

Table 3.1: Composition of crude petroleum Hydrocarbons

Sl. No.	Hydrogen Family	Distinguishing Characteristics	Major Hydrocarbons	Characteristics
1.	Paraffins (Alkanes)	Straight carbon chain	Methane, ethane, propane, butane, pentane, hexane etc.	<ol style="list-style-type: none"> 1. General molecular formula is C_nH_{2n+2}. 2. Boiling point increases as the number of carbon atom increases. 3. With number of carbon 25-40, paraffin becomes waxy.
2.	Isoparaffins (Isoalkanes)	Branched carbon chain	Isobutane, Isopentane, Neopentane, Isooctane	<ol style="list-style-type: none"> 1. The number of possible isomers increases as in geometric progression as the number of carbon atoms increases.
3.	Olefins (Alkenes)	One pair of carbon atoms	Ethylene, Propylene	<ol style="list-style-type: none"> 1. General molecular formula is C_nH_{2n}. 2. Olefins are not present in crude oil, but are formed during process. 3. Undesirable in the finished product because of their high reactivity. 4. Low molecular weight olefins have good anti knock properties.
4.	Naphthenes	5 or 6 carbon atoms in ring	Cyclopentane, Methyl cyclopentane, Dimethyl cyclopentane, cyclohexane, 1,2 dimethyl cyclohexane.	<ol style="list-style-type: none"> 1. General molecular formula is $C_nH_{2n+2-2R_n}$, Where, R_n is the number of naphthenic ring 2. The average crude oil contains is about 50% by weight of naphthenes. 3. Naphthenes are modestly good components of gasoline.
5.	Aromatics	6 carbon atoms in ring with three around linkage.	Benzene, Toluene, Xylene, Ethyl Benzene, Cumene, Naphthaline	<ol style="list-style-type: none"> 1. Aromatics are not desirable in kerosene and lubricating oil. 2. Benzene is carcinogenic and hence undesirable part of gasoline.

Sl. No.	Non-hydrocarbons	Compounds	Characteristics
1.	Sulphur compounds	Hydrogen sulphide, Mercaptans	Undesirable due to foul odour 0.5% to 7%
2.	Nitrogen compounds	Quinoline, Pyridine, pyrrole, indole, carbazole	The presence of nitrogen compounds in gasoline and kerosene degrades the colour of product on exposure to sunlight. They may cause gum formation normally less than 0.2.
3.	Oxygen compounds	Naphthenic acids, phenols	Content traces to 2%. These acids cause corrosion problem at various stages of processing and pollution problem.

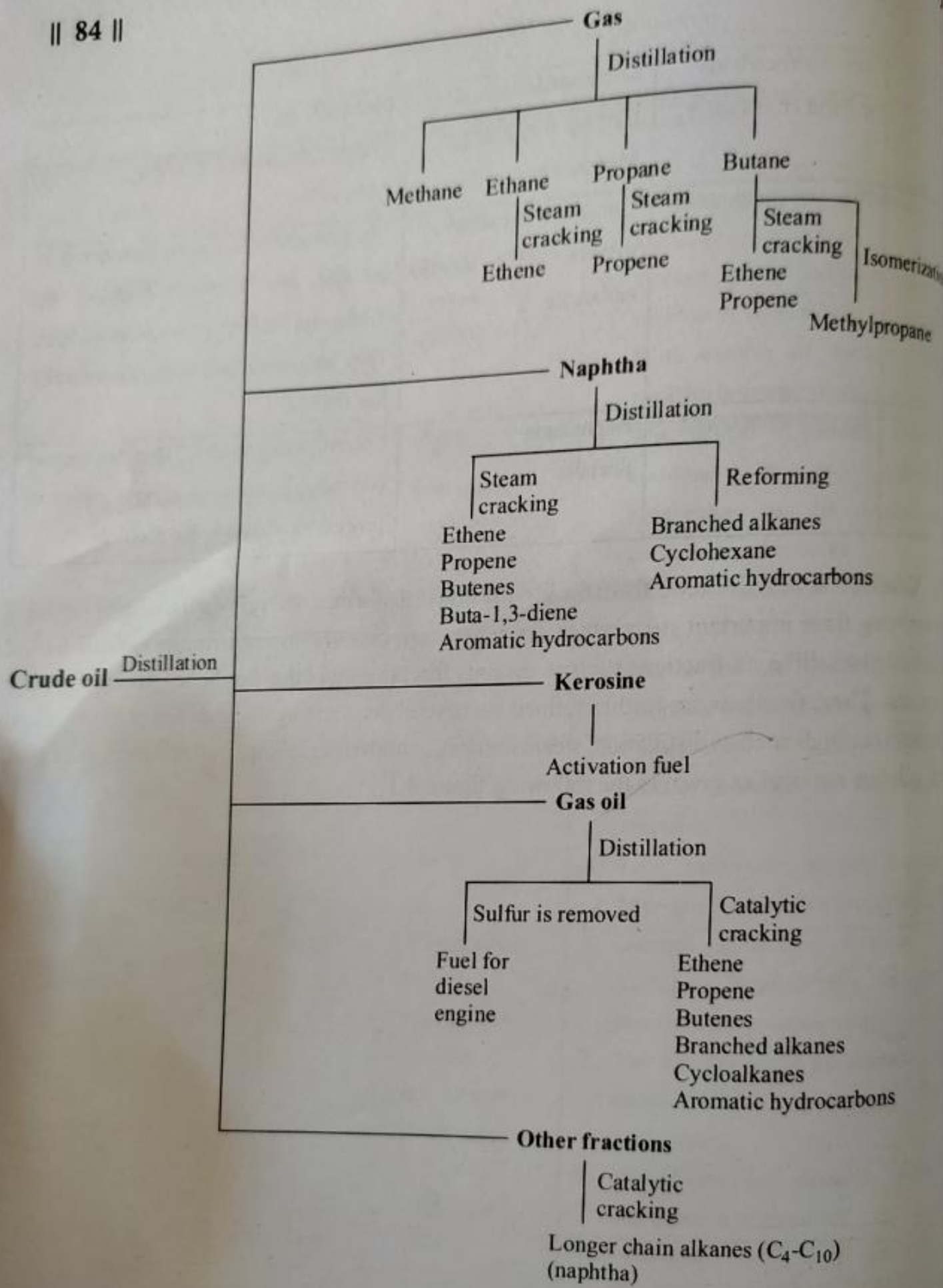


Fig. 4.1: Different useful products of crude petroleum by using different physical and chemical methods.

diesel fuel, liquefied petroleum gas (LPG), fuel oil, kerosene *etc.* asphalt (mainly used in asphalt concrete), paraffin wax and tar.

1. Gasoline

Gasoline or petrol is a completely transparent liquid obtained from fractional distillation of crude petroleum between boiling range of 40 °C and 205 °C. It is an extremely flammable petroleum-derived liquid mixture consists mainly of hydrocarbons enhanced with isooctane or aromatics hydrocarbons like benzene, toluene, ethylbenzene and xylenes to increase octane ratings. Interestingly, it consists of a complex mixture of more than 150 organic compounds and other additives are frequently added to gasoline to improve chemical stability and performance characteristics. To improve the combustion of gasoline some oxygen-containing chemicals such as ethanol, methyl *tert*-butyl ether (MTBE) or ethyl *tert*-butyl ether (ETBE) are also added. Gasoline is useable in vehicles, compressors, electrical generators *etc.* and depending on use, gasoline can be classified as automobile gasoline, aviation gasoline and as solvent.

2. Liquefied Petroleum Gas (LPG)

Liquefied petroleum gas or liquid petroleum gas (LPG or LP gas) is a liquid flammable mixture of different hydrocarbon gases such as propane and butane. It is produced by refining crude oil or wet natural gas, and is almost completely derived from fossil fuel sources. The boiling range for liquefied petroleum gas is less than 25°C. LPG has a very wide range of uses, mainly used in heating application. It is used as a refrigerant for cooking purposes and in vehicles *etc.*

3. Kerosene

Kerosene is a clear and less viscous combustible liquid hydrocarbon typically contain between 10 to 16 carbon atoms and aromatics known as paraffin or coal oil. Kerosene is obtained from the fractional distillation of crude petroleum between 150°C and 275°C of its boiling range. Kerosene oil obtained from distillation generally contains some impurities such as unsaturated hydrocarbons and sulphur compounds, which should be removed before it is put to use. Kerosene is used for burning purposes, and as a fuel, pesticide, solvent, lubricant *etc.*

4. Coal Tar

Coal tar is a thick brown or black liquid of extremely high viscosity which can be manufactured from petroleum, wood, coal and peat by destruction distillation. The boiling point of tar is greater than 600°C. It is a complex and variable mixtures of several organic compounds such as phenols, polycyclic aromatic hydrocarbons (PAHs), and heterocyclic compounds. Its end products contains of different hydrocarbon and

free carbon. Coal tar is used to manufacture paints, synthetic dyes and photographic materials. In addition, tar is used as disinfectant, heating or to fire boilers, hulls of ships and to seal roofs. It is also used in medicated shampoo, soap and ointment, as a treatment for dandruff. Some of the phenolic coal tar derivatives have analgesic properties. Coal tar is also used as spice, cosmetics, anti-dandruff, flavour, shampoo and so on.

5. Diesel

Diesel is an ultra-low sulphur petroleum fuel obtained by fractional distillation of crude oil with a boiling range of 250°C and 350°C under atmospheric pressure. It is also known as petrodiesel or fossil diesel. Unlike gasoline, diesel is easier to refine from crude petroleum due to its heavy molecular weight and less volatility. The quality of diesel fuel is measured by the number known as cetane number. A cetane number is a measure of the delay of ignition of a diesel fuel. A higher cetane number indicates that the fuel ignites more readily when sprayed into hot compression engine. Diesel fuel has several applications primarily for powering automobile, truck, bus and railway engines.

6. Paraffin wax

Paraffin wax is a soft colourless solid and waxy in nature that is also used as a lubricant. It is derived from crude oil and coal, which consists of a mixture of straight chain hydrocarbon molecules containing between twenty and forty carbon atoms ranging in melting point from about 48°C to 66°C . It has a boiling point greater than 370°C . Paraffin is unaffected by most common chemical reagents but burns readily. Its heat of combustion is 42 MJ/kg . Paraffin wax is used in making candle, vaseline, crayons and various waxing materials. In addition paraffin wax is generally used in lubrication and electrical insulation purposes. It can also be used to provide pain relief to sore joints and muscles.

Vaseline is a well-known brand of petrolatum (Petroleum Jelly). Petrolatum is a flammable, semi-solid mixture of hydrocarbons, having a melting point usually ranging from 37°C – 40°C . It is colourless or of a pale yellow colour.

7. Lubricating oils

Lubricating oils are very important hydrocarbon fractions of petroleum products with carbon number 18-25, having wide applications particularly in industry, agriculture and automobile sectors as a lubricant. The boiling range of lubricating oil is between 300°C to 400°C . Viscosity is considered as the most important parameter by which lubricating oil is classified. Lubricating oil contains 90% of base oil and 10% of other additives such as detergents and antioxidants to improve the performance of lubricating oils.

8. Asphalt

Asphalt, is commonly known as bitumen. The majority of asphalt used commercially is obtained from the fractional distillation of crude petroleum boiling at 525°C . It is a black, tacker and sticky semi-solid form of petroleum which obtained both naturally as well as refined products. Chemical compositions of asphalt primarily consist of naphthene aromatics, polar aromatics, saturated hydrocarbons and high molecular weight phenols and heterocyclic compounds. Asphalt is primarily used to lay roads. Other important applications of asphalt are that it is used for waterproofing products.

9. Fuel oil

Fuel oil is the heaviest fuel that can be derived from refining crude oil by fractional distillation between boiling range 370°C and 600°C . Fuel oil is made of long hydrocarbon chains, particularly alkanes, cycloalkanes and aromatics. Fuel oils have many applications primarily in electrical generators, power plants, ships and automobiles etc. Residual fuel oil is less useful because it is so viscous that it has to be heated with a special heating system before use and it may contain relatively high amounts of pollutants particularly sulphur, which forms sulphur dioxide upon combustion.