

APPLIED CHEMISTRY
PETROLEUM CHEMISTRY (UNIT-I)
III B.SC CHEMISTRY

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APPLIED CHEMISTRY

UNIT –I - PETROLEUM CHEMISTRY

Petroleum is a naturally occurring, yellowish-black liquid found in geological formations beneath the Earth's surface.

It consists of naturally occurring hydrocarbons of various molecular weights and may contain miscellaneous organic compounds. The name *petroleum* covers both naturally occurring unprocessed **crude oil** and petroleum products that are made up of refined crude oil.

A fossil fuel, petroleum is formed when large quantities of dead organisms, mostly zooplankton and algae, are buried underneath sedimentary rock and subjected to both intense heat and pressure.

It is commonly refined into various types of fuels. Components of petroleum are separated using a technique called fractional distillation, i.e. separation of a liquid mixture into fractions differing in boiling point by means of distillation, typically using a fractionating column.

The use of petroleum as fuel contributes to global warming and ocean acidification. According to the UN's Intergovernmental Panel on Climate Change, without fossil fuel phase-out, including petroleum, there will be "severe, pervasive, and irreversible impacts for people and ecosystems.

ORGIN OF PETROLEUM

Millions of years ago, the earth was populated with plants and animals. Much of that life was located in or adjacent to ancient rivers, lakes, and sea. As plants and animals died, their remains settled to the bottom of these bodies of water. Ancient rivers carried mud and sand that buried the organic material. As layers of organic material continued to build up, the oxygen supply to the lower layers eventually was cut off and decomposition slowed down. The thickness of such layers grew to 100s of feet over the time.

The origin of petroleum still has uncertainties despite the tremendous researches and studies devoted to it rather than any other natural substance. There are two different theories for the origin of petroleum; Organic and Inorganic origin.

Inorganic or Abiotic origin

States that hydrogen and carbon came together under great temperature and pressure, far below the earth's surface and formed oil and gas where chemical reactions have occurred. The javascript:void. oil and gas then seeped through porous rock to deposit in various natural underground traps. It has also excluded the hypothesis that petroleum is a finite substance. There are some different theories that describe the inorganic origin of petroleum which include:

Metal carbide theory

Developed by a Russian chemist and states that the deposition of petroleum is controlled by tectonic activities that occurred during the life of sedimentary rock. To explain his observations, he has put forth "metal carbide theory". Metal carbides deep in Earth reacted with water at high pressure and temperature to form acetylene which condenses to heavier hydrocarbons.

Reaction equation is: $\text{CaC}_2 + \text{H}_2\text{O} = \text{C}_2\text{H}_2 + \text{Ca}(\text{OH})_2$

Volcanic theory

Involve outgassing of the mantle via volcanic activity or eruption.

Earthquake theory

Involves outgassing deep Earth's mantle via tectonic activities such as faults, and this is still happening till now.

Serpentinization theory

States that hydrocarbon is a by-product that came from a metamorphic transformation of the green dark Olivine mineral, which was found in Earth's mantle

Overwhelming evidences for inorganic origin of petroleum

Geographical location: most of hydrocarbon producing regions are located close to belts of tectonic activities.

Stability with depth: Corresponding to what organic theory's supporters have admitted themselves; petroleum is a fossil fuel, and there has never been a real fossil found below

16000 feet. Nowadays, there is drilling for oil reservoirs at 28000 feet or 30000 feet where there is no a fossil remains.

Organic origin

It is the most widely accepted. The oil and gas are formed from remains of prehistoric plants and animals. Remains of plants have been transformed to coal and animals to oil and gas. These remains were settled into seas and accumulated at the ocean floor and buried under several kilometers of sediments. Over a few million years, the layers of the organic material were compressed under the weight of the sediments above them. The increase in pressure and temperature with the absence of oxygen changed the mud, sand, slit or sediments into rock and organic matter into Kerogen. After further burial and heating, the kerogen transformed via cracking into petroleum and natural gas.

Overwhelming evidences for organic origin of petroleum

- Presence of brine (sea water) with petroleum.
- Petroleum is found only in association with sedimentary rocks. There is no petroleum associated with igneous or metamorphic rocks.
- Polarized light passing through all petroleum resources undergoes a rotation that is similar to all organic oils.
- Molecules in hydrocarbons are thought to be similar to that of the organic matter.
- The organic carbon found in plants is depleted into C13 due to photosynthesis process. In dead organic matter, it is further depleted due to radioactive decaying. The same depletion was found in petroleum and natural gas. ^[3]

ENGLER THEORY

According to this theory, petroleum is of animal origin. He suggested that petroleum is formed by the decay and decomposition of animals under high pressure and temperature. He suggested the following facts: Experiment the destructive distillation of fish oil and other animal fats under high pressure and temperature give a similar product to the natural petroleum. Presence of brine or sea water together with petroleum. Presence of optically active compounds, nitrogen and sulphur compounds and fossils in the petroleum area. Disadvantages It fails to explain the presence of chlorophyll, coal deposits in the vicinity of oil fields.

MODERN THEORY

According to this theory petroleum is believed to be formed by the decay and decomposition of marine chemicals as well as that of vegetable, organisms or simply it is of animal as well as plant origin. This theory explains all the facts which were the drawbacks of previous theories.

COMPOSITION OF PETROLEUM

Petroleum is a mixture of a very large number of different hydrocarbons; the most commonly found molecules are alkanes (paraffins), cycloalkanes (naphthenes), aromatic

hydrocarbons, or more complicated chemicals like asphaltenes. Each petroleum variety has a unique mix of molecules, which define its physical and chemical properties, like color and viscosity.

The *alkanes*, also known as *paraffins*, are saturated hydrocarbons with straight or branched chains which contain only carbon and hydrogen and have the general formula C_nH_{2n+2} . They generally have from 5 to 40 carbon atoms per molecule, although trace amounts of shorter or longer molecules may be present in the mixture.

Petroleum, or crude oil as it is now usually referred too when raw, contains several chemical compounds, the most prolific being the hydrocarbons themselves which give the petroleum composition its combustible nature.

Although the composition of petroleum will contain many trace elements the key compounds are carbon (93% – 97%), hydrogen (10% - 14%), nitrogen (0.1% - 2%), oxygen (0.1% - 1.5%) and sulphur (0.5% - 6%) with a few trace metals making up a very small percentage of the petroleum composition.

The actual overall properties of each different petroleum source are defined by the percentage of the four main hydrocarbons found within petroleum as part of the petroleum composition.

The percentages for these hydrocarbons can vary greatly, giving the crude oil a quite distinct compound personality depending upon geographic region. These hydrocarbons are typically present in petroleum at the following percentages: paraffins (15% - 60%), naphthenes (30% - 60%), aromatics (3% to 30%), with asphaltics making up the remainder.

CLASSIFICATION

The hydrocarbons in crude oil can generally be divided into four categories:

- **Paraffins:** These can make up 15 to 60% of crude and have a carbon to hydrogen ratio of 1:2, which means they contain twice the amount of hydrogen as they do carbon. These are generally straight or branched chains, but never cyclic (circular) compounds. Paraffins are the desired content in crude and what are used to make fuels. The shorter the paraffins are, the lighter the crude.
- **Naphthenes:** These can make up 30 to 60% of crude and have a carbon to hydrogen ratio of 1:2. These are cyclic compounds and can be thought of as cycloparaffins. They are higher in density than equivalent paraffins and are more viscous.
- **Aromatics:** These can constitute anywhere from 3 to 30% of crude. They are undesirable because burning those results in soot. They have a much less hydrogen in comparison to carbon than is found in paraffins. They are also more viscous. They are often solid or semi-solid when equivalent paraffin would be a viscous liquid under the same conditions.

- Asphaltics: These average about 6% in most crude. They have a carbon to hydrogen ratio of approximately 1:1, making them very dense. They are generally undesirable in crude, but their 'stickiness' makes them excellent for use in road construction.

REFINING

Petroleum refinery is an industrial process plant where crude oil is transformed and refined into more useful products such as petroleum naphtha, gasoline, diesel fuel, asphalt base, heating oil, kerosene, liquefied petroleum gas, jet fuel and fuel oils.

Oil refineries are typically large, sprawling industrial complexes with extensive piping running throughout, carrying streams of fluids between large chemical processing units, such as distillation columns. In many ways, oil refineries use much of the technology, and can be thought of, as types of chemical plants.

The crude oil feedstock has typically been processed by an oil production plant. There is usually an oil depot at or near an oil refinery for the storage of incoming crude oil feedstock as well as bulk liquid products.

Petroleum refineries are very large industrial complexes that involve many different processing units and auxiliary facilities such as utility units and storage tanks. Each refinery has its own unique arrangement and combination of refining processes largely determined by the refinery location, desired products and economic considerations

CRACKING

Cracking in petroleum refining process by which heavy hydrocarbon molecules are broken up into lighter molecules by means of heat and usually pressure and sometimes catalysts. Cracking is the most important process for the commercial production of gasoline and diesel fuel.

Cracking of petroleum yields light oils (corresponding to gasoline), middle-range oils used in diesel fuel, residual heavy oils, a solid carbonaceous product known as coke, and such gases as methane, ethane, ethylene, propane, propylene, and butylene.

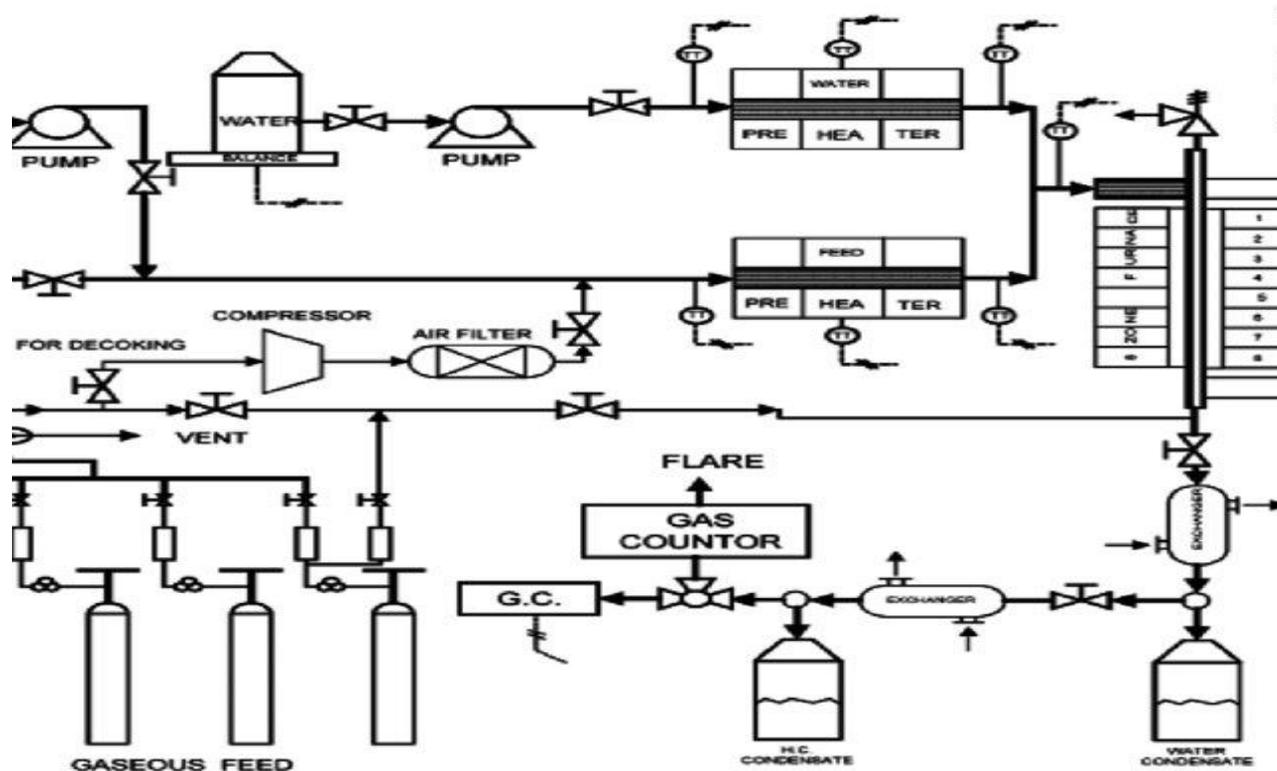
Depending on the end product, the oils can go directly into fuel blending, or they can be routed through further cracking reactions or other refining processes until they have produced oils of the desired weight. The gases can be used in the refinery's fuel system, but they are also important raw materials for petrochemical plants, where they are made into a large number of end products, ranging from synthetic rubber and plastic to agricultural chemicals. There are two types of cracking.

1. Thermal cracking
2. Catalytic cracking

1.THERMAL CRACKING

Modern high-pressure thermal cracking operates at absolute pressures of about 7,000 kPa. An overall process of disproportionation can be observed, where "light", hydrogen-rich products are formed at the expense of heavier molecules which condense and are depleted of hydrogen. The actual reaction is known as homolytic fission and produces alkenes, which are the basis for the economically important production of polymers.

Thermal cracking is currently used to "upgrade" very heavy fractions or to produce light fractions or distillates, burner fuel and/or petroleum coke. Two extremes of the thermal cracking in terms of product range are represented by the high-temperature process called "steam cracking" or pyrolysis (ca. 750 °C to 900 °C or higher) which produces valuable ethylene and other feedstocks for the petrochemical industry, and the milder-temperature delayed coking (ca. 500 °C) which can produce, under the right conditions, valuable needle coke, a highly crystalline petroleum coke used in the production of electrodes for the steel and aluminium industries.

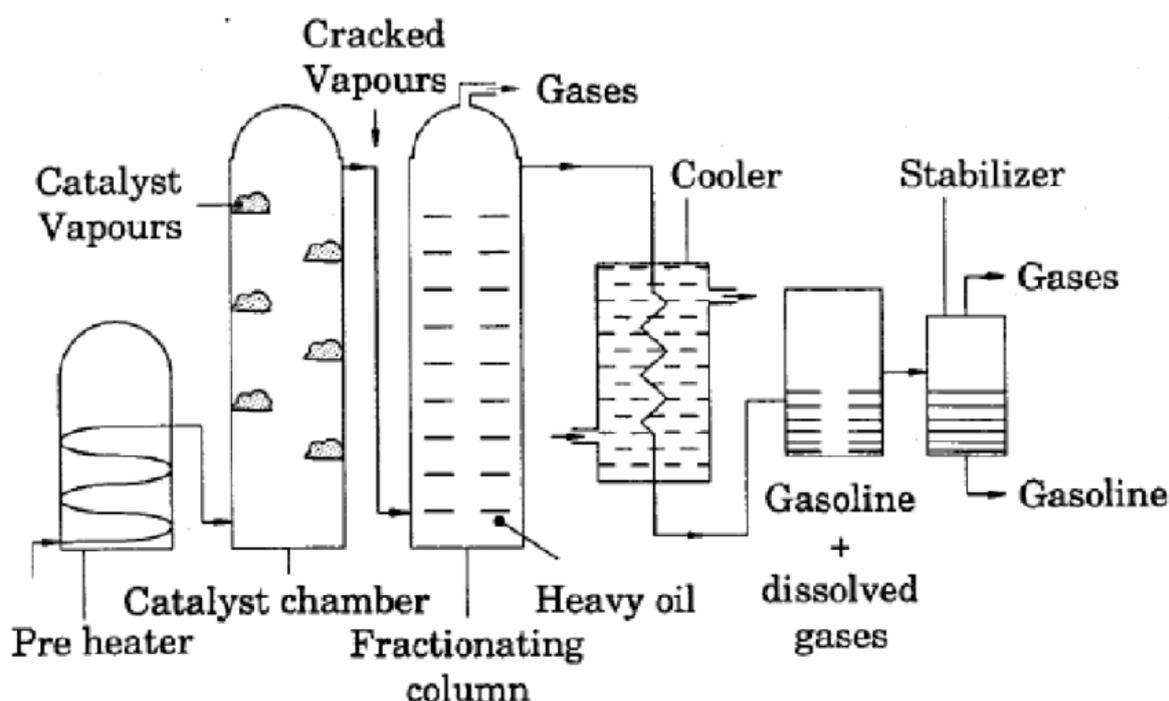


William Merriam Burton developed one of the earliest thermal cracking processes in 1912 which operated at 700–750 °F (370–400 °C) and an absolute pressure of 90 psi (620 kPa) and was known as the *Burton process*. Shortly thereafter, in 1921, C.P. Dubbs, an employee of the Universal Oil Products Company, developed a somewhat more advanced thermal cracking process which operated at 750–860 °F (400–460 °C) and was known as the *Dubbs process*. The Dubbs process was used extensively by many refineries until the early 1940s when catalytic cracking came into use.

2.CATALYTIC CRACKING

The catalytic cracking process involves the presence of solid acid catalysts, usually silica-alumina and zeolites. The catalysts promote the formation of carbocations, which undergo processes of rearrangement and scission of C-C bonds. Relative to thermal cracking, catalytic cracking proceeds at milder temperatures, which saves energy. Furthermore, by operating at lower temperatures, the yield of alkenes is diminished. Alkenes cause instability of hydrocarbon fuels.

Fluid catalytic cracking is a commonly used process, and a modern oil refinery will typically include a *cat cracker*, particularly at refineries in the US, due to the high demand for gasoline. The process was first used around 1942 and employs a powdered catalyst. During WWII, the Allied Forces had plentiful supplies of the materials in contrast to the Axis Forces, which suffered severe shortages of gasoline and artificial rubber. Initial process implementations were based on low activity alumina catalyst and a reactor where the catalyst particles were suspended in a rising flow of feed hydrocarbons in a fluidized bed.



In newer designs, cracking takes place using a very active zeolite-based catalyst in a short-contact time vertical or upward-sloped pipe called the "riser". Pre-heated feed is sprayed into the base of the riser via feed nozzles where it contacts extremely hot fluidized catalyst at 1,230 to 1,400 °F (666 to 760 °C). The hot catalyst vaporizes the feed and catalyzes the cracking reactions that break down the high-molecular weight oil into lighter components including LPG, gasoline, and diesel. The catalyst-hydrocarbon mixture flows upward through the riser for a few seconds, and then the mixture is separated via cyclones. The catalyst-free hydrocarbons are routed to a main fractionator for separation into fuel gas, LPG, gasoline, naphtha, light cycle oils used in diesel and jet fuel, and heavy fuel oil.

During the trip up the riser, the cracking catalyst is "spent" by reactions which deposit coke on the catalyst and greatly reduce activity and selectivity. The "spent" catalyst is disengaged from the cracked hydrocarbon vapors and sent to a stripper where it contacts steam to remove hydrocarbons remaining in the catalyst pores. The "spent" catalyst then flows into a fluidized-bed regenerator where air (or in some cases air plus oxygen) is used to burn off the coke to restore catalyst activity and also provide the necessary heat for the next reaction cycle, cracking being an endothermic reaction. The "regenerated" catalyst then flows to the base of the riser, repeating the cycle.

The gasoline produced in the FCC unit has an elevated octane rating but is less chemically stable compared to other gasoline components due to its olefinic profile. Olefins in gasoline are responsible for the formation of polymeric deposits in storage tanks, fuel ducts and injectors. The FCC LPG is an important source of C₃-C₄ olefins and isobutane that are essential feeds for the alkylation process and the production of polymers such as polypropylene.

KNOCKING

Knocking, in an internal-combustion engine, sharp sounds caused by premature combustion of part of the compressed air-fuel mixture in the cylinder. In a properly functioning engine, the charge burns with the flame front progressing smoothly from the point of ignition across the combustion chamber. However, at high compression ratios, depending on the composition of the fuel, some of the charge may spontaneously ignite ahead of the flame front and burn in an uncontrolled manner, producing intense high-frequency pressure waves. These pressure waves force parts of the engine to vibrate, which produces an audible knock.

Knocking can cause overheating of the spark-plug points, erosion of the combustion chamber surface, and rough, inefficient operation. It can be avoided by adjusting certain variables of engine design and operation, such as compression ratio and burning time; but the most common method is to burn gasoline of higher octane number.

OCTANE RATING

An octane rating, or octane number, is a standard measure of the performance of an engine or aviation gasoline. The higher the octane number, the more compression the fuel can withstand before detonating (igniting). In broad terms, fuels with a higher octane rating are used in high-performance gasoline engines that require higher compression ratios.

In contrast, fuels with lower octane numbers (but higher cetane numbers) are ideal for diesel engines, because diesel engines (also referred to as compression-ignition engines) do not compress the fuel, but rather compress only air and then inject fuel into the air which was heated by compression. Gasoline engines rely on ignition of air and fuel compressed together as a mixture, which is ignited near the end of the compression stroke using electrically activated spark plugs. Therefore, high compressibility of the fuel matters mainly for gasoline engines. Use of gasoline with lower octane numbers may lead to the problem of engine knocking

ANTIKNOCK COMPOUNDS

An antiknock agent is a gasoline additive used to reduce engine knocking and increase the fuel's octane rating by raising the temperature and pressure at which auto-ignition occurs.

The mixture known as gasoline or petrol, when used in high compression internal combustion engines, has a tendency to knock (also called "pinging" or "pinking") and/or to ignite early before the correctly timed spark occurs (*pre-ignition*, refer to engine knocking).

The typical antiknock agents in use are:

- Tetraethyllead (still in use as a high octane additive)
- Alcohol
- Methylcyclopentadienyl manganese tricarbonyl (MMT)
- Ferrocene
- Iron pentacarbonyl
- Toluene
- Isooctane
- BTEX - a hydrocarbon mixture of benzene, toluene, xylene and ethyl-benzene, also called gasoline aromatics^[1]

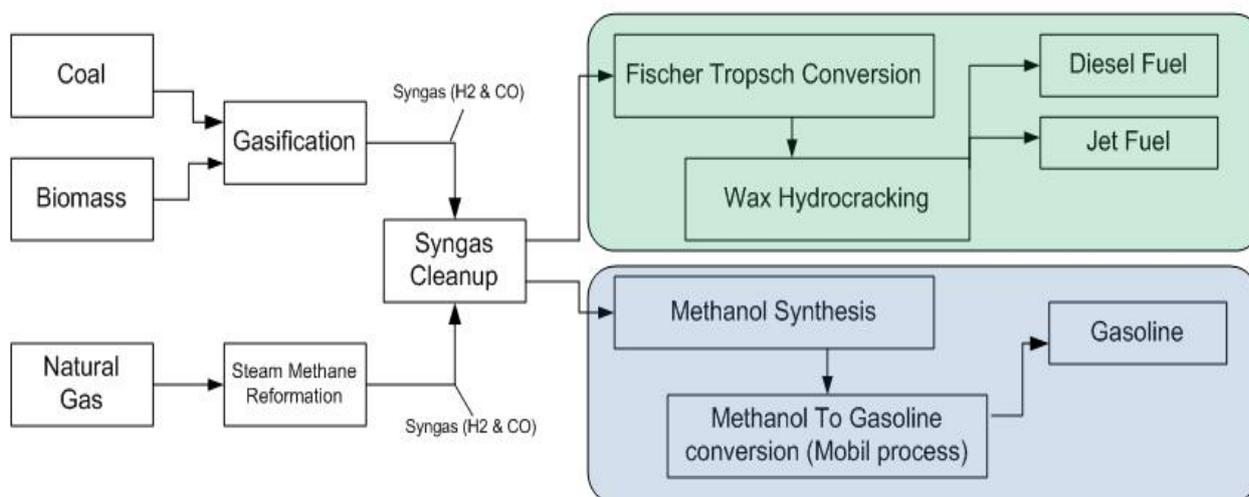
Cetane number (or CN) is an inverse function of a fuel's ignition delay, the time period between the start of ignition and the first identifiable pressure increase during combustion of the fuel. In a particular diesel engine, higher cetane fuels will have shorter ignition delay periods than lower Cetane fuels. Cetane numbers are only used for the relatively light distillate diesel oils. For heavy (residual) fuel oil two other scales are used, CCAI and CII

Synthetic petrol

Synthetic fuel or synfuel is a liquid fuel, or sometimes gaseous fuel, obtained from syngas, a mixture of carbon monoxide and hydrogen, in which the syngas was derived from gasification of solid feed stocks such as coal or biomass or by reforming of natural gas.

Common ways for refining synthetic fuels include the Fischer–Tropsch conversion,^[1] methanol to gasoline conversion,^[2] or direct coal liquefaction

Indirect Conversion Synthetic Fuels Manufacturing Processes



LPG

Liquefied petroleum gas (LPG) is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles. It is increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbons in an effort to reduce damage to the ozone layer. When specifically used as a vehicle fuel it is often referred to as autogas.

Varieties of LPG bought and sold include mixes that are mostly propane (C_3H_8) mostly butane (C_4H_{10}) and most commonly, mixes including both propane and butane. In the northern hemisphere winter, the mixes contain more propane, while in summer, they contain more butane. In the United States, mainly two grades of LPG are sold: commercial propane and HD-5. These specifications are published by the Gas Processors Association (GPA) and the American Society of Testing and Materials (ASTM). Propane/butane blends are also listed in these specifications.

Propylene, butylenes and various other hydrocarbons are usually also present in small concentrations. HD-5 limits the amount of propylene that can be placed in LPG to 5%, and is utilized as an autogas specification. A powerful odorant, ethanethiol, is added so that leaks can be detected easily. The internationally recognized European Standard is EN 589. In the United States, tetrahydrothiophene (thiophane) or amyl mercaptan are also approved odorants, although neither is currently being utilized.

LPG is prepared by refining petroleum or "wet" natural gas, and is almost entirely derived from fossil fuel sources, being manufactured during the refining of petroleum (crude oil), or extracted from petroleum or natural gas streams as they emerge from the ground. It was first produced in 1910 by Dr. Walter Snelling, and the first commercial products appeared in 1912. It currently provides about 3% of all energy consumed, and burns relatively cleanly with no soot and very few sulfur emissions. As it is a gas, it does not pose ground or water pollution hazards, but it can cause air pollution. LPG has a typical specific calorific value of 46.1 MJ/kg compared with 42.5 MJ/kg for fuel oil and 43.5 MJ/kg for premium grade petrol (gasoline). However, its energy density per volume unit of 26 MJ/L

is lower than either that of petrol or fuel oil, as its relative density is lower (about 0.5–0.58 kg/L, compared to 0.71–0.77 kg/L for gasoline).

As its boiling point is below room temperature, LPG will evaporate quickly at normal temperatures and pressures and is usually supplied in pressurised steel vessels. They are typically filled to 80–85% of their capacity to allow for thermal expansion of the contained liquid. The ratio between the volumes of the vaporized gas and the liquefied gas varies depending on composition, pressure, and temperature, but is typically around 250:1. The pressure at which LPG becomes liquid, called its vapour pressure, likewise varies depending on composition and temperature; for example, it is approximately 220 kilopascals (32 psi) for pure butane at 20 °C (68 °F), and approximately 2,200 kilopascals (320 psi) for pure propane at 55 °C (131 °F). LPG is heavier than air, unlike natural gas, and thus will flow along floors and tend to settle in low spots, such as basements. There are two main dangers from this. The first is a possible explosion if the mixture of LPG and air is within the explosive limits and there is an ignition source. The second is suffocation due to LPG displacing air, causing a decrease in oxygen concentration.

A full LPG cylinder contains 85% liquid; the volume will contain vapour at a pressure that varies with temperature.

GOBBAR GAS

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (anaerobically), primarily consisting of methane and carbon dioxide. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source. In India, it is also known as "Gobar Gas".

Biogas is produced by anaerobic digestion with methanogen or anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. This closed system is called an anaerobic digester, biodigester or a bioreactor.

Biogas is primarily methane (CH₄) and carbon dioxide (CO₂) and may have small amounts of hydrogen sulfide (H₂S), moisture and siloxanes.

The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

Biogas can be compressed after removal of Carbon dioxide, the same way as natural gas is compressed to CNG, and used to power motor vehicles. In the United Kingdom, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel. It qualifies for renewable energy subsidies in some parts of the world. Biogas can be cleaned and upgraded to natural gas standards, when it becomes bio-methane. Biogas is considered to be a renewable resource because its production-and-use cycle is continuous, and it generates no net carbon dioxide. As the organic material grows, it is converted and used. It then regrows in a continually repeating cycle. From a carbon perspective, as much carbon dioxide is absorbed from the atmosphere in the growth of the primary bio-resource as is released, when the material is ultimately converted to energy

Composition of biogas

IMPORTANCE OF BIOGAS – IN VILLAGES

Domestic biogas plants convert livestock manure and night soil into biogas and slurry, the fermented manure.

This technology is feasible for small-holders with livestock producing 50 kg manure per day, an equivalent of about 6 pigs or 3 cows. This manure has to be collectable to mix it with water and feed it into the plant. Toilets can be connected. Another precondition is the temperature that affects the fermentation process.

PETROCHEMICALS

Petrochemicals (also known as petroleum distillates) are the chemical products obtained from petroleum by refining. Some chemical compounds made from petroleum are also obtained from other fossil fuels, such as coal or natural gas, or renewable sources such as maize, palm fruit or sugar cane. The two most common petrochemical classes are olefins (including ethylene and propylene) and aromatics (including benzene, toluene and xylene isomers).

Olefins includes Ethene, Propene, Butenes and butadiene. Ethylene and propylene are important sources of industrial chemicals and plastics products. Butadiene is used in making synthetic rubber.

<u>Compound</u>	<u>Formula</u>	<u>%</u>
Methane	CH ₄	50–75
Carbon dioxide	CO ₂	25–50
Nitrogen	N ₂	0–10
Hydrogen	H ₂	0–1
Hydrogen sulfide	H ₂ S	0.1 –0.5
Oxygen	O ₂	0–0.5

- Aromatics includes Benzene, toluene and xylenes, as a whole referred to as BTX and primarily obtained from petroleum refineries by extraction from the reformat produced in catalytic reformers using Naphtha obtained from petroleum refineries. Benzene is a raw material for dyes and synthetic detergents, and benzene and toluene for isocyanates MDI and TDI used in making polyurethanes. Manufacturers use xylenes to produce plastics and synthetic fibers.
- Synthesis gas is a mixture of carbon monoxide and hydrogen used to make ammonia and methanol. Ammonia is used to make the fertilizer urea and methanol is used as a solvent and chemical intermediate. Steam crackers are not to be confused with steam reforming plants used to produce hydrogen and ammonia.
- Methane, ethane, propane and butanes obtained primarily from natural gas processing plants

NATURAL GAS

Natural gas (also called fossil gas; sometimes just gas), is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulfide, or helium.^[2] It is formed when layers of decomposing plant and animal matter are exposed to intense heat and pressure under the surface of the Earth over millions of years. The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in the gas.

Natural gas is a non-renewable hydrocarbon used as a source of energy for heating, cooking, and electricity generation. It is also used as a fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals.

Natural gas has an effect on climate change; it is a greenhouse gas itself, and creates carbon dioxide during oxidation. Natural gas can be used in place of coal, for example, to generate electricity, which may lower net carbon dioxide emissions in absence of carbon capture.

Natural gas is found in deep underground rock formations or associated with other hydrocarbon reservoirs in coal beds and as methane clathrates. Petroleum is another resource and fossil fuel found close to and with natural gas. Most natural gas was created over time by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material.

In petroleum production, gas is sometimes burned as flare gas. Before natural gas can be used as a fuel, most, but not all, must be processed to remove impurities, including water, to meet the specifications of marketable natural gas. The by-products of this processing include ethane, propane, butanes, pentanes, and higher molecular weight hydrocarbons, hydrogen sulfide (which may be converted into pure sulfur), carbon dioxide, water vapor, and sometimes helium and nitrogen.

LIGHT NAPHTHA

Light naphtha can refer to either a finished product used as a petrochemical feedstock or a distillation cut commonly called light straight run naphtha. It is composed of pentane and slightly heavier material.

Light naphtha comes from distillation of crude oil or from separation of NGLs in an NGL fractionation plant. Light naphtha from NGL fractionation is often called natural gasoline or pentanes plus.

In a refinery, light naphtha is often blended directly into gasoline. However, its low octane and relatively high vapor pressure typically limit it to 5% or less of the gasoline pool. To boost its octane, it is often sent to the isomerization unit before gasoline blending. As a petrochemical feed stock, light naphtha is used in steam crackers to make ethylene and ultimately make plastics. In this use, it competes with propane and ethane as a feedstock. Highly paraffinic naphtha is preferred in this use as it provides better yields than more naphthenic or aromatic naphtha.

KEROSENE

Kerosene, also known as paraffin, lamp oil, and coal oil (an obsolete term), is a combustible hydrocarbon liquid which is derived from petroleum. It is widely used as a fuel in aviation as well as households. Its name derives from Greek: κηρός (*keros*) meaning "wax", and was registered as a trademark by Canadian geologist and inventor Abraham Gesner in 1854 before evolving into a genericized trademark. It is sometimes spelled kerosine in scientific and industrial usage. The term kerosene is common in much of Argentina, Australia, Canada, India, New Zealand, Nigeria, and the United States, while the term paraffin (or a closely related variant) is used in Chile, eastern Africa, South Africa, Norway, and in the United Kingdom. The term lamp oil, or the equivalent in the local languages, is common in the majority of Asia. Liquid paraffin (called mineral oil in the US) is a more viscous and highly refined product which is used as a laxative. Paraffin wax is a waxy solid extracted from petroleum.

Kerosene is widely used to power jet engines of aircraft (jet fuel) and some rocket engines and is also commonly used as a cooking and lighting fuel, and for fire toys such as poi. In parts of Asia, kerosene is sometimes used as fuel for small outboard motors or even motorcycles.^[5] World total kerosene consumption for all purposes is equivalent to about 1.2 million barrels (50 million U.S. gallons; 42 million imperial gallons; 190 million liters) per day.

To prevent confusion between kerosene and the much more flammable and volatile gasoline, some jurisdictions regulate markings or colorings for containers used to store or dispense kerosene. For example, in the United States, Pennsylvania requires that portable containers used at retail service stations for kerosene be colored blue, as opposed to red (for gasoline) or yellow.

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