Asphalt Emulsions 101

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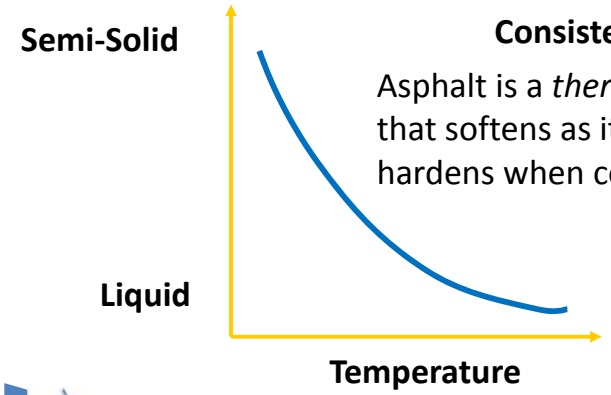
Introduction

Asphalt Binder Properties



Asphalt is a *thermoplastic* material that softens as it is heated and hardens when cooled.

Why Heat Asphalt? So It Can Be:

- Pumped and transported
- Blended with and coat aggregate
- Remain workable during
  - Transport, laydown, and compaction

Other Ways to Make Asphalt Workable:

- Add solvents – cutback asphalt

Emulsify with water

Asphalt Emulsions – A History

- First developed in the early 1900s
- Early use in spray applications + dust palliatives
- Growth use relatively slow:
  - Limited by the type of available emulsions
  - General lack of knowledge
- Steady rise in volume since the 1970's

Why Use Asphalt Emulsions?

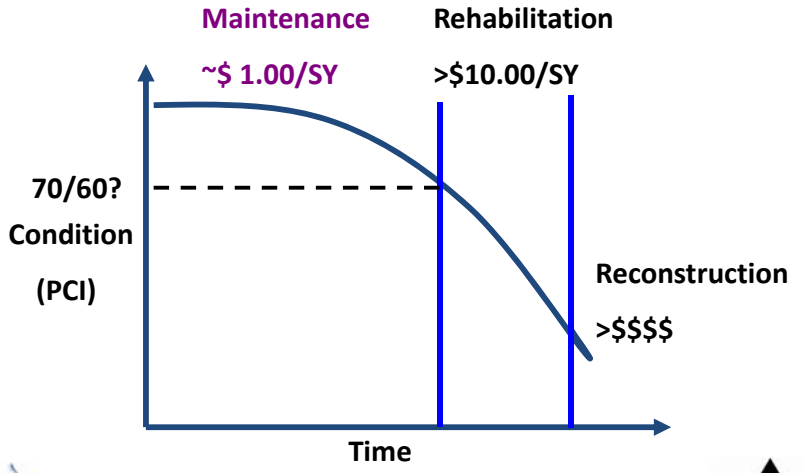
- No petroleum solvent required to liquefy
- Little or no hydrocarbon emissions
- In most cases, used with no additional heat
- The ability to coat damp aggregate
- Can use cold materials at remote sites
- Wide variety of emulsion types available today

Preventive maintenance apps – Improved LCC!

Asphalt Emulsions in Pavement Preservation (PP)

- Strategy of managing pavement condition to:
  - Maximize pavement lifespan at minimal cost
- Applies to all types of roads
  - Low volume local roads to heavy interstates
- Achieved by careful planning and selection
  - Right protective treatment (application)
  - At the optimal (right) time

Pavement Life Cycle Theory



Emulsion Chemistry

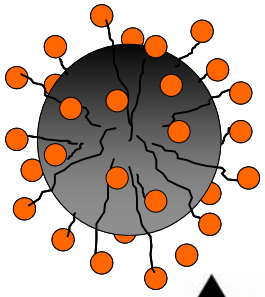
Emulsion Chemistry

- Emulsions are mixtures of
  - Two or more materials
  - Normally do not mix or blend together
  - Created via mechanical + chemical processes
- Some common examples
  - Mayonnaise, latex paint, ice cream

Asphalt Emulsions - Composition

- Three basic ingredients
  - Asphalt
  - Water
  - Emulsifying agent
- May contain other additives
  - Polymers
  - Stabilizers
  - Coating improvers
  - Antistrips
  - Break control agents

+Mechanical Mixing

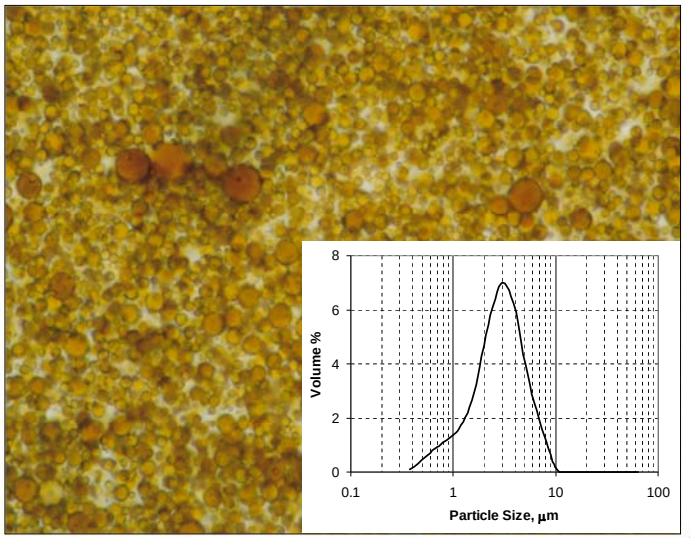


Basic Emulsion Ingredients – Asphalt

- Asphalt cement is basic ingredient
  - Up to 50-75% of finished emulsion
  - Hardness of base asphalt cement varies
    - Emulsion base ranges from 40–250 dmm PEN
    - No exact correlation bwn. asphalt props. and emulsification
    - Climate may require harder or softer base
    - Compatibility of emulsifier needed for stability

Basic Emulsion Ingredients – Water

- **Second basic ingredient in an emulsion is water**
  - **Contribution cannot be minimized**
  - **Water may contain minerals or other matter**
    - **Can affect the production of stable emulsions**
  - **Water considered suitable for drinking,**
    - **Might NOT be suitable for emulsion production**



Basic Emulsion Ingredients – Emulsifying Agents

- **Surfactants**
  - **Adsorbed at interface between liquids and solid**
  - **Concentrate at interface based on their structure**
    - **Hydrophilic head towards <u>more</u> polar phase (H_2O)**
    - **Lipophilic tail towards <u>less</u> polar phase (asphalt)**
  - **Surfactant molecule or ion acts as bridge bwn. phases**

Asphalt Emulsions – Emulsifying Agents

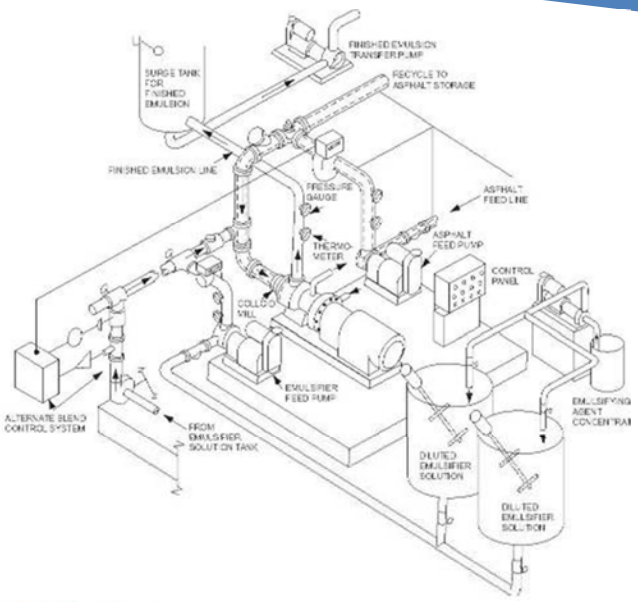
- **Asphalt emulsions are classified into three categories**
  - **Anionic (-)**
  - **Cationic (+)**
  - **Nonionic (neutral)**

Based on electrical charges surrounding asphalt particles

Emulsion Production

Producing the Emulsion - Emulsifying Equipment

- **Basic equipment**
  - High-speed, high-shear mechanical device
  - Usually colloid mill to shear asphalt into droplets
  - **Also required**
    - Emulsifier solution tank
    - Hated asphalt tank
    - Pumps
    - Flow-metering gauges

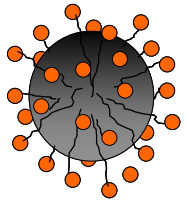


Producing the Emulsion – Emulsification Process

- **Asphalt particle size vital factor for stable emulsion**

Smaller than:

0.001 millimeter (1 micron)	20 percent
0.001–0.005 millimeter (1–5 microns)	57 percent
0.005–0.010 millimeter (5–10 microns)	23 percent



Emulsion Classification

Asphalt Emulsions – Classification by Set Rate

- How quickly do asphalt droplets coalesce?
- Two letter codes used to simplify + standardize
  - RS – Rapid Setting
  - MS – Medium Setting
  - SS – Slow Setting
  - QS – Quick Setting
- Relative terms only

Proportional to break speed after contact agg. surface

Asphalt Emulsions - Classification by Set Rate

- **RS Emulsions**
  - Little/no ability to mix with aggregate
- **MS Emulsions**
  - Can mix with coarse but not fine aggregate
- **SS and QS Emulsions**
  - Can mix with fine aggregate
  - QS expected to break more quickly than SS

Sub-Classifications - Typical Applications

- **RS**
  - **Rapid Setting**
    - Chip Seals
- **MS**
  - **Medium Setting**
    - Plant Mixing
    - In-place Recycling
- **SS**
  - **Slow Setting**
    - Cold Mixes
    - Tack Coats
- **QS**
  - **Quick Setting**
    - Slurry Seals
    - Micro Surfacing

Asphalt Emulsions – Full Classification

- Identified by numbers and letters related to:
  - Particle charge (prefix)
  - Set rate (prefix)
  - Viscosity of liquid emulsion (suffix)
  - Hardness of base asphalt cements (suffix)

Hardness + Modification Suffixes

No suffix
- 100-200 pen

h
- 40-90 pen (hard)

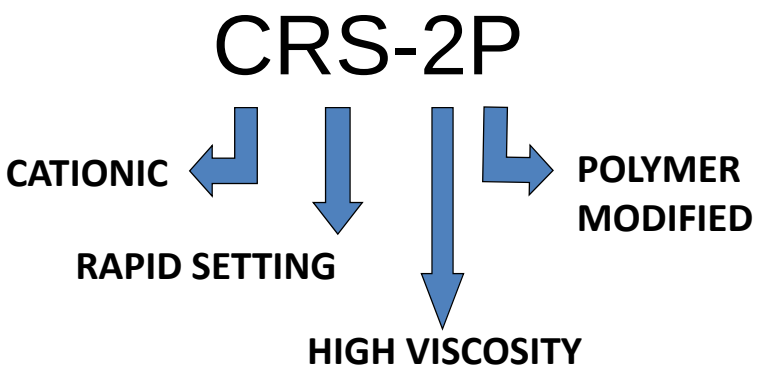
s
- > 200 pen (soft)

L
- Latex-modified

P
- Polymer-modified

R
- Recycling agent-mod.

Asphalt Emulsion Nomenclature



Asphalt Emulsion (ASTM D 977, AASHTO M 140)	Cationic Emulsion (ASTM D 2397, AASHTO M 208)	Polymer-Modified Cationic Emulsion (AASHTO M 316)
RS-1	CRS-1	—
RS-2	CRS-2	CRS-2P, CRS-2L
HFRS-2	—	—
MS-1	—	—
MS-2	CMS-2	—
MS-2h	CMS-2h	—
HFMS-1	—	—
HFMS-2	—	—
HFMS-2h	—	—
HFMS-2s	—	—
SS-1	CSS-1	—
SS-1h	CSS-1h	—
QS-1h	CQS-1h	—

Asphalt Emulsions – Micro Surfacing Classification

- **Micro surfacing often specifies CSS-1hP emulsion**
  - **Meets ASTM and AASHTO CSS-1h requirements**
    - **With the exception of the cement mixing test**
  - **Min. polymer content of 3% solids on asphalt**
    - **Enhances high temperature performance**
    - **Permits application in multiple stone depths:**
      - **Rut-filling**
      - **Leveling operations**

Emulsion Application

Asphalt Emulsions – Breaking and Curing

- **Breaking/Drying**
  - **Separation and evaporation of water**
- **Curing**
  - **Return of residual asphalt properties**
    - **Adhesion**
    - **Durability**
    - **Water-resistance**

Emulsions – Breaking

- **Breaking**
  - **H_2O separating from asphalt phase + evaporating**
  - **Emulsions formulated to break according to app.**
  - **Two breaking mechanisms**
    - **Chemical**
    - **Physical or evaporative**

Emulsions - Breaking

- **Breaking**
  - For SS grades = mechanism mainly evaporation
  - For MS + RS grades = mechanism mainly chemical

Emulsions - Curing

- ***Curing*** **– Process whereby mechanical properties of the asphalt return after application**
  - Water must completely evaporate
  - Asphalt particles must coalesce and bond to intended surface
  - Water fully removed by evaporation + absorption