1. PETROLEUM

- Petroleum is a complex mixture of hydrocarbons that occur in the Earth in liquid, gaseous, or solid forms. The term is often restricted to the liquid form, commonly called **crude oil**, though as a technical term it also includes *natural gas* and *the viscous or solid form (bitumen)*.
- The liquid and gaseous phases of petroleum constitute the most important of the primary fossil fuels. Indeed, liquid and gaseous hydrocarbons are so intimately associated in nature that it has become customary to shorten the expression “petroleum and natural gas” to “petroleum” when referring to both.

i. Origins of Crude Oil

- Although it is recognized that the original source of carbon and hydrogen was in the materials that made up the primordial Earth, it is generally accepted that these two elements have had to pass through an organic phase to be combined into the varied complex molecules recognized as crude oil.

- This organic material has been subjected for hundreds of millions of years to extreme pressures and temperatures that have transformed it into the fuel source as it is known today.

Element	Composition (% by mass)
Carbon	84 – 87
Hydrogen	11 - 14
Sulfur	0.6 - 8
Nitrogen	0.02 - 1.7
Oxygen	0.08 - 1.8
Metals	0 - 0.14

Table enlists the most common elements found in crude oil and natural gas.

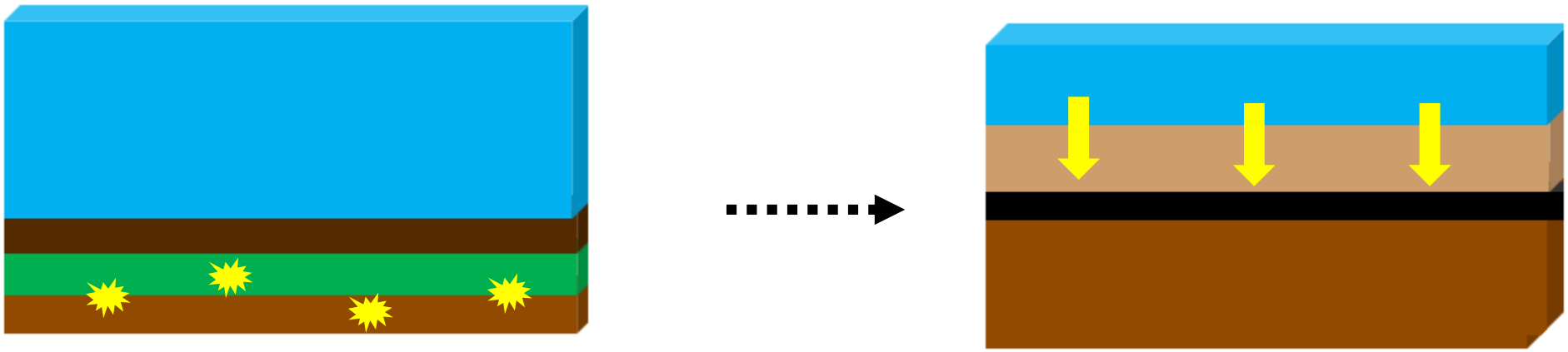
ii. Formation of Petroleum

From planktonic remains to kerogen

The organic material that is the source of most oil has probably been derived from single-celled planktonic plants, such as diatoms and blue-green algae, and single-celled planktonic animals, which live in aquatic environments of marine, brackish, or fresh water. Such simple organisms are known to have been abundant long before the Paleozoic Era, which began some 542 million years ago.

- Rapid burial of the remains of the single-celled planktonic plants and animals within fine-grained sediments effectively preserved them.

- This provided the organic materials, the so-called protopetroleum, for later diagenesis (i.e., the series of processes involving biological, chemical, and physical changes) into true petroleum.

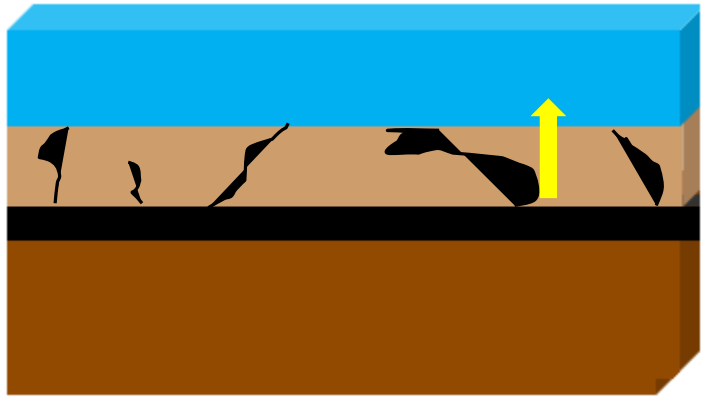


- The first, or immature, stage of petroleum formation is dominated by biological activity and chemical rearrangement, which convert organic matter to kerogen. This dark-coloured, insoluble product of bacterially altered plant and animal detritus is the source of most hydrocarbons generated in the later stages.

- During the first stage, biogenic methane is the only hydrocarbon generated in commercial quantities. The production of biogenic methane gas is part of the process of decomposition of organic matter carried out by anaerobic microorganisms.

From kerogen to petroleum

- Deeper burial by continuing sedimentation, increasing temperatures, and advancing geologic age result in the mature stage of petroleum formation, during which the full range of petroleum compounds is produced from kerogen and other precursors by thermal degradation and cracking (the process by which heavy hydrocarbon molecules are broken up into lighter molecules).
- Depending on the amount and type of organic matter, oil generation occurs during the mature stage at depths of about 750 to 4800 metres at temperatures between 65 and 150 °C. This special environment is called the "**oil window**."



- Approximately 90% of the organic material in sedimentary source rocks is dispersed kerogen. Its composition varies, consisting as it does of a range of residual materials whose basic molecular structure takes the form of stacked sheets of aromatic hydrocarbon rings in which atoms of sulfur, oxygen, and nitrogen also occur.

- Attached to the ends of the rings are various hydrocarbon compounds, including normal paraffin chains. The mild heating of the kerogen in the oil window of a source rock over long periods of time results in the cracking of the kerogen molecules and the release of the attached paraffin chains.

- Further heating, perhaps assisted by the catalytic effect of clay minerals in the source rock matrix, may then produce soluble bitumen compounds, followed by the various saturated and unsaturated hydrocarbons, asphaltenes, and others of the thousands of hydrocarbon compounds that make up crude oil mixtures.

- At the end of the mature stage, below about 4800 metres, depending on the geothermal gradient, kerogen becomes condensed in structure and chemically stable. In this environment, crude oil is no longer stable and the main hydrocarbon product is dry thermal methane gas.

iii. Petroleum Refining

- The extraction of petroleum from underground reservoirs is followed by the conversion of crude oil into useful products in a process known as **refining.**

- In **refining,** the first step is distillation, which separates the different parts of petroleum through their different boiling points.

- The petroleum is initially heated from the bottom and then passed into a fractionating tower. The various petroleum products condense at different temperature levels in this tower and are collected.

- The heaviest fractions (or products) collect at the bottom of the tower, while gasoline condenses near the top. (Some gases do not condense and are taken off at the top and added to the natural gas.)

Basic refinery processes

Each refinery is uniquely designed to process specific crude oils into selected products. In order to meet the business objectives of the refinery, the process designer selects from an array of basic processing units. In general, these units perform one of three functions:

(1) Separating the many types of hydrocarbon present in crude oils into fractions of more closely related properties,

(2) Chemically converting the separated hydrocarbons into more desirable reaction products,

(3) Purifying the products of unwanted elements and compounds.

- Most of the products from the tower are treated further chemically and/or thermally to produce such products as gasoline, heating oil, jet fuel, diesel oil, paraffins, and asphalt.
- Gasoline is the most important petroleum product, accounting for about 45% of the refinery output. The refinery output can be adjusted according to the season to produce more or less gasoline and heating oil.
- About 10% of all petroleum provides the chemical industry with raw materials such as methane, ethane, benzene, and toluene. These are used in the production of fertilizers, plastics, solvents, nylon, synthetic rubber, and so on.

The world's first commercial oil well, Titusville, Pennsylvania, 1859.

iv. Petroleum Fuel Products

Although petroleum is the source material for many chemicals and synthetic materials such as plastic, its most important use is as a fuel. Following are some of the most prominent petroleum fuel products.

a. Gases

b. Gasoline

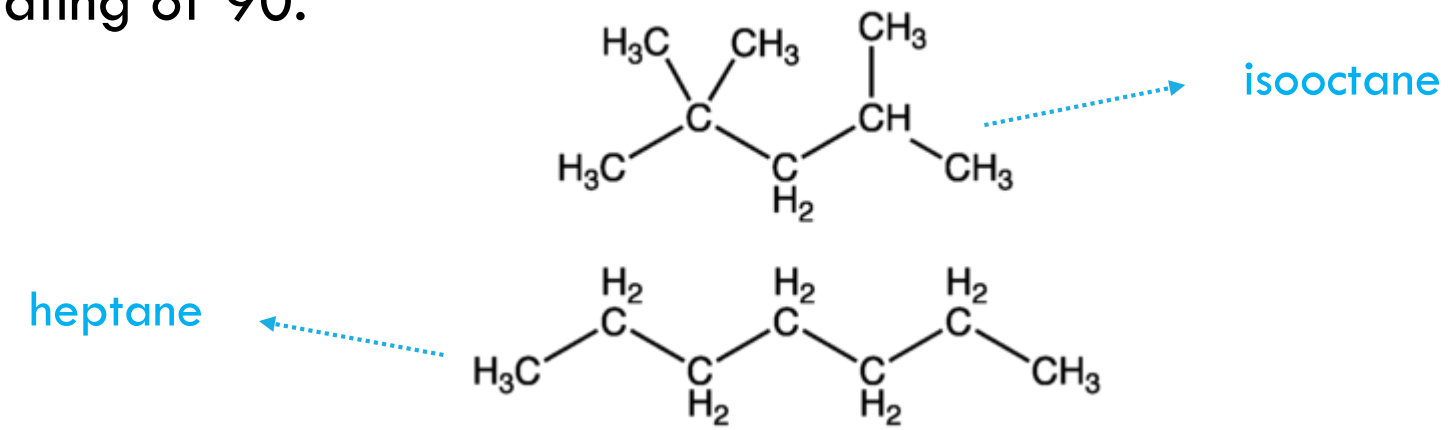
c. Diesel Fuel

d. Fuel Oil

Octane rating

- Experimental studies led to the determination that, of the standard fuels available at the time, *the most extreme knock* was produced by a fuel composed of pure normal heptane, while *the least knock* was produced by pure isooctane. This discovery led to the development of the octane scale for defining gasoline quality.

- Thus, when a motor gasoline gives the same performance in a standard knock engine as a mixture of 90% isooctane and 10% normal heptane, it is given an octane rating of 90.



PETROLEUM	
Advantages	**Disadvantages**
It can be extracted easily	Its resources are limited
It has high density.	It contributes to environmental pollution.
It can be extracted at a low cost.	It produces hazardous substances.
It can easily be transported.	It is a non-renewable form of energy.
It has broad areas for application.	Its transport can cause oil spills.
It is a crucial element in industries.	It sustains growth of terrorism and violence.
It can power up almost all types of vehicles.	
It can support constant power use.	
It is a powerful source of energy.	