CHEMISTRY IN EVERYDAY LIFE

- All the chemical reactions taking place in our body are due to chemistry.
- Hydrocarbons are the most important one.
- The whole civilization is driven by hydrocarbons because they make up the fossil fuels petroleum and natural gas.

Hydrocarbon

- Hydrocarbons are the organic compounds consisting of hydrogen and carbon atoms.
- They are combustible and produce large amount of heat energy along with carbon dioxide and water vapour, on burning.
- Hence, many hydrocarbons are used as fuels.

Sources of Hydrocarbons

- They are found in fossil fuels like crude oil, natural gas and coal.
- About 300 million years ago plants and animals died and they were buried on the ocean floor.
- Overtime they were covered by silt and soil layers.
- Then they were buried deep inside the earth and compressed through temperature and pressure and converted to fossil fuels like oil and natural gas.
- Found in porous rocks which lie below large bodies of water, especially oceans.
- By drilling these rocks hydrocarbons can be extracted.
- Hydrocarbons are present in different trees and plants also.

Properties of Hydrocarbons

- Among all the chemical compounds hydrocarbons have some unique properties.

- Most of the hydrocarbons are insoluble in water.
- Hydrocarbons are less dense than water.
- So they float on top of water.
- Most hydrocarbons react with oxygen to produce carbon dioxide and water.
- Hydrocarbons can be gases (e.g. methane and propane), liquids (e.g. hexane and benzene) or waxes (paraffin).
- Hydrocarbons are capable of making bonds with one another.
- This property is known as catenation.
- Due to this property they form more number of complex molecules.

Types of Hydrocarbons

- In hydrocarbons carbon and hydrogen atoms are linked together through different chemical bonds.
- Depending on the bond between these atoms there are number of hydrocarbons.
- The four general classes of hydrocarbons are: alkanes, alkenes, alkynes and arenes.
- Some of the common hydrocarbons are methane, ethane, propane, butane and pentane.
- Methane is the simplest hydrocarbon in which four hydrogen atoms are linked with one carbon atom.
- It is a colourless, odourless and inflammable gas.
- It is an eco-friendly fuel because it does not produce any harmful products.
- It is used as a fuel in electricity generation.
- Methane is also known as marsh gas as it is present in marshes.
- Dead and decaying plants and animals release methane gas.
- It is a renewable source of energy.
- Sewage sludge can also be decomposed by microorganisms to produce methane gas along with impurities like carbondioxide and hydrogen sulphide.
- After removing these impurities, methane gas can be used as an efficient fuel.

Name	Formula

Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_6H_{12}

- Propane is an odourless and highly inflammable gas.
- It is heavier than air.
- It is liquefied through pressurisation and commonly used as LPG (Liquefied Petroleum Gas) along with butane.
- Propane is used as fuel in heating, cooking, and vehicles.
- Propane can also be used as refrigerants.
- Propane is used in LPG cylinders.
- Since it is an odouress gas, any leakage cannot be detected.
- Hence, a chemical by name Mercaptan is mixed with LPG to help in detection of any leakage of LPG.
- Butane is a gas at room temperature and atmospheric pressure.
- They are highly flammable, colorless gases that quickly vaporize at room temperature.
- Butane is used as a fuel gas and propellant in aerosol sprays such as deodorants.
- Pure forms of butane can be used as refrigerants.
- Butane is also used as lighter fuel for a common lighter or butane torch.
- Pentanes are liquids with low boiling point.
- They are used as fuels and solvents in the laboratory.
- They are also used to produce polystyrene.

Natural Gas

- Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane along with other higher alkanes and a small percentage of carbon dioxide, nitrogen and hydrogen sulphide (H_2S).
- Natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas.

- If higher hydrocarbons like propane and butane are also present in the gas, it is called wet gas.
- Natural gas is always found above the oil in the oil wells.
- This gas is trapped inside the small spaces in underground rocks called reservoirs.
- Conventional natural gas can be extracted through drilling wells.
- Natural gas can also be found in reservoirs with oil and is extracted along with oil.
- This is called associated gas.
- Natural gas is a fossil fuel used as a source of energy for heating, cooking and electricity generation.
- Natural gas occurs in Tripura, Rajasthan, Maharashtra, Andhra Pradesh (Krishna, Godavari Basins) and Tamil Nadu (Cauveri Delta).
- It is also formed by the decomposition of organic matter in marshy areas and waste sewages.
- The natural gas formed by this way contains mainly methane.
- Take a glass bottle and put some leaves, twigs, waste paper and saw-dust in it.
- Pour some water in it and keep it for 20 days.
- Open the bottle and bring a glowing splinter near the mouth.
- You can see a gas burning near the mouth showing its combustible nature.
- It is due to the evolution of natural gas.

Uses of Natural Gas

- Natural gas is used as an industrial and domestic fuel.
- It is used in thermal power stations.
- It is used as fuel in vehicles as an alternative for petrol and diesel.
- When heated it decomposes and forms hydrogen and carbon.
- Hydrogen thus formed is used in the manufacture of fertilizers.
- It is used to manufacture chemicals, fabrics, glass, steel, plastics and paints.
- It is also used in electricity generation.
- Mo derate temp erature and humidity is needed to keep paintings and other ancient artifacts from being destroyed by environmental factors.
- Thus natural gas is used in museums to protect the monuments.

Advantages of Natural Gas

- It produces lot of heat as it is easily burnt.
- It does not leave any residue.
- It burns without smoke and so causes no pollution.
- This can be easily supplied through pipes.
- It can be directly used as fuel in homes and Industries.

Compressed Natural Gas

- When the natural gas is compressed at high pressure, it is called Compressed Natural Gas (CNG).
- Nowadays it is used as fuel in automobiles.
- The primary hydrocarbon present in CNG is methane (88.5%).
- Natural gas is liquefied for shipping in large tankers.
- This is called Liquefied Nitrogen Gas (LNG).
- CNG is stored at high pressure whereas LNG is stored in ultra cold liquid form.
- CNG has the following properties.
- It is the cheapest and cleanest fuel.
- Vehicles using this gas produce less carbon dioxide and hydrocarbon emission.
- It is less expensive than petrol and diesel.

The average composition of CNG.

Constituents	Percentage
Methane	88.5
Ethane	5.5
Propane	3.7
Butane	1.8
Pentane	0.5

Fuel Gases

- Apart from natural gas, there are some other gases used as fuel.
- Producer gas, coal gas, bio gas and water gas are some of them.

Producer Gas

- Producer gas is a gaseous mixture of carbon monoxide and nitrogen.
- It is produced by passing air mixed with steam, over red hot coke at a temperature of 1100 ˚C.
- It is used as an industrial fuel for iron and steel manufacturing.
- Producer gas is known by different names in different countries.
- It is referred as Wood gas in USA and as Suction gas in UK.

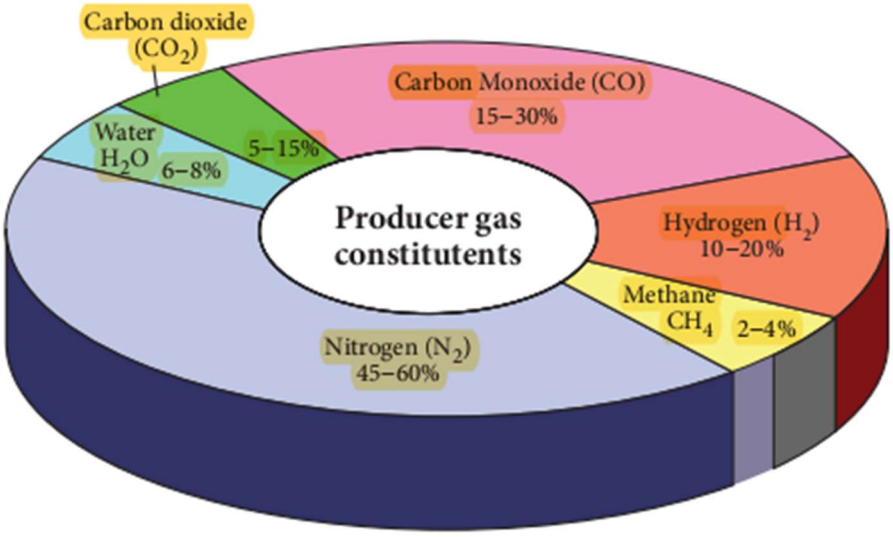


Figure 6.6 Composition of Producer Gas

Coal Gas

- It is a mixture of gases like hydrogen, methane and carbon monoxide obtained by the destructive distillation of coal.
- Heating coal in the absence of air is called destructive distillation.
- It is used in heating open hearth furnace in the manufacture of steel.
- It is also used as a reducing agent in certain metallurgical operations.

Water Gas

- It is a gaseous mixture of carbon monoxide and hydrogen.
- It is made by passing steam over incandescent coke at a temperature of 1000°C.

$$C_{(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2\ (g)}$$

- It is also called as syngas or synthesis gas as it is used to synthesize methanol and simple hydrocarbons.
- It is used as an industrial fuel also.

Bio Gas

- Bio-gas is a mixture of methane and carbon dioxide.
- It is produced by the decomposition of plant and animal waste which form the organic matter.
- The breaking down of organic matter in anaerobic condition (ie., in the absence of oxygen) leads to the formation of biogas.
- It is an example for renewable source of energy.

Coal and its types

- Coal is one of the fossil fuels.
- It is a mixture of free carbon and compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.
- Three hundred million years ago, some plants grew into giant ferns and mosses.
- These plants got buried into the bottom of the soil.
- They slowly started to decompose and formed a dense, sponge like material called peat.
- Over time peat was compressed due to high temperature and pressure and coal was formed.
- As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called carbonization.

Extraction of Coal

- Coal is extracted from the coal beds found below the surface of the earth.
- Depending on the depth of the coal bed, coal is extracted in two ways.

Surface mining

- If the coal beds lie within 22 feet of the earth's surface, the top soil is removed and coal is dug out.
- This is called surface mining.

Underground mining

- Coal beds are found very deep inside the earth.
- In that case underground tunnels are made to get this coal.
- This is called underground mining or deep mining.
- Coal reserves can be found in about 70 countries worldwide.
- The largest coal reserves are available in United State, Russian, China, Australia and India.
- The US is the international leader in coal reserves, with nearly 30% of the world's supply.
- Coal mining was started in India in 1774.
- India now ranks third among the coal producing countries in the world.
- USA and China have two third of the world's coal reserve.

Types of Coal

- Coal is classified into four main categories based on the amounts of carbon it contains and the heat energy it can produce.
- They are lignite, sub bituminous, bituminous and anthracite.
- Among these four types anthracite is the most desirable one due to its high heat content.

Lignite

- Lignite is a brown colored coal of lowest grade.
- It has least content of carbon.
- 25 – 35% Lignite contains a high amount of water and makes up almost half of our total coal reserves.
- It is used for electricity generation.
- The other uses include generating synthetic natural gas and producing fertilizer products.

Sub bituminous

- When lignite becomes darker and harder over time sub-bituminous coal is formed.
- Sub bituminous coal is a black and dull coal.
- It has higher heating value than lignite and contains 35-44% carbon.
- It is used primarily as fuel for electricity power generation.
- This coal has lower sulfur content than other types and burns cleaner.

Bituminous

- With more chemical and physical changes, sub-bituminous coal is developed into bituminous coal.
- Bituminous coal is dark and hard.
- It contains 45-86% carbon.
- It has high heating value.
- It is used to generate electricity.
- Other important use of this coal is to provide coke to iron and steel industries.
- By-products of this coal can be converted into different chemicals which are used to make paint, nylon, and many other items.

Anthracite

- It is the highest grade coal.
- It is hard and dark black in colour.
- It has a very light weight and the highest heat content.
- It contains 86-97% carbon and has a heating value slightly higher than bituminous coal.
- It burns longer with more heat and less dust.

Uses of coal

- Coal is used to generate heat and electricity.
- It is used to make derivatives of silicon which are used to make lubricants, water repellents, resins, cosmetics, hair shampoos, and toothpaste.
- Activated charcoal is used to make face packs and cosmetics.
- Coal is used to make paper.
- Coal helps to create alumina refineries.
- Carbon fibre which is an extremely strong but lightweight material is used in construction, mountain bikes, and tennis rackets.
- Activated carbon, used in filters for water and air purification and in kidney dialysis machines is obtained from coal.

Products obtained from coal

- Coal when heated in the absence of air does not burn but produces many by-products.

- This process of heating coal in the absence of air is called destructive distillation of coal.
- Some of them are soap, aspirins, solvents, dyes, plastics, and fibres, such as rayon and nylon.
- The main by products obtained during destructive distillation are coke, coal tar, ammonia and coal gas.

Destructive Distillation of Coal

- Finely powdered coal is taken in a test tube and heated.
- At a particular temperature coal breaks down to produce coke, coal tar, ammonia and coal gas.
- Coal tar is deposited at the bottom of the second test tube and coal gas escapes out through the side tube.
- The ammonia produced is absorbed in the water, forming ammonium hydroxide.
- Finally a black residue called coke is left in the first tube.
- Coke: Coke contains 98% carbon.
- It is porous, black and the purest form of coal.
- Burns without smoke.
- Used as a reducing agent in the extraction of metals from their ores.
- Used in making fuel gases like producer gas and water gas which is a mixture of carbon monoxide and hydrogen.
- **Coal tar:** Coal tar is a mixture of different carbon compounds.
- It is a thick, black liquid with unpleasant smell.
- The fractional distillation of coal tar gives many chemical substances like benzene, toluene, phenol and aniline.
- They are used in the preparation of dyes, explosives, paints, synthetics fibers, drugs, and pesticides.
- Another product obtained from coal tar is naphthalene balls which are used to repel moth and other insects.
- **Coal Gas:** Coal gas also known as town gas is mainly a mixture of gases like hydrogen, methane and carbon monoxide.
- The gases present in coal gas are combustible and hence, it is an excellent fuel.
- It has high calorific value.
- Ammonia: The other by product obtained from coal is ammonia.

- It is used for making fertilizers such as ammonium sulphate, ammonium superphosphate etc.
- It is also known as Black Diamond owing to its precious nature.
- On destructive distillation, 1000 kg of coal gives 700 kg of coke, 100 litres of ammonia, 50 litres of coal tar and 400 m^3 of coal gas.

Petroleum

- The term 'petroleum' is derived from the latin words 'petra' meaning rock and 'oleum' meaning oil.
- It is a fossil fuel formed from the remains of ancient marine organisms through death and decay.
- Petroleum is a complex mixture of hydrocarbons that occur in Earth in liquid, gaseous, or solid form.
- The term petroleum commonly denotes the liquid form, crude oil.
- But technically petroleum also includes natural gas and bitumen, a solid form.
- The natural gas and the crude oil constitute the primary fossil fuels.
- Ancient cultures used crude oil for binding materials.
- It was also used as a sealant for waterproofing various surfaces.

Occurrence of Petroleum

- The chief petroleum producing countries are U.S.A, Kuwait, Iraq, Iran, Russia and Mexico.
- In India, petroleum is found in Assam, Gujarat, Maharashtra (Mumbai), Andhra Pradesh (Godavari and Krishna basin) and Tamil Nadu (Cauveri Basins).
- The crude oil is pumped out from the well as a black liquid.
- The first oil well in the world was drilled in Pennsylvania, USA in 1859.
- The second oil well was drilled in Makum, Assam, India in 1867.

Refining of crude petroleum

- The crude petroleum obtained from the well is a dark colored viscous liquid which contains many impurities such as water, solid particles and gases like methane and ethane.
- The process of separating petroleum into useful by-products and removal of undesirable impurities is called refining.

Separation of water

- The crude oil obtained from the oil wells will have salt water mixed with it.
- As the first step the water is removed from the crude oil.

Removal of sulphur compounds

- The crude oil will have harmful sulphur compounds as impurities.
- These impurities are removed.

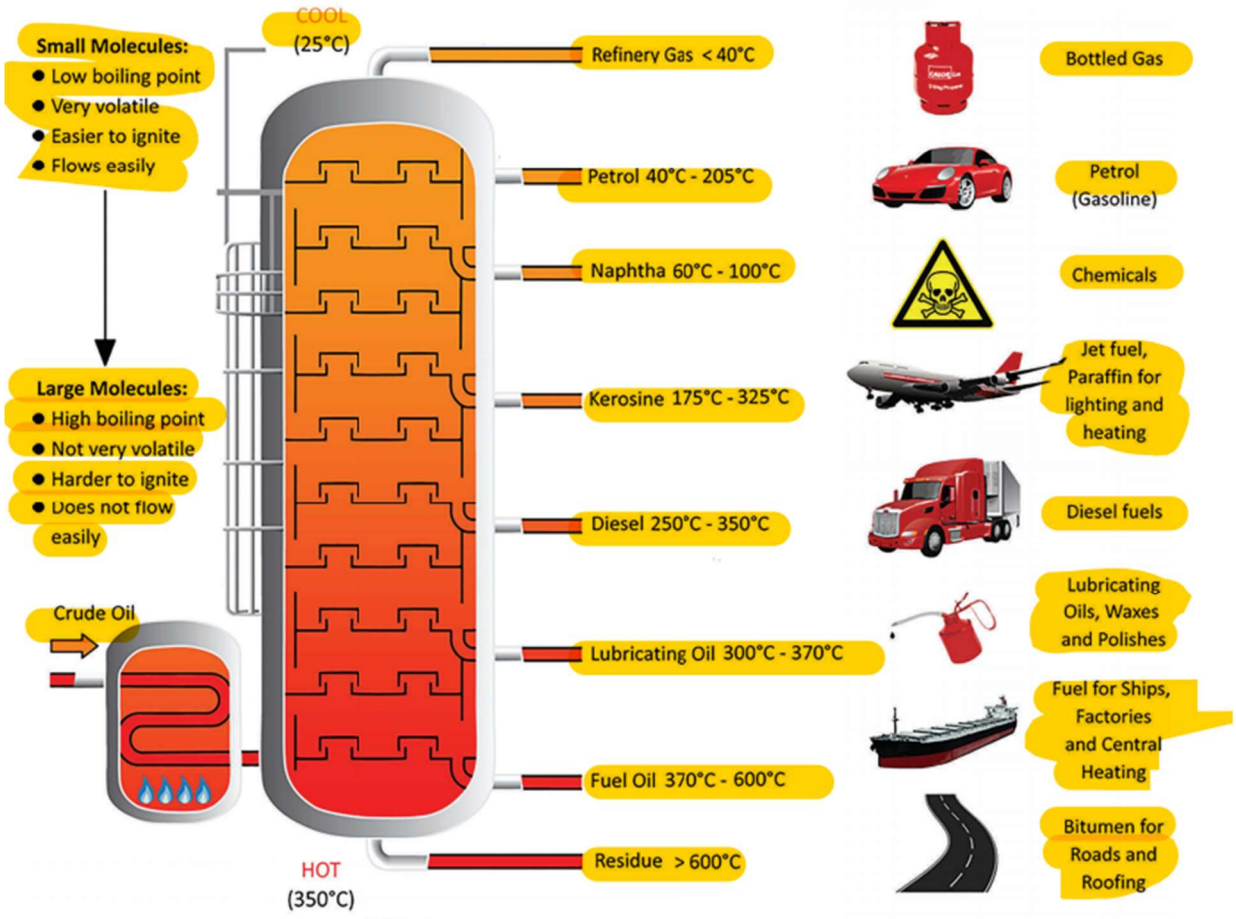
Fractional distillation

- Petroleum is a mixture of various constituents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc.
- The process of separation of various constituents or fractions of petroleum is done by fractional distillation in fractionating columns.
- The process of heating a mixture of liquids having different boiling points and then separating them by cooling is called fractional distillation.
- Crude petroleum is first heated to about 400°C in a furnace.
- The various fractions condense according to their boiling point ranges.
- Many useful substances are obtained from petroleum and natural gas.
- These are termed 'petrochemicals'.
- These are used in the manufacture of detergents, fibres, and other man-made plastics like polythene.
- Hydrogen gas obtained from natural gas, is used in the production of fertilizers.
- Due to its great commercial importance, pertoleum is also called 'black gold'.

Uses of Petroleum

- Products obtained from crude oil have a number of uses.
- Liquefied Petroleum Gas or LPG is used in houses as well as in the industry.
- Diesel and petrol are used as fuels for vehicles.
- It is also used to run electric generators.
- Petrol is used as a solvent for dry cleaning.
- Kerosene is used as a fuel for stoves and also in jet planes.
- Lubricating oil reduces wear and tear and corrosion of machines.

- Paraffin wax is used to make candles, ointments, ink, crayons, etc.
- Bitumen or asphalt is mainly used to surface roads.



Fuel

- Any substance that can produce heat and energy on burning is called fuel.
- We use this heat for various purposes such as cooking, heating and many industrial and manufacturing purposes.
- Some of the fuels that we use in our daily life are wood, coal, petrol, diesel and natural gas.

Types of fuel

- Solid, liquid and gaseous fuels.

Solid fuels

- Fuels like wood and coal are in solid state and they are called solid fuels.
- This type of fuel was the first one to be used by man.

- The production cost is also very low.

Liquid fuels

- Most of the liquid fuels are derived from the fossil remains of dead plants and animals petroleum oil, coal tar and alcohol are some of the liquid fuels.
- These fuels give more energy on burning and burn without ash.

Gaseous fuel

- Coal gas, oil gas, producer gas and hydrogen are some of the gaseous fuels.
- Easily transported through pipes and they do not produce pollution.

Characteristics of fuel

- It should be readily available
- It should be easily transportable
- It should be less expensive
- It should have high calorific value
- It should produce large amount of heat
- It should not leave behind any undesirable substances

Efficiency of Fuel

- Any fuel contains carbon as its main constituent.
- During the combustion of fuel carbon combines with oxygen and liberates large amount of heat.
- It is expected that a fuel liberates maximum amount of heat in the short time.
- The efficiency of a fuel can be understood from the following terms.

Specific Energy

- Specific energy is the amount of energy produced by unit mass of a fuel.
- It is defined as the energy per unit mass.
- It is used to measure the stored energy in certain substances.
- Its unit is Jkg^{-1}.

Calorific Value

- It is the quantity of heat produced by the complete combustion of fuel at constant pressure and normal conditions.
- It is measured in terms of $125kg^{-1}$.

Calorific value of fuel

Fuel	Calorific Value (KJ/kg)
Cow dung cake	6000 – 8000
Wood	17000 – 22000
Coal	25000 – 33000
Petrol	45000
Kerosene	45000
Diesel	45000
Methane	50000
CNG	50000
LPG	55000
Biogas	35000 – 40000
Hydrogen	150000

Octane Number

- Octane number denotes the amount of octane present in petrol.
- The fuel having high octane number is called as an ideal fuel.

Cetane Number

- Cetane Number measures the ignition delay of the fuel in diesel engine.
- When cetane number is higher the ignition delay is shorter.
- The fuel with high cetane number is called as the ideal fuel.

Difference between Octane number and Cetane number

Octane Number	Cetane Number

Octane rating is used for Petrol	Cetane rating is used for diesel
It measures the amount of octane present in petrol	It measures the ignition delay of the fuel in diesel engine.
Octane number of petrol can be increased by adding benzene or toluene.	Cetane number of diesel can be increased by adding acetone.
The fuel with high octane number has low cetane number	The fuel with high cetane number has low octane number.

Alternative Fuel

- It is estimated that coal will last for 148 years, petroleum for 40 years and natural gas for 61 years.
- So we need to find alternative sources of energy.
- More over fossil fuels emit harmful gases like carbon dioxide, carbon monoxide and sulfur dioxide which pollute the atmosphere.
- Burning fossil fuels also cause temperature rise in the earth's atmosphere.
- Many believe that fuel which does not cause pollution is needed to enhance the quality of our environment.

Bio diesel

- Bio diesel is a fuel obtained from vegetable oils such as soya bean oil, jatropha oil, corn oil, sunflower oil, cotton seed oil, rice-bran oil and rubber seed oil.

Hydrogen - The future fuel

- Hydrogen could be the best alternative fuel in the future.
- It is a clean fuel as it gives out only water while burning.
- Moreover, it has the highest energy content.
- It does not pollute air.

Wind energy

- Wind energy is obtained with the help of wind mills.
- When wind blows, they rotate the blades of the wind mills and current is produced in the dynamo.

- Wind mills are mostly located at Kayathar, Aralvaimozhi,
- Palladam and Kudimangalam in Tamil Nadu.

Gobar Gas

- Gobar gas is obtained by the fermentation of cow dung in the absence of air (anaerobic conditions).
- It mainly contains methane and a little ethane.
- It is widely used in rural areas for cooking and operating engines.

Solar Energy

- Sun is the first and foremost energy source that makes life possible on our earth.
- Sun provides a free and renewable source of energy.
- It is the potential source to replace the fossil fuel in order to meet the needs of the world.
- With the advancements in science and technology, solar energy has become more affordable, and it can overcome energy crisis.
- Solar energy is a clean energy.
- With the minimum efforts maximum energy can be harnessed using various equipments.

Applications of Solar Energy

- Solar energy has wider applications in various fields.
- It is used in solar water heater.
- It is used in drying of agricultural and animal products.
- It is used in electric power generation.
- It is used in solar green houses.
- It is used in solar pumping and solar distillation.
- It is used for solar cooking and solar furnaces also.