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

Grade

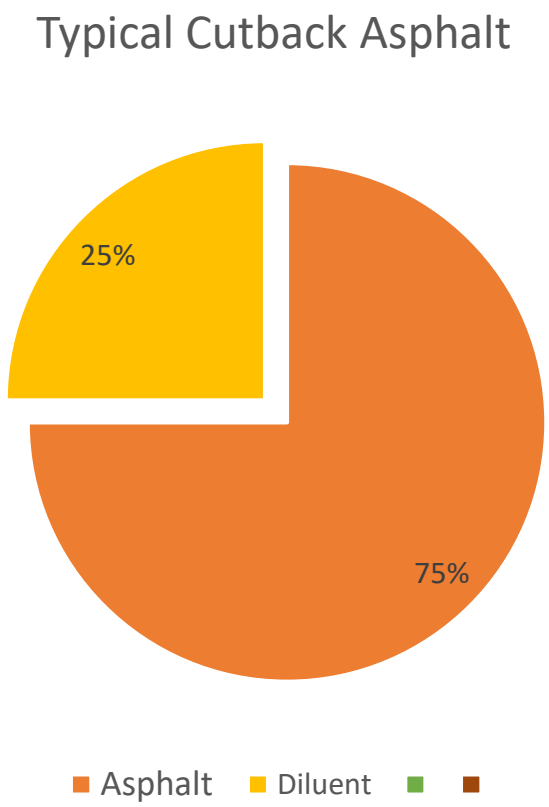
- ~~Rapid Cure (RC)~~
- Medium Cure (MC)
- Slow Cure (SC)

Cutter / diluent

- 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

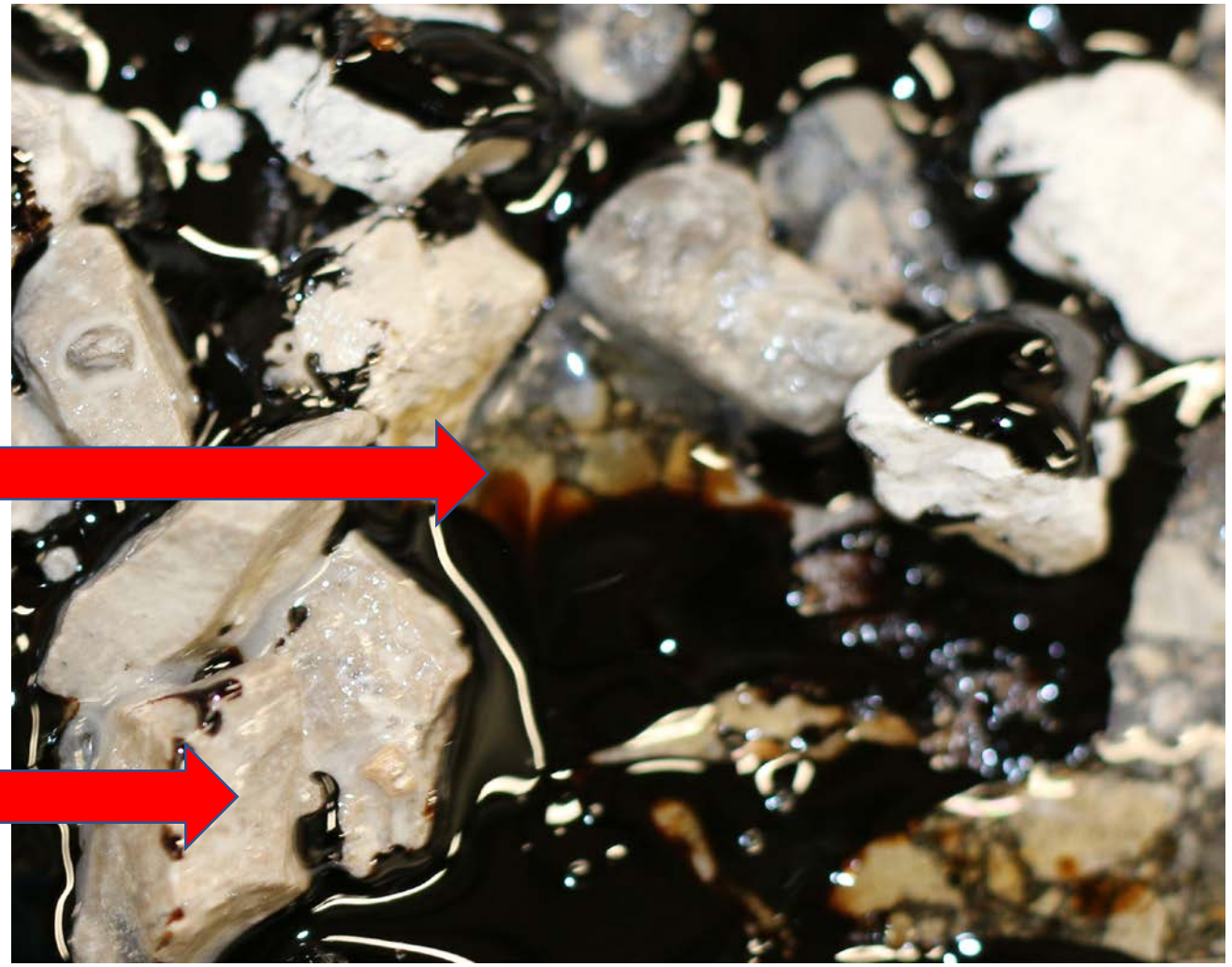
Dry Aggregate and Surface with Cutback

- 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

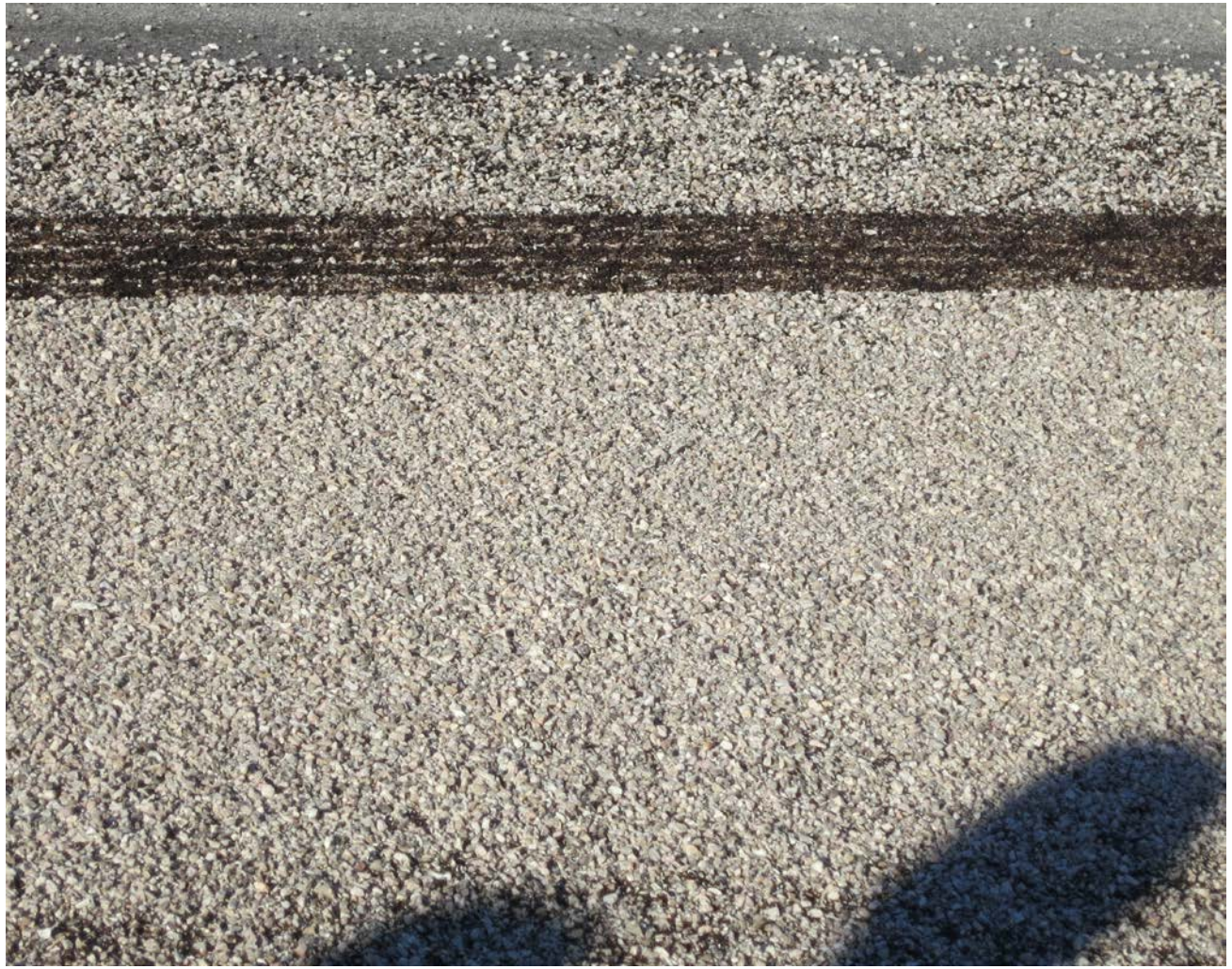
MC-3000 is prevented from bonding to the surface if the pavement or aggregate is wet

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

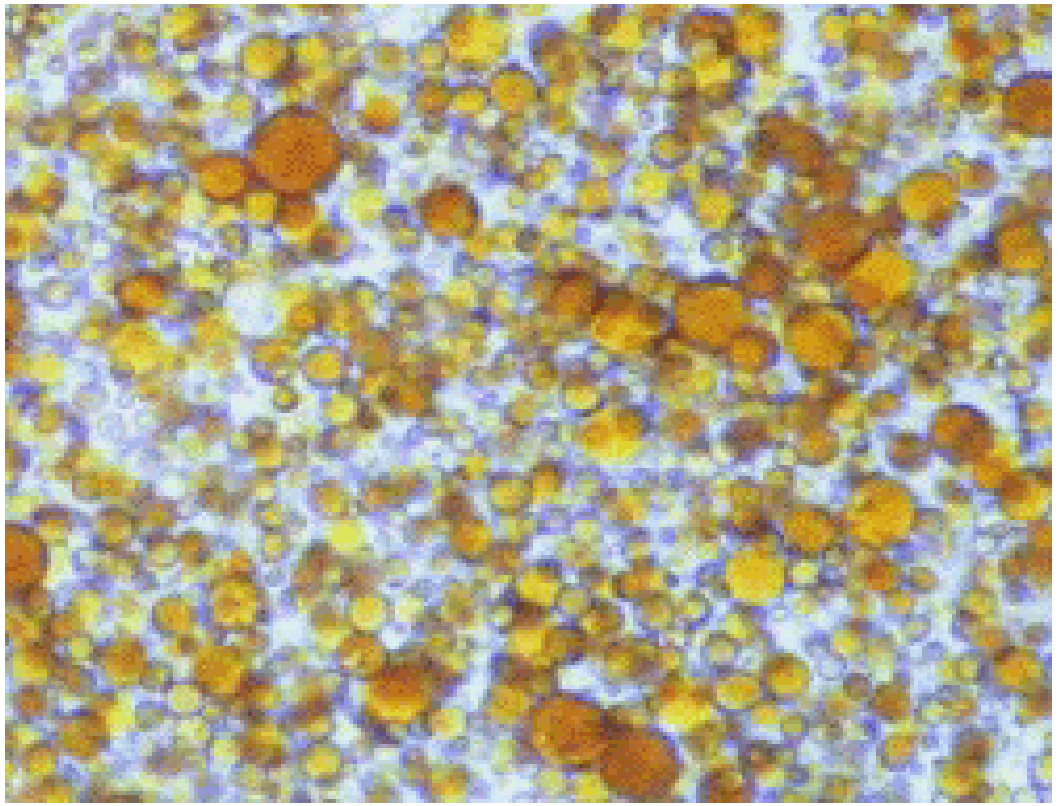
What is an Asphalt Emulsion?

Production and Components

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

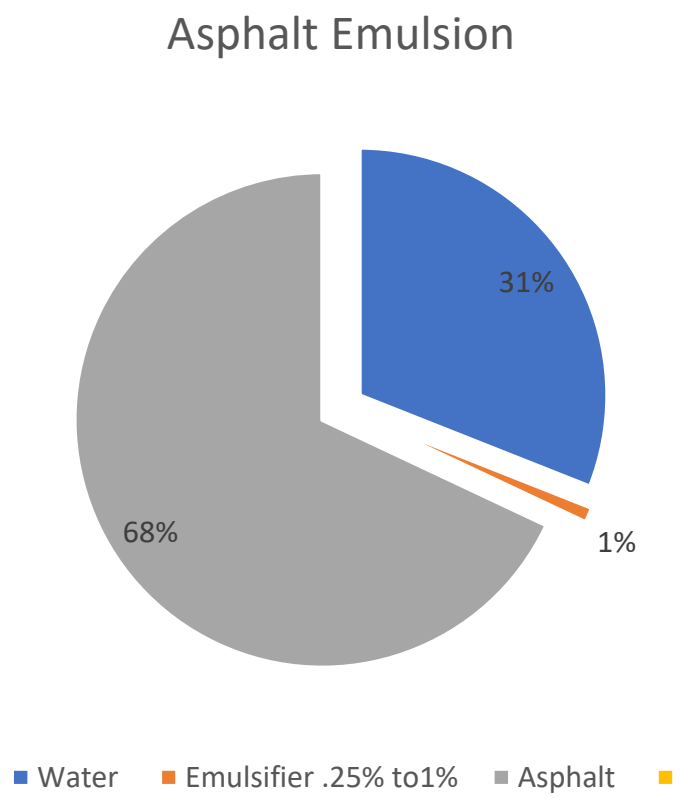
- Hydrophobic asphalt becomes the dispersed phase, and water the continuous phase

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



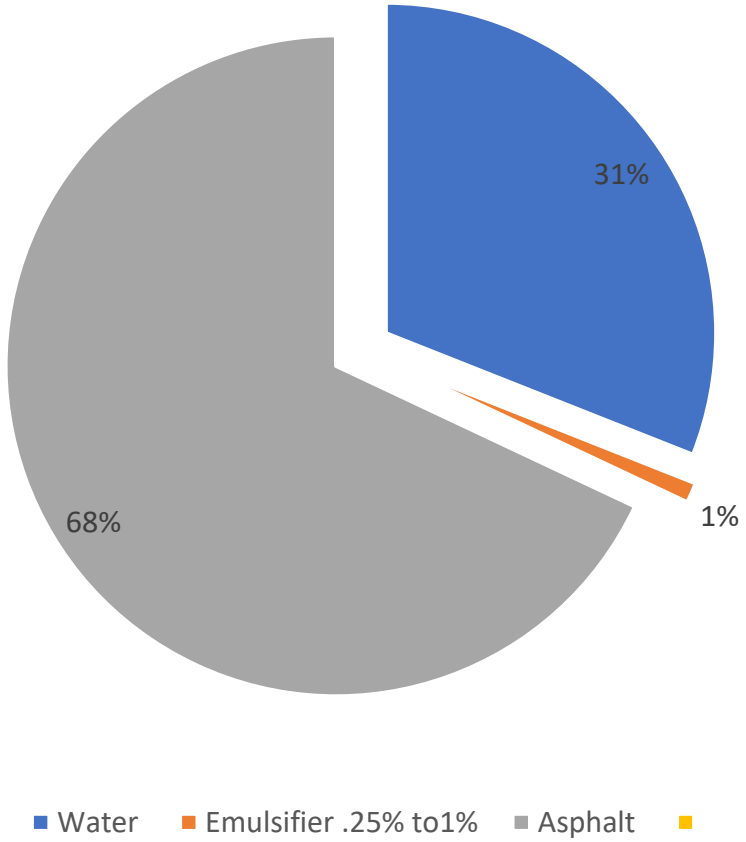
- TRB circular E-C102

Asphalt Emulsion Components

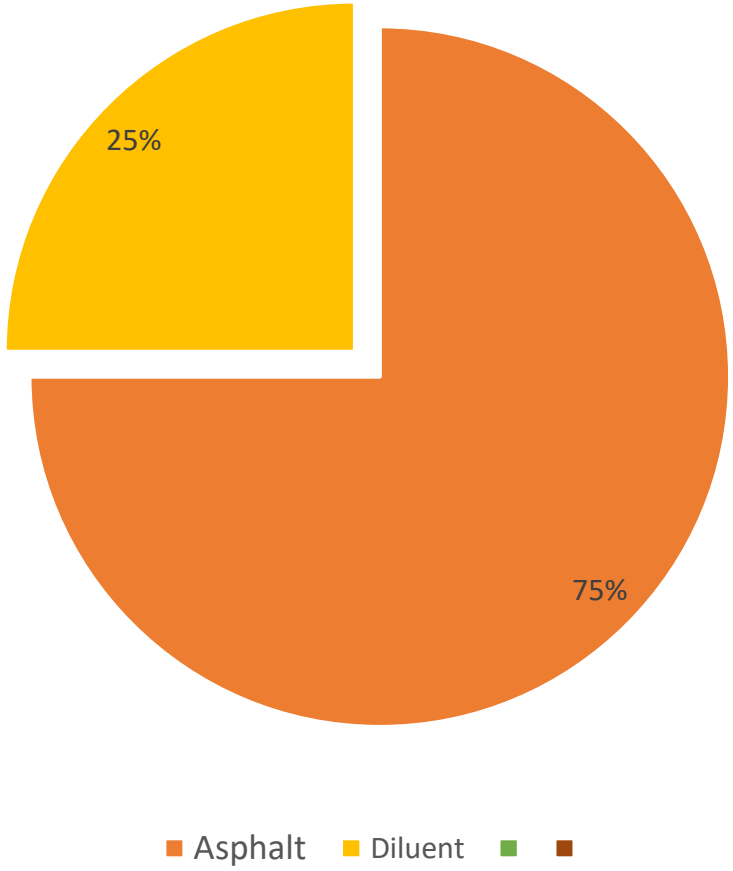


- Emulsion: a mixture of immiscible liquids
- Asphalt Emulsion
- Other common emulsions
  - Milk (fat in water)
  - Vinaigrette (oil and vinegar)
  - Fog (water in air)
  - Latex Paints (polymer in water)
- Emulsifiers add stability

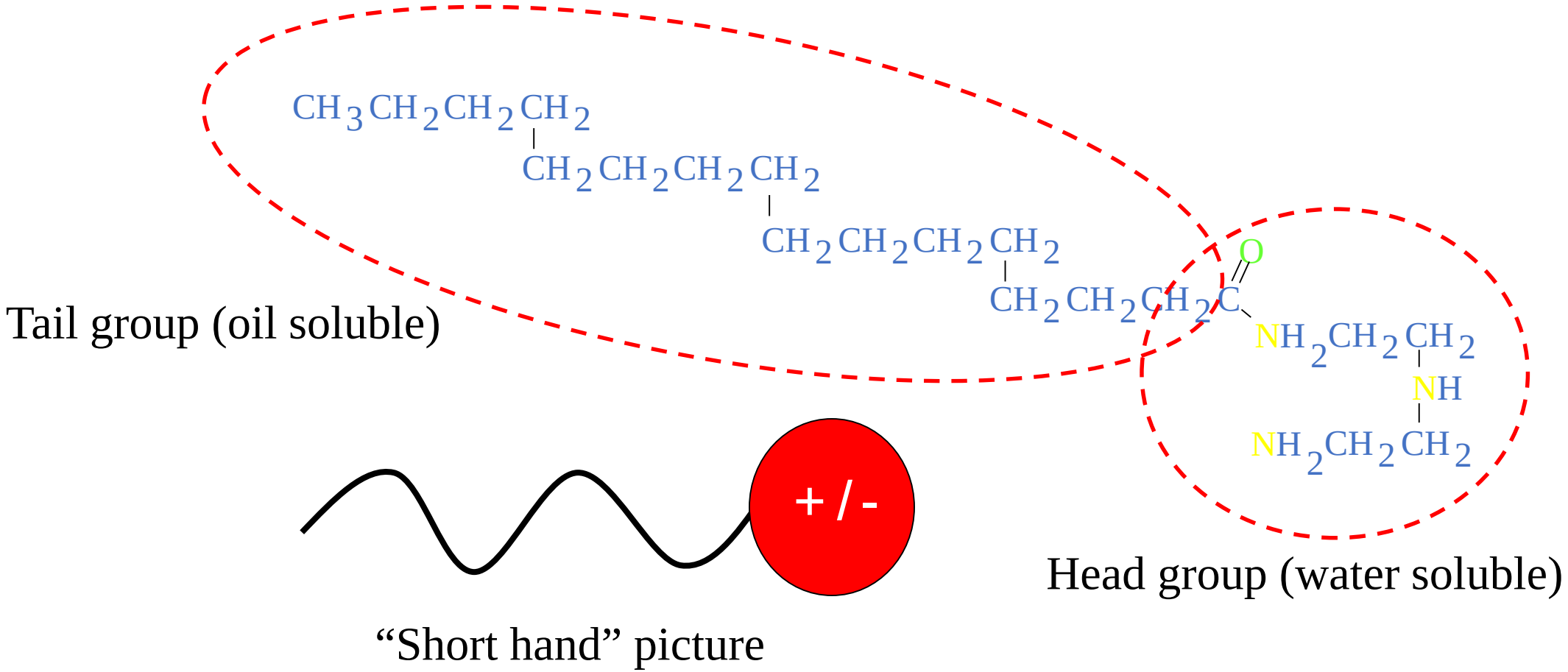
Example Asphalt Emulsion



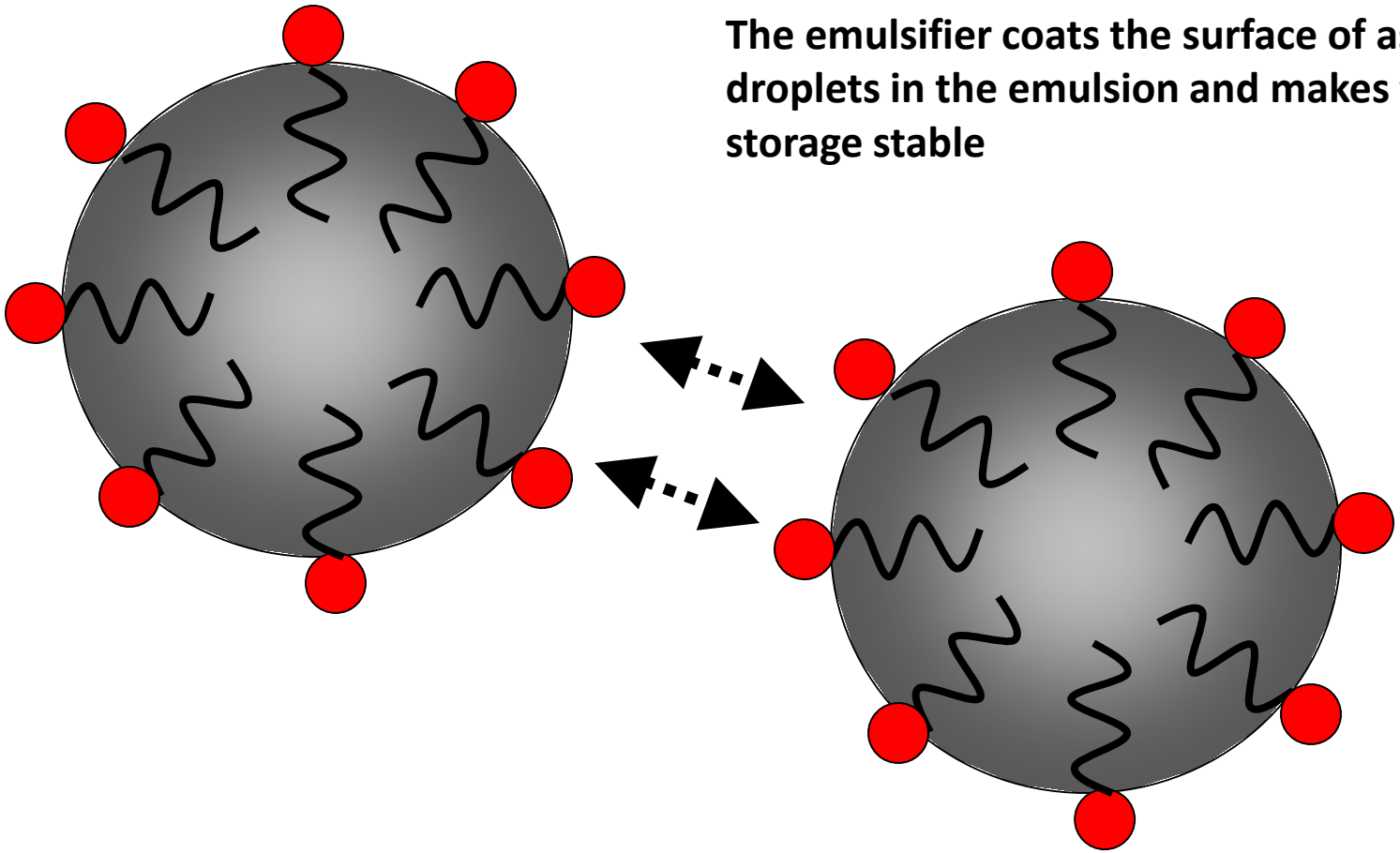
Example Cutback Asphalt



Emulsifiers or Surfactants



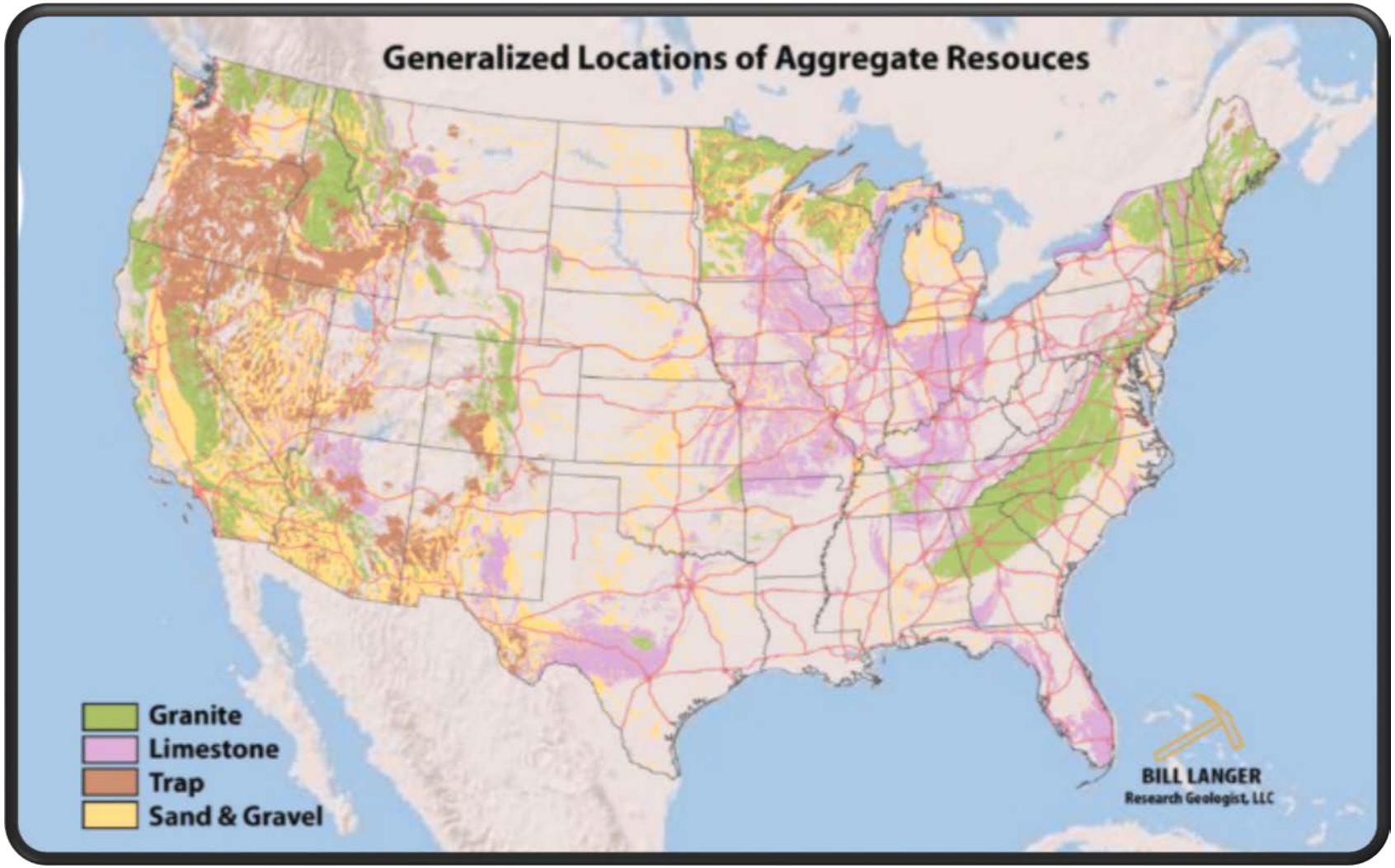
Emulsifiers, Surfactants



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

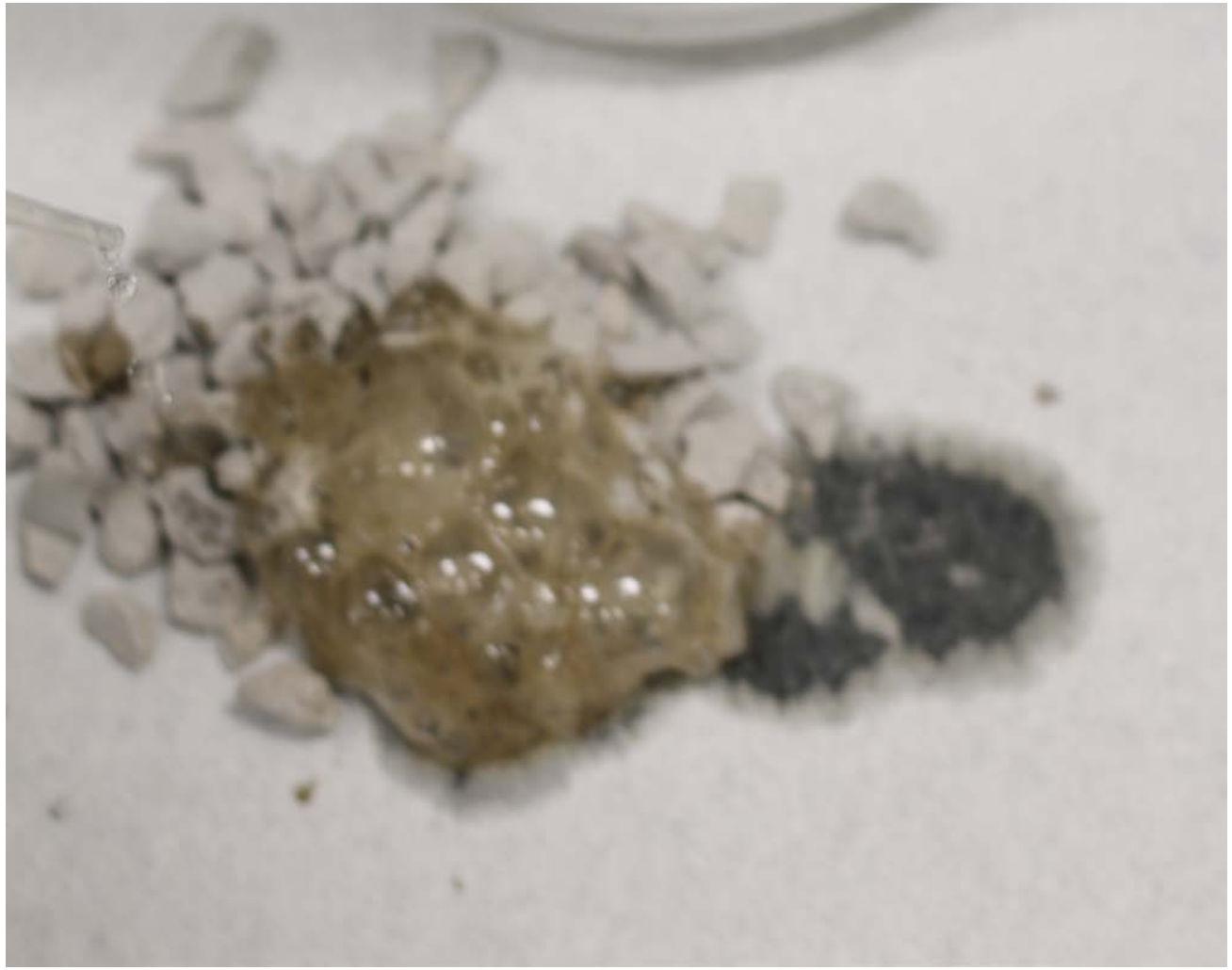
  - Examples:
    - Carbonates = limestone, dolomite
    - Silicates = Granite, basalt

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

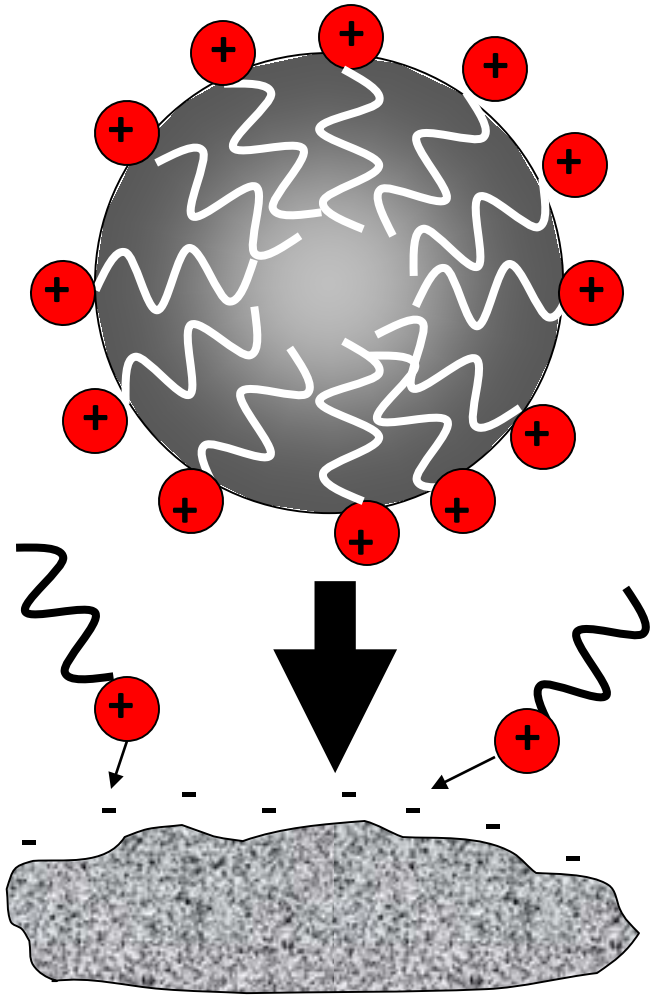
- May be dusty
- Often work well with High Float Emulsion
- Usually reacts strongly with HCl (foams and bubbles)



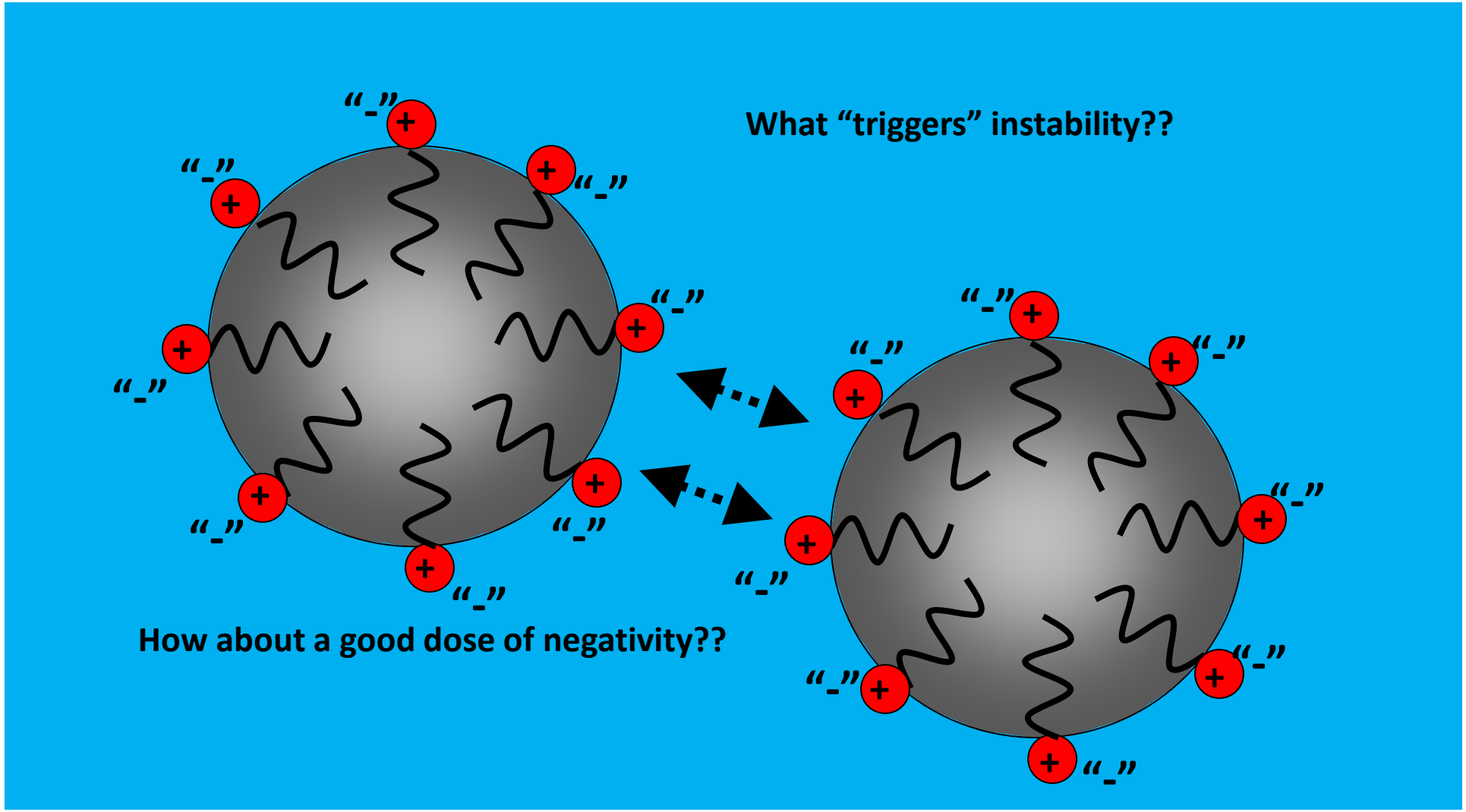
Emulsifiers, Surfactants

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

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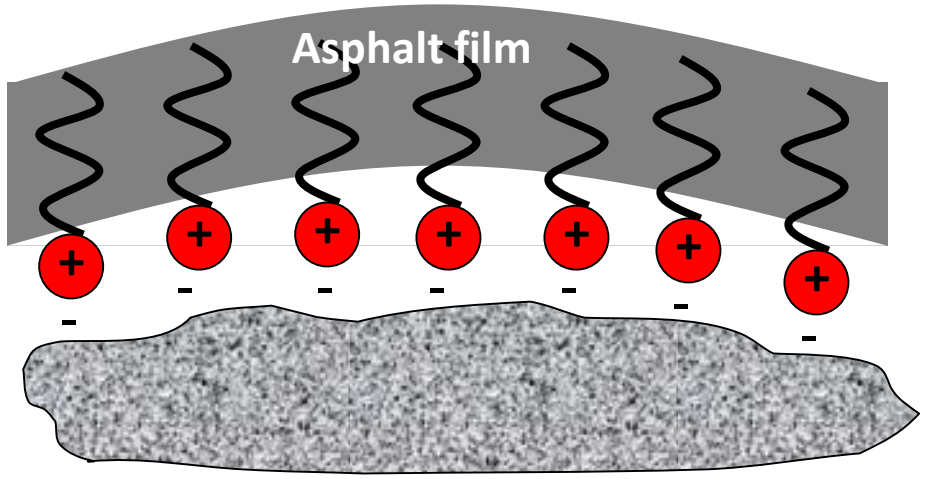
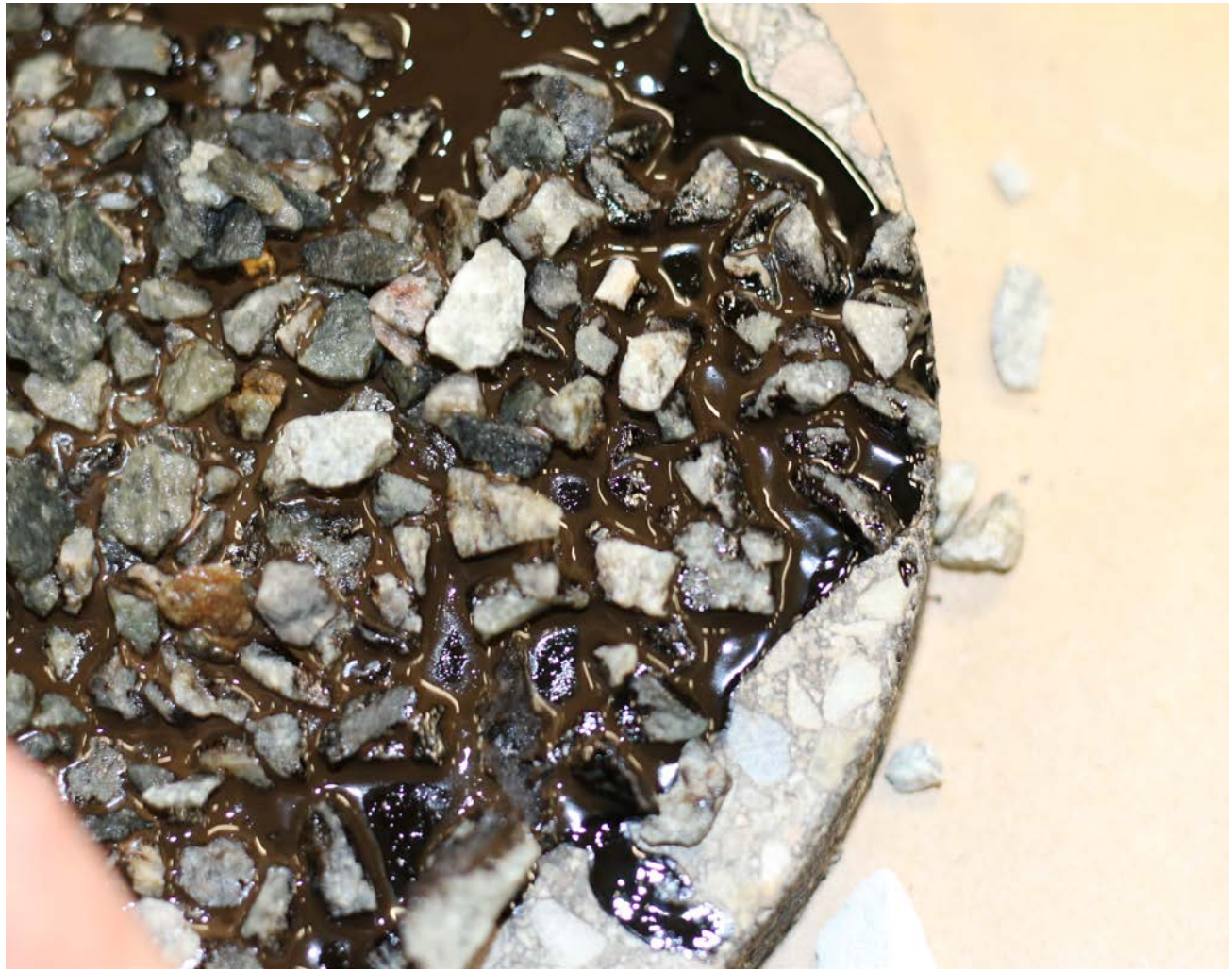
- Opposite charges neutralize each other and emulsion breaks
- Asphalt particles stick to each other and to the aggregate



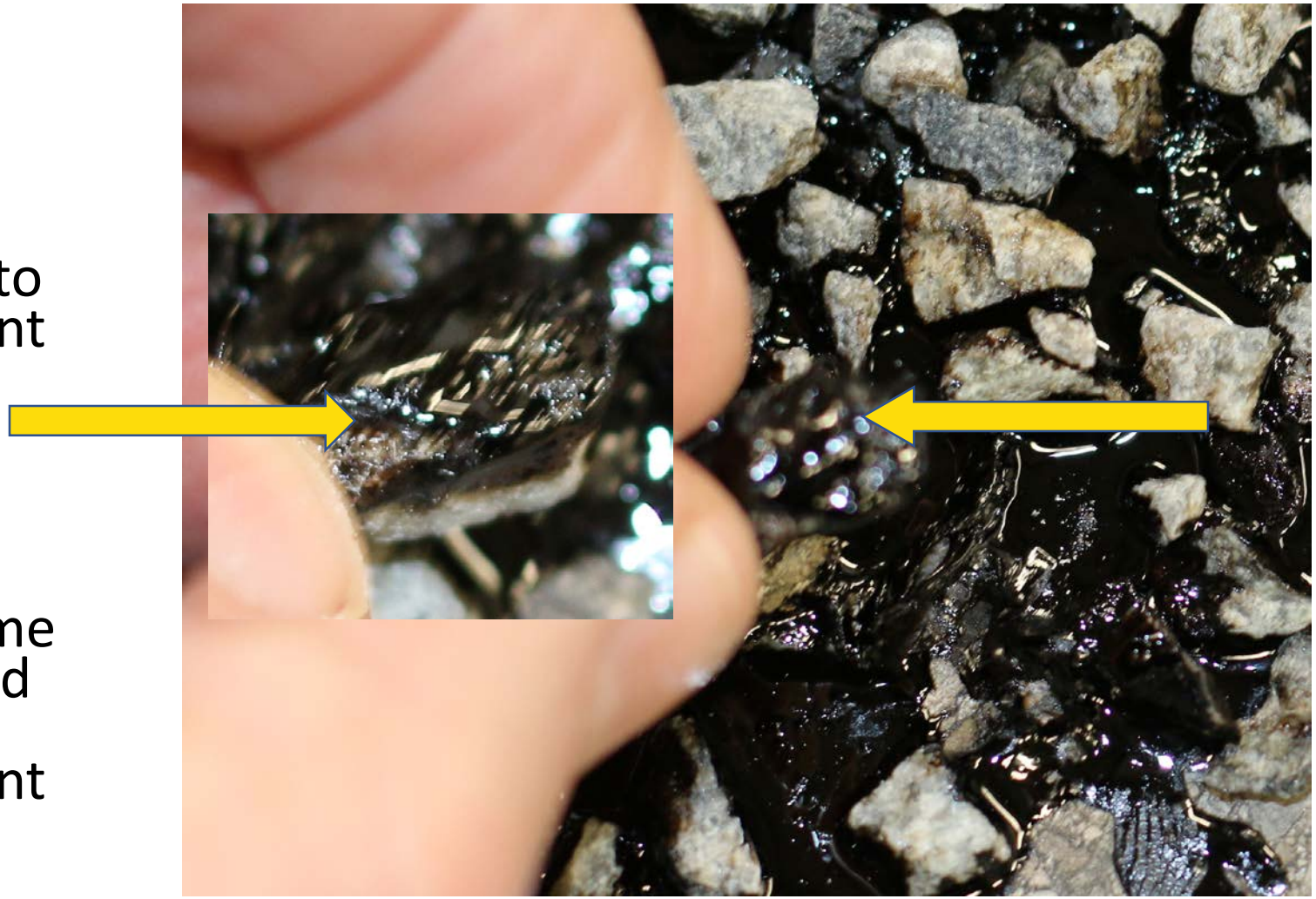
Asphalt emulsions tolerate damp aggregate and surfaces

Having the aggregate slightly damp can improve adhesion

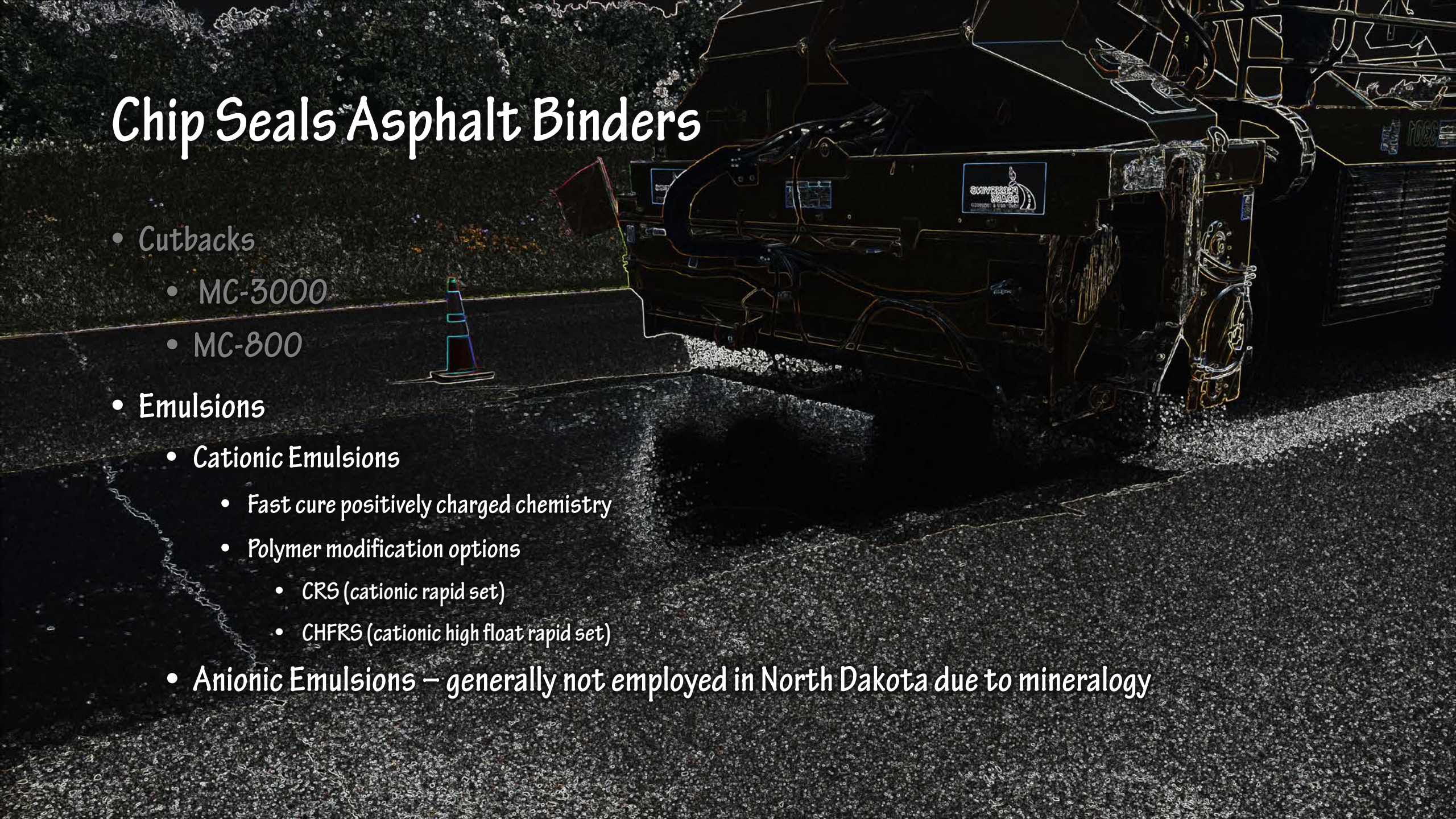


Fast Emulsion Clean Aggregate

- 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



Chip Seals Asphalt Binders



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APPLICATIONS OF CUTBACK AND ASPHALT EMULSION

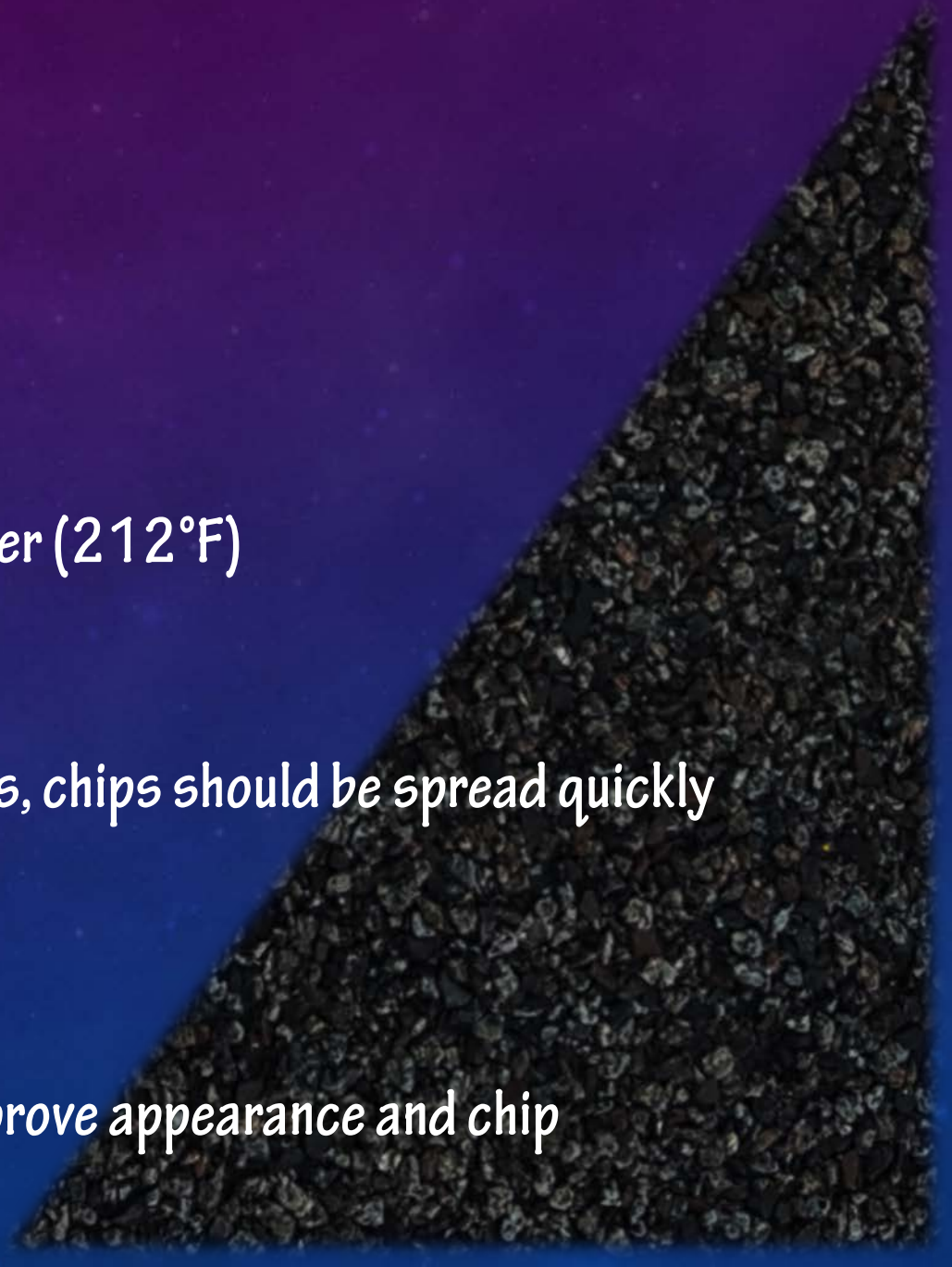
- Emulsions may be used in place of cutbacks
  - Chip Seals
  - Prime Coats
  - Tack Coats

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