Part 3: Classification of Crude Oil

The oil classified in several ways, either the chemical composition or the natural properties.

- For example, oil classifies by qualitative density and its viscosity to light, medium and heavy.
- According to its components of hydrocarbon to paraffinic, naphthenic, Naphthenic-aromatic and asphaltic.
- It can also called Paraffinic base, Naphthenic base, mixed or hybrid Oil and Asphaltic base.

1- Paraffinic base:

It contains a high proportion of paraffins with straight or branched chains, these chains consisting of carbon atoms up to more than 44 carbon atoms. Carbon atoms are linked together by single bonds.

These chains exist as: (Gaseous C_1-C_4), (Liquid C_5-C_{15}), (Solid-state C_{16}- to up).

This oil is called Light paraffinic oil. it the most important components of natural gasoline (low-octane number) and paraffin wax and types of lubricant.

2- Naphthenic base oil.

Crud oil in this type contains a high percentage of naphthenes such as annular cyclic paraffin like cyclopentane and cyclohexane.

The presence of these compounds by a significant proportion earns crude oil more viscosity and so-called, in this case the heavy oil. The most important components of these groups gasoline which has a higher octane number, kerosene, diesel, lubricants and asphalt.

3- Mixed or hybrid Oil:

Crude oil in this type contains a mixture of paraffin components and naphthenic components in similar percentage and a few aromatic hydrocarbons and this type of crude oil represents most of the crude oil.

4- Crude oil with asphalt composition

This type of crude oils contains aryl compounds and a high proportion of asphalt.

Assessment of petroleum

Petroleum raw materials vary in physical and chemical properties according to:

1. The diversity of sources production of the rocks.
2. Physical properties.
3. Chemical properties of the rocks contained it.
4. The depths of the container layers ore and the difference in their geology and mineral structures.

Physical properties of crude oil

You can determine the quality of petroleum product and its chemical composition by studying of some :physical and chemical properties, such as

1- Sulfur content:

The quality of crude oil decrease with the more proportion of sulfur compounds and vice versa.

The implications of the increase in the sulfur content of crude oil:

1- Corrosion caused a continuous basis in all parts of the engines.
2- Gas SO_2 and SO_3 is formed and in combination with air moisture consists of sulfuric acid which causes corrosion in engine and iron pipes.

3- Works to reduce the octane number, especially in gasoline, which reduces the quality and becomes invalid as a fuel for cars.

4- Reduces the solubility of organic compounds produced from the distillation of petroleum which leading to the existence of other side reactions in addition to the basic interaction.

5-Increased sulfur content helps to form more complex compounds, which leads to form a resin heavy compounds are concentrated in heavy distillates (diesel and asphalt).

2- Density and specific gravity:

Density is the mass per unit volumes. The mass of unit volume specific gravity is the ratio between the liquid mass to the same size of the mass of water at the same temperature.

Density = Mass / Volume

The density of petroleum hydrocarbons ranging from 0.69 to 0.95. An increase in density at the hydrocarbons of the sam number of carbon atoms from normal hydrocarbons to cyclic hydrocarbons then to aromatic.

We also find heavy types which increases the value of density about 0.88, a species that contain high proportions of asphalt.

Relative density = density of pet. fraction / density of water at the same temperature.

3- Aniline Point:

The aniline point is a physical characteristic of hydrocarbon compounds, such as oils, and refers to the minimum temperature at which the hydrocarbon and the same amount of the aniline ($C_5H_5NH_2$) are perfectly miscible.

- At temperatures below this point, a mixture of the compound and an equal volume of aniline will not dissolve together.

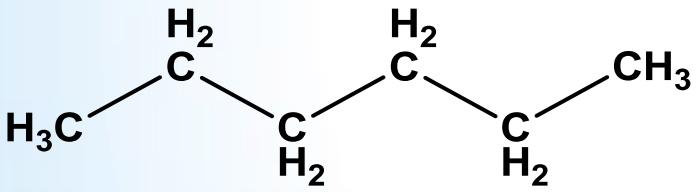
- The result of a test, called the aniline test, gives chemists this information about a hydrocarbon, including certain details about its composition, such as the relative content of aromatic chemicals and various paraffins.
- The aniline point of a liquid will vary, depending upon the relative concentration of aromatic compounds dissolved in it.
- Generally, a higher aniline point means a relatively low level of dissolved aromatics.

- By using reference materials for a pure sample of a given substance and comparing the aniline point of the pure sample to that of the test sample, a chemist can calculate the amount of aromatics in the test sample with a high degree of accuracy.

Aniline Point

- Increase by increasing carbon atoms in the paraffinic carbon chain
- Increase by increasing side chains in the paraffinic carbon chain
- Decrease by increasing aromatic content.

Arrange the following compounds according to increasing in their Aniline point.



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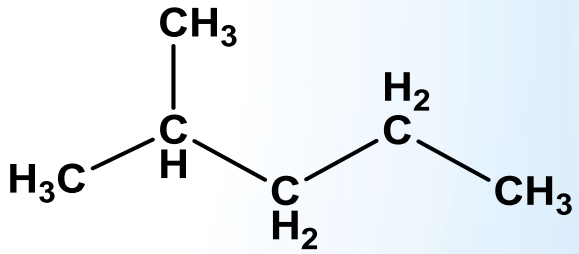

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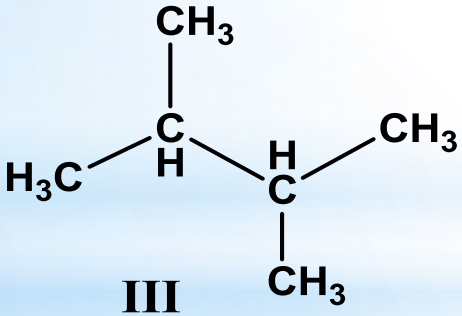

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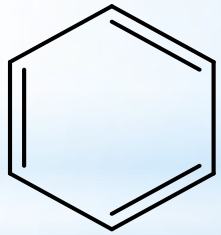


IV

4- Flash Point:

The **flash point** of a volatile material is the lowest temperature at which it can vaporize to form an ignition mixture in air. Measuring a flash point requires an ignition source

5- Fire Point:

The **fire point** of a fuel is the temperature at which the vapor produced by that given fuel will continue to burn for at least 5 seconds after ignition by an open flame. At the flash point, a lower temperature, a substance will ignite briefly, but vapor might not be produced at a rate to sustain the fire.

6- Viscosity :-

Kinematic viscosity: a measure of the time for a fixed volume of liquid to flow by gravity through a capillary. The cgs (centimeter-gram-second) unit of kinematic viscosity is the **stoke** which has the dimensions centimeters-squared per second. In the petroleum industry kinematic viscosity is usually expressed in centistokes, cSt, so that 1 St = 100 cSt.

$$\text{Kinematic viscosity, cSt} = C \cdot t$$

where:

C = calibration constant of the viscometer, cSt/s, and

t = flow time, s.

Dynamic viscosity:- (sometimes called absolute viscosity) is numerically the product of kinematic viscosity and the density of the liquid, both at the same temperature. The cgs unit of dynamic viscosity is the **poise**, P, which has the dimensions grams per centimeter per second.

$$\text{Dynamic viscosity, cP} = \rho \cdot \nu$$

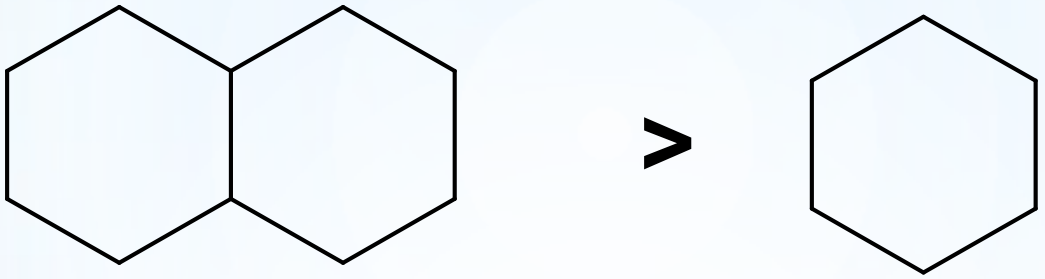
where:

ρ = density, g/cm^3 (Note 6) at same temperature as kinematic viscosity, and

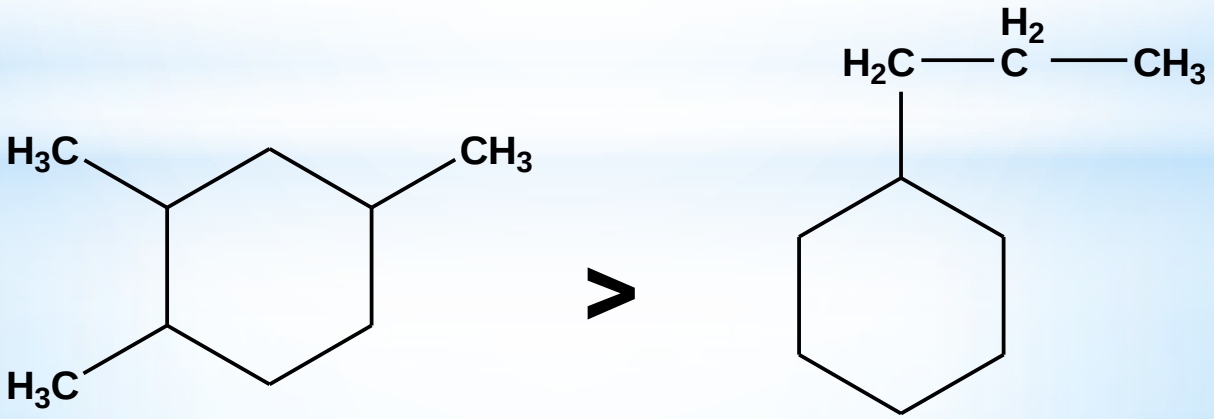
ν = kinematic viscosity, cSt.

Paraffinic-base oil has lower viscosity (higher quality) and *vice-versa*.

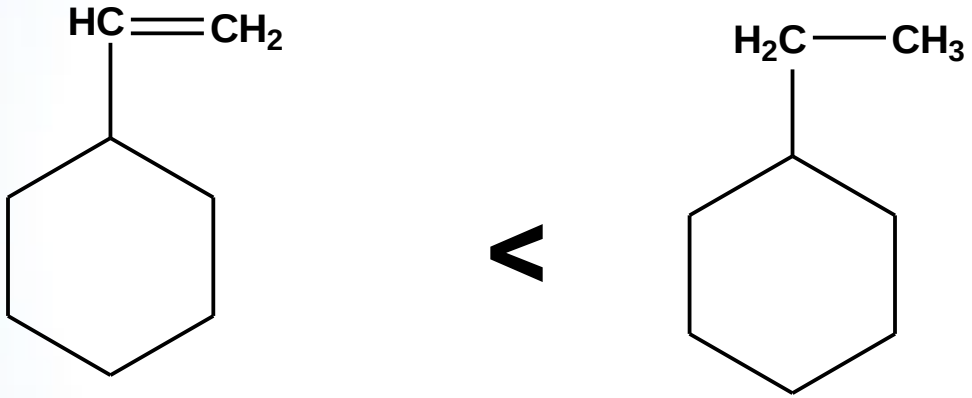
- Viscosity increased by rings increased



- Viscosity increased by side-chains increased at the same carbon atoms.



- Viscosity in olefinic hydrocarbons is lower than viscosity of paraffinic hydrocarbons.



Absolute viscosity (dynamic viscosity) provides a measure of a fluid’s internal resistance to flow. For liquids, viscosity corresponds to the informal notion of "thickness".

For example, honey has a higher viscosity than water.

7- Salt Content:

The salt content expressed in milligrams of sodium chloride per liter oil (or in pounds/barrel) indicates the amount of salt dissolved in water. Water in crudes is mainly present in an emulsified form. A high salt content in acrude oil presents serious corrosion problems during the refining process. In addition, high salt content is a major cause of plugging heat exchangers and heater pipes. A salt content higher than10 lb/1,000 barrels (expressed as NaCl) requires desalting.

Jet fuel

Jet fuel or **aviation turbine fuel** (**ATF**) is a type of aviation fuel designed for use in aircraft powered by gas-turbine engines. It is colorless to straw-colored in appearance.

The most commonly used fuels for commercial aviation are **Jet A** and **Jet A-1**, which are produced to a standardized international specification.

The only other jet fuel commonly used in civilian turbine-engine powered aviation is **Jet B**, which is used for its enhanced cold-weather performance.

Jet fuel is a mixture of a large number of different hydrocarbons. The range of their sizes (molecular weights or carbon numbers) is restricted by the requirements for the product, for example, the freezing point or smoke point.

Types of Jet fuel:

1- Kerosene-type jet fuel (including Jet A and Jet A-1) has a carbon number distribution between about 8 and 16 (carbon atoms per molecule), (boiling range 150-250).

2- Jet B is a fuel in the gazoline-kerosene region

that is used for its enhanced cold-weather performance. However, Jet B's lighter composition makes it more dangerous to handle. For this reason it is rarely used, except in very cold climates.

A blend of approximately 30% kerosene (C_8-C_{16}) and 70% gasoline (C_4-C_{12}), it is known as wide-cut fuel. It has a very low freezing point of −60 °C (−76 °F) and a low flash point as well. It is primarily used in some military aircraft.

It is also used in Canada because of its freezing point.