Asphalt Emulsion Basics

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THE KING
DELTA BLUES
CREDIT

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Overview of Asphalt Emulsion

TRB Circular E-C102
Moving Asphalt

Heated

Cutback

Emulsified
HOT

Safety hazard
Requires continual heat source

Consistent properties
Very familiar
Storage stable
Cutback

Extreme fire hazard
Environmental issues

Mobile, far less heat required
Great penetrating, mixing and coating properties
Emulsion

Challenging physics
Property migration

Safe
Environmentally friendly
Designer properties
Emulsion Advantages

Aggregates do not need to be dry

Lower viscosity allows cracks and voids to be filled
Emulsion Advantages

Water based product requires lower energy usage to modify the asphalt

When solvents are desired, the amount necessary can be much less than cutbacks
Emulsion Advantages

Lower viscosities provide the ability for use at lower temperatures

Reduced Emissions
Reduced Energy Consumption
Smaller Carbon Footprint
Definition

A dispersion of small droplets of one liquid in another

- Milk
- Paint
- Cosmetics
- Butter
- Mayonnaise
Asphalt Emulsions

Usage began in early 20th Century

Comprise between 5-10% of “paving grade” asphalt used worldwide

Also used in other industries
  Automobile manufacturing
  Pipe Coating
EMULSION TYPES

O/W          W/O          W/O/W

O/W          W/O          W/O/W
Components

Asphalt 40-75%

Emulsifier 0.1-2.5%

Water, additives remainder
MANUFACTURING

- Asphalt
- Emulsion
- Colloid mil
- Stabilizer
- Acid
- Emulsifier
- Batch soap tank
- Water inlet
Simple
But We Must Have Balance
Asphalt Emulsion Droplet
Particle Size and Distribution

Differential Volume

Volume %

0.04 0.1 0.2 0.4 1 2 4 6 10 20 40 100 200 400 1000 2000

70.3%
61.4%
67.3%
65.6%
61.0%
63.3%
58.9%
Size and Distribution
Influenced by
Raw Materials
Mill Properties
Operating Conditions
Size and Distribution Influence

Physical properties of the emulsion
• Viscosity
• Storage stability

Larger size and broader distribution result in lower viscosities
Size and Distribution Influence

Emulsion Performance

Mixing       Spraying            Coating

Are all improved with smaller particle size
We Demand **Stability**

The emulsion must withstand being

- Stored
- Tested
- Pumped
- Transported
- Pumped
- Applied
We Require **Instability**

Asphalt needs to be in a relatively thin layer to function as a binder or glue holding aggregate particles together.

Until an emulsion falls apart, the asphalt in it can not perform.
Compromise

The asphalt droplets in an emulsion have a small charge that repel other droplets on close approach. Once this force is overcome the asphalt separates from the water.
Hydrocarbon Chain (Oil Loving)

Head Group (Water Loving)

Counterion (Water Loving)
Flocculation to Coalescence

Emulsion charge on droplets prevents close approach.

Flocculation: Close approach of droplets leads to adhesion between droplets. Water is squeezed out.
Flocculation to Coalescence

Coalescence: Water drains between droplets and surfactant film breaks down; droplets fuse, trapping some water.

Coalescence: Trapped water diffuses out.
Flocculation to Coalescence

Flocculation can be reversed or discouraged

- Agitation
- Dilution (to a point)
- Emulsifier addition

Coalescence is a more permanent condition
Flocculation to Coalescence

Gravity
Evaporation
Shear
Temperature
Pressure
Flocculation to Coalescence

contact of emulsion with aggregate

adsorption of 'free' Emulsifier, pH rises
Flocculation to Coalescence

Rise in pH leads to flocculation

coagulation/spreading over surface
Anionic emulsions typically rely on evaporative or mechanical forces to reach coalescence.
Emulsion Testing

Handling

Classification

Residue
Handling

Residue Content
Viscosity
Storage stability
Sieve
Classification

Demulsibility

Cement Mixing

Coating
Residue

Penetration
Ductility
Elastic Recovery
Softening Point
Emulsion Testing

Are you sure you want it in spec
There is sometimes a difference between an emulsion being in spec and performing as expected.
Double Chip Seal

Middle of August in Arkansas
CRS-2P
Granite aggregate
Demulsibility of 50

What is the likely result?
Texas Chip Seal

TX Grade 2 Aggregate
Shot Rate .60 gal/yd2
CRS-2P
Viscosity @125 SSF

What is the likely result?
Mississippi Summer
Over a fresh Chip Seal
Product is CSS-1
In spec but....

What is the likely result?
Late Season Chip Seal

Northern Climate
CRS-2
Penetration of 100
In spec maybe but…

What is the likely result?
Work on understanding properties and the effect on the project you have planned. Work with your industry partners to examine the requirements for the project.

**BE FLEXIBLE**
Emulsions used in preservation techniques are a balance of the issues we have discussed and many that we have not. **MUCH more information** is available on these topics. Great strides are being made in all areas of asphalt emulsion usage.