



Background

- **Asphalt**
 - Soluble in petroleum products
 - Generally a by-product of petroleum distillation process
 - Can be naturally occurring
- **Tar**
 - Resistant to petroleum products
 - Generally by-product of coke (from coal) production

Petroleum-Based Asphalts

- Asphalt is waste product from refinery processing of crude oil
 - Sometimes called the “bottom of the barrel”
- Properties depend on:
 - Refinery operations
 - Composition crude source-dependent



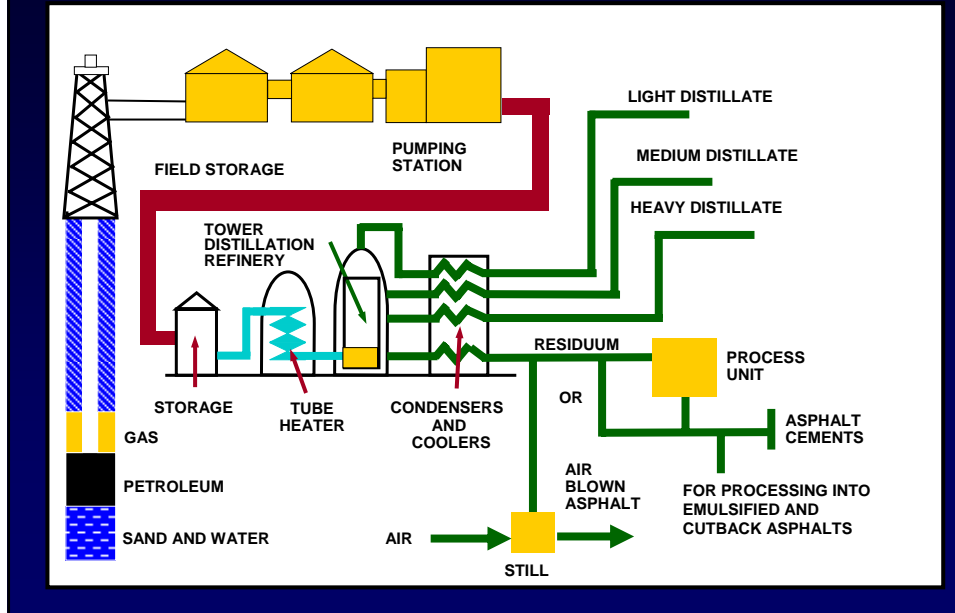
Barrel of Crude Oil

Asphalt Cement Components

- Asphaltenes
 - Large, discrete solid inclusions (black)
 - High viscosity component
- Resins
 - Semi-solid or solid at room temperature
 - » Fluid when heated
 - » Brittle when cold
- Oils
 - Colorless liquid
 - Soluble in most solvents
 - Allows asphalt to flow



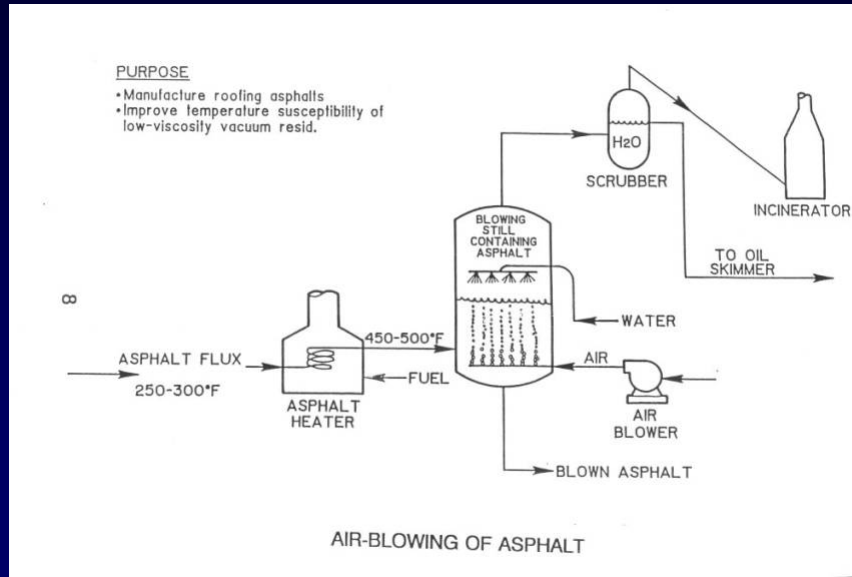
Refinery Operation



Types

- Asphalt cements
 - Generally refinery produced material
 - Air blown asphalt cements
- Cutbacks
 - Asphalt cements “cut” with petroleum solvents
- Emulsions
 - Mixture of asphalt cement, water, and emulsifying agent

Air Blown Asphalt Cement



Cutbacks

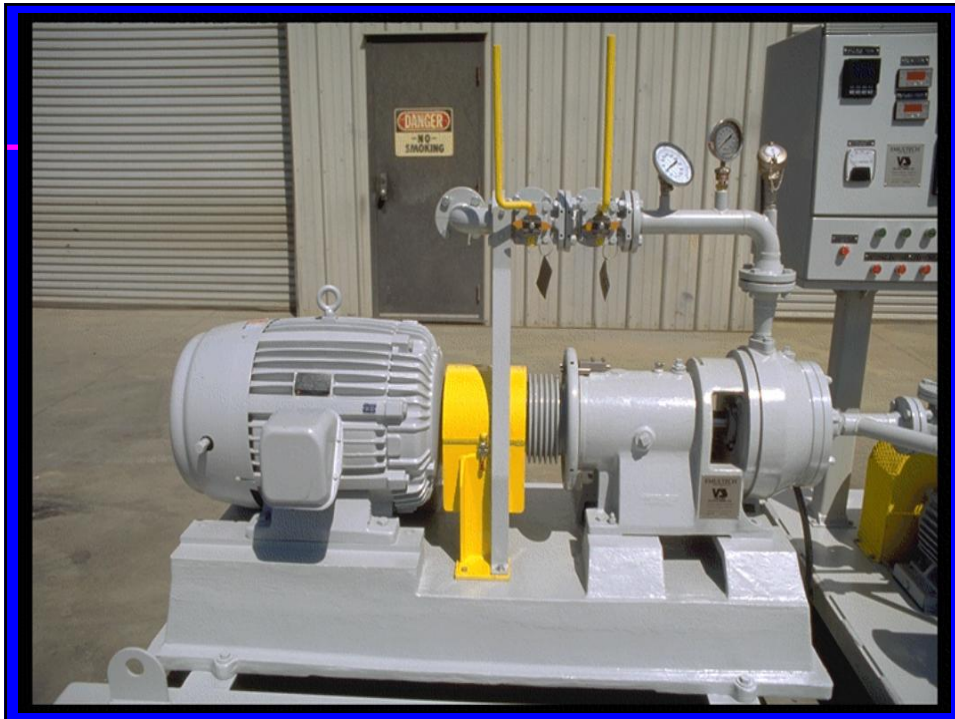
- Rapid cure (RC) (Naphtha or Gasoline)
 - High volatility of solvent
 - Tack coats, surface treatments
- Medium cure (MC) (Kerosene)
 - Moderate volatility
 - Stockpile patching mix
- Slow cure (SC) (Low viscosity oil)
 - Low volatility
 - Prime coat, dust control

Emulsions

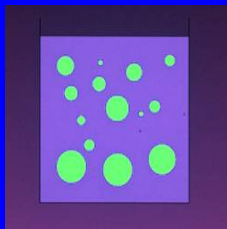
- Emulsifier gives surface charge to asphalt droplets suspended in water medium
 - Anionic
 - » Negative charge
 - » Alkaline
 - » Good with limestones (positive charge)
 - Cationic
 - » Positive charge
 - » Acid
 - » Good with silica gravels (negative charge)

Containerized



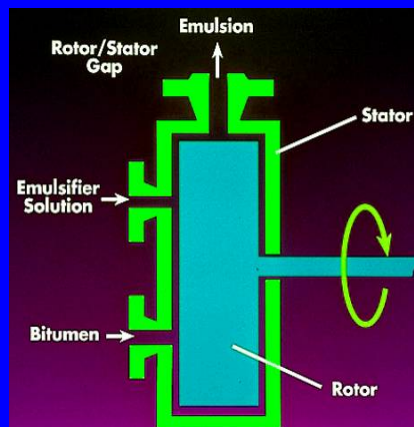


Emulsion Formation

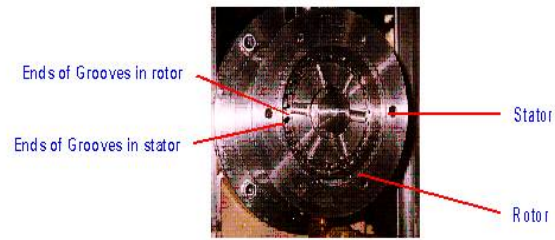


Sheared to a fine particle size

Asphalt Dispersed in Water



How does it work?



The rotor fits inside the and stator of Charlotte mill and they are very close fitting. They are both conically shaped and have grooves cut along the sides of the cones.

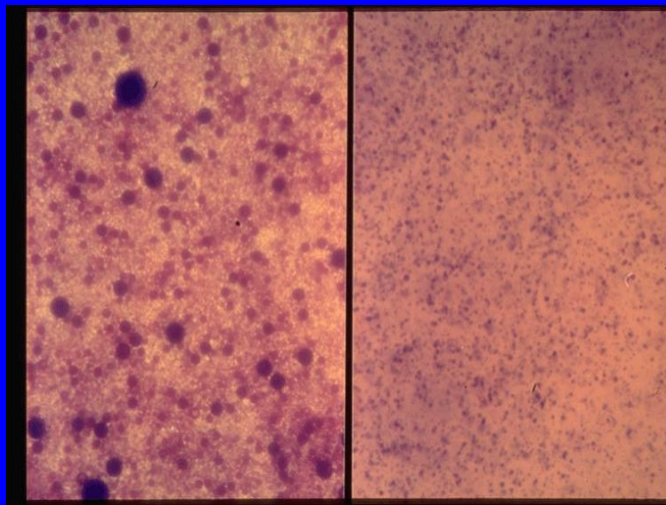


Rotor



Stator

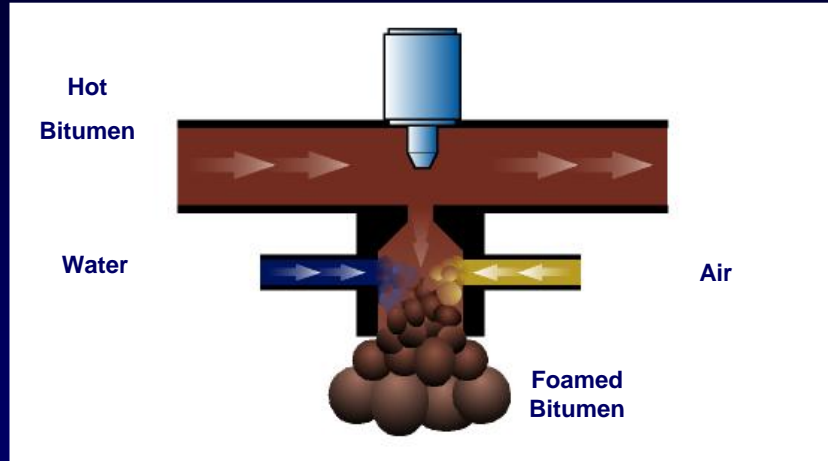
Particle Sizing 1-5 micron



Poor

Good

Cold recycling



2 - 3% cold water injected into the hot bitumen will produce foam with an expansion of 10 to 20 times of the original volume



Purchasing of Asphalt Cements

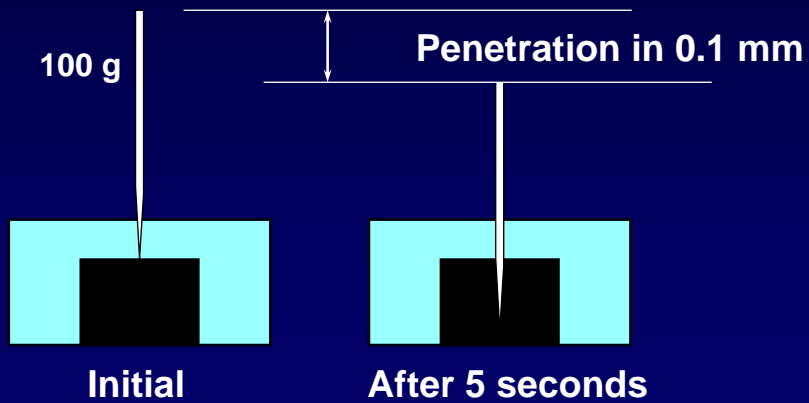
- Need to be able to specify desirable characteristics
- “Desirable characteristics” have evolved over time and with increasing technological advances
- Purchasing requires ***specifications***

Early Specifications

- Lake Asphalts
 - Appearance
 - Solubility in carbon disulfide
- Petroleum asphalts (early 1900's)
 - Consistency
 - » Chewing
 - » Penetration machine
 - Measure consistency

Penetration Testing

- Sewing machine needle
- Specified load, time, temperature



Penetration Specification

- Five Grades
 - 40 - 50
 - 60 - 70
 - 85 - 100
 - 120 - 150
 - 200 - 300

Viscosity Graded Specifications

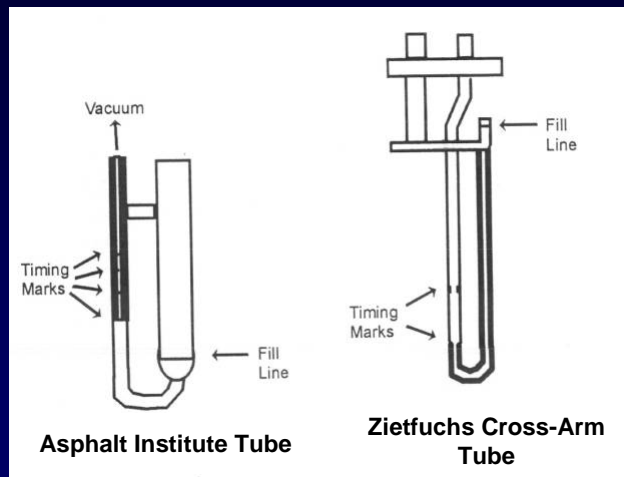
Definition

Viscosity: the ratio between the applied shear stress and the rate of shear.

$$\eta = \tau / \dot{\gamma}$$



Types of Viscosity Tubes

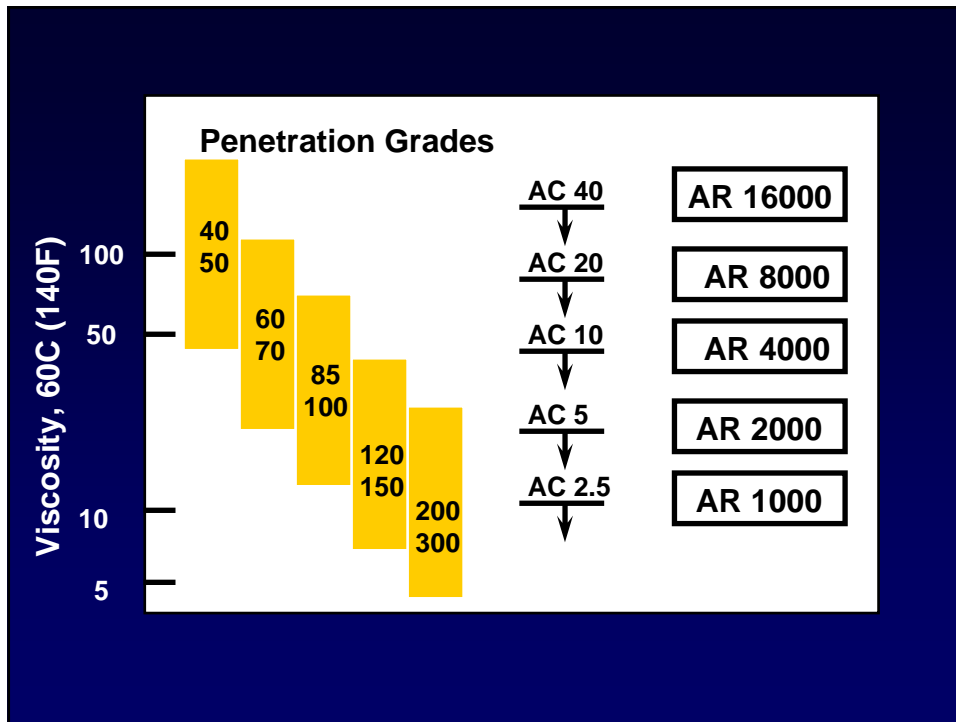


Testing

Absolute viscosity

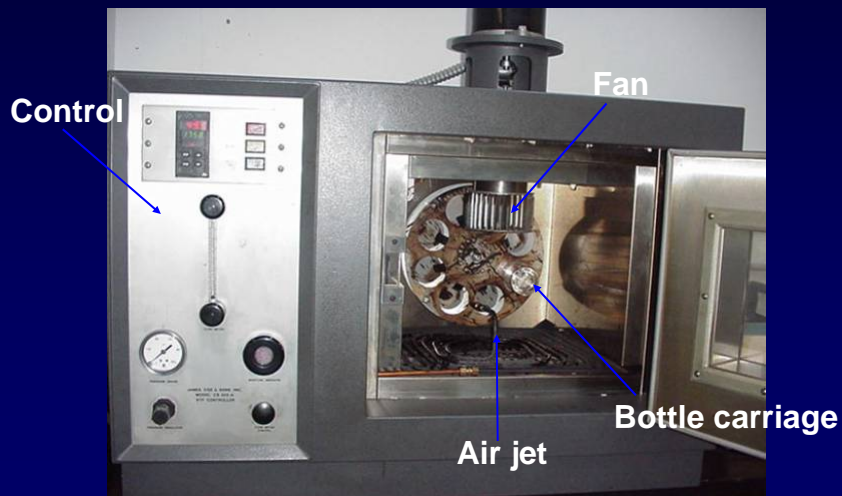
- U-shaped tube with timing marks & filled with asphalt
- Placed in 60C bath
- Vacuum used to pull asphalt through tube
- Time to pass marks
- Viscosity in Pa s (Poise)

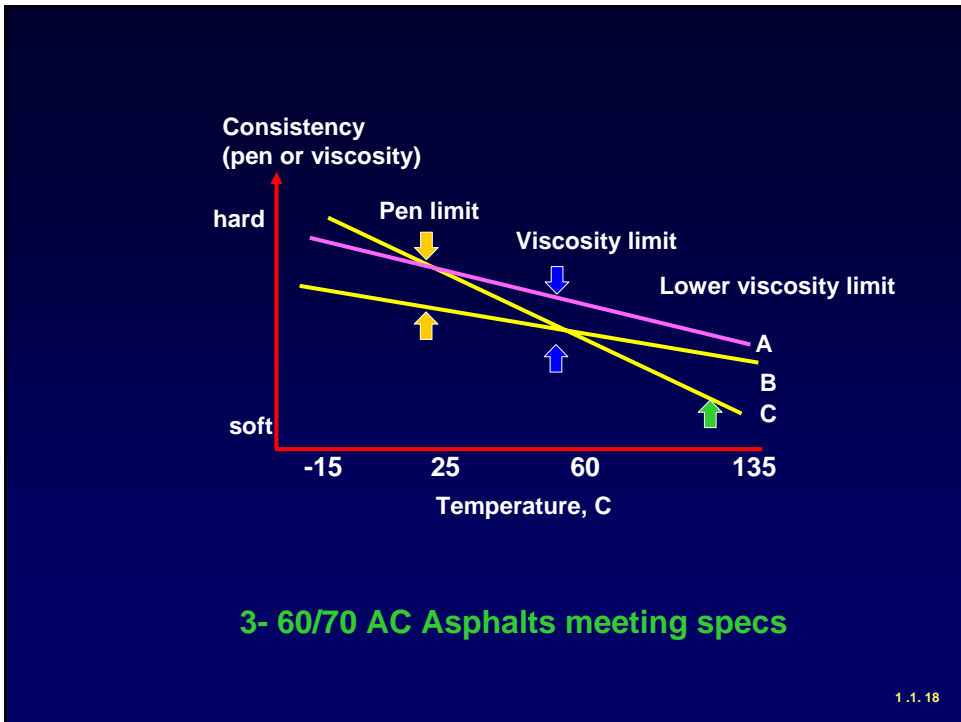
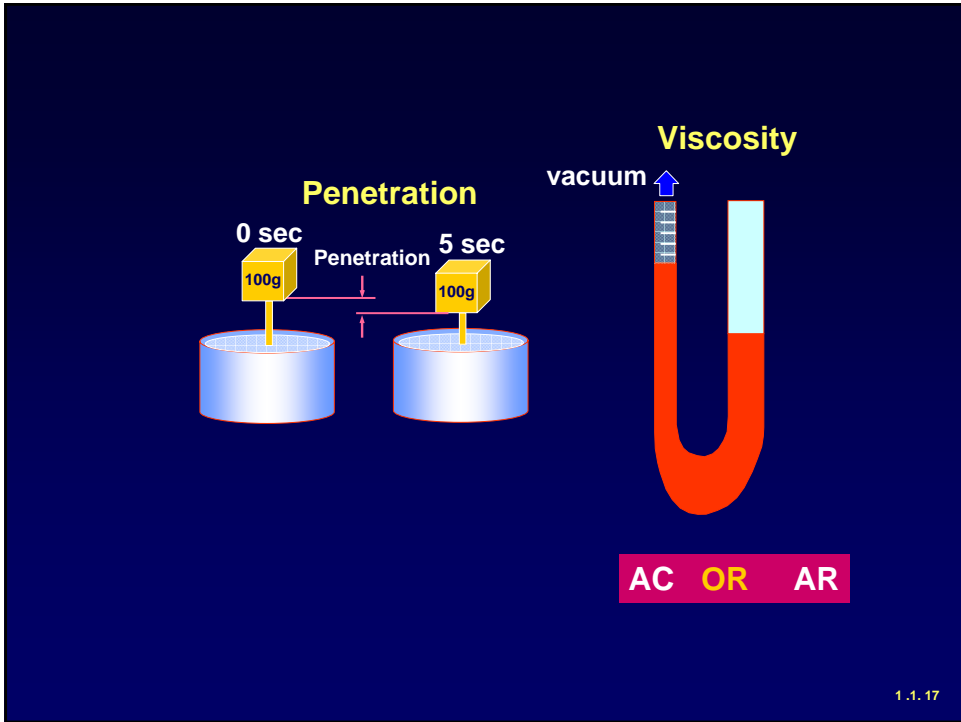




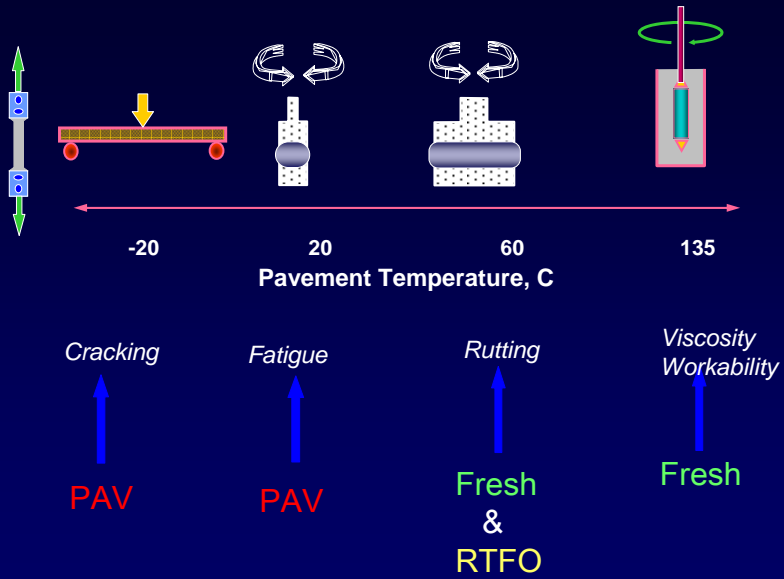
Short Term Binder Aging

- Rolling Thin Film Oven
 - Simulates aging from hot mixing and construction

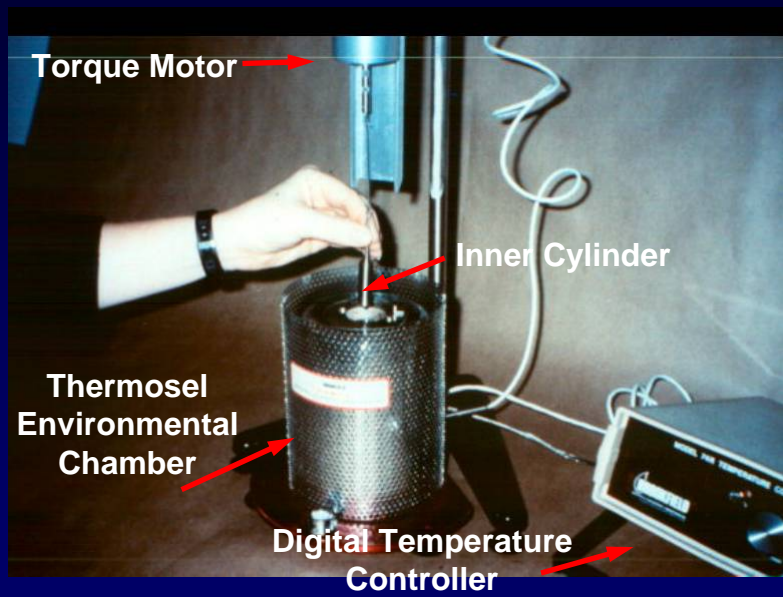




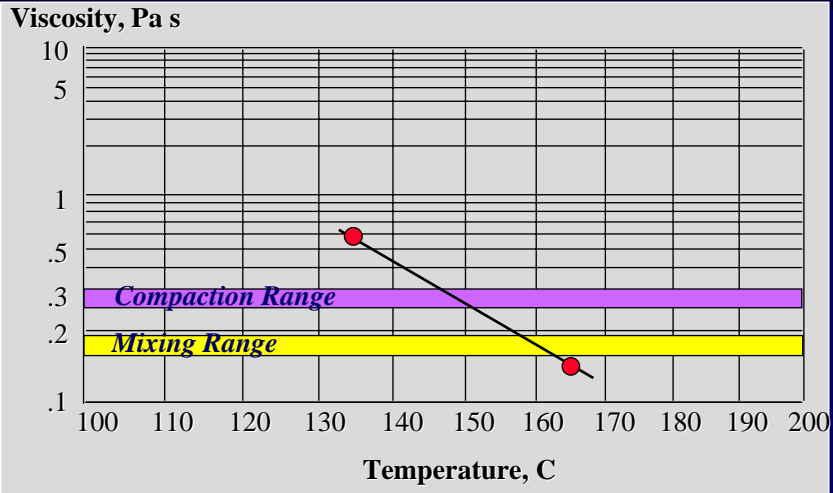
SUPERPAVE



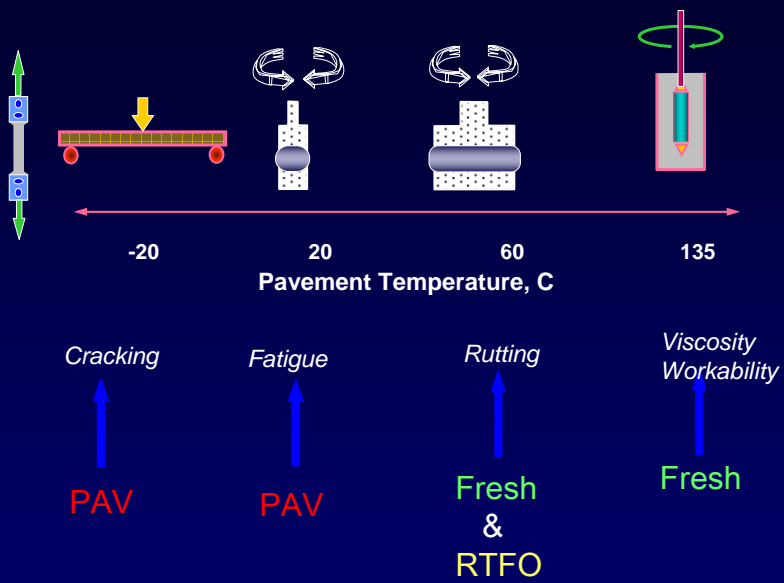
Rotational Viscometer (Brookfield)



Mixing/Compaction Temps

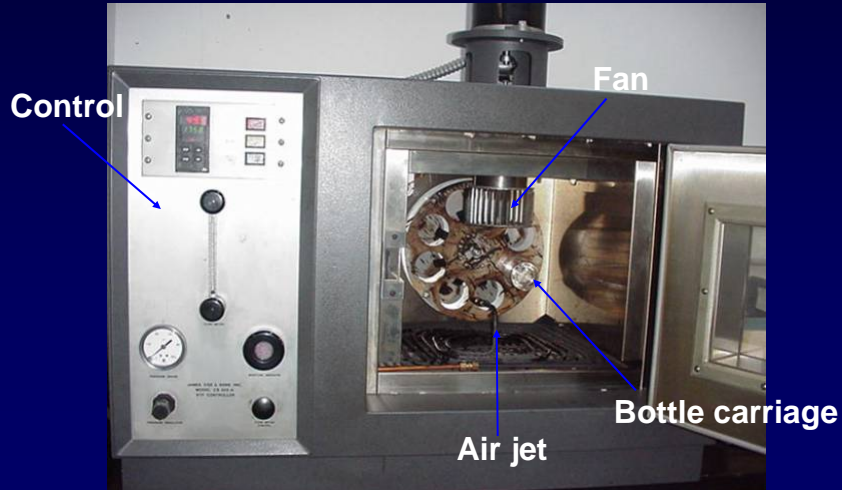


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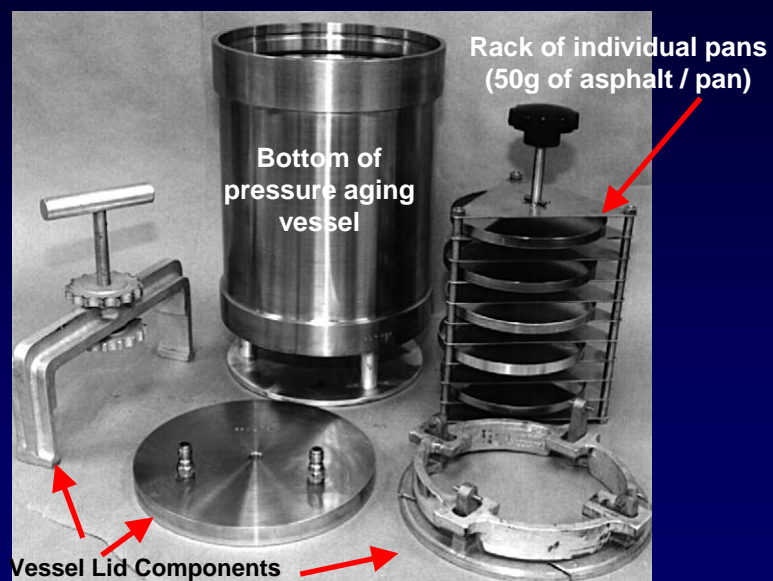


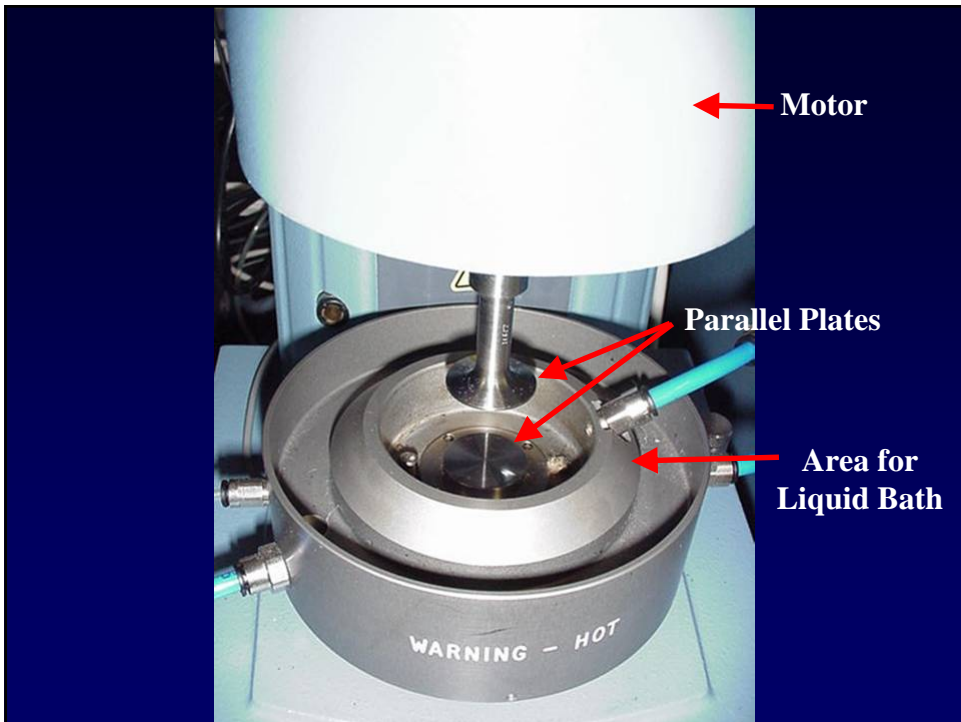
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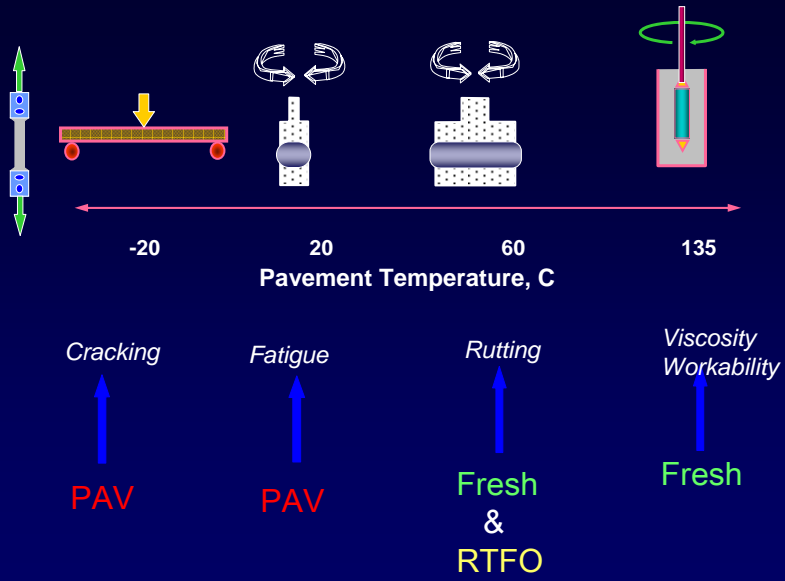


Pressure Aging Vessel

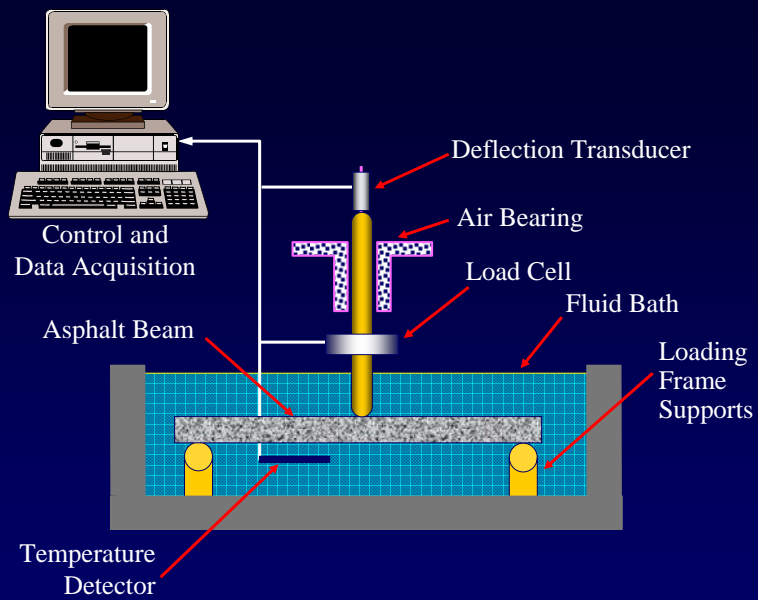




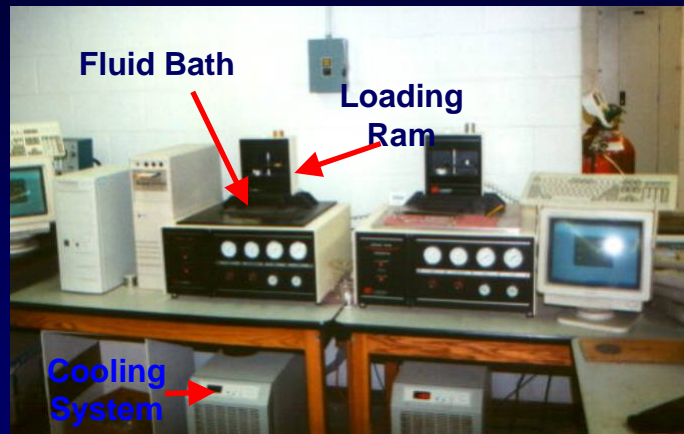
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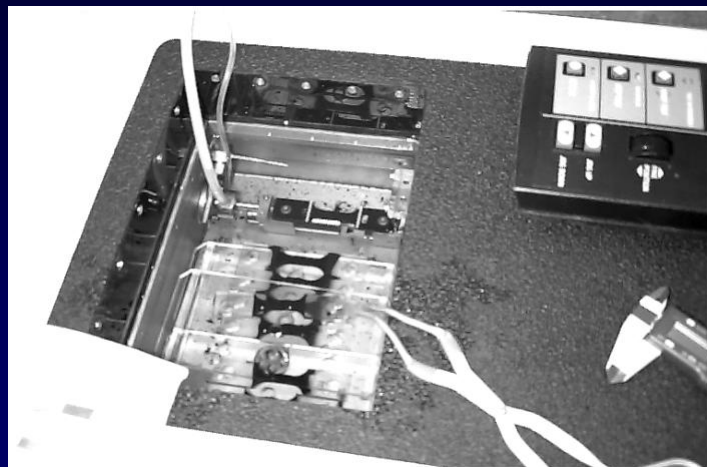
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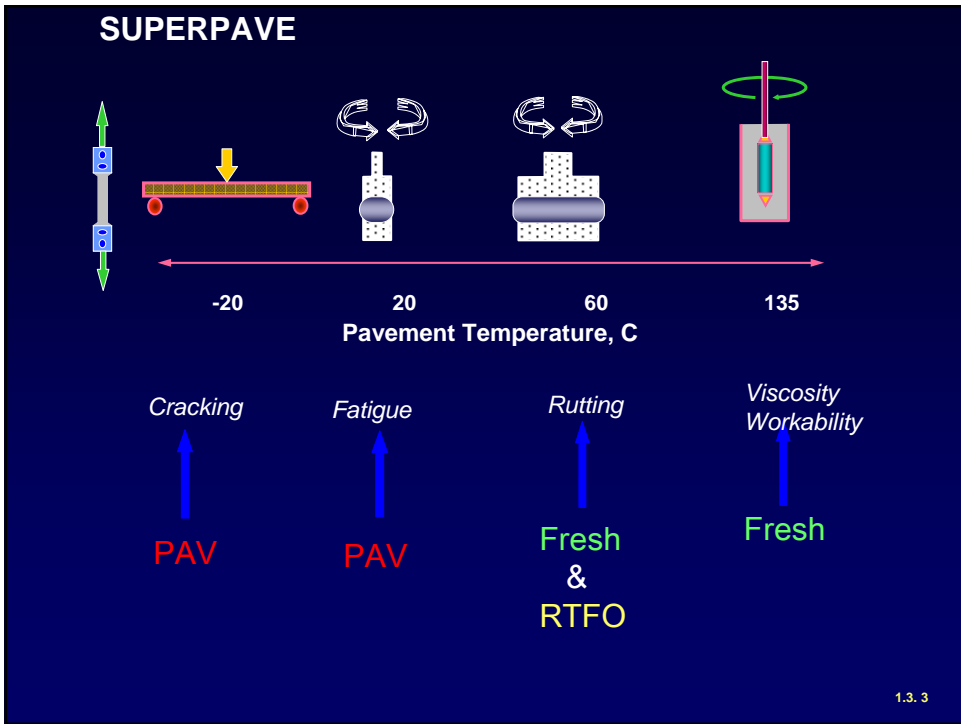
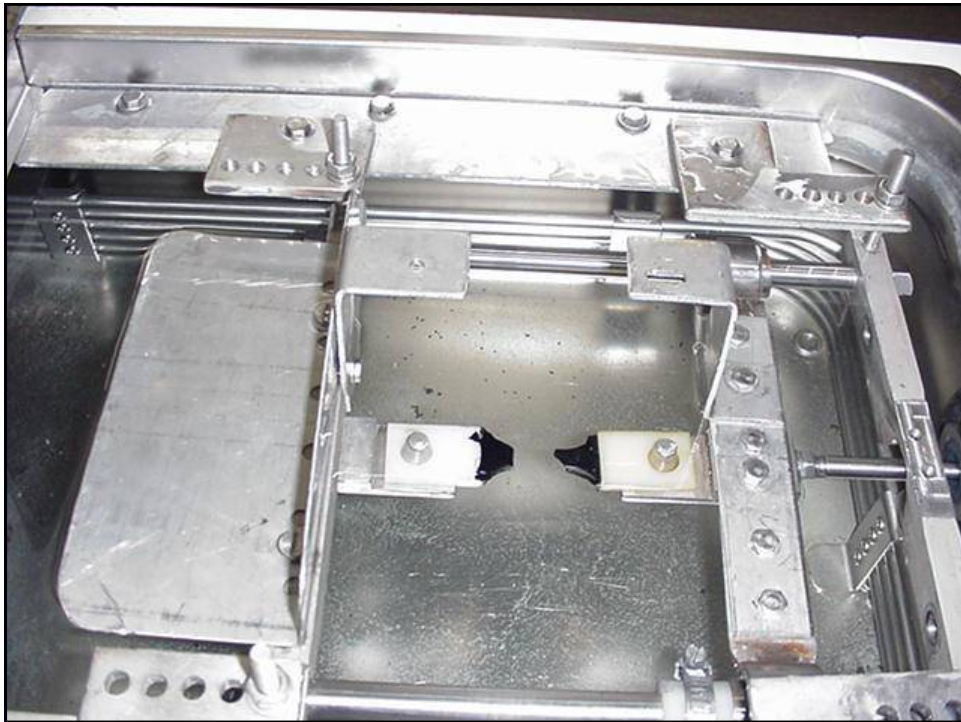
Bending Beam Rheometer Equipment



Direct Tension Test

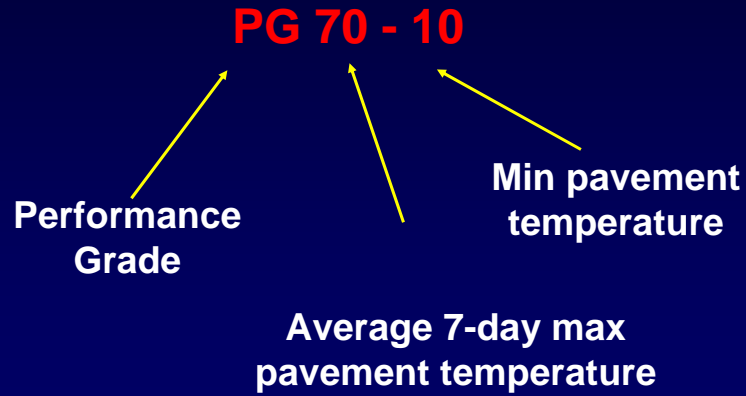


Courtesy of FHWA



Superpave Asphalt Binder Specification

The grading system is based on Climate



Binder Selection & Tests

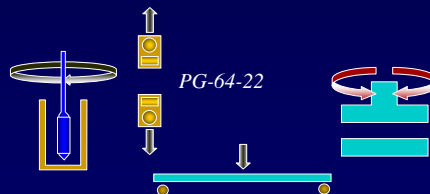
□ Select Grade

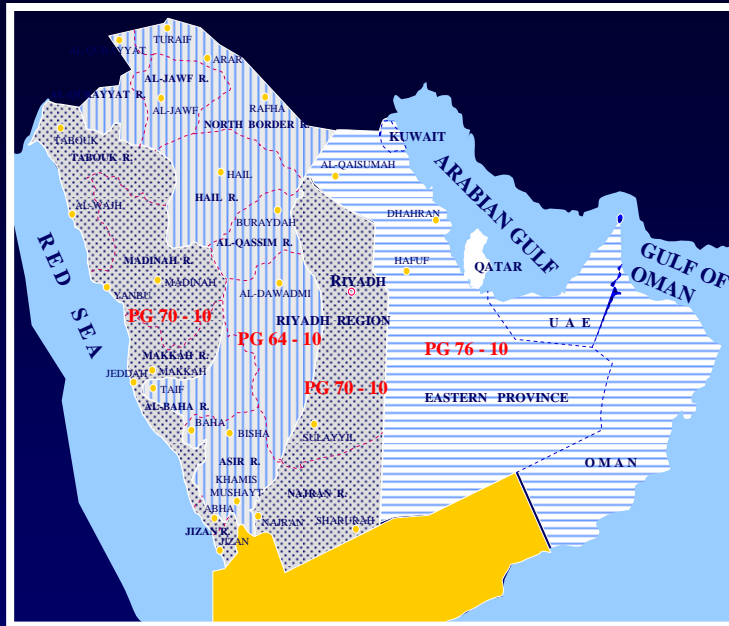
- climate
- reliability



□ verify Grade

- G^* , δ , S, m, etc.
- temp/vis. profile





Tentative Temperature Zoning for Asphalt Binder Specifications for the Gulf Countries.

Questions - ?

