

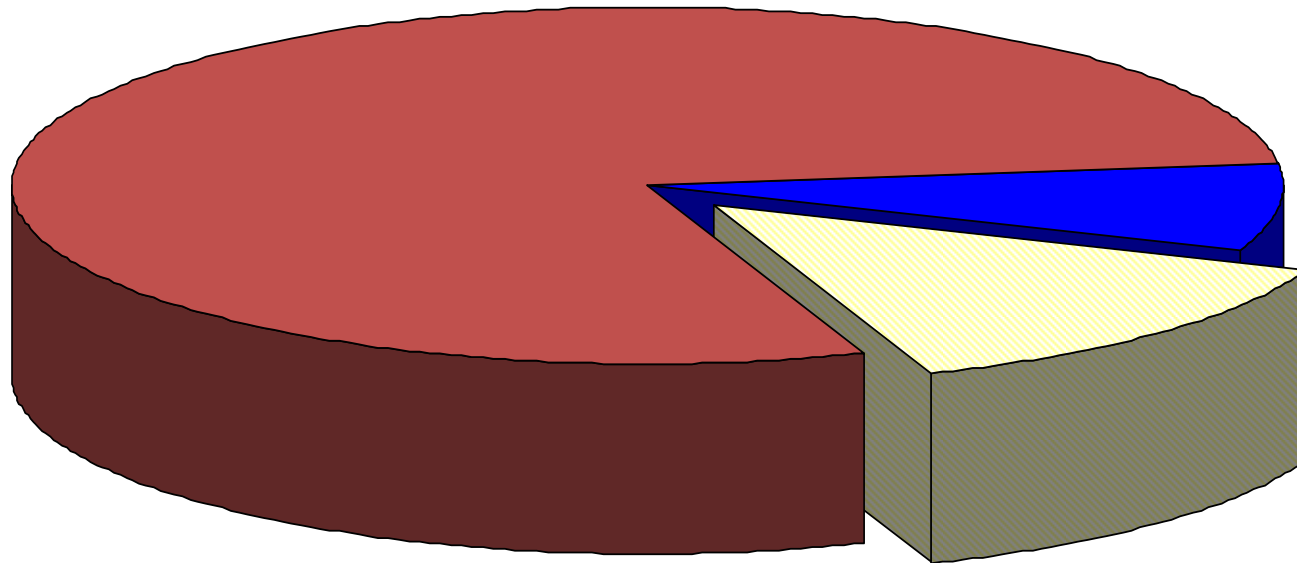
Origins, Manufacture and Handling of Bitumen (Asphalt Cement)

Jacques van Heerden
Bitumen Specialist – Sasol Technology

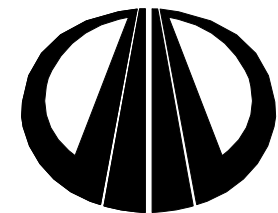
18th Road Pavements Forum
CSIR ICC – Pretoria
11 November 2009



Uses of bitumen



- Road - maintenance
- Road - new build
- Industrial



100's of Uses



Roofing



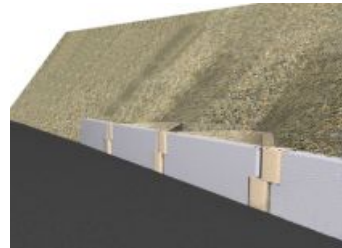
Soil stabilisation



Water proofing piers



Environmental protection



Land slip containment



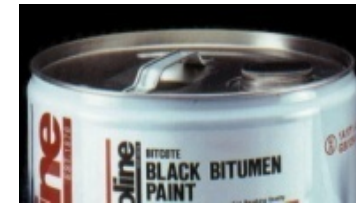
Walk ways



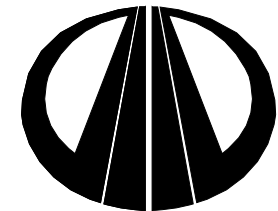
Sound proofing



Pipe coating



Paints

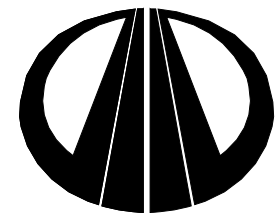


What is Bitumen (Asphalt)?

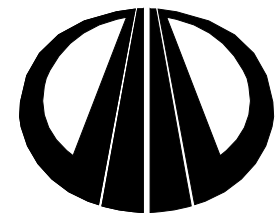
- “A dark brown to black cementitious material in which the predominating constituents are bitumens which occur in nature or are obtained in petroleum processing.” (ASTM D8)
- “Asphalt is a dark brown or black cementitious material which is a natural constituent of most crude oils found throughout the world. “ (About Asphalt)
- " Asphalt is a dark brown to black, highly viscous, hydrocarbon produced from petroleum distillation residue.” (US FHWA)
- A virtually involatile, adhesive and waterproofing material obtained by refinery processes from crude petroleum, or present in natural asphalt deposits in some parts of the world. It is black or brown in colour and completely or nearly completely soluble in toluene. It is very viscous or near solid at ambient temperatures and softens gradually when heated.
- (1) A class of amorphous, black or dark colored, (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons, soluble in carbon disulfide, and found in asphalts, tars, pitches and asphaltites; (2) a generic term used to denote any material composed principally of bitumen.

Presentation Overview

- History and Overview
- Bitumen Manufacturing Processes
- Bitumen Production in South Africa
- Handling of Bitumen

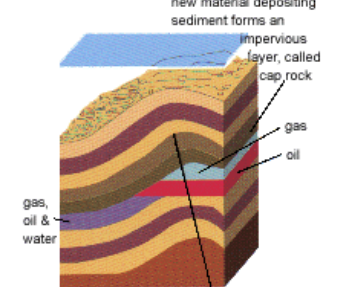
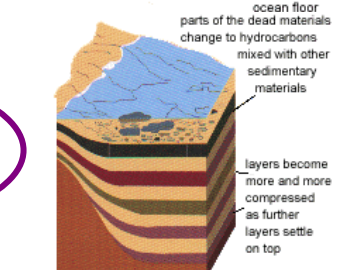
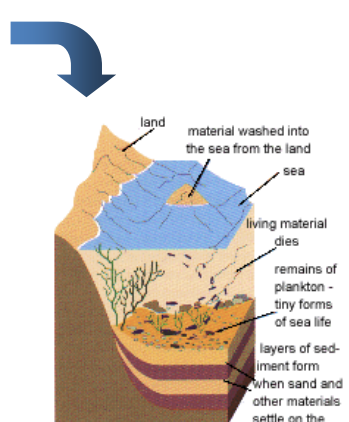


History and Overview of Bitumen



History of Bitumen

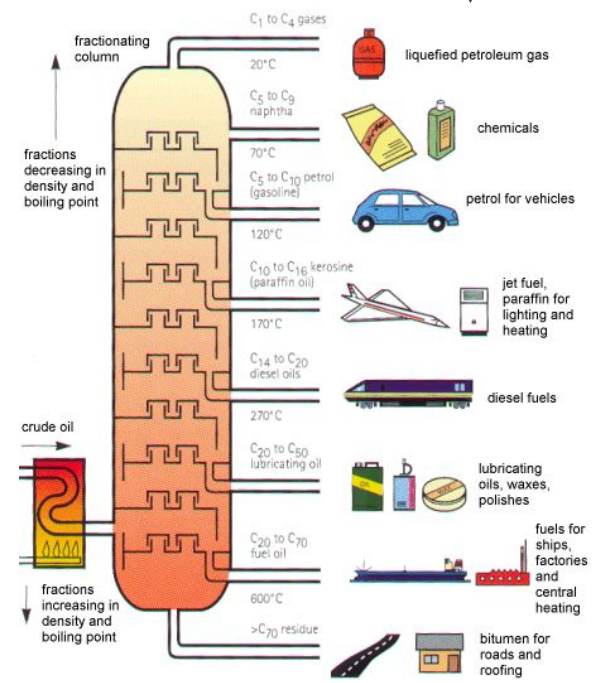
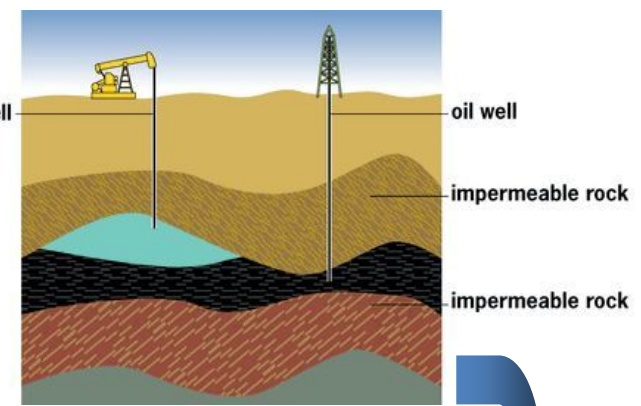
| PERIOD IN EARTH'S HISTORY | | |
|---------------------------|--|-----------------|
| CENOZOIC OR RECENT AGE | TODAY | Humans appear |
| | QUATERNARY 0-1.8 million years ago | Humans appear |
| | TERTIARY 1.8-65 million years ago | Apes Mammals |
| MESOZOIC OR MIDDLE AGE | CRETACEOUS 65-135 million years ago | Dinosaurs |
| | JURASSIC 135-205 million years ago | Ammonites |
| | TRIASSIC 205-250 million years ago | Amphibians |
| PALAEOZOIC OR ANCIENT AGE | PERMIAN 250-290 million years ago | Reptiles |
| | CARBONIFEROUS 290-355 million years ago | Coal Age |
| | DEVONIAN 355-405 million years ago | Fish |
| | SILURIAN 405-435 million years ago | Corals |
| | ORDOVICIAN 435-510 million years ago | Graptolites |
| | CAMBRIAN 510-570 million years ago | Trilobites |



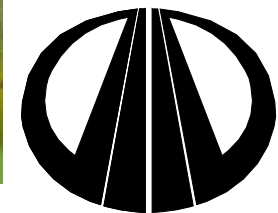
Drake's Pennsylvania Well brought oil to the surface using methods used to drill for water. 1859



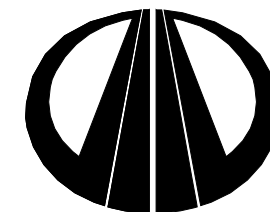
Samuel Kier converted petroleum to lamp oil by distillation. Early 1800s



Early Uses of Bitumen



Ancient natural seepages of bitumen



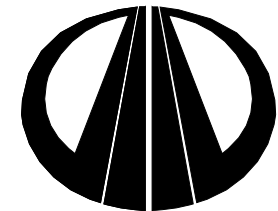
Terminology - Bitumen

Bituminous Binders

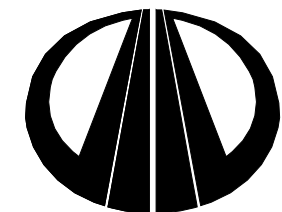
Natural
Asphalt

Petroleum
binders

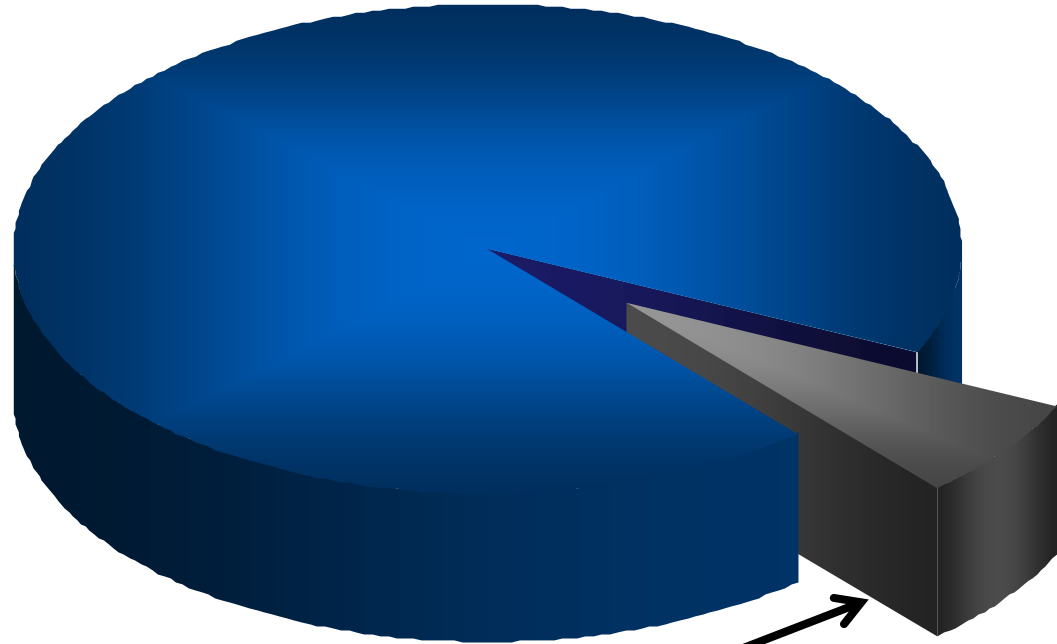
Gilsonite Lake
asphalt Rock
asphalt



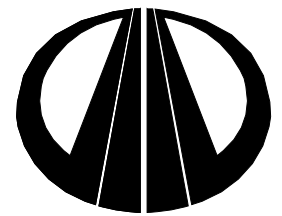
Seepages of Trinidad lake bitumen



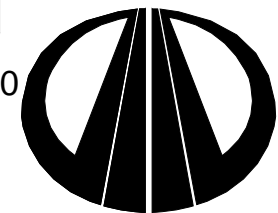
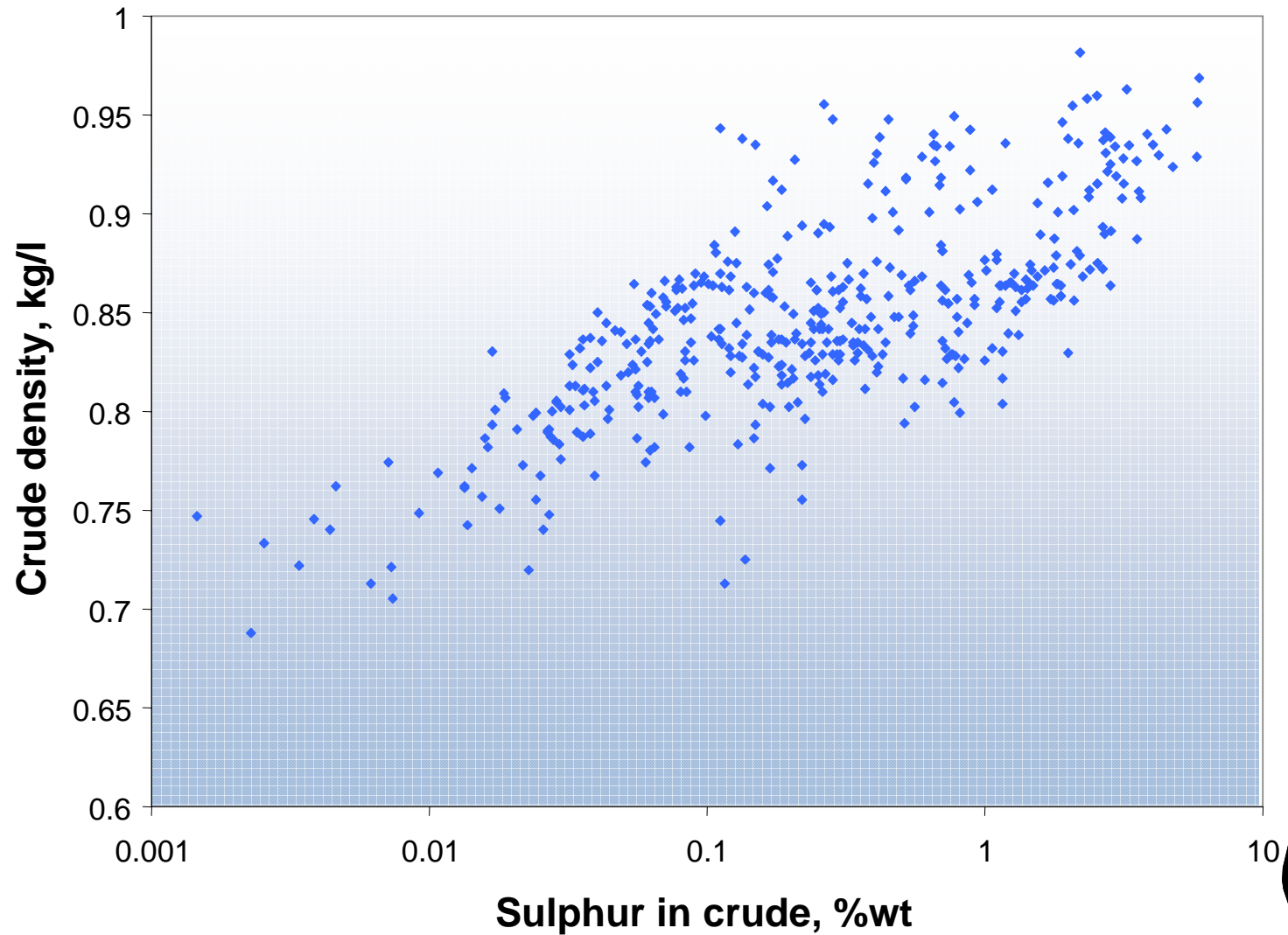
Crudes suitable for bitumen



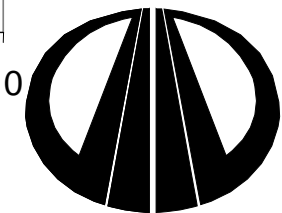
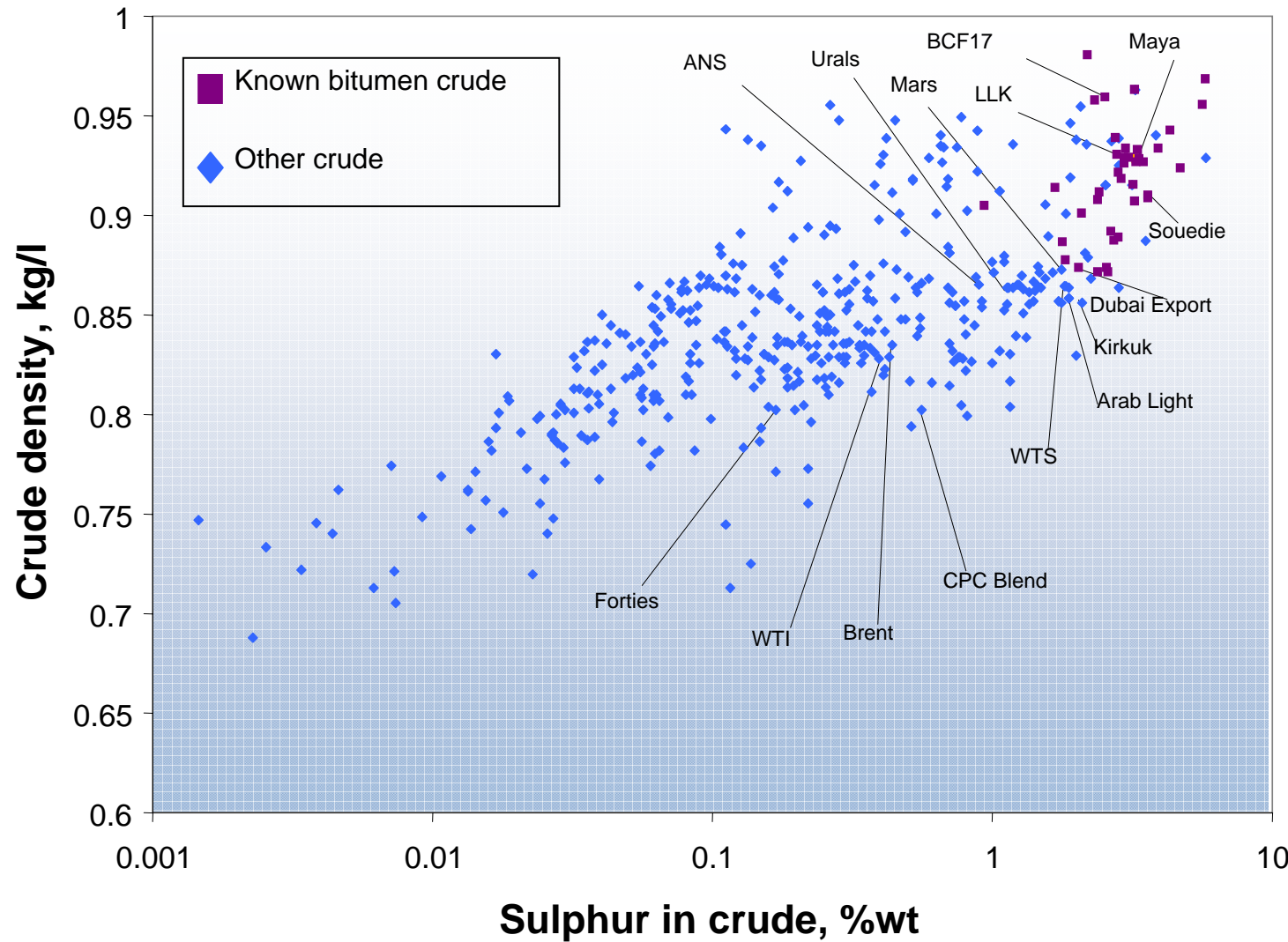
1500 known crudes
100 suitable for bitumen



Crude oils vary in composition and physical properties

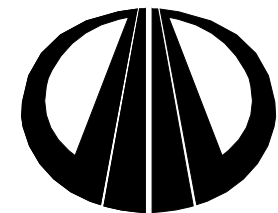


Heavy crudes are best for bitumen

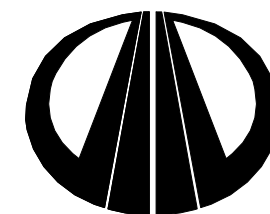
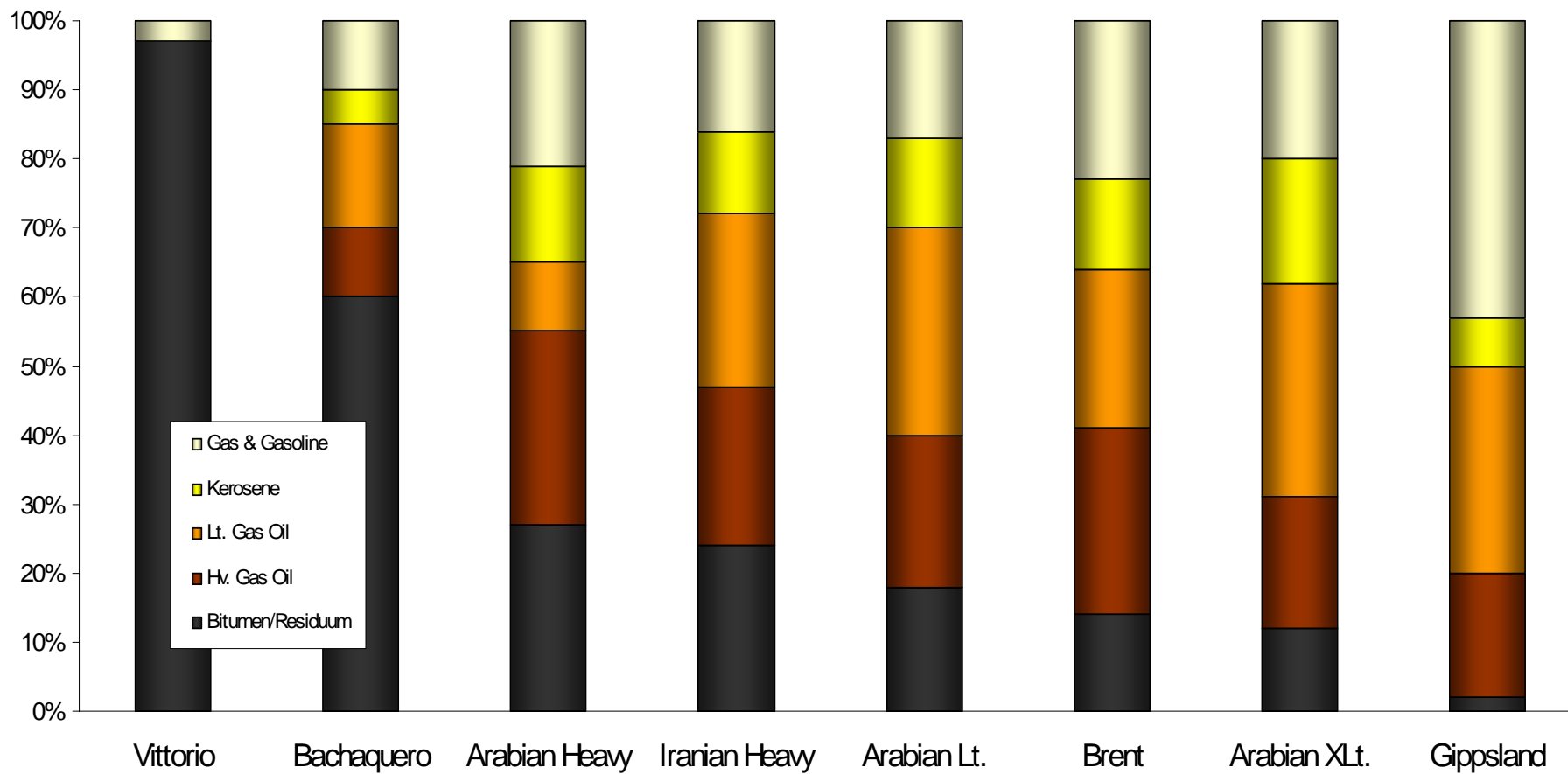


The make-up of crude oil

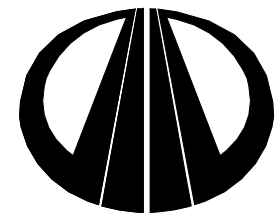
| Carbon number | | Boiling point (°C) |
|---------------|------------------|--------------------|
| 3 - 4 | LPG | -10 - 15 |
| 5 - 10 | Gasoline | 15 - 150 |
| 12 - 18 | Kerosene | 150 - 260 |
| 18 - 24 | Gas oils | 230 - 370 |
| 24 - 40 | Lubricating oils | 370 - 525 |
| 24 - ~300 | Heavy fuel oil | 370 - |
| ~40 - ~300 | Bitumen | 525 - |



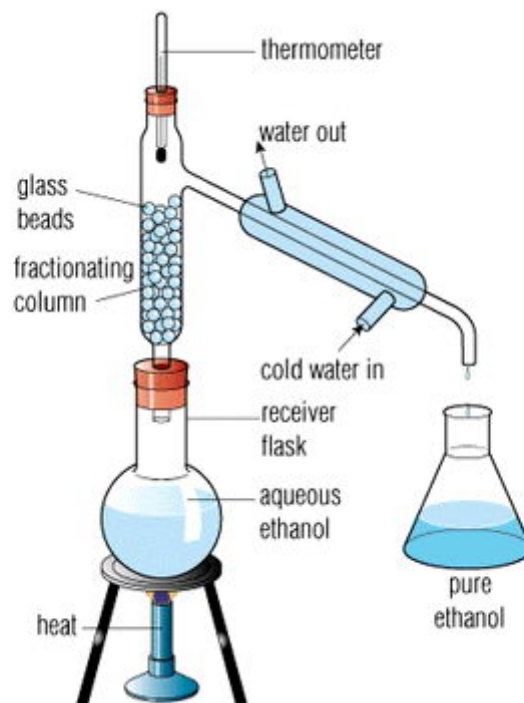
Variability of crude oil



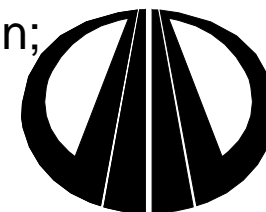
Bitumen Manufacturing Processes



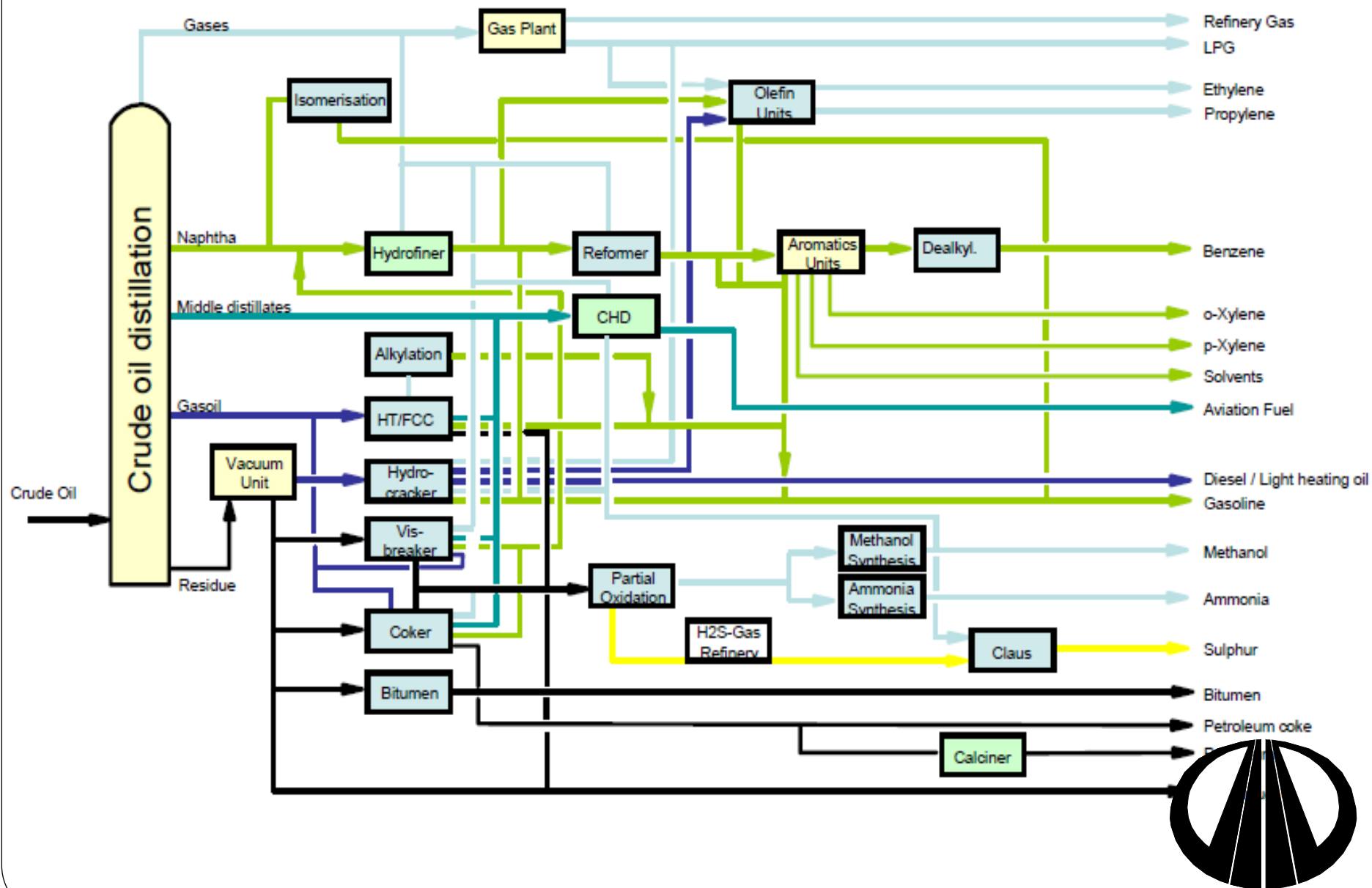
Fractional Distillation



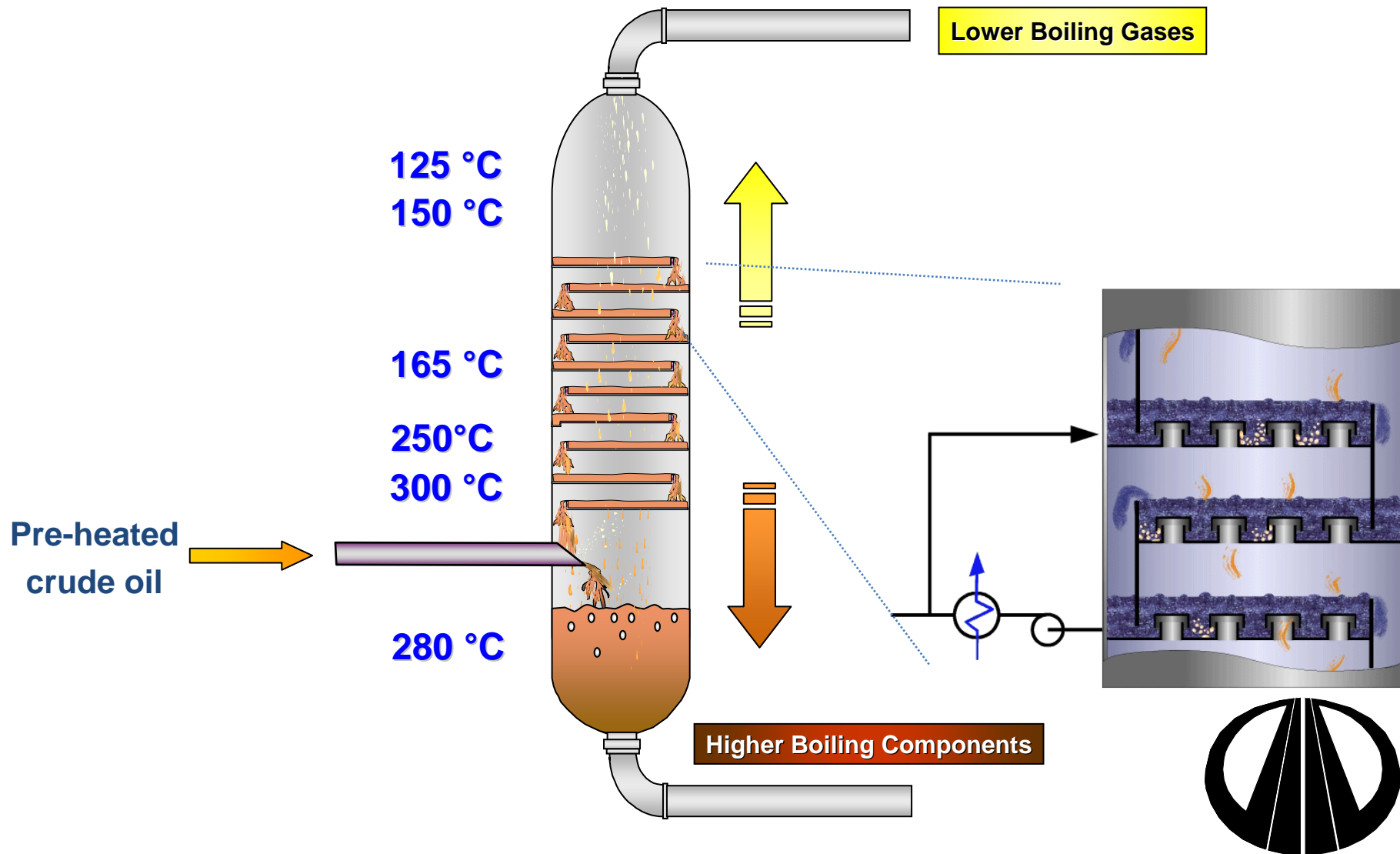
Definition: A process by which components in a chemical mixture are separated according to their different boiling points. Vapors from a boiling solution are passed along a column. The temperature of the column gradually decreases along its length. Components with a higher boiling point condense on the column and return to the solution; components with a lower boiling point pass through the column and are collected.



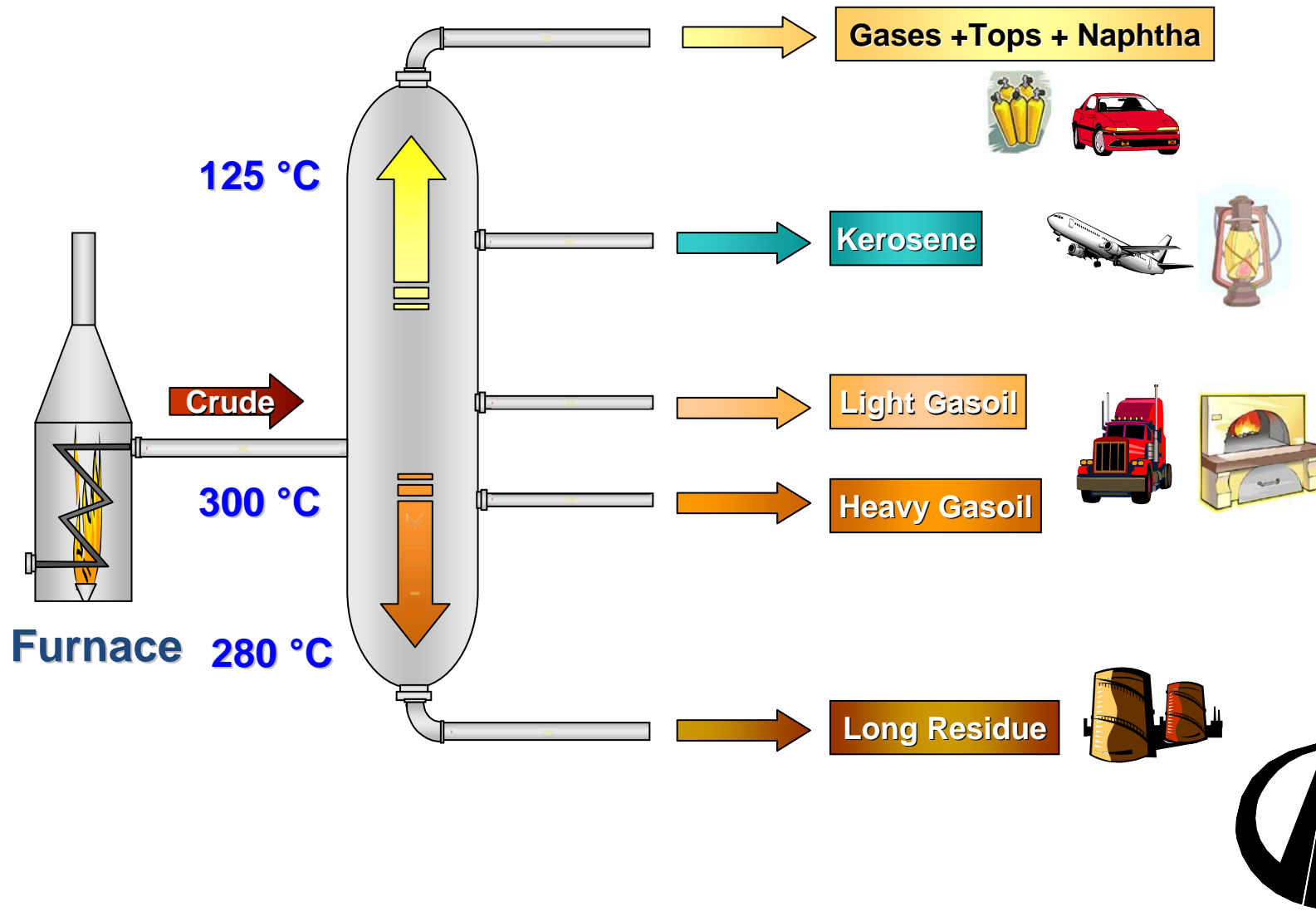
Complex refinery process diagram



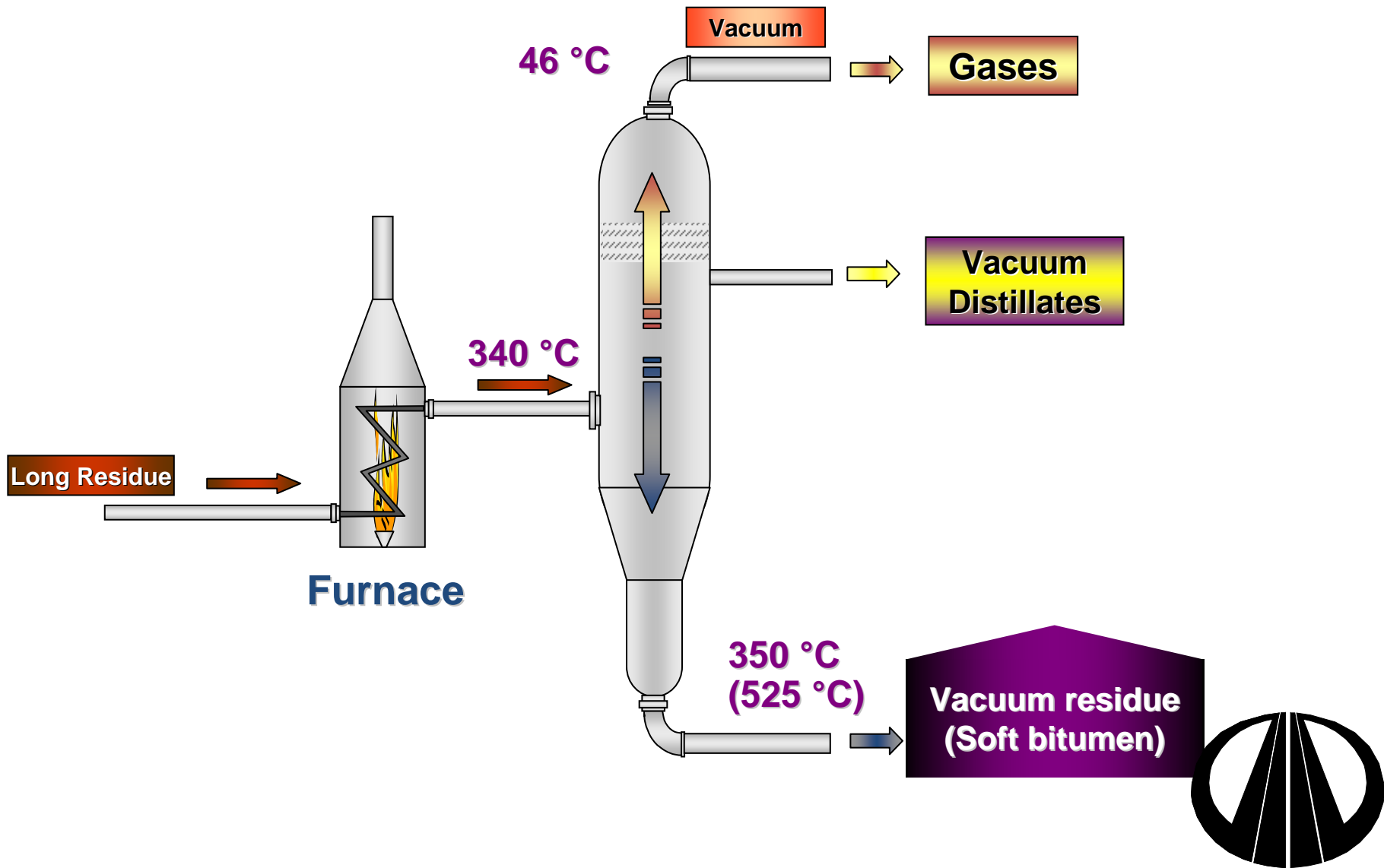
Fractional Distillation of Crude Oil



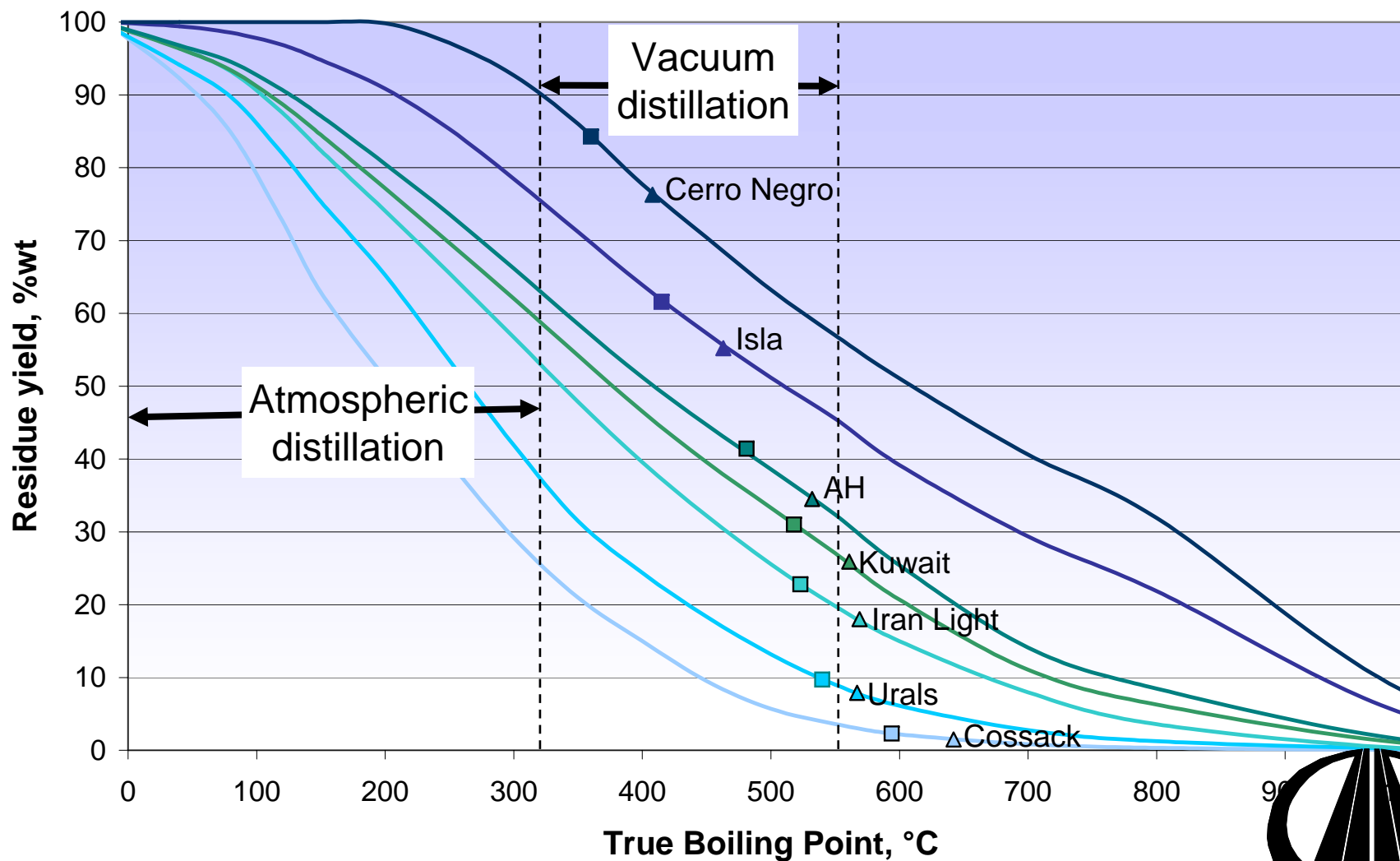
Atmospheric Distillation



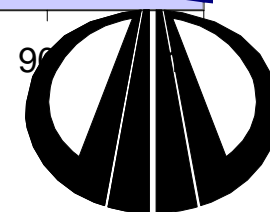
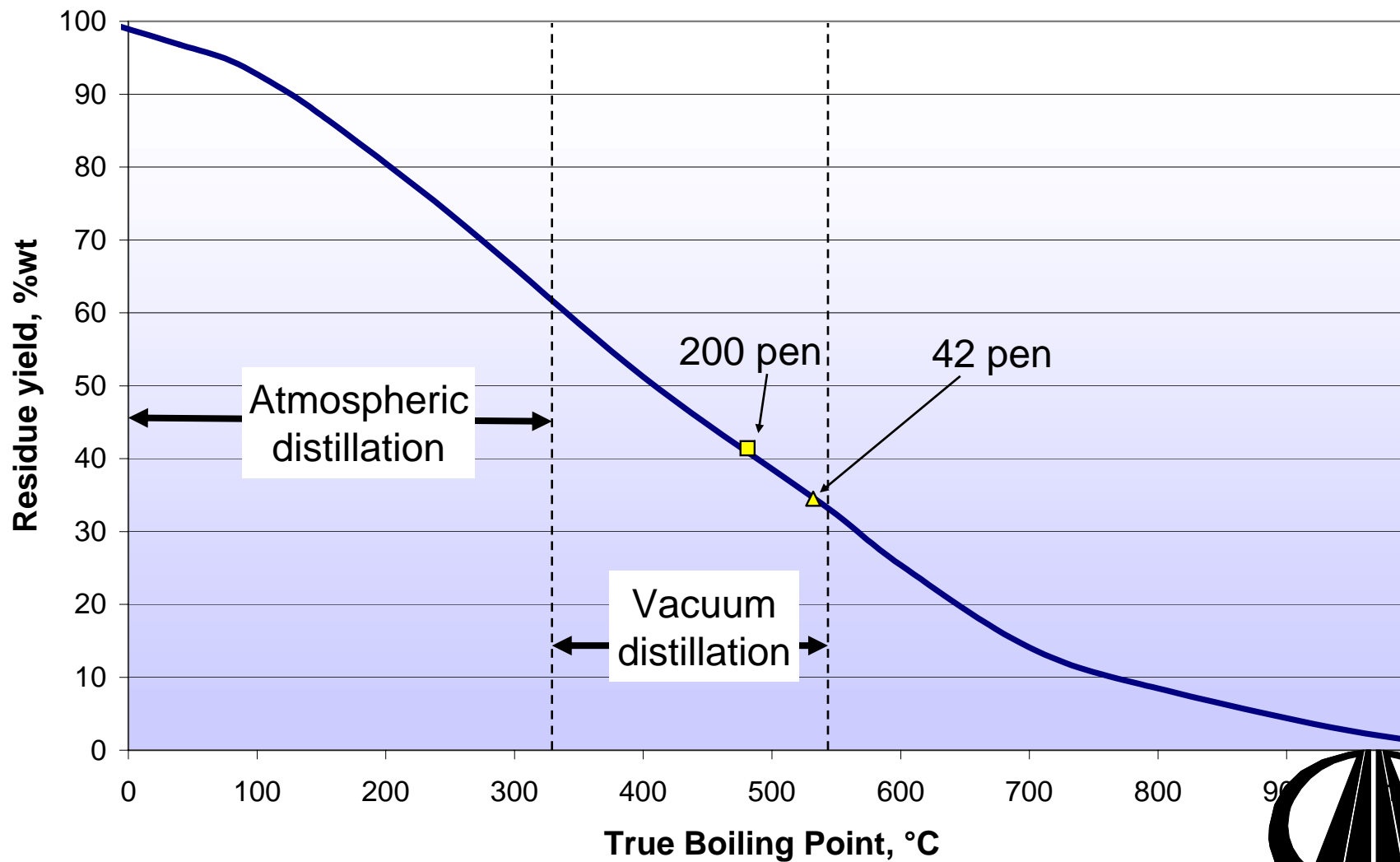
Vacuum Distillation



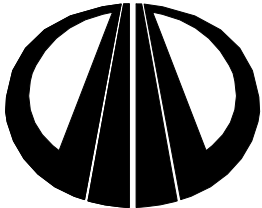
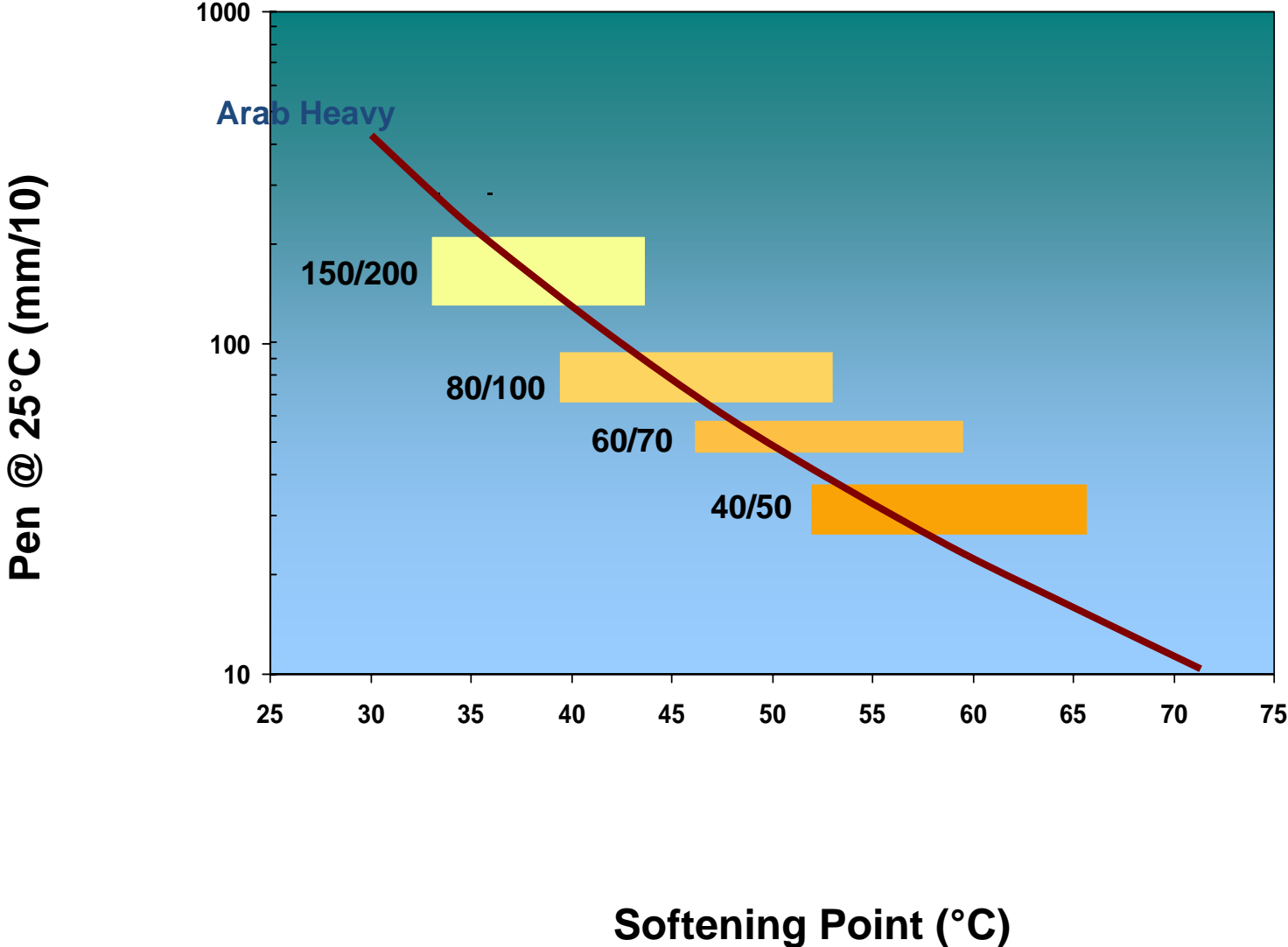
Distillation curves



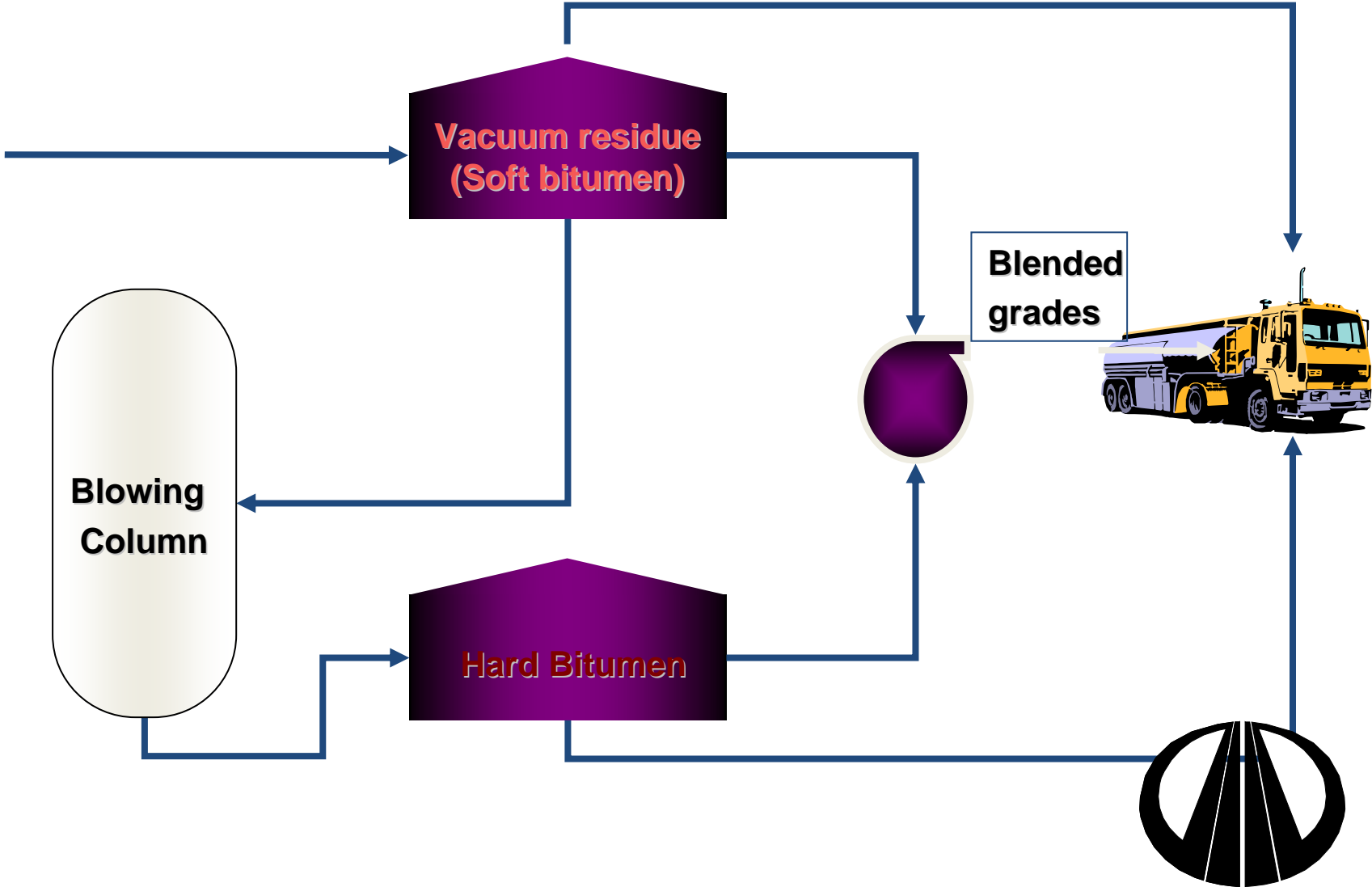
Distillation curve – Arabian Heavy



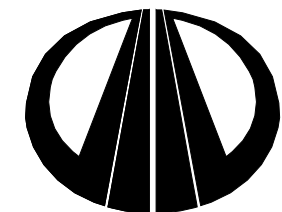
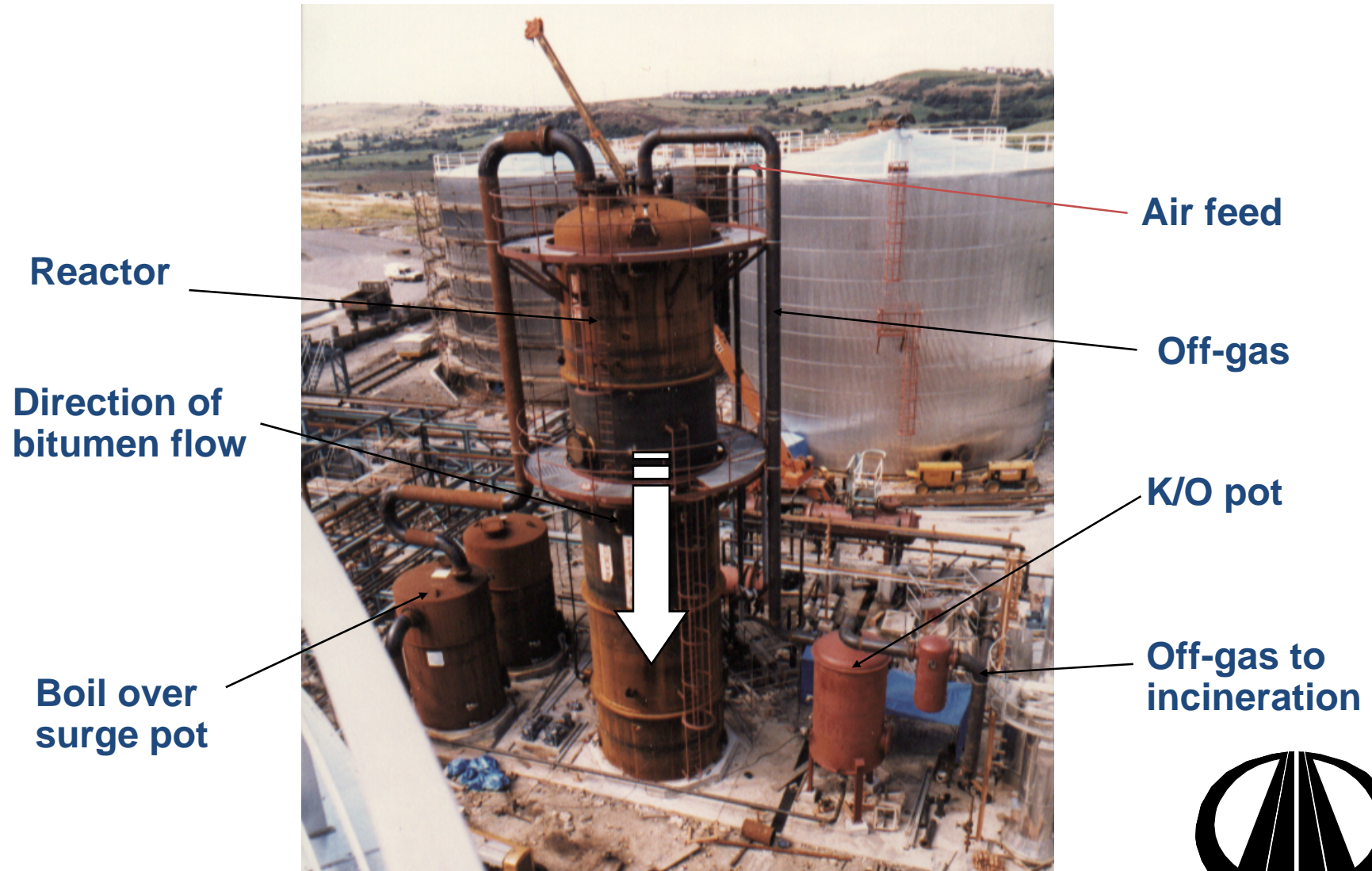
Bitumen grading in RSA



Bitumen blowing

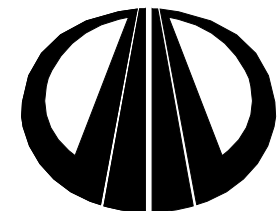


A bitumen blowing unit

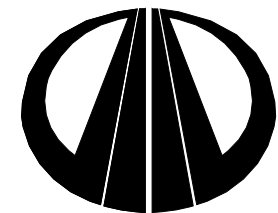
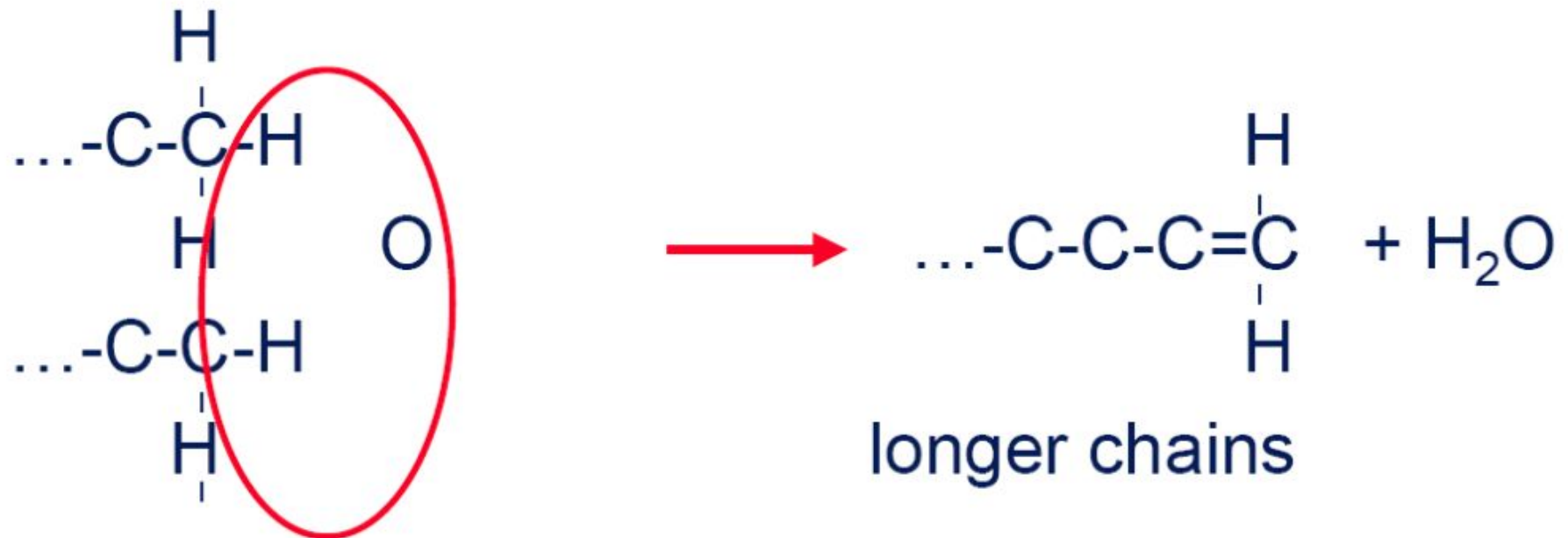


Typical bitumen blowing conditions

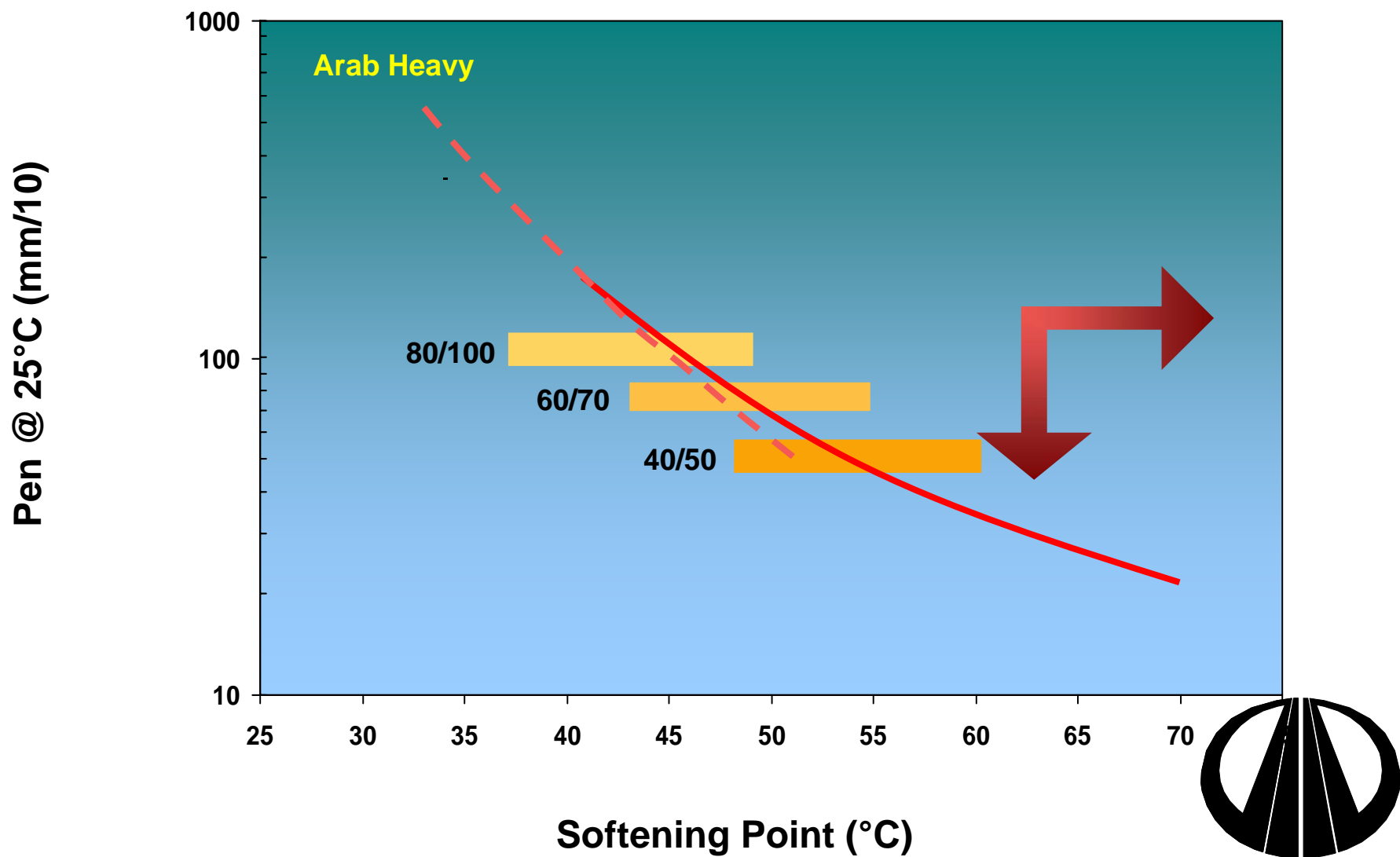
- Tower diameter: 3 m
- Bed depth: 10 m
- Bed temperature: 250 °C
- Feed rate: 500 m³/day
- Air/Feed ratio (vol): 100
- Pressure : 0.2 bar



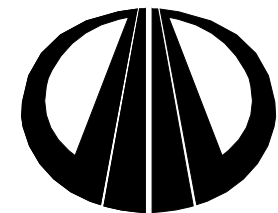
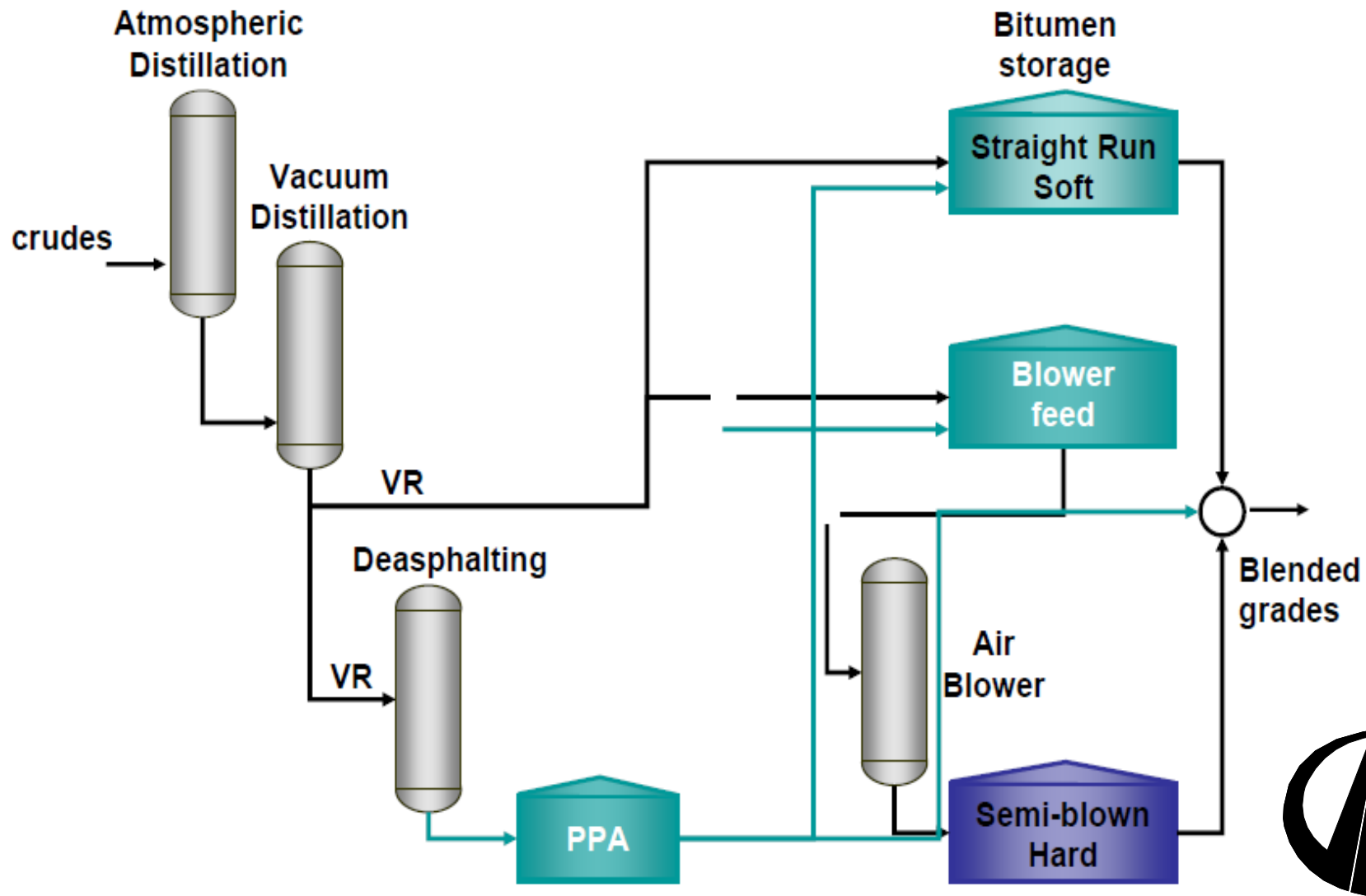
Chemistry of Blowing



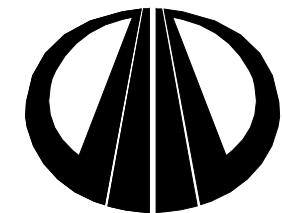
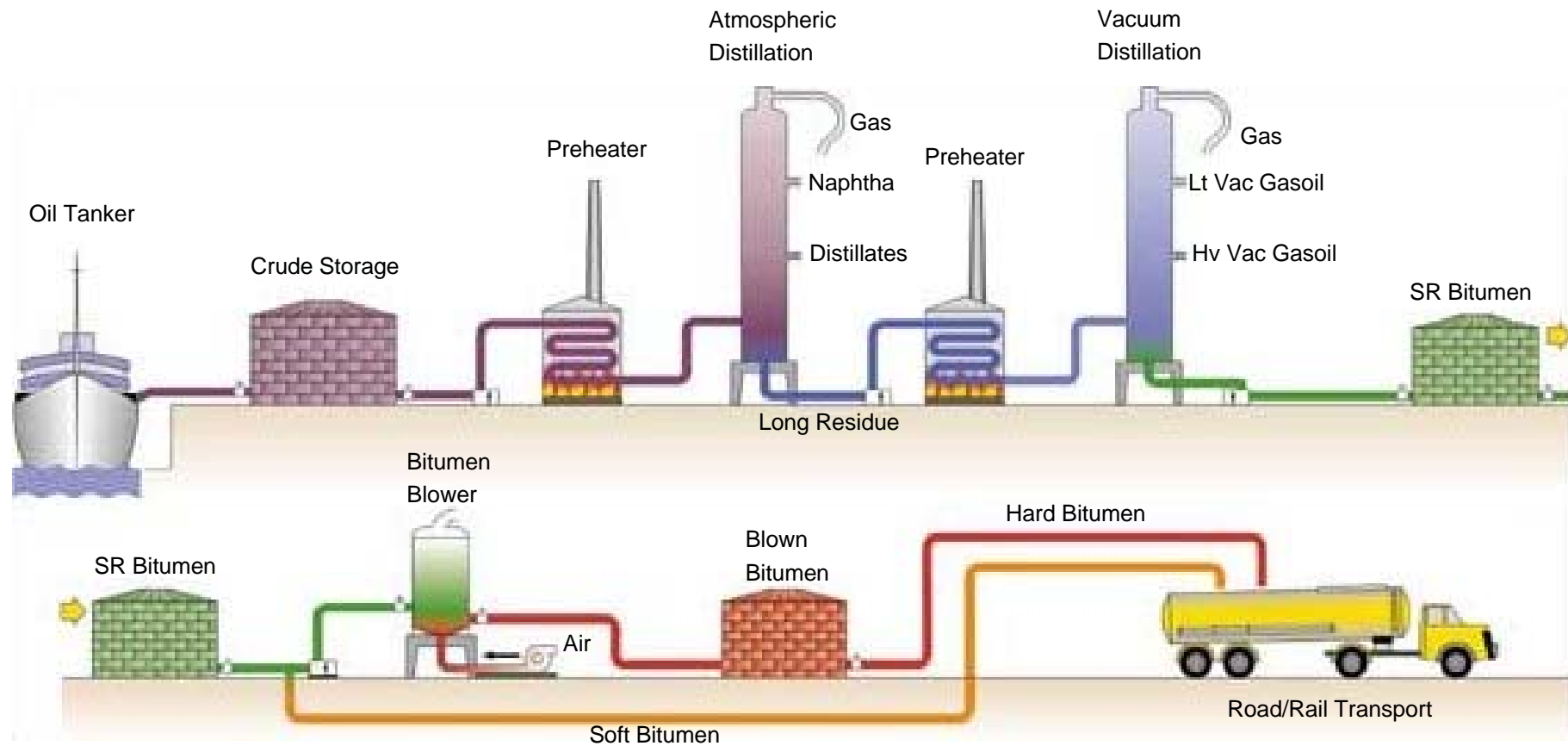
Effect of blowing on bitumen grading



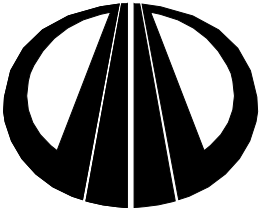
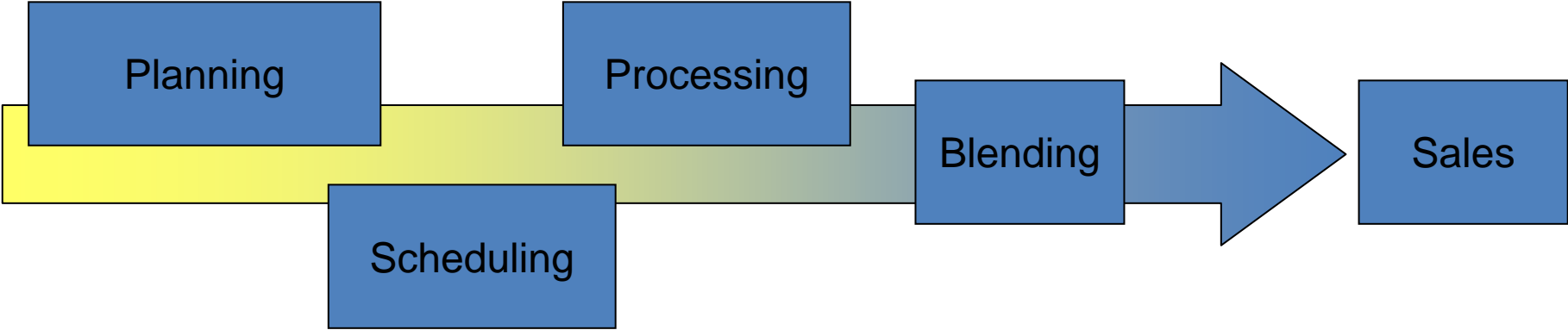
Bitumen production with PPA and blowing



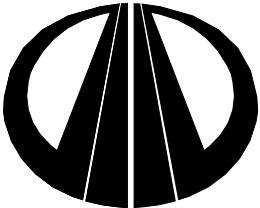
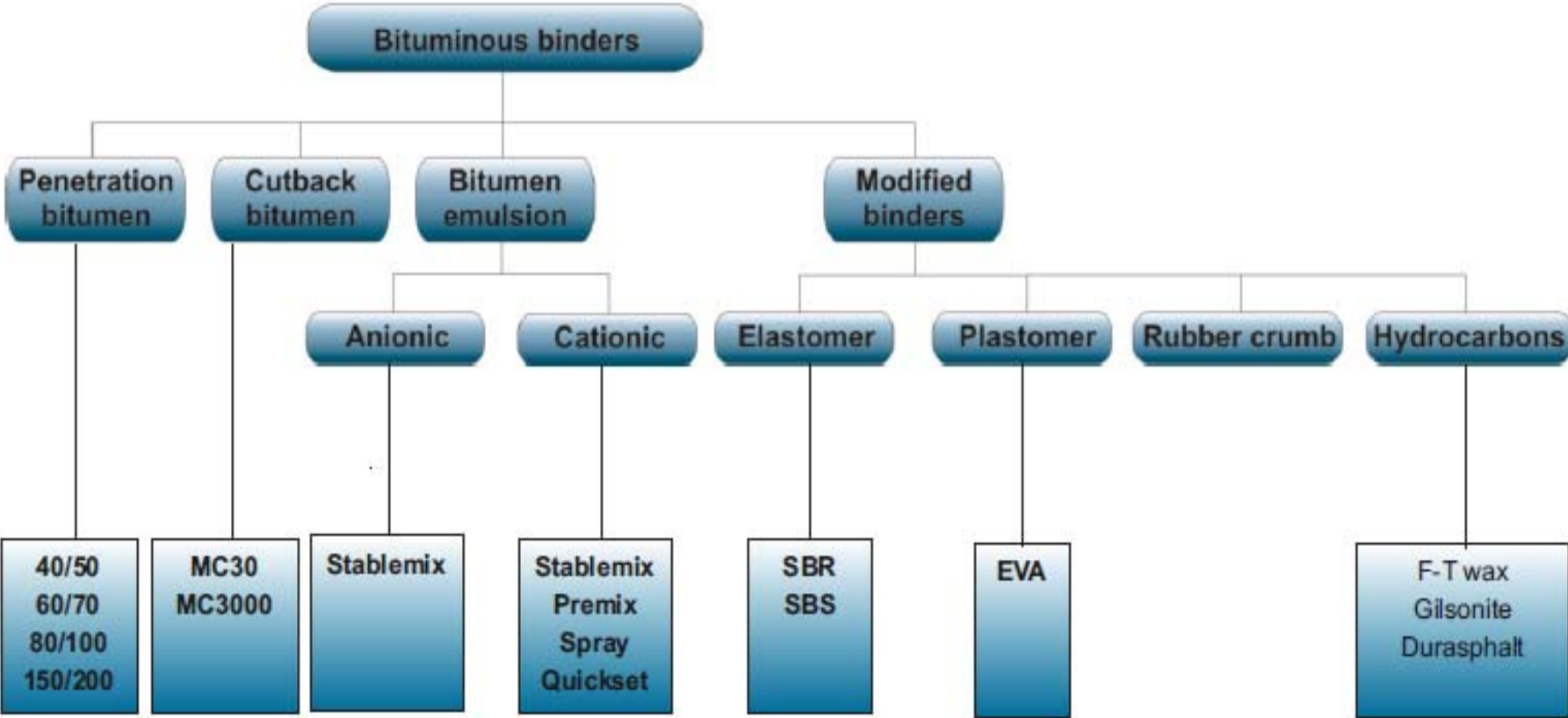
From Crude Oil to Bitumen



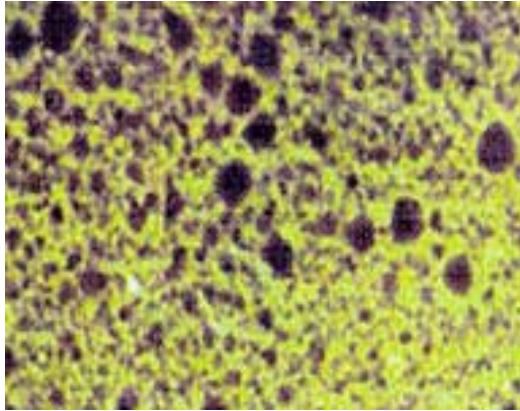
Bitumen production activities



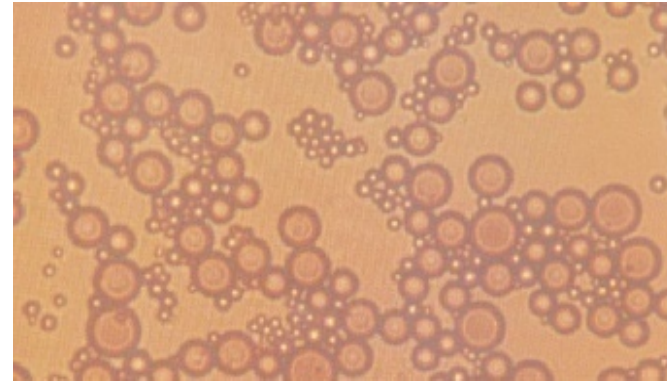
Classification of bituminous binders



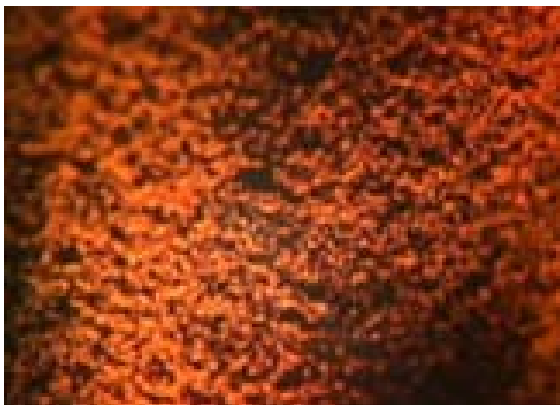
Bituminous Products



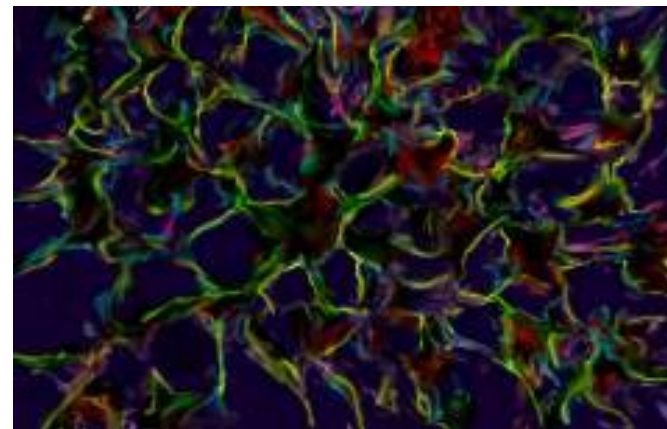
SBR modified Bit



Bitumen Emulsion



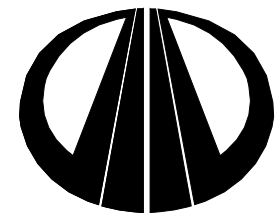
SBS modified Bit



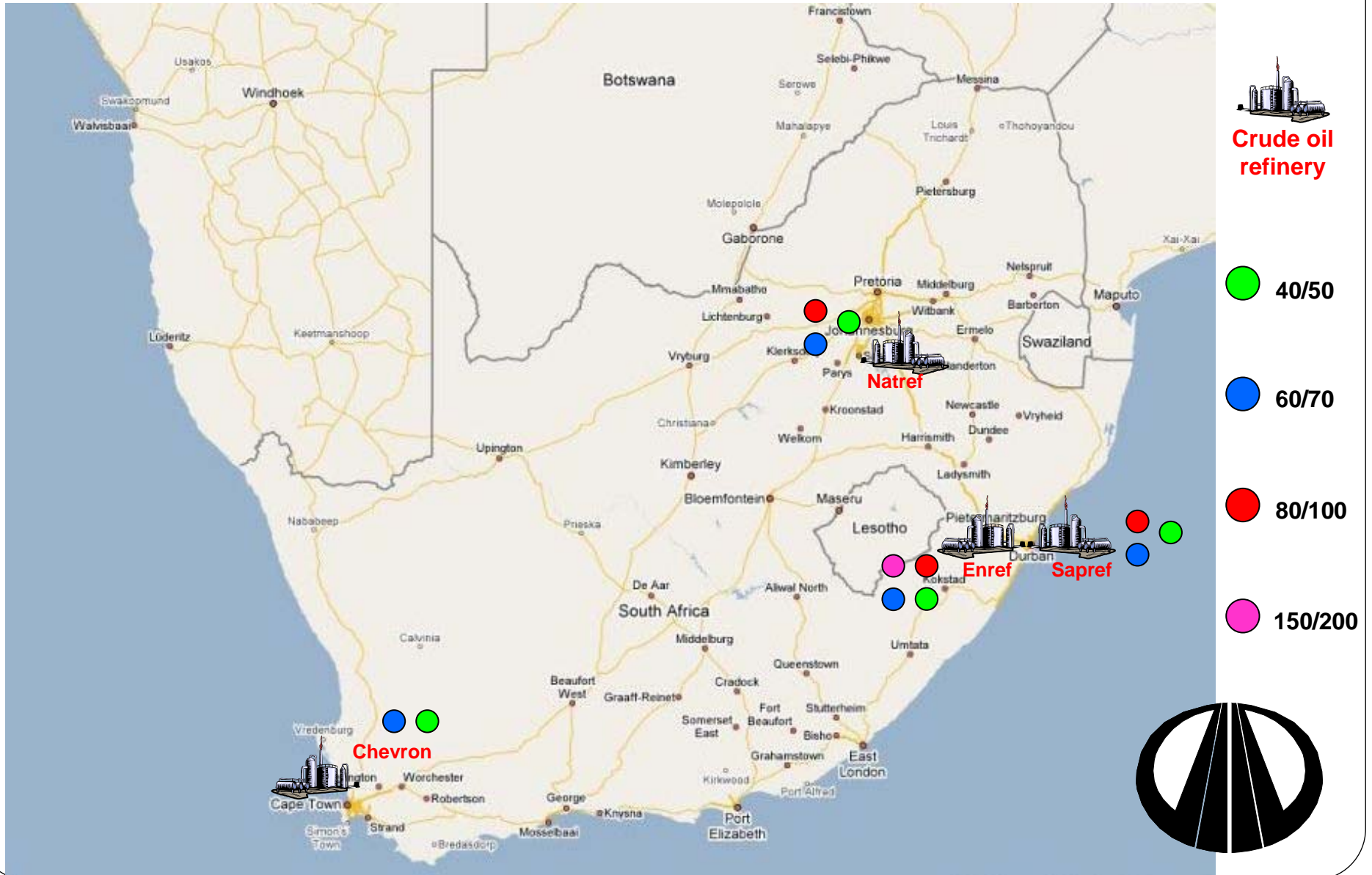
Bitumen Rubber



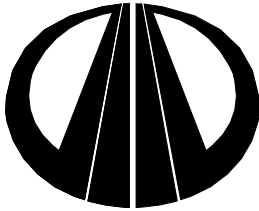
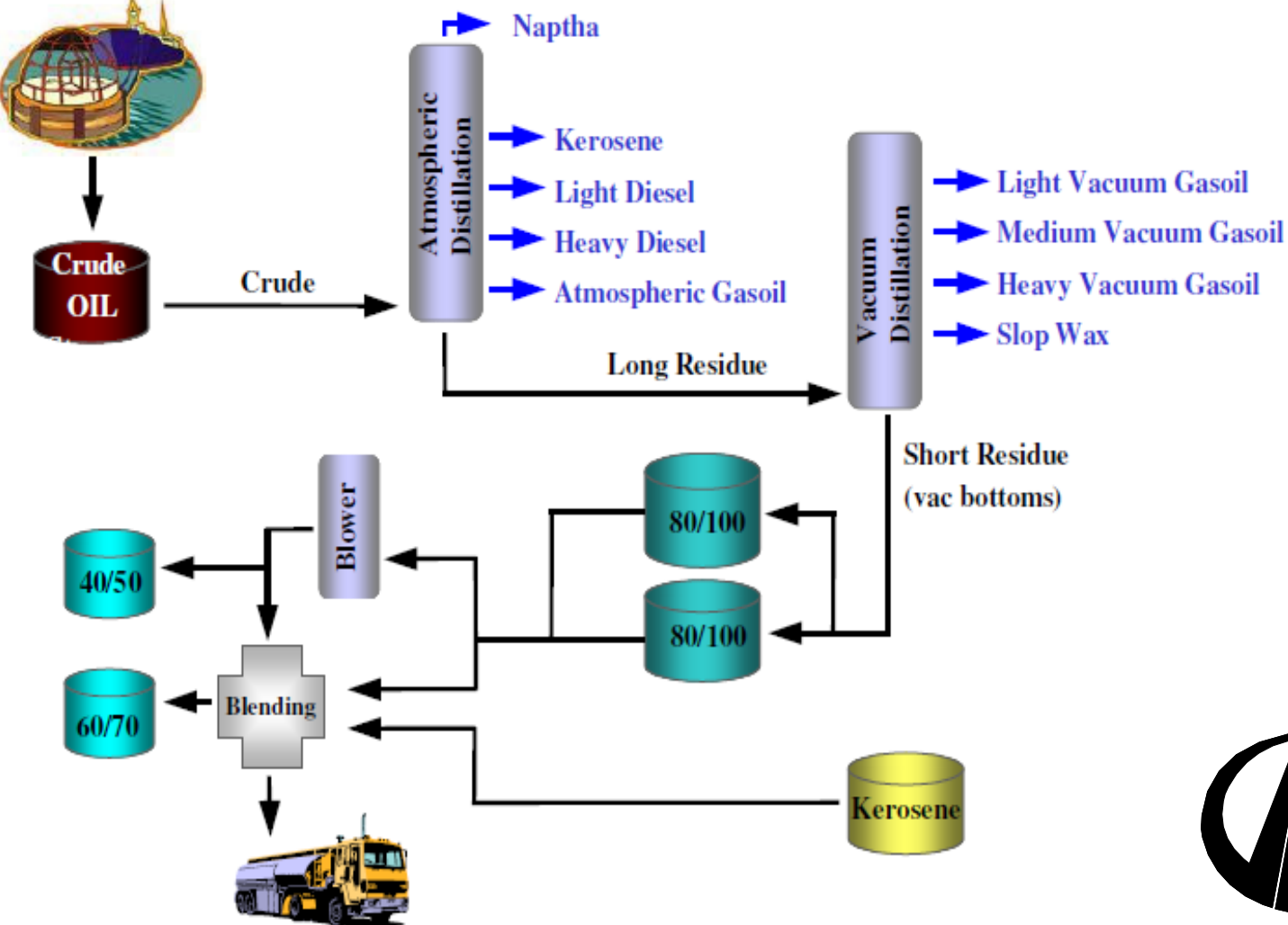
Bitumen Production in South Africa



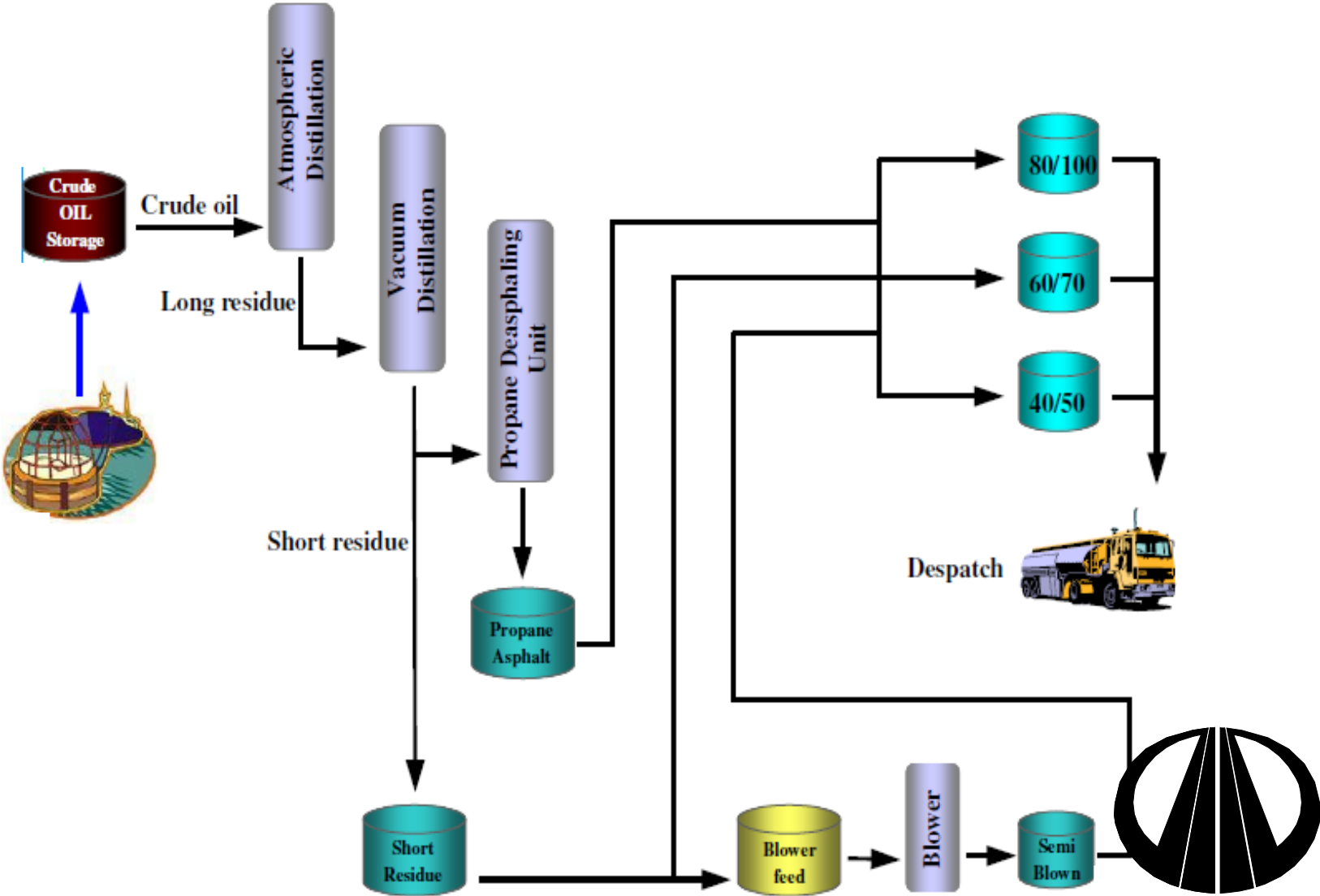
Bitumen supply in Southern Africa



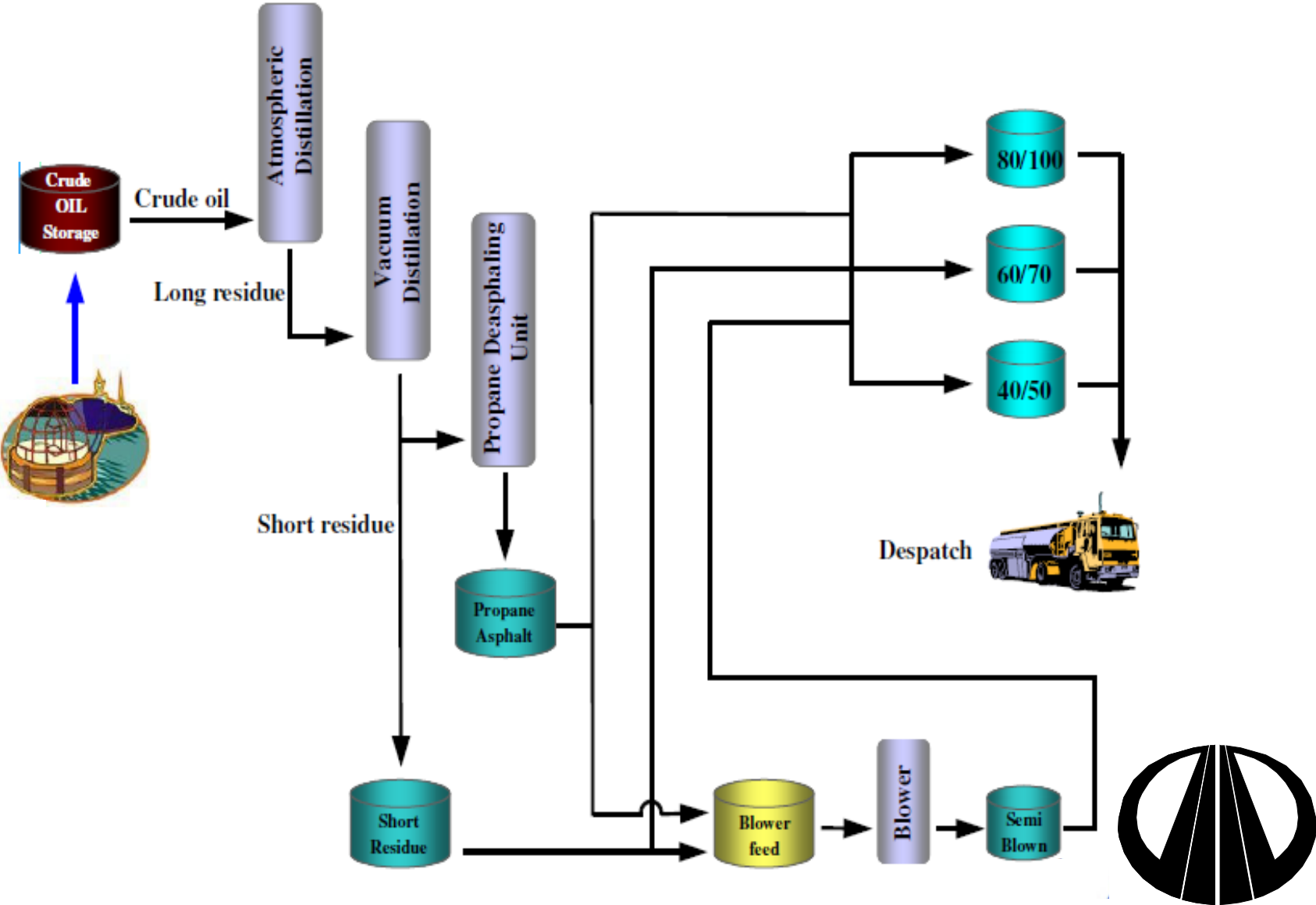
Bitumen production: Natref



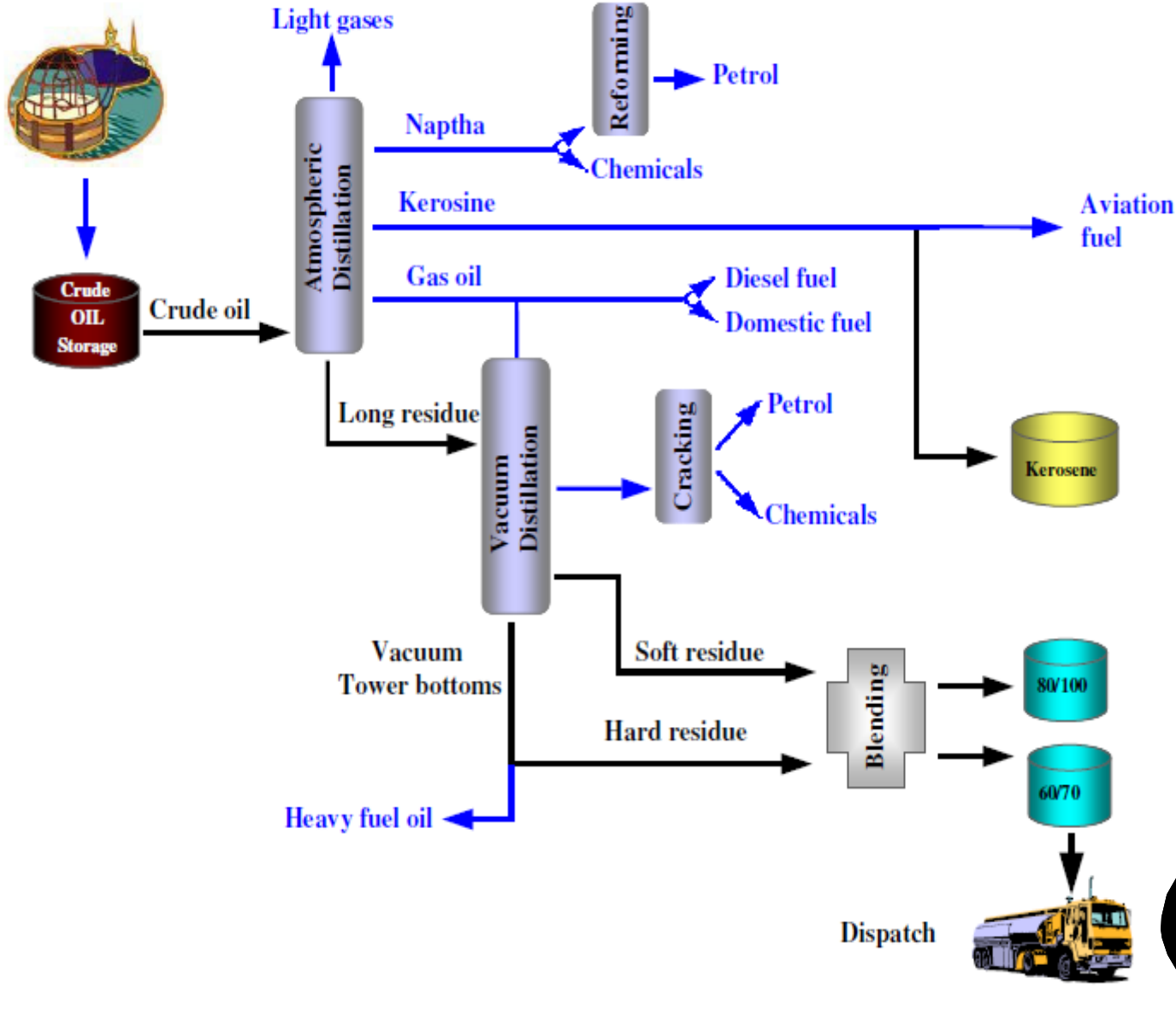
Bitumen production: Sapref



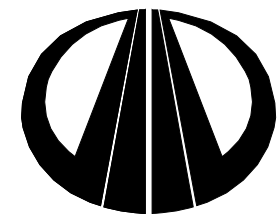
Bitumen production: Enref



Bitumen production: Chevron

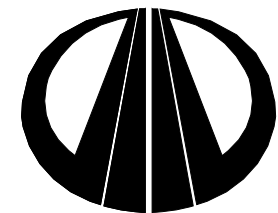


Handling, Mixing & Compaction

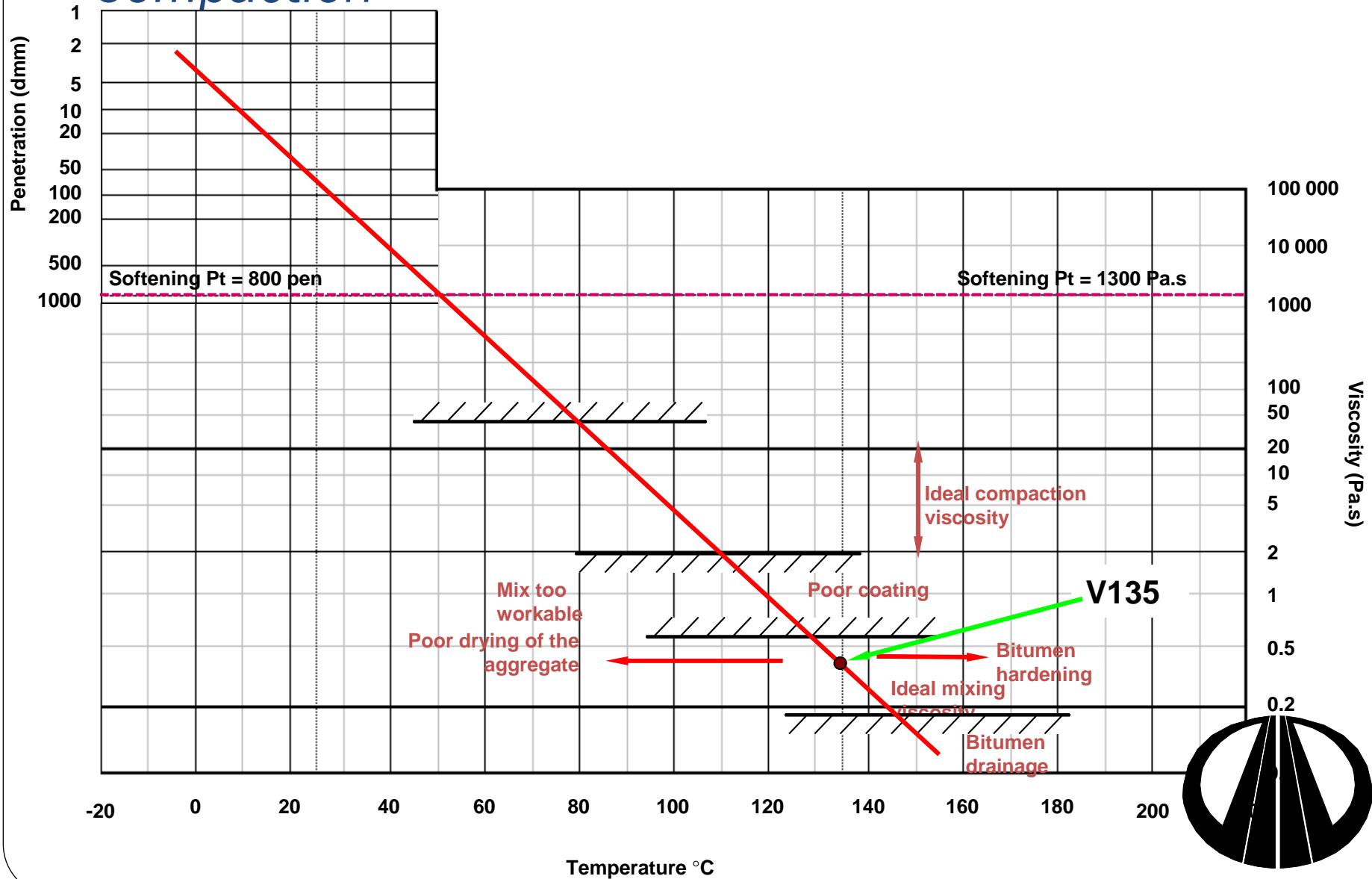


Penetration Specification Framework

| Test | Units | Remarks |
|--|--------------|----------------|
| Penetration | 0.1 mm | Range |
| Softening Pt | °C | Range |
| Viscosity @ 60 °C | Pas | Range |
| Viscosity @ 135 °C | Pas | Range |
| Spot Test | % xylene | Max |
| Rolling Thin Film Oven Test (RTFOT) | | |
| Mass change | % orig | Max |
| Visc Ratio@60 °C | % orig | Max |
| Softening Pt | °C | Min |
| Increase in Soft Pt | °C | Max |
| Retained Pen | % orig | Min |

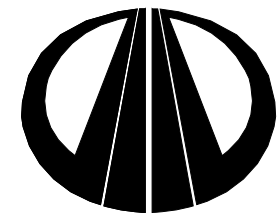
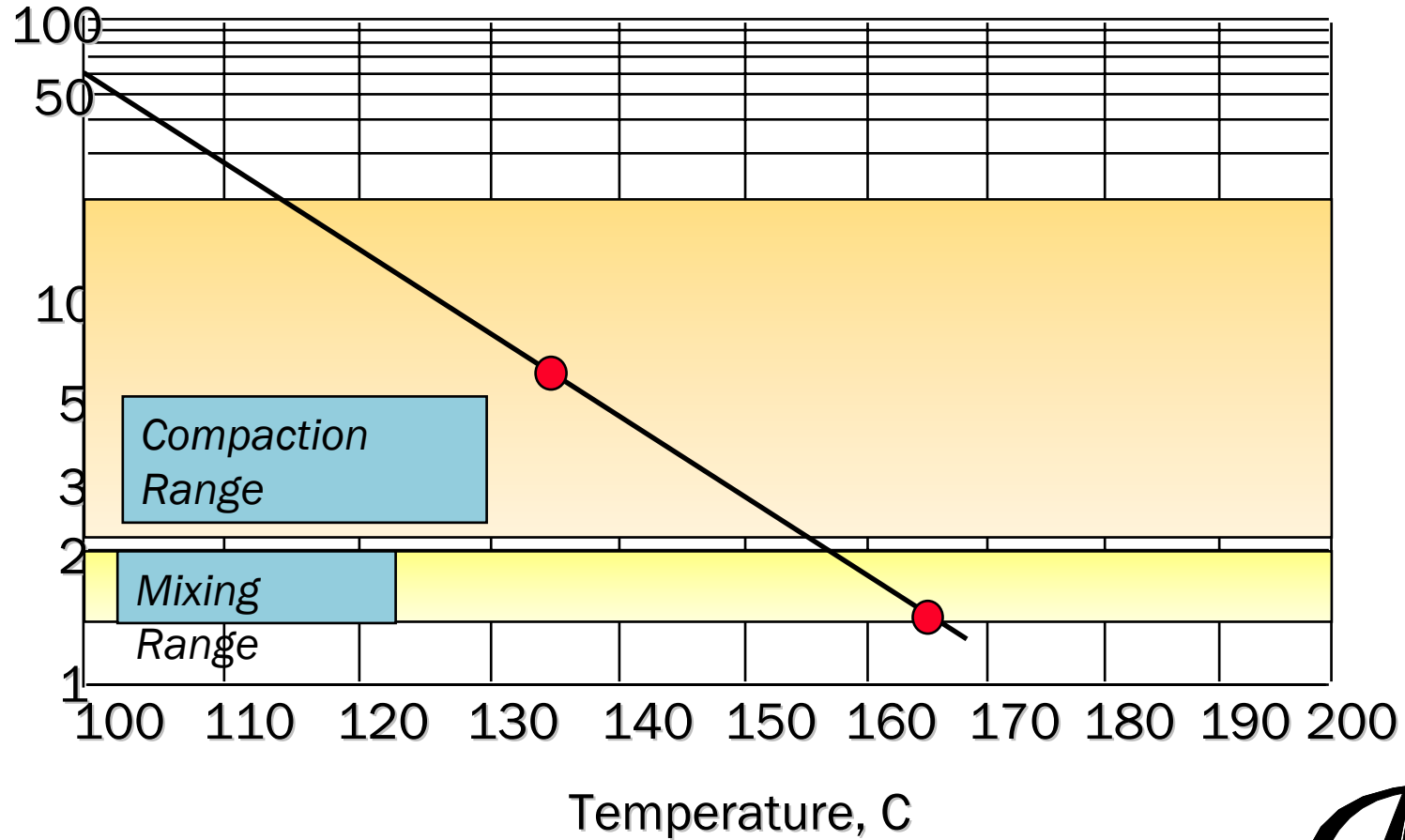


Bitumen Test Data Chart - Zones of Mixing & Compaction



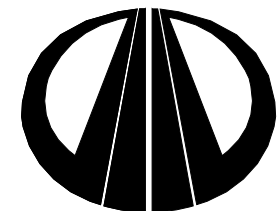
Mixing & Compaction Temps

Viscosity, P.



Bitumen Handling Temps

| Product | Mixing temp °C | Compaction temp. °C | Max. storage temp. <24 hrs °C | Max. storage temp >24 hrs °C | Min. pumping temp °C |
|------------------------------------|-------------------|------------------------|----------------------------------|---------------------------------|-------------------------|
| 60/70 | 150 - 160 | 135 - 145 | 160 | 140 | 120 |
| 40/50 | 155 - 165 | 140 - 150 | 165 | 140 | 125 |
| SBR modified | 175 - 190 | 150 - 160 | 180 | 150 | 140 |
| SBS modified | 170 - 180 | 140 - 150 | 180 | 150 | 140 |
| EVA modified | 160 - 170 | 140 - 150 | 170 | 150 | 140 |
| F-T wax modified | 135 - 145 | 120 - 130 | 150 | 120 | 120 |
| Natural hydrocarbon modified | 165 - 175 | 150 - 160 | 175 | 150 | 130 |
| Bitumen rubber | 190 - 210 | 150 - 165 | 165 | 140 | 160 |

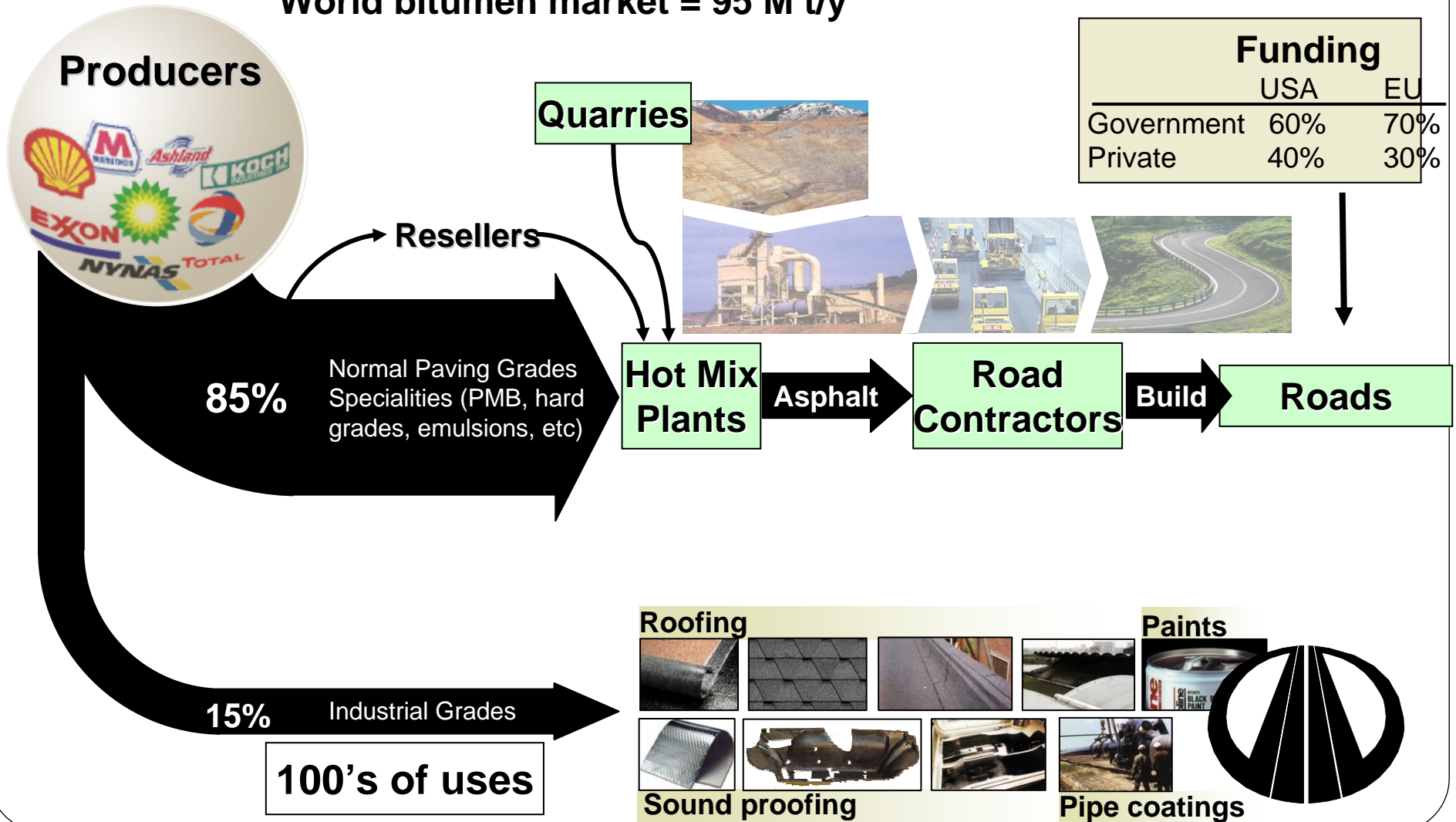




"Are there any questions?"

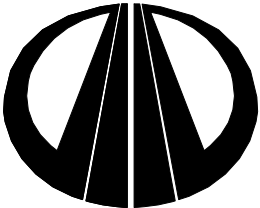
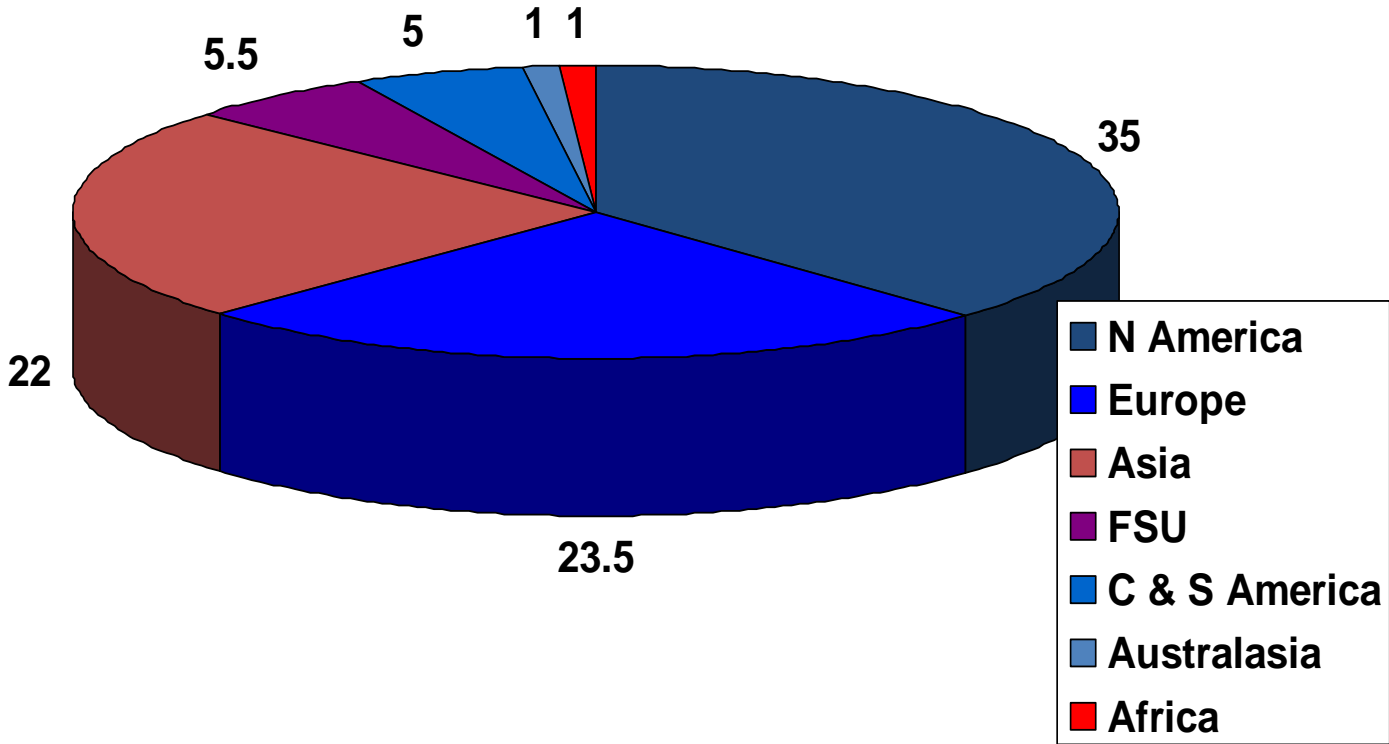
The bitumen business

Bitumen is ca 2.5 % of oil consumption
 World bitumen market = 95 M t/y

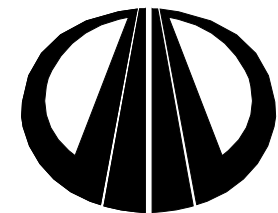


Annual bitumen demand in 2000

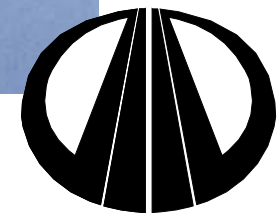
Millions of tonnes



Composition and Structure of Bitumen

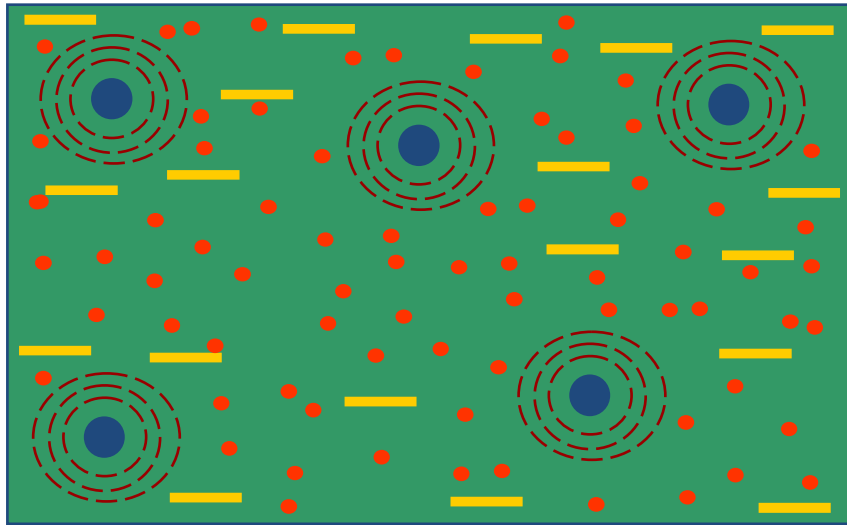


Components of Bitumen

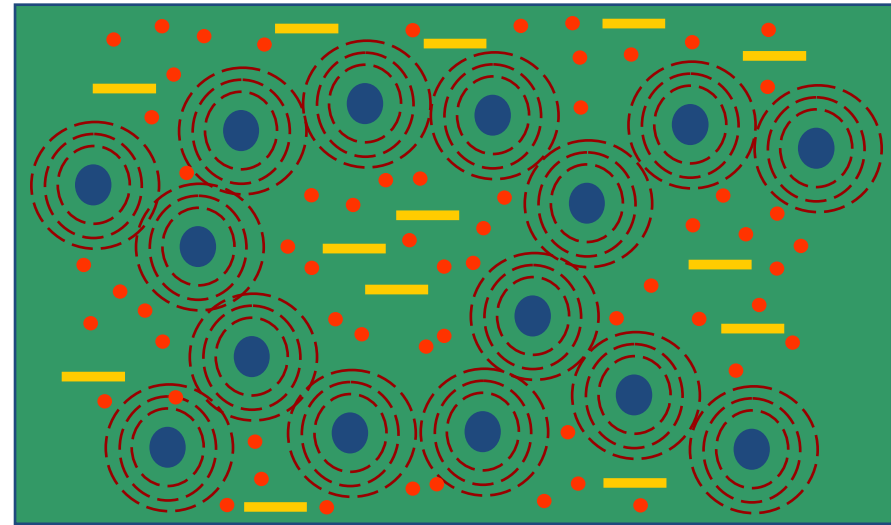


Colloidal structure of bitumen

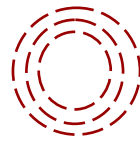
Sol type bitumen



Gel type bitumen



● **Asphaltenes**



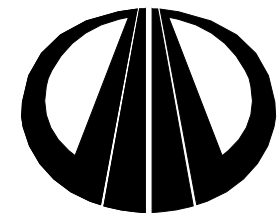
Resins



Aromatics



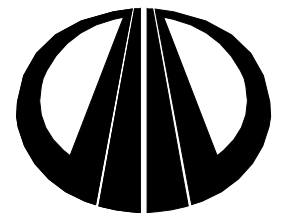
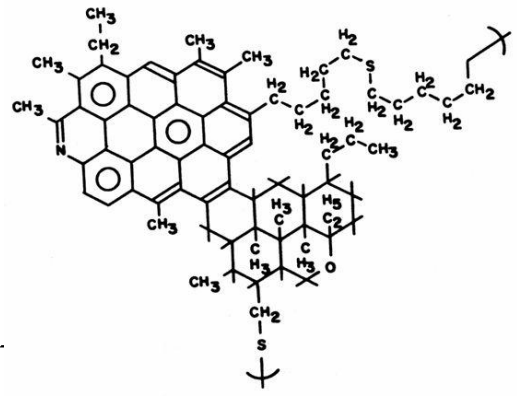
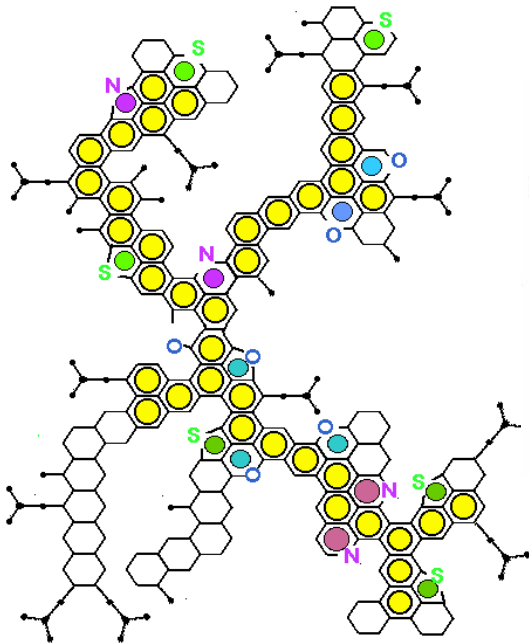
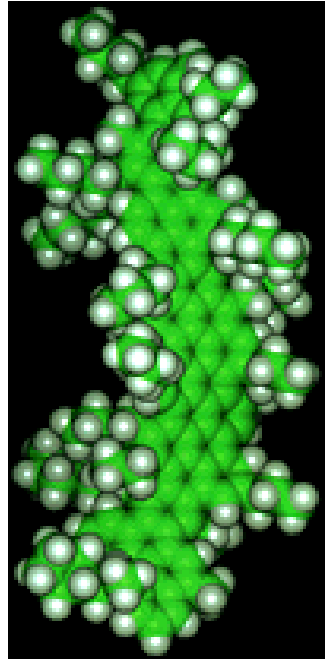
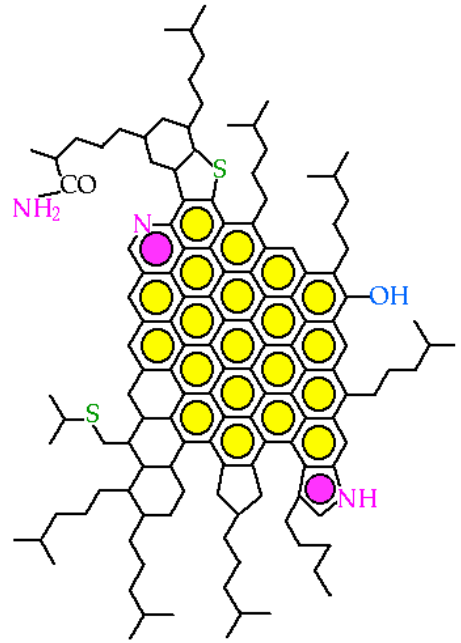
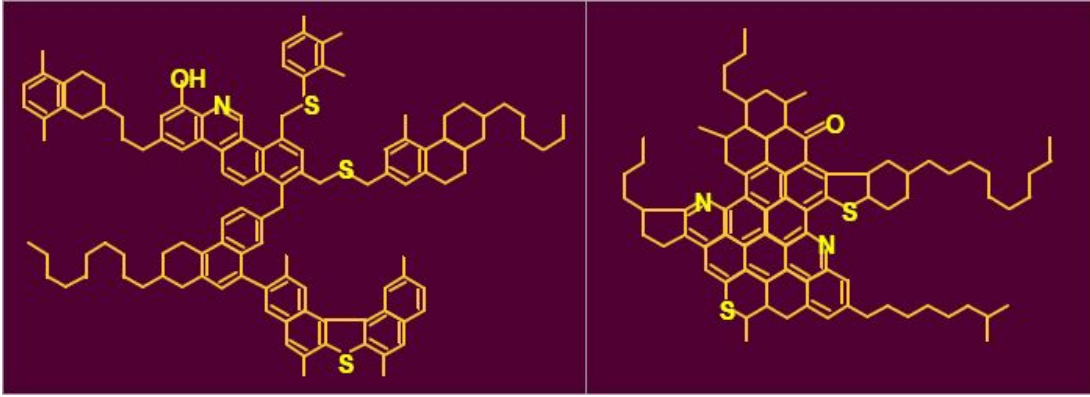
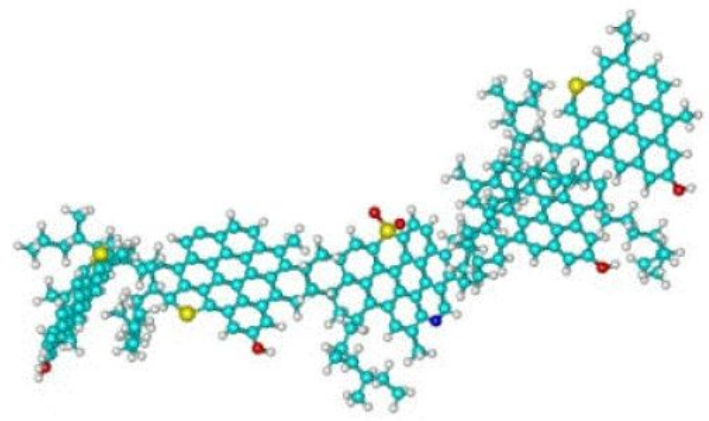
Saturates



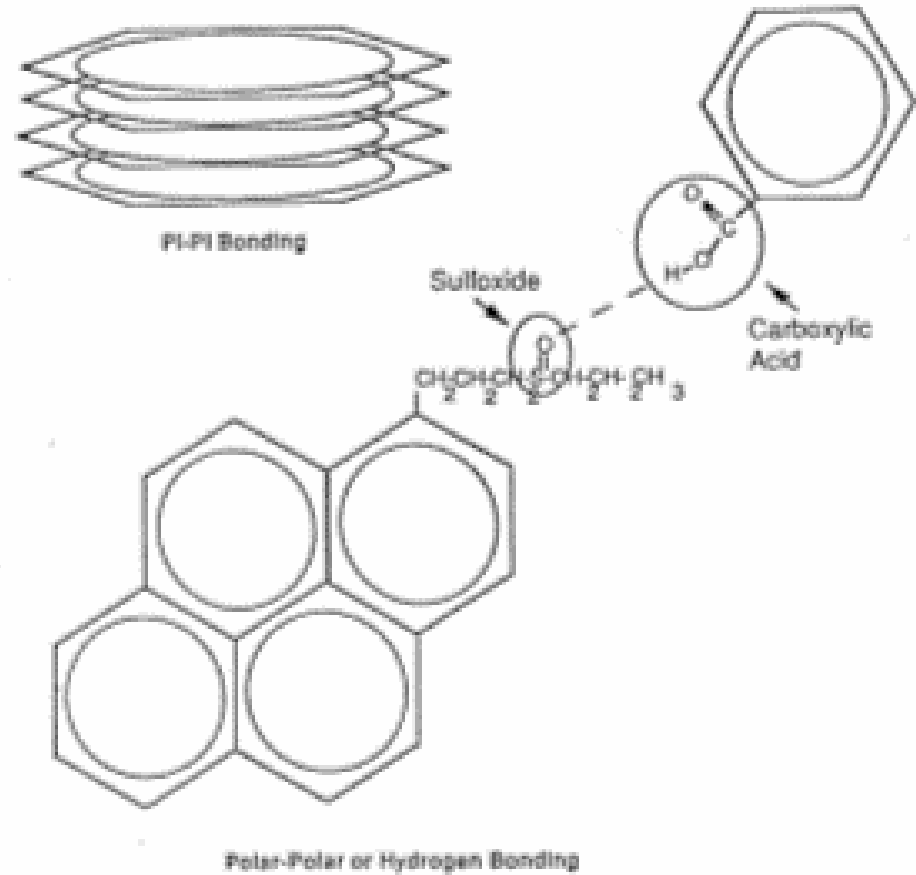
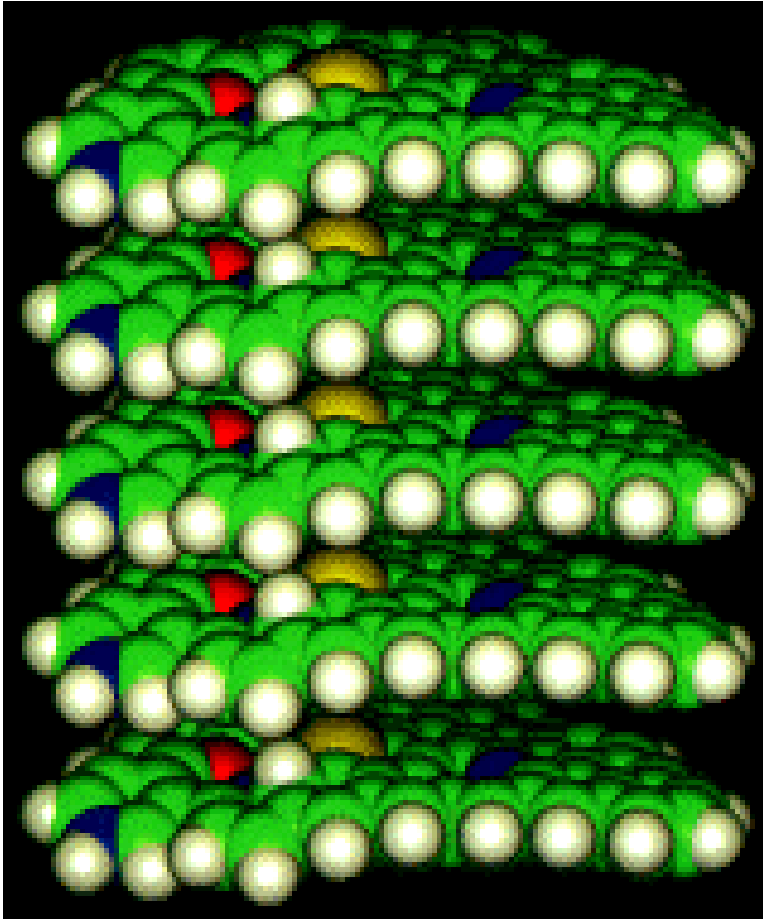
Asphaltenes – Hypothetically Speaking



Asphaltenes – Models



Types of Bonding in Bitumen



Complex, flat structure

