of cutbacks
  - Chip Seals
  - Prime Coats
  - Tack Coats

# EMULSION CHIP SEALS

- Enhanced aggregate adhesion
- Emulsion cures quickly as emulsion breaks and water evaporates
- Laboratory design of emulsion chip seals
    - Identifies optimum shot rate based on surface condition
    - Verifies system compatibility and resistance to stripping

# Best Practices – Emulsion Chip Seals

- Emulsion applied at a warm temperature
- Typical range (150°F-190°F)
- Always hold emulsion below the boiling point of water (212°F)
- The water in emulsion will boil
- Because emulsions cure more rapidly than cutbacks, chips should be spread quickly following emulsion application
- Avoid excessive pumping of emulsions
- Fog seal application over a chip seal can further improve appearance and chip retention



# PENETRATING EMULSIFIED PRIME PRIME COATS

- Cutback
  - MC-70 or MC -250
- Emulsion
  - Penetrating Emulsified Prime (PEP)
    - Less costly vs. cutback
    - Formulated to outperform MC-70
    - Laboratory Sand Penetration Test predicts performance

# Best Practices – Penetrating Emulsified Prime

- Application on damp surfaces can improve penetration
- Emulsion applied at cooler temperatures
  - Can be applied at ambient temperature or warm
  - Hold below the boiling point of water (212F)
  - The water in emulsion will boil

# SUMMARY Page 1

- Modern emulsion products are available for use in chip seals, prime coats, tack coats, and more
- These emulsions offer:
  - Improved performance
  - At lower cost
  - Compared to traditional cutback products

# SUMMARY Page 2

- Asphalt Emulsions provide a chemical and mechanical bond on the aggregate and pavement surface
- Asphalt Emulsions can tolerate damp aggregate and pavement surface
- Asphalt Emulsions are less hazardous and more environmentally friendly that asphalt cutbacks.

# THANK YOU