PAVEMENT MATERIALS

Lecture 14 & 15

Pavement Surface Layers

- Bituminous Materials
- Aggregates
- Asphalt-Aggregate Interaction
  - Adhesion
  - Water Sensitivity
- Asphalt-Aggregate Mixtures
  - Weight-Volume Relationships
  - Design (Mix Design Methods)
  - *CRITICAL ISSUES*
- Construction

Pavement Surface Layers

- IDENTIFICATION
- EVALUATION
- SELECTION
- CONSTRCUTION

Bituminous Materials

- Definitions
  - BITUMEN?
  - ASPHALT?
  - TAR?……..
- History
- Sources / Manufacture
- Chemical Composition
- Structure
- Properties
  - Chemical, Physical, Rheological
  - Rheology is the study of flow and deformation of materials under applied forces

Bituminous Materials-*Definitions*

- Origin of Word "BITUMEN" ?
- Sanskrit Word "*jatu*" stands for Pitch
- Latin Equivalent
- "*gwitu-men*" means pertaining to Pitch
- or "*pixtu-men*" means bubbling Pitch
- In French "BITUMEN"
- *Then the same word was transferred to English*

Bituminous Materials-*Definitions*

- *In British Terminology*
- BITUMEN
- A class of black or dark-colored (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons found in Asphalts, Tars, Pitches, and Asphaltites are typical.
- ASPHALT
- A dark brown to black cementitious material in which the predominating constituents are bitumens which occur in nature or are obtained in fractional distillation of petroleum (crude oil) alongwith certain mineral matter.
- *In American Terminology*
  - Both Asphalt and Bitumen are same and are
  - "ASPHALT"

Bituminous Materials-*Definitions*

- TAR
- Brown or black bituminous material, liquid or semi-solid in consistency, in which the predominating constituents are bitumens obtained as condensates in the destructive distillation of coal, petroleum, oil, shale, wood, or other organic materials, and which yields substantial quantities of pitch when distilled.
- PITCH
- Black or dark-brown solid cementitious materials which gradually liquefy when heated and which are obtained as residual in the partial evaporation or fractional distillation of tar.

Bituminous Materials-*History*

- Hazrat Noah (AAS) is said to have built his Ark with the aid of asphalt.
- 3800 B.C. in Mesopotamia where the Sumerians used the material as an adhesive mortar for building stones and paving blocks.
- Reservoirs, canals, and bathing pools constructed with these blocks were made watertight with this material found in natural deposits in the region.
- Asphalt was also used by these people in the Euphrates Valley to place an eye in a statue.
- 3000 B.C. the people of India used asphalt mastic as a waterproofer.
- From 2500 to 1500 B.C. Egyptians made use of asphalt for embalming the dead.
- In the period 2500 to 538 B.C. the Babylonians built roadways and reservoirs from mastic bricks and coated wood piles with asphalt.
- Greek and Roman civilizations in the period 500 B.C. to 817 A.D. made use of asphalt for a number of purposes including paint,
- Sailing ships were often lined with asphalt in the 15th century.

Bituminous Materials-*History*

- The first recorded production of wood tar occurred in 1661 while coal tar and tar pitch were discovered in 1681.
- Asphalt was first used as a paving material in the middle of the nineteenth century. Natural deposits of rock asphalt from the Rhone Valley in France served as the source of material for this construction.
- A foot pavement was placed in 1838 in Philadelphia made with asphalt.
- The first road in the United States was placed in Newark, New Jersey in 1870. In 1876 portions of Pennsylvania Avenue in Washington, D.C., were paved using Trinidad Lake asphalt.
- Most of the early paving in the United States was done using asphalt either from Trinidad or the Bermudez Lake in Venezuela.
- Asphalts from Refineries were marketed in the United States in the late 1800s. These materials were used for roofing, road oiling and fluxing of native asphalt materials.
- The quantity of asphalts produced from crude oil first surpassed the quantity of asphalt from natural sources in 1907 in the United States.
- In Subcontinent, early 20th century

Bituminous Materials-*Sources*

- There are two sources of asphalt
- Natural
- Refining of Petroleum
- In both cases, asphalt is the product of fractional distillation of petroleum, whether over short periods of time as in the refinery or longer periods as in nature.

Bituminous Materials-*Sources*

- Natural Asphalts
- Natural asphalts can exist either in the relatively pure form in nature or in impregnated rock deposits.
- Oldest Deposits ?

Trinidad Lake Asphalt-*Composition*

TABLE 1.1 - COMPOSITION OF TRINIDAD LAKE ASPHALT

Condition	Ingredient	Percent by Weight
Natural	Bitumen	39.3
	Mineral Matter	27.2
	Water, etc., volatile at 160°C.	29.0
	Water of hydration	3.3
	Other organic material.	1.2
Refined	Bitumen	53-55
	Mineral Matters	36-37
		9-10

Bituminous Materials-*Sources*

Petroleum Asphalts

- At present the primary source of asphalt is that obtained from the refining of petroleum or crude oil.
- The heavier or more viscous portions of certain crude oils are asphalts.

Crude Oil

- Breakdown of crude oil is shown schematically in the Figure.
- It should be realized that this is merely a schematic representation of the constituents of a crude oil and that the proportions will vary, depending upon the particular crude.
- Asphalt based crudes can vary in consistency and color from that of a burgundy wine to a material as black and viscous as the asphalt itself.

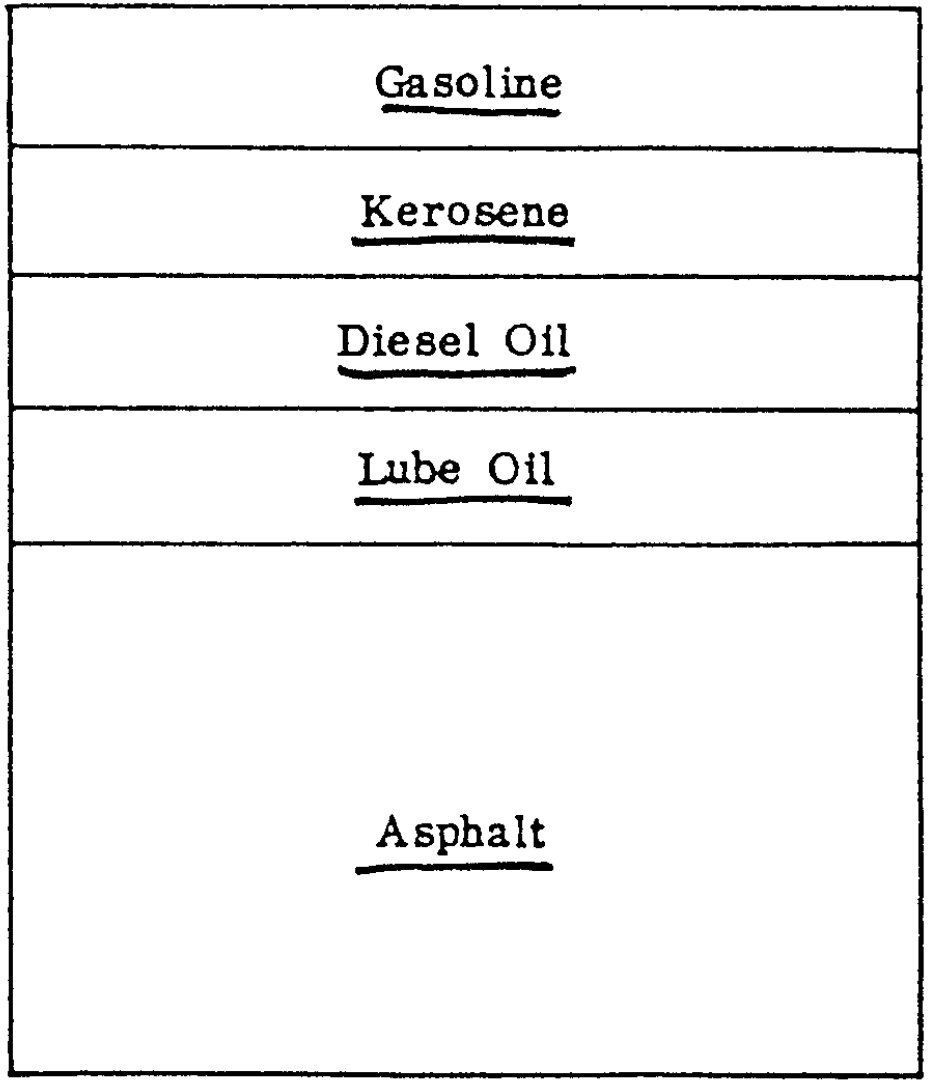

FIGURE 1.1 - COMPONENTS OF TYPICAL ASPHALT PRODUCING CRUDE OIL .

Bituminous Materials-*Sources*

- Petroleum Asphalts

- All crude oils do not contain asphalts as the heavier portions.
- In general, there are two other classifications for crudes, depending upon their base or more viscous constituents. These are

- (1) Paraffin or Wax base
- (2) Asphalt Base
- (3) Mixed base

- As their name implies, the paraffin or wax base crudes are those in which the material left after fractional distillation of the more volatile constituents is essentially a paraffin wax.
- The mixed base crudes are those in which the heavier portions are a mixture of wax and asphalt.
- Special treatment is necessary to separate the asphalt from these crudes.

Bituminous *Materials-Manufacturing*

- Manufacturing Processes

- The major methods used for the production of asphalts
- Atmospheric Distillation
- Distillation at Reduced Pressure
- Air Blowing
- Solvent Refining
- Early refinery methods consisted of a simple distillation in a retort with attached condenser. The procedure was to pump a quantity of crude oil into the vessel and apply heat to the bottom causing the lower boiling point fractions to boil off leaving a residue which, depending on the type of crude, could be axle grease, bunker fuel oil, or asphalt. Only certain types of crude containing relative high asphalt contents could be used for the productions of asphalt by this method.
- Distillation remains by far the most common process.

Bituminous *Materials-Manufacturing*

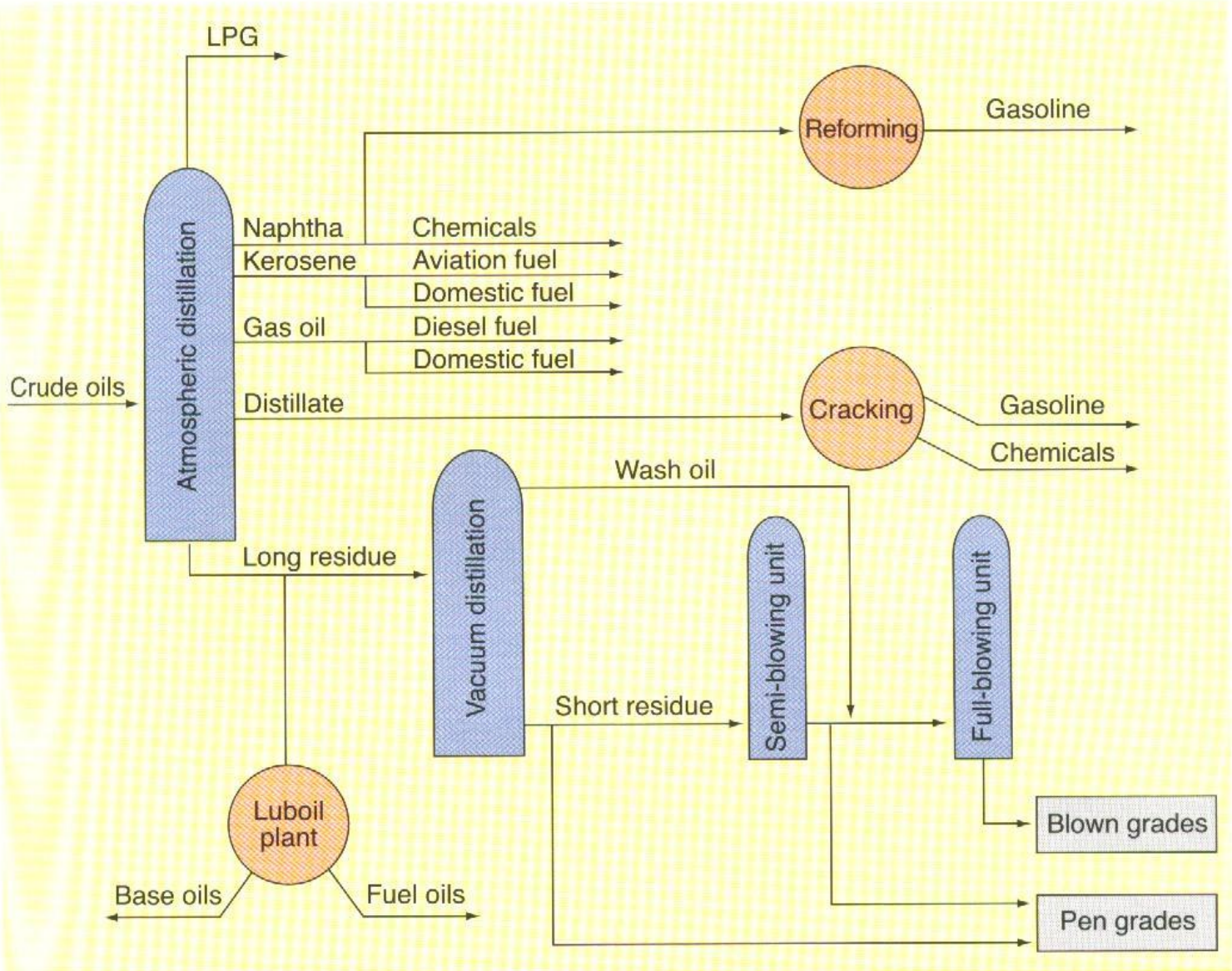

Fig. 2.2 Schematic representation of the crude oil distillation process

Bituminous *Materials-Manufacturing*

- The consistency of the material is controlled by

- (1) Temperature
- (2) Quantity of Steam
- (3) Pressure
- (4) Amount of Reflux
- (5) Type of Crude
- (6) Rate or Time of Processing

- It is often, not economical for a refinery to produce asphalt to a number of paving grades directly. Hence, blending is utilized.

- Refineries may stock two grades of asphalt:, one at each end of the viscosity spectrum and blend to produce, intermediate grades.

- Relatively high flash distillates have also been used as blending materials with hard asphalts.

Bituminous Materials-*Sources*

- Tars and pitches do not occur in nature since they are the product of chemical change.

- For example, tars are products of the destructive distillation (as distinguished from fractional distillation in the case of asphalt) of a number of organic materials such as coal, wood and sugar.

- Tar obtained from the destructive distillation of bituminous coal is a crude Tar which must undergo further refinement to obtain road tar. Tar can also be produced from petroleum by chemical rather than physical change; that is, the destructive distillation of petroleum.

Bituminous Materials-*Manufacturing*

- Asphalt is a very diverse material and has widespread usage. For convenience, asphalt will be categorized into three classifications which cover the majority of uses. These are

- (1) Paving
- (2) Roofing, and
- (3) Protective Coatings

- Paving The paving asphalts are the materials used in road construction and are produced primarily by the vacuum and steam and quite often will contain finely divided mineral fillers, in which case the materials are referred to as filled asphalts.
- Asphalts blown in the presence of special catalysts, such as P2O5, and referred to as catalytically blown asphalts are included in this category.

Bituminous Materials-*Paving Grades*

- Asphalt Cement
- A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of bituminous pavements, and having a penetration between 5 and 300.
- Depending on the classification system 5 to 6 types of asphalt cements are available. These materials vary in consistency from a solid at room temperature to a semi-liquid at the same condition. The materials are classified by either penetration or viscosity as will be discussed later.
- Bituminous Emulsions
- (a) a suspension of minute globules of bituminous material in water or in an aqueous solution
- (b) a suspension of minute globules of water or of an aqueous solution in a liquid bituminous material.
- Cut-Back Products
- Petroleum or Tar residuum which have been blended with distillates.

Bituminous Materials-*Paving Grades*

- Cut-Back Products
- Three types of cutback asphalts are available.
- (1) Rapid Curing (2) Medium Curing (3) Slow Curing
- The rapid and medium curing materials are referred to at times as cutbacks and the slow curing materials as road oils.
- Rapid Curing (RC) liquid asphalts are produced by dissolving a relatively hard asphalt cement (85-100 penetration) in a gasoline or naphtha-type solvent. The proportions of solvent are varied to produce different grades of RC materials. These grades are assigned numbers depending on their viscosity.
- Medium Curing (MC) liquid asphalts are produced by dissolving a softer base asphalt cement (generally a 120-150 penetration) in a kerosene-type solvent.
- As with the RC asphalts, by varying the proportion of solvent, different grades are obtained.
- Slow Curing (SC) liquid asphalts are produced in either of two ways. In the first case, they may be reduced directly to grade in the distillation process in the same manner as the asphalt cements.

Bituminous Materials-*Paving Grades*

- Modified Asphalts

- Polymer Modified etc

Thank You