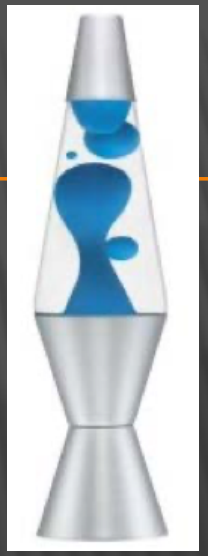
ASPHALT EMULSION MANUFACTURING

BLUE LINE
ROAD PRODUCTS

INTRODUCTION



- It is said that oil and water don't mix……
- An asphalt emulsion is asphalt binder that is mechanically dispersed in water and chemically stabilized.
- Why emulsify asphalt? The primary reasons we emulsify asphalt is to reduce the temperature required for handling and the ability to coat damp aggregate.

ASPHALT EMULSION INGREDIENTS

ASPHALT EMULSION INGREDIENTS

- The three basic ingredients are:
  - Asphalt binder
  - Water
  - Emulsifying agent
- Other ingredients:
  - Polymers
  - Solvents
  - pH modifying agents

ASPHALT BINDER

- Asphalt binder is a basic ingredient but an important one. The properties must be analyzed and tested prior to use because not all asphalt binder is conducive to emulsification.

- Considerations
  - Source of the binder
  - Binder modification
  - Emulsifier compatibility

WATER

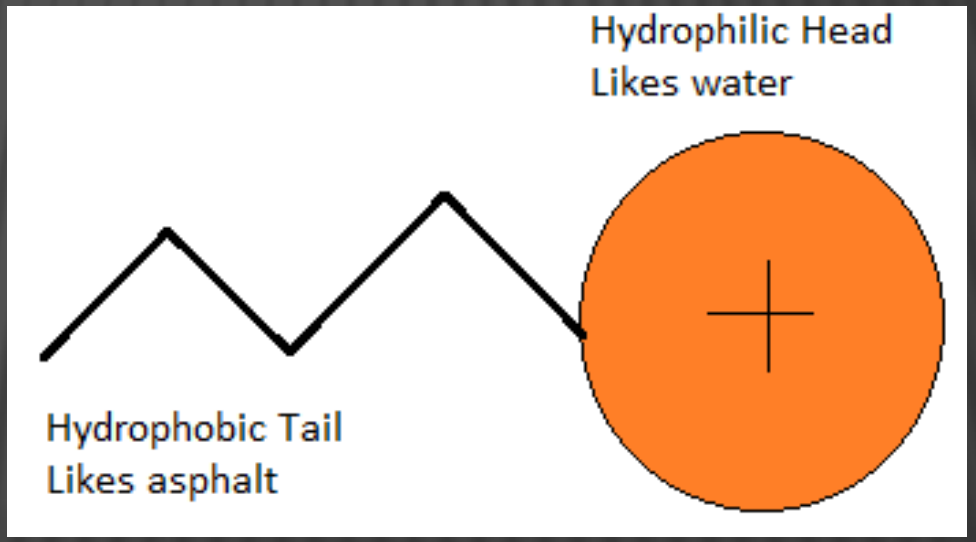
- The composition and properties of the water is also very important. Additives in potable water may interfere with the emulsification process.

- Considerations
  - pH
  - Free of contaminants
  - Hard or soft

EMULSIFYING AGENT

- The emulsifying agent allows the asphalt and water to be emulsified with less energy and produces greater stability as the droplets are formed in the colloid mill.

- Considerations
  - Particle charge
  - Setting requirements
  - Stability



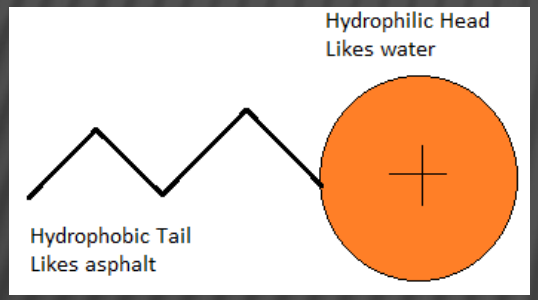
OTHER INGREDIENTS

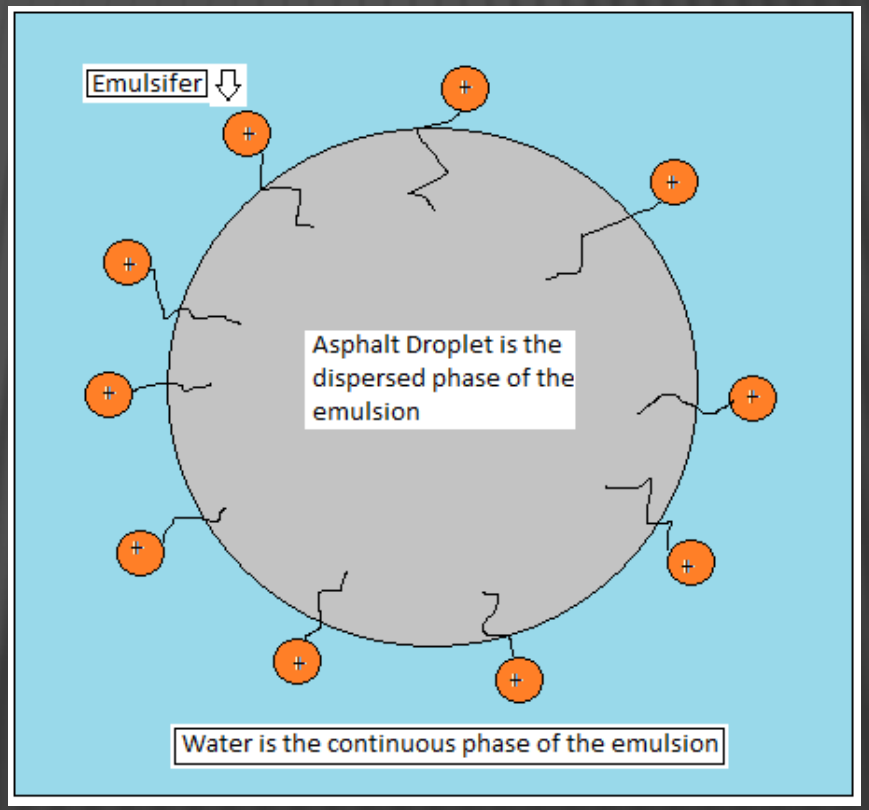
- The addition of other ingredients is determined by the needs of the end user.
  - Polymers add elasticity and/or strength to the asphalt binder.
  - Solvents soften the asphalt binder, improves adhesion to aggregate during mixing and slows the curing time.
  - pH modifying agents allow for adjustment of the pH when the emulsifying agent does not meet the requirement.

ASPHALT EMULSION CHEMISTRY

DROPLET CHARACTERISTICS

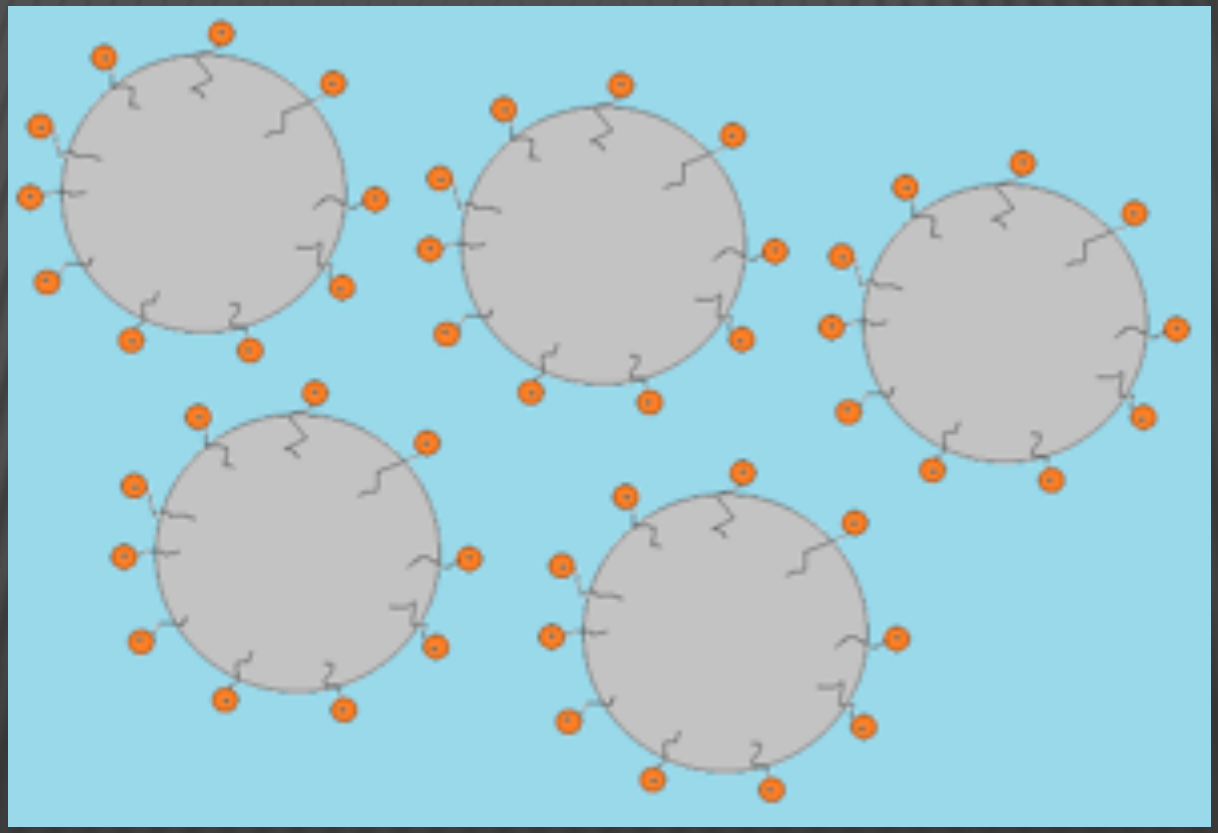
- Cationic or anionic emulsifying agents provide a positive or negative charge to the surface of the asphalt droplet.





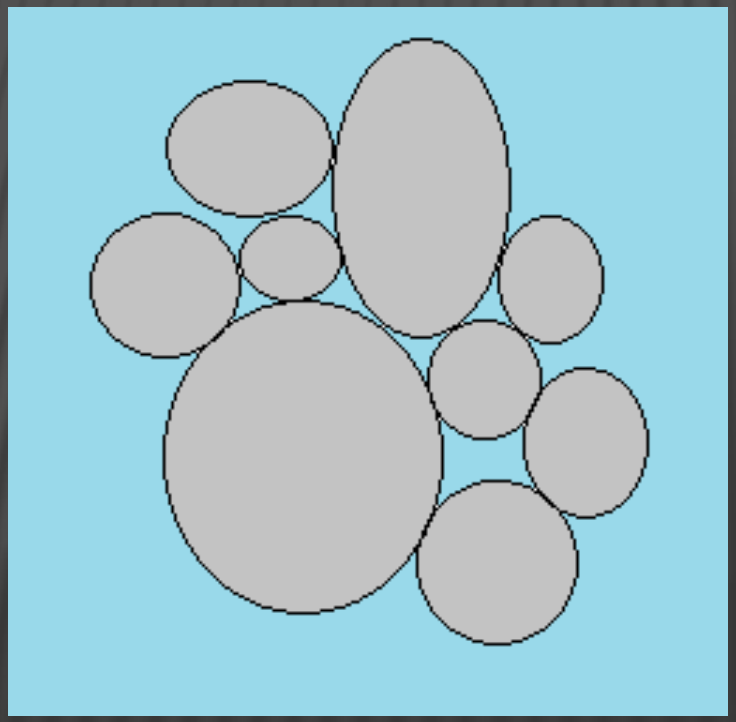
EMULSION CHARACTERISTICS

- Through electrostatic repulsion the asphalt droplets stay dispersed in water.



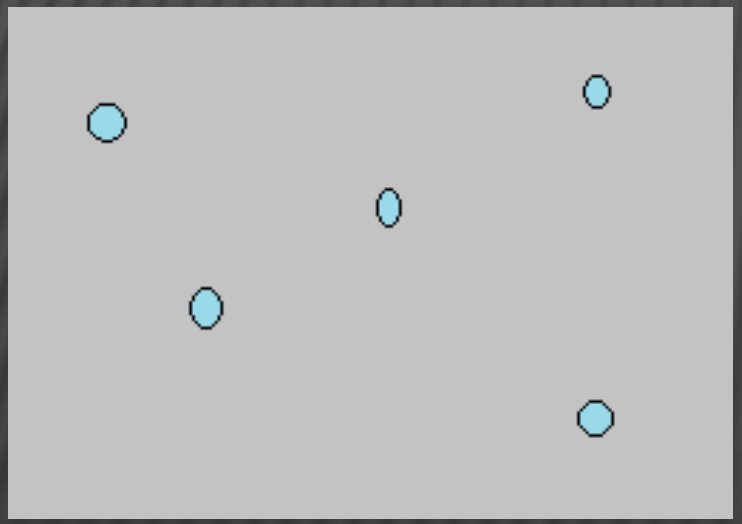
FLOCCULATION (BREAKING)

- Flocculation describes the clustering of individual dispersed droplets that do not lose their identity.



COALESCENCE (CURING)

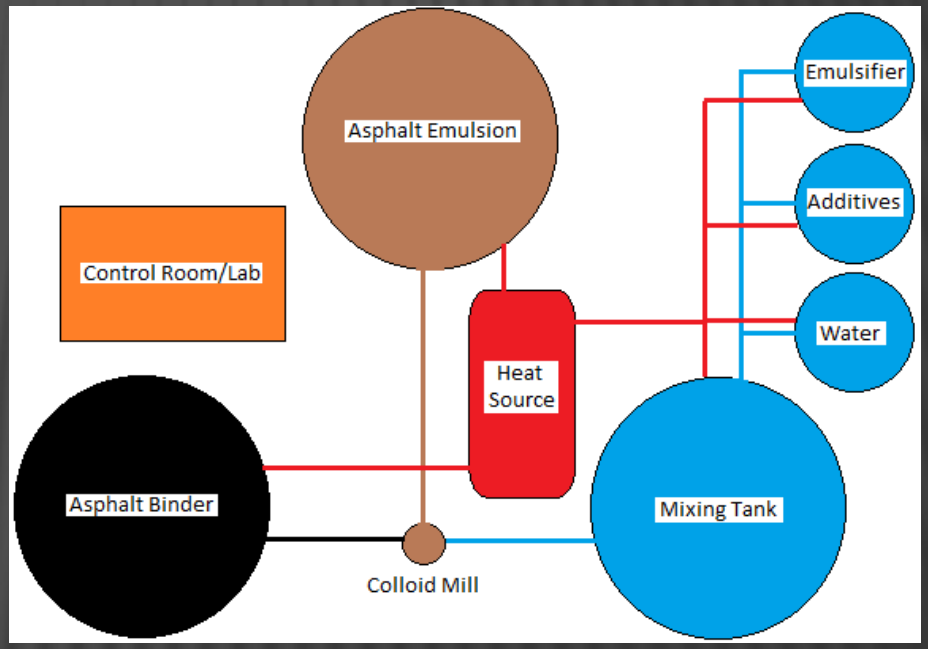
- Coalescence is the process of breaking down the emulsifier coating and allowing the asphalt droplets to combine. Small amounts of water will be trapped within the asphalt droplet until fully cured.



ASPHALT EMULSION MANUFACTURING FACILITY

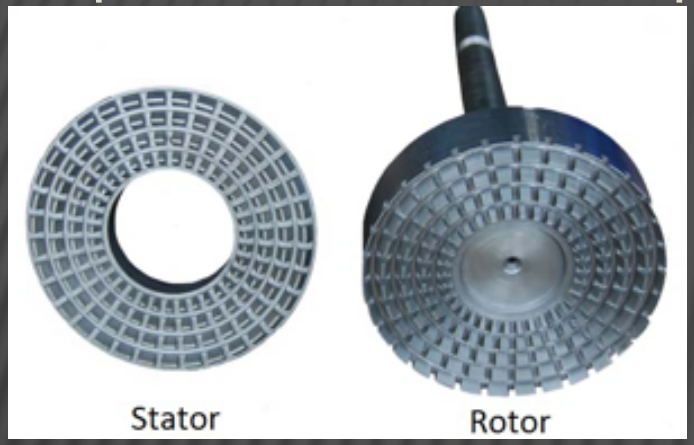
EQUIPMENT

- The manufacturing of asphalt emulsions requires specialized equipment.
  - Colloid mill
  - Asphalt binder storage
  - Emulsion storage
  - Water storage
  - Mixing tank
  - Heat source
  - Additive storage
  - Control Room / Laboratory
  - Pumps



COLLOID MILL

- The colloid mill provides the mechanical force needed to shear the asphalt binder into microscopic droplets that then disperse into the water pha



  - The main components of the mill are the Rotor and Stator. They mesh closely together and when operating, the rotor rotates while the stator remains stationary.
  - The gap between the rotor and stator determines the particle size of the asphalt binder droplets produced.

CONTROL ROOM / LABORATORY

- The control room and laboratory work in conjunction with each other to produce quality asphalt emulsions.
  - Control room - Designed so that all equipment can be operated and monitored from a single point.
  - Laboratory - Produces mix designs and ensures quality control on all asphalt emulsions being produced.

STORAGE AND MIXING TANKS

- From storing the asphalt binder to the finished asphalt emulsion, the facility is equipped with many different tanks.
  - Asphalt Binder – heated and insulated
  - Asphalt Emulsion – heated, insulated and equipped with a mixer
  - Water – heated and insulated
  - Mixing (soap) – equipped with a mixer
  - Additive – specific to product requirements

ASPHALT EMULSION MIX DESIGN

INTRODUCTION

- Prior to manufacturing, a mix design must be established.
- Mix designs determine the characteristics of the finished product.
- Product type and customer expectation drive the mix design.
- Chemistry determines the successfulness of the mix design.

PRODUCT TYPE

- Product type is generally determined by the end use application.
  - Tack
  - Chip seal
  - Fog Seal
  - Cold mix
  - In-place recycling

CHARACTERISTICS

- Once the product type is determined the characteristics come in to play.
  - Demulsibility
  - Penetration
  - Viscosity
  - Elastic recovery
  - Particle charge
  - Residue
  - Distillate
  - Stability

FINALIZING THE MIX DESIGN

- Once the product type and characteristics are determined the chemistry and mechanical force is addressed.
  - Compatibility – Ingredients
  - Compatibility – Other emulsions
  - Dosage
  - Temperatures
  - Ductility

ASPHALT EMULSION MANUFACTURING

PROCESSING TEMPERATURES

- The ingredient temperatures play a vital roll in determining the quality of the finished asphalt emulsion.
  - Asphalt Binder - 300° F
  - Soap – 100° F
  - Emulsion exit temperature must not exceed 212° F

$$\frac{[(\text{AB wt\%}) \times (\text{AB Temp}) \times .5] + [(\text{Soap wt\%}) \times (\text{Soap Temp})]}{[(\text{AB wt\%}) \times .5] + [\text{Soap wt\%}]} = \text{Emulsion Temp}$$

$$\frac{[(62) \times (300) \times .5] + [(38) \times (100)]}{[(62) \times .5] + [38]} = 189.85^\circ \text{F}$$

SOAP MIXING

- Mixing the soap ingredients to achieve the mix design is the next step.
  - Water
  - Emulsifier
  - Additives
  - Check pH
  - Adjust
  - Check temperature

PRODUCTION

- Production is where it all comes together.
  - Mill activation and conditioning
  - Introduce the soap
  - Introduce the asphalt binder
  - Check the production temperature
  - Check the residue
  - Continue checking everything – STRESS FACTOR 10
  - Shut down the asphalt binder
  - Shut down the soap
  - Shut down the mill

ASPHALT EMULSION TESTING

INTRODUCTION

- The primary purpose for testing the asphalt emulsion is to ensure the quality and characteristics of the product.
  - Sampling
  - Viscosity
  - Sieve
  - Storage stability
  - Demulsibility
  - Distillation
  - Penetration
  - Solubility
  - Ductility
  - Elastic recovery

SAMPLING

- Sampling is as important as the testing, and precautions must be taken to ensure a true representation of the asphalt emulsion.

  - New plastic containers only
  - One (1) gallon drawn prior to sampling
  - Sampling under pressure can entrap air
  - Label the container with the proper information. NOT THE LID
  - Fill completely full to avoid skin formation at the air- emulsion interface

VISCOSITY

- Viscosity determines the utility of an asphalt emulsion and is measured as Saybolt Furol Seconds (SFS). Viscosity of asphalt emulsion is ever changing and protocol must be followed.
  - Condition the sample
  - Prepare the Saybolt Furol viscometer
  - Conduct the test
  - Record the data

SIEVE

- Sieve identifies excessive amounts of particles that may form due to handling, manufacturing and/or contamination issues.
  - Condition the sample
  - Prepare the sieve
  - Run the test
  - Record the data

Oversized Particles % = [(B-A)/(C-D)]x100

A = mass of sieve and pan
B = mass of sieve, pan and residue
C = mass of full sample container
D = mass of empty sample container

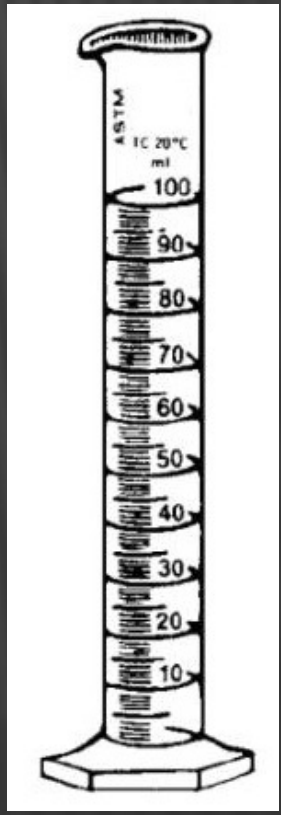
STORAGE STABILITY

- Determines in a relatively short time frame the ability of the asphalt emulsion to remain uniformly dispersed during storage.
  - Condition the sample
  - Prepare the equipment
  - Run the test
  - Record the data

% = B – A

A = percentage of residue from the top sample

B = percentage of residue from the bottom sample



DEMULSIBILITY

- Determines the classification of the chemical breaking of the asphalt emulsion.

  - Condition the sample
  - Prepare the solution
  - Run the test
  - Record the data

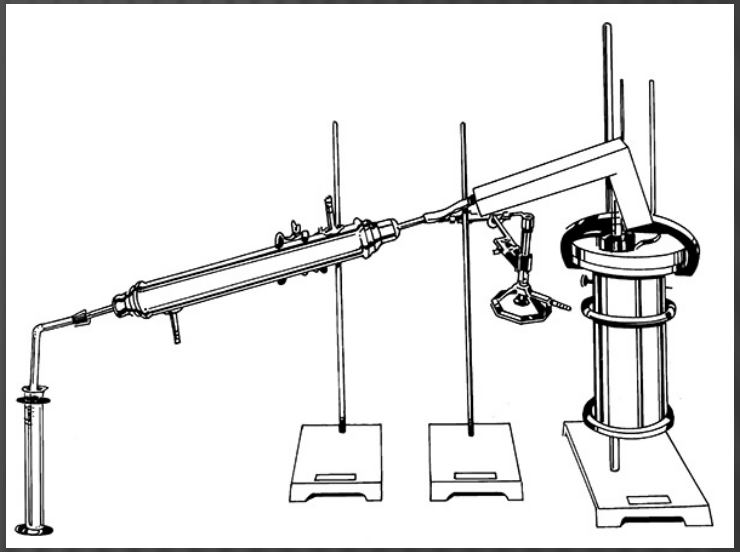
% = (A/B) x 100

A = weight of demulsibility residue from the test of the sample of emulsified asphalt

B = weight of residue in 100g of the asphalt emulsion

DISTILLATION

- Quantifies the percentage of asphalt residue and oil distillate in the asphalt emulsion. This test method also obtains the asphalt residue for additional tests.
  - Condition the sample
  - Prepare the still apparatus
  - Run the test
  - Record the data



% = ((B – A)/C) x 100

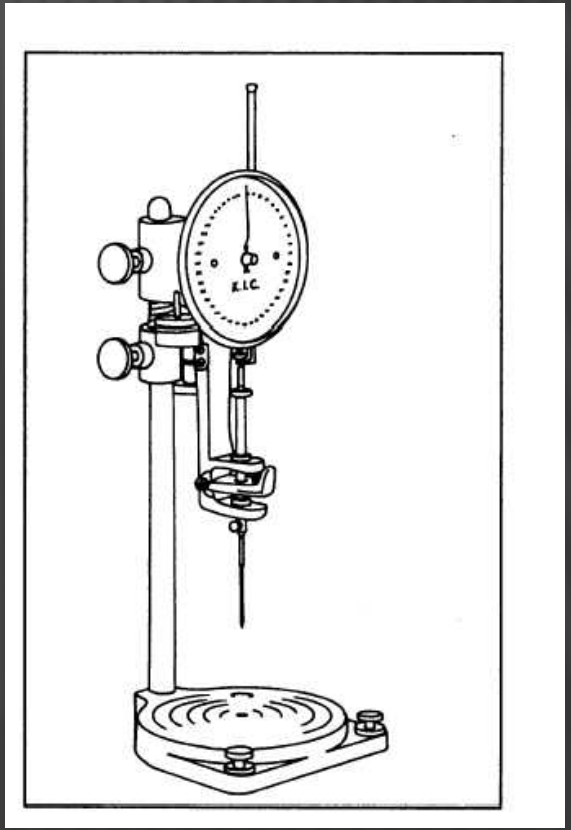
A = weight of empty still assembly before test

B = weight of still assembly after test + 1.5

C = weight of asphalt emulsion added to still

PENETRATION

- Determines the hardness of the asphalt residue expressed in tenths of a millimeter.
  - Condition the sample
  - Prepare the penetration apparatus
  - Run the test
  - Record the data



SOLUBILITY

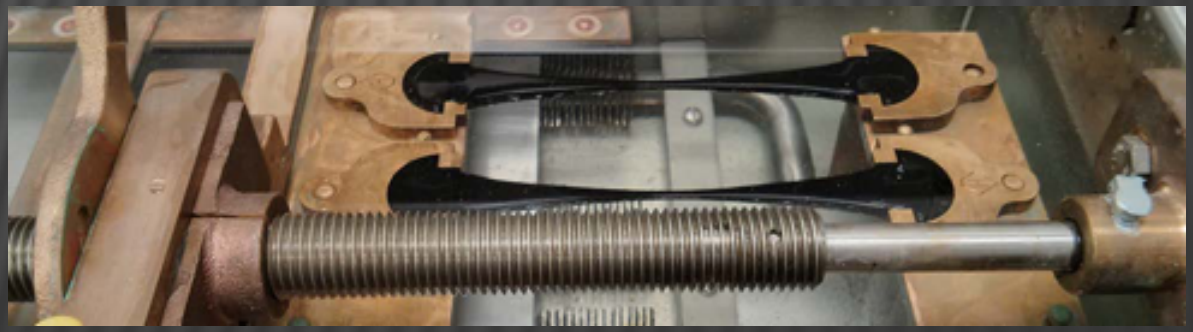
- This test method determines the degree of solubility in trichloroethylene of asphalt residue.
- TRICHLOROETHYLENE is toxic and extremely flammable so this test is conducted at an outside laboratory.

DUCTILITY

- Determines at what length does a specific specimen break under controlled temperature and speed.
  - Prepare the specimen
  - Prepare the testing apparatus
  - Run the test
  - Record the data

ELASTIC RECOVERY

- Verifies an elastomeric material has been added to the asphalt and is quantified as a percentage.
  - Prepare the specimen
  - Prepare the testing apparatus
  - Run the test
  - Record the data



ASPHALT EMULSION QUALITY

INTRODUCTION

- The characteristics of a quality asphalt emulsion will differ depending on who you are talking to.
  - Emulsion nomenclature
  - Specifications polymer modified
  - Specifications non-polymer modified
  - Performance expectations

EMULSION NOMENCLATURE

- Understanding the nomenclature of Asphalt Emulsion is essential when engineering for a given application.

- C = Cationic
- HF = High Float
- QS = Quick Set
- RS = Rapid Set
- MS =Medium Set
- SS = Slow Set
- 1 = Low Viscosity
- 2 = High Viscosity
- P = Polymer
- H = Hard

HFRS-2
CRS-2
HFRS-P1
CRS-2P
HFMS-2
CMS-2
SS-1
CSS-1
SS-1H
CSS-1H

SPECIFICATION GRADE POLYMER MODIFIED

General Requirements: This specification has been designed to yield a set of distinguishing characteristics for a polymer-modified emulsion. It is for use in chip seal projects where early chip retention and resistance to chip loss is an important objective. The binder is not a conventional asphalt cement. The asphalt must be polymerized before shipment. It shall show no separation of asphalt after thorough mixing within 14 days after delivery. It shall meet the following requirements when tested within 14 days of sampling according to AASHTO Method T 59 as modified.

GRADE	HFRS-P1		CRS-2P		HFRS-P2		RS-LTP	
	Min	Max	Min	Max	Min	Max	Min	Max
TESTS ON EMULSION:								
Saybolt Viscosity @ 50°C (122°F), SFS	100		100	400	100		100	
Sieve Test, %		0.10		0.10		0.10		0.10
Storage Stability, % (1 day)		1.0		1.0		1.0		1.0
Demulsibility, %	30		40		40		60	
Distillation: Oil distillate, % (by volume of emulsion) Residue, % (by weight)	65[1]	3.0	65[2]	3.0	65[1]	2.0	65[1]	3.0
Breaking Index @ 25°C (77°F) [3]								80
TESTS ON RESIDUE FROM:	**DISTILLATION**						**DISTILLATION**	
Penetration @ 25°C (77°F), 100g, 5s, dmm	90	200	90	200	90	200	150	300
Float Test @ 60°C (140°F), seconds	1200				1200			
Solubility in Trichloroethylene, % [4]	97.5		97.5		97.5			
Elastic Recovery, % [5] or	30		45		58		45	
Torsional Recovery	18[7]		18[6]		18[7]		18[6]	

[1] AASHTO T 59 with modifications to include a 204 ± 5°C (400 ± 10°F) maximum temperature to be held for 15 minutes.

[2] AASHTO T 59 with modifications to include 300 grams emulsion and a 177 ± 5°C (350 ± 10°F) maximum temperature to be held for 15 minutes.

[3] ODOT TM 431, Breaking Index - method of testing on file at ODOT Materials Laboratory in Salem, Oregon.

[4] AASHTO T 44, Solubility of Bituminous Materials. May be waived if polymer modification interferes with test accuracy.

[5] ODOT TM 429, Elastic Recovery – method of testing on file at ODOT Materials Laboratory in Salem, Oregon.

[6] ODOT TM 428 Method A, Torsional Recovery - method of testing on file at ODOT Materials Laboratory in Salem, Oregon.

[7] ODOT TM 428 Method B, Torsional Recovery - method of testing on file at ODOT Materials Laboratory in Salem, Oregon.

SPECIFICATIONS – NON-POLYMER MODIFIED

General Requirement: The cationic emulsified asphalt furnished under this specification shall be an emulsion of asphalt cement, water and emulsifying agent. The emulsified asphalt shall be homogeneous. It shall show no separation of asphalt after thorough mixing within 30 days after delivery. It shall meet the following requirements when tested within 30 days of sampling according to AASHTO Method T 59.

GRADE	RAPID SETTING				MEDIUM SETTING						SLOW SETTING			
	CRS-1[a]		CRS-2[a]		CMS-2S		CMS-2		CMS-2h		CSS-1		CSS-1h	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
TESTS ON EMULSION:														
Saybolt Viscosity @ 25°C (77°F), SFS											20	100	20	100
Saybolt Viscosity @ 50°C (122°F), SFS	20	100	150*	400	100*	450	100*	450	100	450				
Storage Stability, % (1 day)		1		1		1		1		1		1		1
Demulsibility %[b]	40		40											
Coating ability & water resistance:														
Coating, dry aggregate					Good		Good		Good					
Coating, after spraying					Fair		Fair		Fair					
Coating, wet aggregate					Fair		Fair		Fair					
Coating, after spraying					Fair		Fair		Fair					
Particle charge test	Positive		Positive		Positive		Positive		Positive		Positive		Positive	
Sieve test, %[c]		0.10		0.10		0.10		0.10		0.10		0.10		0.10
Cement mixing test, %												2.0		2.0
Distillation to 260°C (500°F):														
Oil distillate, % (by volume of emulsion)		3		3		12[b]		8[b]		8[b]		3[b]		3[b]
Residue, % (by weight)	60		65		60		65		65		57		57	
TESTS ON RESIDUE FROM DISTILLATION:														
Penetration @ 25°C (77°F), 100g, 5s, dmm	100[d]	250[d]	100[d]	250[d]	100	250	100	250	40	90	100	250	40	90
Ductility @ 25°C (77°F), cm	40		40		40		40		40		40		40	
Solubility in Trichloroethylene, %	97.5		97.5		97.5		97.5		97.5		97.5		97.5	

* Modification of AASHTO M 208

[a] The demulsibility test shall be performed within 30 days from date of shipment.

[d] When CRS-1h or CRS-2h is specified, the penetration range is changed from 100-250 dmm to 40-90 dmm.

[b] Required under Oregon Administrative Rules, Chapter 340, Division 232-0120 - Department of Environmental Quality.

[c] This test requirement on representative samples is waived, if successful application of the material has been achieved in the field. (per AASHTO M-140)

CRS-3P

General Requirements: The specification has been designed to yield a set of distinguishing characteristics of a polymer-modified emulsion for use in chip seal projects where engineered design and early return to traffic is desired. The emulsion must be homogenous and polymerized before shipment. It shall meet the following requirements when tested within 10 days of sampling according to AASHTO Method T 59 as modified[1].

TESTS ON EMULSION	Minimum	Maximum	TEST METHOD
Saybolt Viscosity @ 50°C (122°F), SFS	150	-	ASTM D7496
Storage Stability % (1 Day)	-	1	ASTM D6930
Demulsibility %	40	-	ASTM D6936
Particle Charge Test	Positive	-	ASTM D7402
Sieve Test %	-	0.1	ASTM D6933
Distillation to 260°C (500°F)[1]: Oil distillate % (by volume of emulsion)	-	3	ASTM D6997
Residue % (by weight)	65	-	ASTM D6934

TESTS ON RESIDUE FROM DISTILLATION	Minimum	Maximum	TEST METHOD
Penetration @ 25°C (77°F), 100g, 5s, dmm	80	150	ASTM D5
Elastic Recovery, %[2]	58	-	ODOT TM429
Solubility in Trichloroethylene, %[3]	97.5	-	ASTM D2042

[1] AASHTO T59 with modifications to include 300 grams emulsion and 177 + 5°C (350 +10°F) maximum temperature to be held for 15 minutes.
[2] ODOT TM429 Elastic Recovery method of testing on file at ODOT Materials Laboratory in Salem, OR.
[3] AASHTO T44, Solubility of Bituminous Materials may be waived if polymer modification interferes with test accuracy.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QUESTIONS?