What is Petroleum?

The word petroleum originated from the Latin words, Petra, meaning rock and oleum, meaning oil. Literally it means 'Rock Oil,' and can also be defined as a non-renewable fossil fuel or oil that is found underground. This is any naturally-occurring flammable mixture of hydrocarbons found in geological formations such as rock strata.

Technically, the term petroleum refers to describe any solid, liquid or gaseous hydrocarbons. It's also known as 'crude oil' or 'mineral oil.'

Differences Between Crude Oil, Petroleum Products And Petroleum

Crude oil- Mixture of hydrocarbons existing as liquid in natural underground reservoirs and remain liquid during extraction.

Petroleum products- Produced from the processing of crude oil at petroleum refineries and extraction of liquid hydrocarbons at natural gas processing plants.

Petroleum- refers to the broad category that includes both crude oil and petroleum products.

Occurrence of Petroleum

Petroleum occurs in the earth's crust, in all possible states and varies in color from light brown to dark brown or black, exhibiting luminescence in some cases. It is a mixture of various hydrocarbons, of homologous series namely paraffins, napthenes and aromatics.

The final result is a black viscous product of composition:

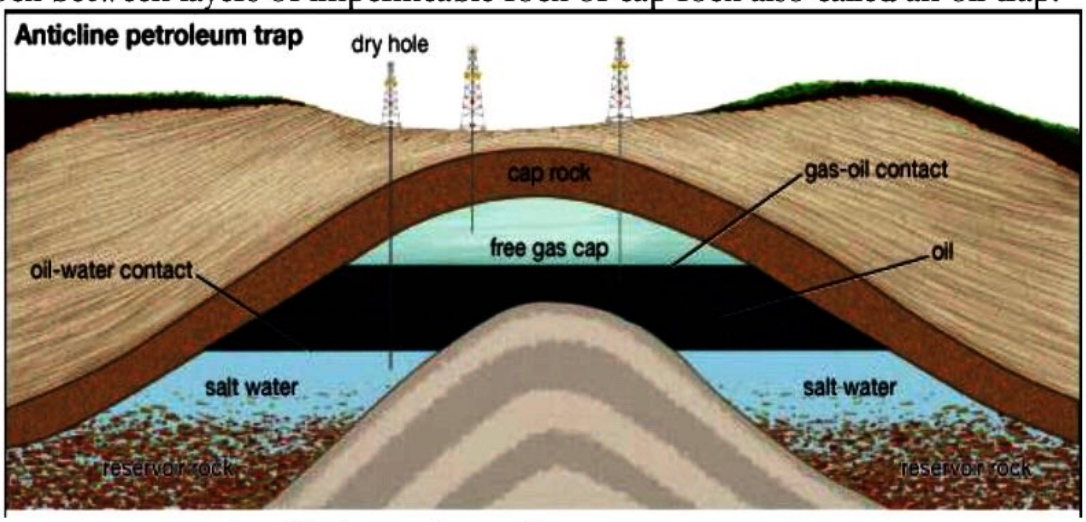
Carbon	80 to 89%
Hydrogen	12 to 14%
Nitrogen	0.3 to 1 %
Sulphur	0.3 to 3%
Oxygen	2 to 3%

Petroleum Formation.

There are basically two theories explaining the origin of oil,

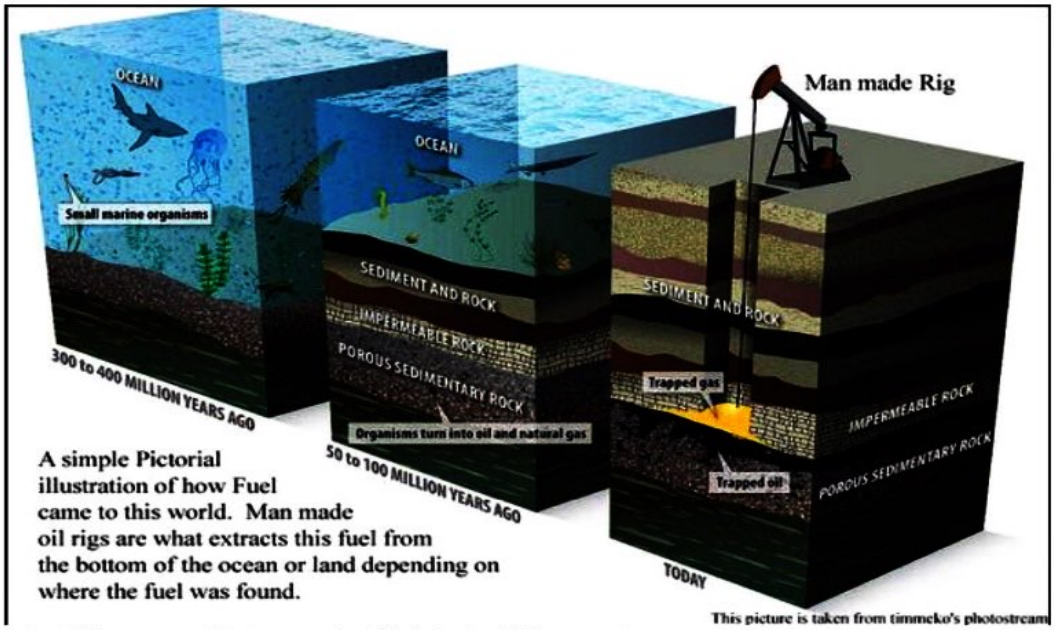
1-Organic Theory (Biotic Theory)

- Oil developed millions of years from organic material remains of dead plants and animals (algae and planktons).
- The dead organisms sank to the bottom of water bodies (seas and lakes), where the environment tends to be anaerobic.
- They accumulated in the mud on the beds of the water bodies, partially decomposed.
- Sediment deposition on the bed of the water body, burying and compressing the organic matter under its weight.
- Increase in temperatures(100-160°c) and pressures resulted due to continued sediment deposition.
- With time the conditions broke down the organic compounds into shorter hydrocarbon chains, forming oil and natural gas.
- Oil and natural gas flowed from the source rock, accumulating in thicker more porous rock called a reservoir rock.
- Earth movements (faulting, folding) trapped the oil and natural gas in the reservoir rock between layers of impermeable rock or cap rock also called an oil trap.



Conditions necessary for biotic on formation.

1. Deep burial under sand and mud.
2. Pressure cooking.
3. Hydrocarbon migration from the source to the reservoir rock.
4. Impermeable rock to trap the oil.



2- Inorganic Theory (Abiogenic/Abiotic Theory)

- This hypothesis of petroleum origin without biology was first proposed in 16th century by Georg Agricola, then in 19th century by Alexander (Prussian geographer), Dmitri (Russian chemist), Marceline (French chemist) and re-defined in 20th century by Cornell University physicist, Thomas Gold.
- Supporters of this hypothesis argued that hydrocarbons existed at the formation of the solar system and were abundant in other system and were abundant in other planets e.g. Saturn (زحل), Jupiter(كوكب المشتري),...
- The theory argued that petroleum originated from limitless pools of liquid primordial (الأساسي)hydrocarbons at great depths in the earth.
- These carbon-bearing fluids migrated upward from the mantle where they slowly replenish(تجديد) the reservoirs that conventional oil drillers tap.

Other hypothesis arose (نشأت) as a result of the Abiotic theory. These include,

i. Deep seated terrestrial hypothesis.

Proposed by Dmitri Mendeleev, he postulated that metallic carbides deep within the earth reacted with water at high temps, forming acetylene.

$CaC_2(s)_+2H_20$ ------> $Ca(OH)_2(s)+C_2H_2(g)$

ii. Extra terrestrial hypothesis.

Proposed by Sokoloff, he based a cosmic (الكون)origin to petroleum origin. He postulated that hydrocarbons precipitated as rain from original nebular matter from which the solar system formed.

Composition of Petroleum

Petroleum occurs in nature in all three possible states solid, liquid and gas. The liquid petroleum is usually colored from dark brown to bluish black or black, exhibiting sometimes bloom or fluorescence. The semi-solid or solid petroleum is well known by the name pitch, usually black in color. Such kind of deposits ate assumed to form after the evaporation or migration of lighter fractions. The gaseous deposits of petroleum are known as natural gas deposits, where sometimes gasolines are also accompanied. Gas from condensate reservoirs contain a good portion of lighter fractions of a boiling point upto 30° C. Associated reservoirs contain gas mainly in dissolved form in liquid petroleum.

Although the composition of petroleum depends not, very much on the origin of formation, but certainly change with the time of formation, storage and different stratas (الطبقات) through which it migrated. It is a homogeneous mixture of various hydrocarbons of saturates and ring-structures. The average ultimate composition of petroleum is mainly given in terms of constituents of hydrocarbons, namely carbon and hydrogen as follows :

Carbon	84—86%
Hydrogen	11—14%

The other major elements of importance are sulfur, oxygen and nitrogen. These elements in hydrocarbons are usually treated as impurities because of their inherent properties like odor, color corrosiveness etc. Generally these three elements combined, do not exceed 5% on an average.

The bulk of petroleum is made up of hydrocarbons, of saturated compounds like paraffins, naphthenes and unsaturated cyclic compounds mainly aromatics.

The highest carbon atom present in the crude is C70. Further, except first few hydrocarbons, all other hydrocarbons exhibit isomerism. The general properties of these homologous series are discussed below :

Paraffins :

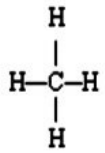
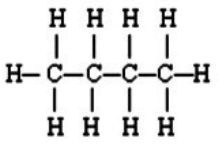
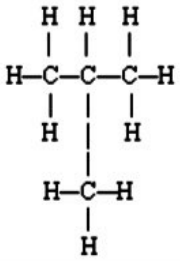
C_nH_{2n+2} is the general formula of paraffins. First three compounds are gases while compounds upto C_{16} are liquids and beyond that, they assume semisolid consistency. Well beyond C_{30} assume shape of solid blocks, sometimes even crystalline forms. There are number of isomeric compounds for each compound, profoundly differing in properties. For example upto C_3 no isomers are possible, C_4 exhibits only two isomers, as shown here :

And C_5 exhibits three isomers. The number of isomers increases as the number of carbon atoms increase $C_{13}H_{28}$ exhibits 802 isomeric forms.

General properties of paraffins

Paraffins are stable, not attacked by sulfuric acid or other oxidizing agents. However, paraffins of higher order > C_{30} are prone to oxidation. Even usual oxidizing agents like potassium permanganate can cause good amount of oxidation. The aptitude to contribute the substituted products with halogens has magnified the petrochemical industry. Higher

paraffins are very much insoluble in water ; though the lower ones are soluble in ethers and alcohols. Paraffins upto 3 carbon atoms have inclination to form hydrates such as [$CH_4.7H_2O$, $C_2H_6.\ 7H_2O$] and these hydrates offer clogging and corrosion difficulties. Hence drying is essential before usage.

Example of simplest HC molecule (CH_4):	Examples of straight chain paraffin molecule (Butane) and branched paraffin molecule (Isobutane) with same chemical formula (C_4H_{10}):	
METHANE (CH_4)	BUTANE (C_4H_{10})	ISOBUTANE (C_4H_{10})
		

The specific gravity of the series increases with molecular weight, still paraffins have less specific gravity and boiling point than aromatics. Viscosity of paraffins is less but viscosity index is high in contrast to aromatics. The smoke point of the paraffins is very high, with poor illuminating characteristics. The pour point of paraffins is usually high; due to this paraffin rich crudes and products bring difficulties in transpiration and storage.

Isomers differ from n-paraffins by having slightly low boiling points, low pour points, high viscosity and viscosity index. Usually i-paraffins, are more reactive than n-paraffins.

High molecular compounds (> C_{20}) may be of saturated or unsaturated nature, decompose if exposed to a temperature of above 370°C. Vacuum distillation is essential for distilling such boiling stocks to prevent them from thermal degradation.

Unsaturated (Olefins and Properties)

Olefins are represented by the general formula CnH_{2n}. The first four are gases and upto C_{15} are liquids and beyond C_{15} are solids. The boiling points of olefins are generally lower by few degrees than the saturated compounds of the same carbon number. Chemically these differ very much from paraffins. They are easily attacked by sulfuric acid and some of them even polymerize. Treatment with sulfuric acid and subsequent hydrolysis yields alcohols (e.g. isopropyl alcohol) and with permanganate oxidation, glycols are formed. Unsaturated compounds like olefins, diolefins, in general, do not appear in crudes to measurable quantities, however they are detected in some crudes. These unsaturated are mainly formed during cracking operations. The absence of unsaturates to a large extent can be best judged by the probable catalytic activity of the earth's crest in converting unsaturates to saturates and ring structures.