**FUELS (ENERGY SOURCES**)

**CHEMICAL FUELS**: A chemical substance, which produces significant amount of heat and light energy when it is burnt in air or oxygen is called a chemical fuel. The main constituents of fuel are carbon and hydrogen.

During the process of combustion of a fuel the atoms of carbon, hydrogen etc. combine with oxygen with the simultaneous liberation of heat at a rapid rate. This energy is liberated due to the rearrangement of valence electrons in the atoms, resulting in the formation of new compounds (like CO2, H2O etc.). Since the heat content of combustion products being lower than that of reactants, the chemical fuels release heat during their combustion process.

FUEL + O2  PRODUCTS + HEAT

The primary or main sources of fuels are coal and petroleum oil. These are stored fuels available in earths crust and are generally called fossil fuels.

**Classification of fuels:**

Depending on their origin fuels are classified into primary and secondary fuels. These are again classified into solids, liquids and gases, depending on their physical state.

Primary fuels or natural fuels: Which are found in nature.

Eg: Solid: wood, peat, lignite, coal.

Liquid: crude oil.

Gas: Natural gas.

Secondary fuels: are those that are prepared from the primary fuels.

Eg: Solid: Coke, charcoal, coal etc.

Liquid: Gasoline, diesel, kerosene, synthetic petrol.

Gases: Producer gas, water gas, coal gas, LPG, Biogas.

Characteristics of a good fuel:

The following are the desirable properties of a good chemical fuel.

1. High calorific value: A fuel should possess high calorific value, since the amount of heat liberated and temperature attained thereby depends upon the calorific value of fuel.
2. Moderate ignition temperature: Ignition temperature is the lowest temperature to which the fuel must be pre heated so that it starts burning smoothly. Low ignition temperature is dangerous for storage and transport of fuel, since it can cause fire hazards. On the other hand, high ignition temperature causes difficulty in igniting the fuel, but the fuel is safe during the storage, handling and transport. Hence, an ideal fuel should have moderate ignition temperature.
3. Low moisture content: The fuel should have low moisture content. High percentage of moisture increases the ignition temperature and also reduces calorific value.
4. Products of combustion should not be harmful: Fuel, on burning should not giving out harmful gases such as CO, H2S, SO2, PH3 etc. In other words the gaseous products of combustion should not pollute the atmosphere.
5. Combustion control: One can avoid large wastage of valuable fuel if its combustion rate can be properly regulated and burning can be stopped immediately as and when desired.
6. Low cost: A good fuel should be readily available in bulk at a cheap rate.
7. Should not undergo spontaneous combustion.
8. Storage cost in bulk should be low.
9. Should burn in air with efficiency, without much smoke.
10. Fuel must be easy to handle, store and transport at a low cost.

**Calorific value**: Calorific value of a fuel is “the total quantity of heat liberated, when a unit mass or volume of the fuel is burnt completely in air or oxygen”.

**Units:**

The calorific value is normally expressed in ***Calories/gram*** in cgs units.

SI unit for solid fuels ***J/ kg***

For gaseous fuels ***J/m3***

**Gross(higher) calorific value (HCV) :**

Gross or HCV is the “ **total amount of heat produced, when unit mass/volume of the fuel has been burnt completely and the products of combustion have been cooled to room temperature”** Usually all fuels contains some hydrogen and when the calorific value of hydrogen containing fuel is determined experimentally, the hydrogen is converted into steam. If the products of combustion are condensed to the room temperature, the latent heat of condensation of steam also gets included in the measured heat. Therefore it is always higher than the net calorific value.

**Net (lower) calorific value (LCV)**:

LCV is “**the net heat produced, when unit mass/volume of the fuel is burnt completely and the products are permitted to escape**”.In actual practice combustion products are not cooled to temperature but simply let off into the atmosphere. Since this calorific value does not include the latent heat of steam, hence, net calorific value is always lower than gross calorific value.

Net calorific value = GCV – LATENT HEAT OF WATER

9 X H

NCV = GCV – X 587

100

Because 1g of H2 gives 9g of H2O and the latent heat of steam is 587 cal/g.

**CRACKING**: Is defined as the process of breaking of higher molecular weight hydrocarbons into lower molecular weight hydrocarbons (low B.P).

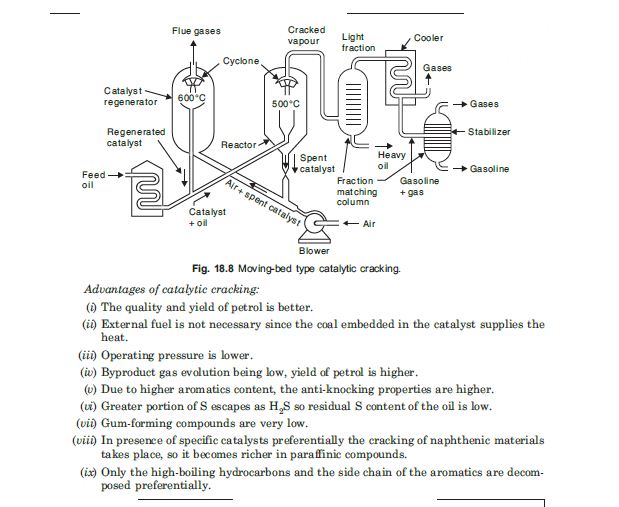
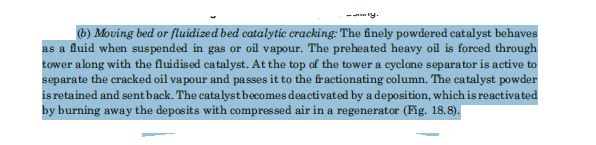
Cracking process involves breaking of carbon – carbon and carbon – hydrogen bonds.

Heat and pressure

Eg: C14H30 C7H16 + C7H14 Absence of air

Cracking process aims at:

1. To convert low demand, high boiling fractions into low boiling fractions suitable for automobiles.
2. To produce raw materials for petrochemical industries.

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**KNOCKING**

Premature and instantaneous ignition of petrol – air (fuel-air) mixture in a petrol engine, leading to

production of an explosive violence is known as knocking.

The resistance offered by gasoline to knocking cannot be defined in absolute terms. It is generally

expressed on an arbitrary scale known as Octane rating.

In an internal combustion engine, a mixture of gasoline vapor and air is used as a fuel. After the

initiation of the combustion reaction, by spark in the cylinder, the flame should spread rapidly and smoothly

through the gaseous mixture; thereby the expanding gas drives the piston down the cylinder. The ratio of the

gaseous volume in the cylinder at the end of the suction-stroke to the volume at the end of compression ratio.

The efficiency of an internal combustion engine increases with the compression ratio, which is dependent on the

nature of the constituents present in the gasoline used. In certain circumstances (due to the presence of some

constituents in the gasoline used), the rate of oxidation becomes so great that the last portion of the fuel air

mixture gets ignited instantaneously, producing an explosive violence, known as knocking. The knockingresults in loss of efficiency.

ADVERSE EFFECT OF KNOCKING:

1. It produces undesirable rattling noise.
2. It increases the fuel consumption.
3. It results in decreased power output.
4. It causes mechanical damage due to overheating, to engine parts such as spark-plug, piston and engine walls.
5. The driving becomes unpleasant.

**The knocking can be controlled or even stopped by the following methods:**

1. increasing engine r.p.m

2. reducing pressure in the inlet manifold by throttling

3. Retarding spark

4. Making the ratio too lean or rich, preferably latter.

5. Water injection increases the delay period as well as reduces the flame temperature.

6. Use of high octane fuel can eliminates detonation. High octane fuels are obtained by

adding additives known as dopes like tetraethyl lead, benzol, xylene to petrol

**Chemical structure and knocking:** The tendency of fuel constituents to knock in the following order.

Straight – chain paraffins > Branched- chain paraffins (i.e.,iso paraffins)> Olefines> Cycloparaffins

(i.e.,naphthalenes)> aromatics.

Thus, olefins of the same carbon chain length possess better anti knock properties than the corresponding paraffins and so on.

OCTANE NUMBER: Knocking capacity of a fuel is measured in terms of octane number. Branched chain compounds produce low knocking while straight chain compounds produce high knocking. Isooctane, which has an excellent combustion characteristics and very little tendency to knocking is given an octane number 100. While n-Heptane which has poor combustion characteristics and knocks badly, is given octane number zero.

CH3 CH3

CH3-C-CH2-CH-CH3 CH3-(CH2)5-CH3

CH3

**Isooctane ON=100 n-Heptane ON=O**

DEFINITION: Octane number of a fuel is defined as the percentage by volume of isooctane in a mixture of isooctane and n-Heptane blend, which has the same knocking characteristic as the gasoline under test.

Thus if the octane number of a gasoline is 70 it means that its knocking characteristics are similar to that of the knocking characteristics of a mixture of 70% isooctane and 30% n-Heptane.

NOTE: Octane number varies in the following order

Benzene > Alkenes > Cycloalkane > Branched chain hydrocarbons > Straight chain hydrocarbons

CETANE NUMBER: The Cetane number is a measure of the ease with which the given diesel fuel will undergo compression ignition.

α-Methylnaphthalene and n- Cetane are specified as standards, since n-Cetane has low ignition lag, its cetane number is fixed as 100, while α-Methylnaphthalene has long ignition lag and its cetane number is fixed as zero.

C10H7-CH3 CH3-(CH2)14-CH3

α-Methylnaphthalene n-Cetane

**Cetane number=0** **cetane number=100**

DEFINITION: Cetane number is defined as the percentage of n-Cetane in a mixture of n-Cetane and α-Methylnaphthalene that has the same ignition characteristics as the diesel fuel under test.

The structural requirements for a diesel fuel are

1.The straight chain alkanes like n-Cetane, which ignite readily, are good diesel fuels.

2.Aromatics like α-Methylnaphthalene that has long ignition delay are poor diesel fuels.

1. The cetane number of a diesel fuels can be raised by the addition of small quantity of ethyl nitrite, isoamylnitrite and acetone peroxide.

PREVENTION OF KNOCKING:

Anti-knocking agents: Knocking of petrol may be reduced by the addition of some organo- lead compounds into it.

The substances added to motor or aviation gasoline to control knocking is called anti-knocking agents.

1. Tetraethyl lead 2.tetramethyl lead and a mixture of TEL AND TML is used as anti-knocking agents. They are used along with ethylene dichloride or ethylene dibromide.

TEL and TML get converted to Pb or PbO and get deposited on the engine parts or the exhaust pipe causing damages. But if they are used along with ethylene dichloride or dibromide, Pb and PbO are converted to volatile PbCl2 or PbBr2 that escape as gases into atmosphere.

UNLEADED PETROL: one, which does not contain any lead compound. To improve its octane number, the process of reforming increases concentration of high-octane components. In addition to it, compounds like Methyl tertiary butyl ether (MTBE) is added to improve octane number of unleaded petrol in IC engines, thereby reducing considerably the formation of peroxy compounds (which causes knocking)

ADVANTAGES OF UNLEADED PETROL:

1.Eliminates the pollution level of lead in atmosphere.

2.This permits the attachment of catalytic converters to the exhaust pipe in automobiles.

The catalyst converts the toxic exhaust gases like CO and NO to non- toxic gases CO2 and N2 respectively. Consequently, the pollution level is reduced to a great extent.

NOTE: Leaded petrol cannot be used in automobile exhaust pipes fitted with catalytic converter, since the released lead compounds poisons the catalyst itself, thereby destroying its catalytic activity.

**Characteristics of good fuel:** A good fuel should satisfy the following requirements:

It should have a high calorific value per unit weight i.e. it should evolve a large amount of heat when a

unit weight of it is burnt under the conditions in which it is to be used as a fuel.

Its moisture content should be low, so that its heating value should be high.

Its should not produce harmful products like CO2, SO2, H2S and other poisonous gases on burning since

they pollute the atmosphere.

A fuel should have low content of non-combustible matter in the form of ash or clinker. The presence of

non-combustible matter will enhance the cost of storage, handling and disposal of the waste.

In case of solid fuel, the size should be controllable so that it can be started or stopped.

It should be economical and easily available.

It should not give any offensive odour.

An ideal fuel should have moderate ignition temperature. Normally low ignition temperature during

storage and transport of fuel leads to fire hazards on the other hand, fuel with high ignition temperature

is safe for storage, handling and transport.

**Analysis of coal:**

The composition of coal varies widely and hence it is necessary to analyze the coal samples so that types of

coal can be selected for a particular industrial use. The following methods of analysis can be utilized for the

selection of coal.

1. Proximate analysis: This analysis records moisture, volatile matter, ash and fixed carbon as percentages

of the original weight of the coal sample. Proximate analysis is of significance in commercial classification

and industrial utilization of coal.

2. Ultimate analysis: This consists of determination of C, H, S, N and O. The ultimate analysis is essential

for calculating heat balances in any process for which coal is employed as a fuel.

**2. Q. Explain the determination & significance of the following constituents present in coal. i. Moisture ii.**

**Volatile matter iii. Ash and iv. Fixed carbon. Or Explain in detail an account of proxima te analysis of coal.**

1. **Proximate analysis**: It is a quantitative analysis of the following parameters.

1. Moisture

2. Volatile matter

3. Ash

4. Fixed carbon

1. **Moisture:** About 1 gram of finely powdered air-dried coal sample is weighed in a crucible. The crucible

is placed inside an electric hot air-oven, maintained at 105 to 1100C. The crucible is allowed to remain

in oven for 1 hour and then taken out, cooled in desiccators and weighed. Loss in weight is reported as

moisture.

**Percentage of Moisture = \_\_Loss in weight\_\_ X 100**

**Weight of coal taken**

2. **Volatile Matter:** The dried sample taken in a crucible in and then covered with a lid and placed in an

electric furnace or muffle furnace, maintained at 925 + 20C. The crucible is taken out of the oven after 7

minutes of heating. The crucible is cooled first in air, then inside desiccators and weighed again. Loss in

weight is reported as volatile matter on percentage-basis.

**Percentage of volatile matter =**

**Loss\_in weight\_due\_to\_removal\_of\_volatile\_matter X 100**

**Weight of coal sample taken**

3. **Ash** : The residual coal sample taken in a crucible and then heated without lid in a muffle furnace at 700

+ 50 C for ½ hour. The crucible is then taken out, cooled first in air, then in desiccators and weighed.

Hearing, cooling and weighing is repeated, till a constant weight is obtained. The residue is reported as

ash on percentage-basis.

Thus,

**Percentage of ash = \_\_Weight of ash left\_\_ X 100**

**Weight of coal taken**

**4. Fixed carbon:**

**Percentage of fixed carbon = 100 - % of (Moisture + Volatile matter + ash)**

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**Significance of proximate analysis:** Proximate analysis provides following valuable information’s in

assessing the quality of coal.

1. **Moisture**: Moisture is coal evaporates during the burning of coal and it takes some of the liberated heat in

the form of latent heat of evaporation. Therefore, moisture lowers the effective calorific value of coal.

Mover over, it quenches the fire in the furnace, hence, lesser, the moisture content, better the quality of coal

as a fuel. However, presence of moisture, up to 10%, produces a more uniform fuel-bed and less of “flyash”.

2. **Volatile matter**: a high volatile matter content means that a high proportion of fuel will distil over as gas

or vapour, a large proportion of which escapes un-burnt, So, higher volatile content in coal s undesirable. A

high volatile matter containing coal burns with a long flame, high smoke and has low calorific value. Hence,

lesser the volatile matter, better the rank of the coal.

3. **Ash:** Ash is a useless, non-combustible matter, which reduces the calorific value of coal. Moreover, ash

causes the hindrance to the flow of air and heat, thereby lowering the temperature. Also, it often causes

trouble during firing by forming clinkers, which block the interspaces of the grate, on which coal is being

burnt. This in-turn causes obstruction to air supply; thereby the burning of coal becomes irregular. Hence,

lower the ash content, better the quality of coal. The presence of ash also increases transporting, handling

and storage costs. It also involves additional cost in ash disposal. The presence of ash also causes early wear

of furnace walls, burning of apparatus and feeding mechanism.

4. **Fixed carbon**: Higher the percentage of fixed carbon, greater is it’s calorific and betters the quality coal.

Greater the percentage of fixed carbon, smaller is the percentage of volatile matter. This also represents the

quantity of carbon that can be burnt by a primary current of air drawn through the hot bed of a fuel. Hence,

high percentage of fixed carbon is desirable. The percentage of fixed carbon helps in designing the furnace

and the shape of the fire-box, because it is the fixed carbon that burns in the solid state.

**3.Q. Explain the determination & significance of the following constituents present**

**in coal. i. Total carbon ii. Hydrogen iii. Nitrogen iv. Sulphur and v. Oxygen.**

**Or explain in detail an account of ultimate analysis of coal.**

**Ultimate analysis**: This is the elemental analysis and often called as qualitative analysis of coal. This

analysis involves the determination of carbon and hydrogen, nitrogen, suphur and oxygen.

1. **Carbon and Hydrogen** : About 1 to 2 gram of accurately weighed coal sample is burnt in a current of

oxygen in a combustion apparatus. C and H of the coal are converted into CO2 and H2O respectively.

The gaseous products of combustion are absorbed respectively in KOH and CaCl2 tubes of known

weights. The increase in weights of these are then determined.

**C + O2**  **CO2**

**2KOH + CO2**  **K2CO3 + H2O**

**H2 + ½ O2**  **H2O**

**CaCl2 + 7 H2O**  **CaCl2.7H2O**

**Percentage of C = Increase in weight of KOH tube X 12 X 100**

**Weight of Coal sample taken X 44**

**And Percentage of H = Increase in weight of CaCl2 tube X 2 X 100**

**Weight of Coal sample taken X 18**

2. **Nitrogen:** About 1 gram of accurately weighed powdered coal is heated with concentrated H2SO4 along

with K2SO4 (catalyst) in a long-necked Kjeldahl’s flask. After the solution becomes clear, it is treated

with excess of KOH and the liberated ammonia is distilled over and absorbed in a known volume of

standard acid solution. The unused acid is then determined by back titration with standard NaOH solution. From the volume of acid used by ammonia liberated, the percentage of N in coal is calculated

as follows:

**Percentage of N = Volume acid X Normality of acid X\_1.4**

**Weight of coal taken**

3. **Sulphur:** Sulphur is determined from the washings obtained from the known mass of coal, used in

bomb calorimeter for determination of a calorific value. During this determination, S is converted in to

Sulphate. The washings are treated with Barium chloride solution, when Barium-sulphate is precipitated.

This precipitate is filtered, washed and heated to constant weight.

**Percentage of Sulphur = Weight of BaSO4 obtained X 32 X 100\_**

**Weight of coal sample taken in bomb X 233**

4. **Ash:** The residual coal taken in the crucible and then heated without lid in a muffle furnace at 700 + 50

C for ½ hour. The crucible is then taken out, cooled first in air, then in desiccators and weighed.

Hearing, cooling and weighing is repeated, till a constant weight is obtained. The residue is reported as

ash on percentage-basis.

Thus,

**Percentage of ash = \_\_Weight of ash left\_\_ X 100**

**Weight of coal taken**

**5.Oxygen:** It is determined indirectly by deducting the combined percentage of carbon, hydrogen, nitrogen,

sulphur and ash from 100.

**Percentage of Oxygen = 100 – percentage of ( C + H + S + N + Ash)**

**Significance of ultimate analysis:**

**Carbon and Hydrogen:** Greater the percentage of carbon and hydrogen, better is the coal in quality and

calorific value. However, hydrogen is mostly associated with the volatile mater and hence, it affects the

use to which the coal is put.

**Nitrogen:** Nitrogen has no calorific value and hence, its presence in coal is underirable. Thus, a good

quality coal should have very little Nitrogen content.

**Sulphur:** Sulphur, although contributes to the heating value of coal, yet on combustion produces acids

like SO2, SO3, which have harmful effects of corroding the equipments and also cause atmospheric

pollution. Sulphur is, usually, present to the extent of 0.5 to 0.3% and derived from ores like iron,

pyrites, gypsum, etc., mines along with the coal. Presence of sulphur is highly undesirable in coal to be

used for making coke for iron industry. Since it is transferred to the iron metal and badly affects the

quality and properties of steel. Moveover, oxides of sulphur pollute the atmosphere and leads to

corrosion.

**Ash:** Ash is a useless, non-combustible matter, which reduces the calorific value of coal. Moreover, ash

causes the hindrance to the flow of air and heat, thereby lowering the temperature. Hence, lower the ash

content, better the quality of coal. The presence of ash also increases transporting, handling and storage

costs. It also involves additional cost in ash disposal. The presence of ash also causes early wear of

furnace walls, burning of apparatus and feeding mechanism.

**Oxygen;** Oxygen content decreases the calorific value of coal. High oxygen-content coals are

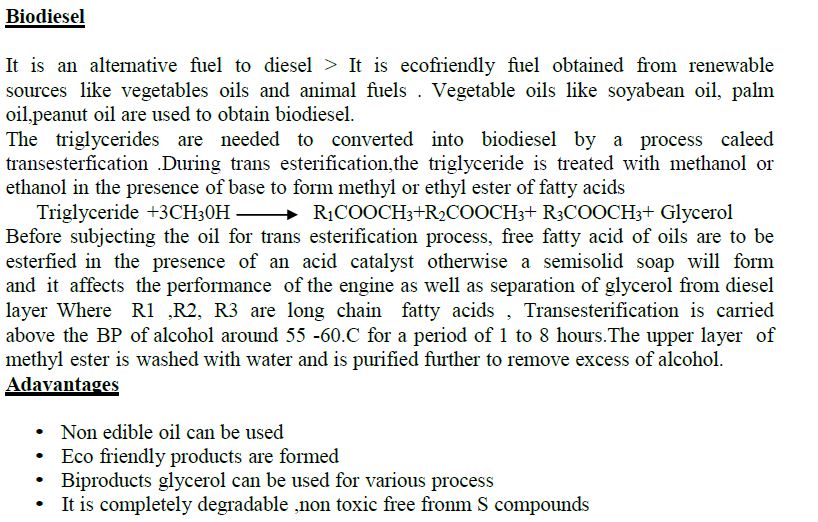
characterized by high inherent moisture, low calorific value, and low coking power. Moreover, oxygen

is a combined form with hydrogen in coal and thus, hydrogen available for combustion is lesser than actual one. An increase in 1% oxygen content decreases the calorific value by about 1.7% and hence, oxygen is undesirable. Thus, a good quality coal should have low percentage of oxygen.

**Fractional distillation:** Heating of crude oil around 4000C in an iron retort, produces hot vapor which is allowed to pass through fractionating column. It is a tall cylindrical tower containing a number of horizontal stainless trays at short distances and is provided with small chimney covered with loose cap. As the vapors go up they get cooled gradually and fractional condensation takes place. Higher boiling fraction condenses first later the lower boiling fractions.



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **THE FRACTIONAL DISTILLATION** **OF CRUDE OIL** | **names  of fractions at the different condensation levels**(% in crude oil) | **Number of C atoms in the hydrocarbon molecule fraction** | **The approximate boiling range in oC of the fraction** | **USES of the fraction**  Many are useful fuels - alkane hydrocarbons, but they are **non-renewable fossil fuels**- specific use depends on physical properties (see later) |
| **A simplified diagram of a fractionating column used in the fractional distillation of crude oil**  doc b oil notes  **The decrease and increase trends for the hydrocarbon molecules are given on the left of fractionating column** | **Fuel Gas, LPG, refinery gas**  (1–2%) | C 1 to 4  mainly propane and butane gases which can be compressed or liquified | < 25oC | doc b oil notesmethane CH4 (domestic heating), ethane anothergaseous fuel, C3–4 easily liquefied petroleum gas, portable energy source e.g. bottled gas for heating and cooking (butane), higher pressure cylinders (propane), feedstock for other organic chemicals |
| **Gasoline – petrol**  (?%) | C 5 to 7 | 25 to 75oC | easily vaporised, highly flammable, easily ignited, car fuel – petrol molecules |
| **Naphtha**  (20–40%) | C 6 to 10 | 75 to 190oC | no good as a fuel, but valuable raw material source of organic chemicals to make other things,[**cracked**](http://www.docbrown.info/page04/OilProducts06.htm) to make more petrol and alkenes |
| **Paraffin, kerosene**  (10–15%) | C 10 to 16 | 190 to 250oC | less volatile, less flammable than petrol, domestic central heating fuel, (paraffin) aircraft jet fuel (kerosene) |
| **Diesel oil, gas oil**  (15–20%) | C 14 to 20 | 250 to 350oC | less volatile than petrol, diesel fuel for some cars and larger vehicle like haulage trucks, trains, central heating fuel, also [**cracked**](http://www.docbrown.info/page04/OilProducts06.htm) to make more petrol and alkenes |
| RESIDUE – **fuel oil, lubricating oils, waxes**  AND **bitumen**  (40–50%) | over C 20, maybe up to several hundred | high boiling liquids or low melting solids, that boil over 350oC  bitumen components boil over a 500oC - 700oC range | not so easily evaporated, not as flammable, safe to store, liquid fuel oil for power stations and ships, quite viscous (sticky) and can also be used for lubricating oils (lubricants, 'mineral oils'), low melting solids used as candle wax, clear waxes and polishes (can be dyed)  AND the biggest molecules make bitumen/asphalt – low melting solid used on roads as it forms a thick, black, tough and resistant adhesive surface on cooling, used as a roofing waterproofing material (it sticks rock chips on roofs or road surfaces) |
| \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* | \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* | \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* | \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* |



**CARBON NEUTRAL**

Carbon neutral is a term used to describe carbon-based fuels that when burned will not increase carbon dioxide (CO2) in the atmosphere. These fuels neither contribute to nor reduce the amount of carbon (measured in the release of CO2) into the atmosphere.

[Carbon dioxide](https://www.thoughtco.com/carbon-dioxide-greenhouse-gas-4118337) in the atmosphere is plant food, which is a good thing, and it also helps keep our planet warm. However, too much CO2 can lead to what we now call [global warming](https://www.thoughtco.com/what-is-global-warming-p2-1203887). Carbon neutral fuels can help prevent too much CO2 from accumulating in the atmosphere. It accomplishes this when the released carbon is absorbed by plant crops that will help produce tomorrow’s next gallon of a carbon-neutral fuel.

Every time we travel in a gasoline or diesel-powered vehicle, we add [greenhouse gases](https://www.thoughtco.com/what-is-the-greenhouse-effect-1203853)to the atmosphere. That’s because burning a petroleum fuel (which were created millions of years ago) releases CO2 into the air

every gallon of a carbon-neutral fuel that is burned can contribute to the reduction of CO2 in the atmosphere, thus helping to reduce global warming.

### Biofuels

Many people believe the future lies with carbon-neutral alternative fuels made from crops and waste products that are known as [biofuels](https://www.thoughtco.com/the-pros-and-cons-of-biofuels-1203797). Pure biofuels such as biodiesel, bio-ethanol, and [bio-butanol](https://www.thoughtco.com/pros-cons-biobutanol-85645) are carbon neutral since plants absorb the C02 released by being burned.

### Biodiesel

The most common carbon neutral fuel is [biodiesel](https://www.thoughtco.com/make-biodiesel-from-vegetable-oil-605975). Because it is produced from such organically derived resources as animal fats and vegetable oil it can be used to recycle a wide range of waste material. It’s available in a range of blend percentages—B5, for example, is 5 percent biodiesel and 95 percent diesel, while B100 is all biodiesel—and there are biodiesel filling stations throughout the U.S. Then there’s the small number of drivers who homebrew their own biodiesel and some who convert their diesel engines to run on straight vegetable oil recycled from restaurants.

## Ways to become Carbon Neutral

There are many ways a company or an individual can follow to start down the path to being carbon neutral. The first three that come to mind are to limit energy usage and emissions, obtain power from renewable energy sources and offset emissions with other efforts.

* Limit energy usage and emissions: The simplest way to do this is to decrease your use of motorized transportation. You can help the environment directly by walking, riding a bicycle, driving a [hybrid vehicle](https://greenliving.lovetoknow.com/Hybrid_Vehicles_Negative_Environmental_Impact) that has low emissions or utilizing public transportation. Additionally, you can attempt to live "[greener](https://greenliving.lovetoknow.com/Green_Living_Tips)" by choosing housing, work and other appliances that are energy savers.
* Obtain cleaner electricity: One way you can do this is to create your own energy by installing solar panels, choosing an energy provider that is "green" or by utilizing biofuels for your energy or heat production.
* Offset emissions with other efforts: There are some emissions that simply can't be avoided. However, you can help offset those by planting trees or participating in other carbon projects. Another option is to purchase carbon credits.

## Inconsistent Standards

There are many companies internationally that claim to provide carbon neutral certification for companies and industries. However, the standards are rarely consistent and differ widely. The World Resource Institute requires that all direct emissions to be decreased and balanced. Conversely, many corporations enforce policies that include both direct and indirect emissions.

## Look to the Future

There are many opportunities for companies to help the environment in the future. Obtaining a true carbon neutral status is something that the entire global community should strive toward.

**GASEOUS FUELS**

Primary gaseus fuel is Natural gas. Secondary gaseous fuels-LPG CNG, Producer gas ,coal gas , water gas etc. Source is under ground strata present with crude oil.

Composition-methane=70-90%,etane propane and butane<20%, other gases like CO2,H2S,N2 and traces of rare gases.

**LPG**-Liquified petroleum gas,

composition- C4=90%, C3 approx 10% Calorific value=27,800Kcal/m3

Also known as bottle gas or refinery gas, obtained as byproduct,during cracking of heavy oil from natural gas. The higher hydrocarbons ( butane,isobutene, butane) can be compressed easily under low pressure.LPG consists of HC that can be readily liquefied under pressure, but can exist as gas under atmospheric pressure. LPG is dehydrated, desulphurised and traces of odourus organicsulphides are added to give warning of the gas leakage.

**USES**- domestic fuel,industrial fuel and as motor fuel for IC engines.

**Advantages:**

-High efficiency and heating rate

- combustion with no smoke

- portable in steel containers

-less health hazard ,since no CO emissions, but great fire hazards.

-cheaper than gasoline.

**CNG**- Compressed natural gas

composition=methane 85-90%, ethane 4-5%,propane 1.7-2% traces of CO2,N2,S.

Calorific value=8600kcal/m3

Methane ( low BP and low mol wt) is compressed and chilled to -260°F turning it to liquid, stored in cylinders . The gas vaporizes mixes with air to become flammable.

USES- excellent domestic fuel and for vehicles-cars and trucks.

Advantages-

-High octane no. and high efficiency

-clean burning safe fuel, excellent antiknock property

-most environment friendly and economical

-reduces toxic soot to 90% than diesel.

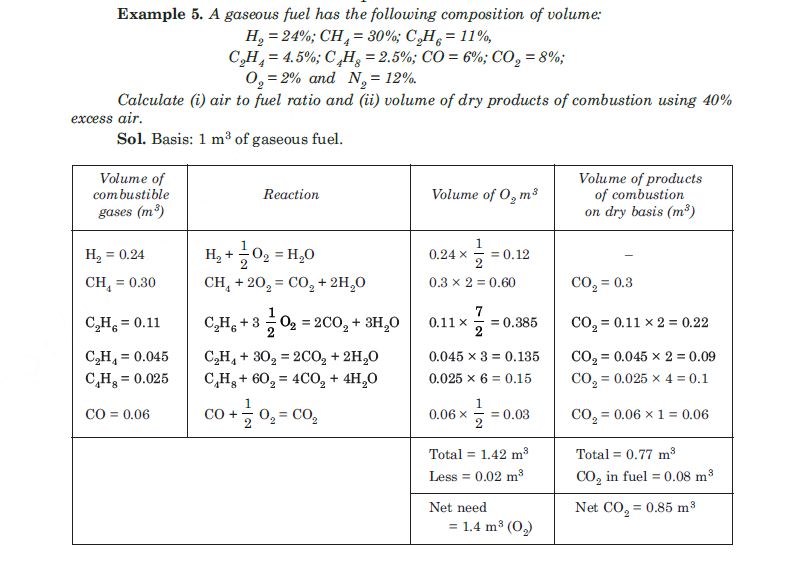
- when released into atmosphere rises harmlessly, disperses into atmosphere.

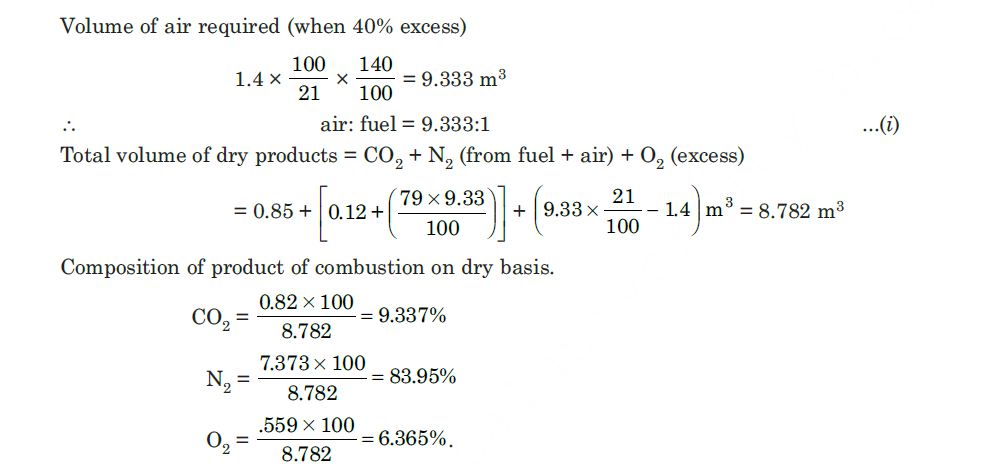
Comparison chart

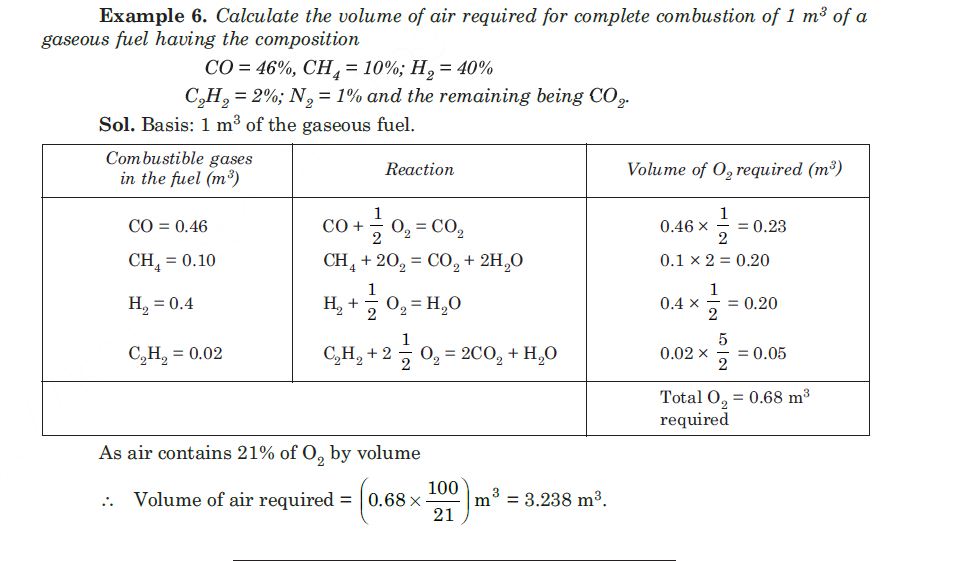
| CNG versus LPG comparison chart | | |
| --- | --- | --- |
|  | CNG | LPG |
| **Constituents** | Methane | Propane and Butane |
| **Source** | Obtained from natural gas-and-condensate wells, oil wells, coal bed methane wells. | Automatically generated from gas fields when natural gas is extracted from the reservoir. By-product of cracking process during crude-oil refining. |
| **Uses** | Substitute for gasoline in automobiles. | Heating and cooking in homes, refrigeration, industrial, agricultural, catering and automobile fuel. |
| **Environmental effects** | Releases lesser greenhouse gas. | Releases CO2 which is a greenhouse gas but is cleaner when compared to gasoline. |
| **Properties** | It is lighter than air and hence disperses quickly in the event of spillage. | Highly inflammable. It is heavier than air and on leakage will settle to ground and accumulate in low lying areas. |
| **Safety** | Easily disperses, hence risk of ignition is minimized. | Since it is difficult to disperse risk of fire is more. |

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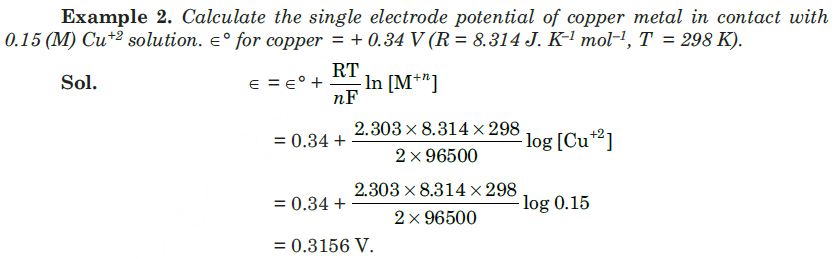
**FUELS-NUMERICALS-**

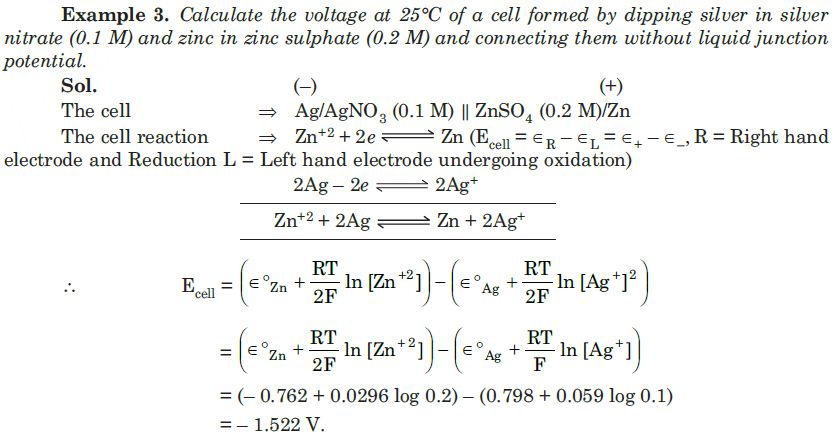
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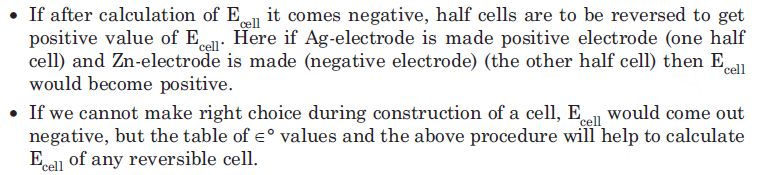
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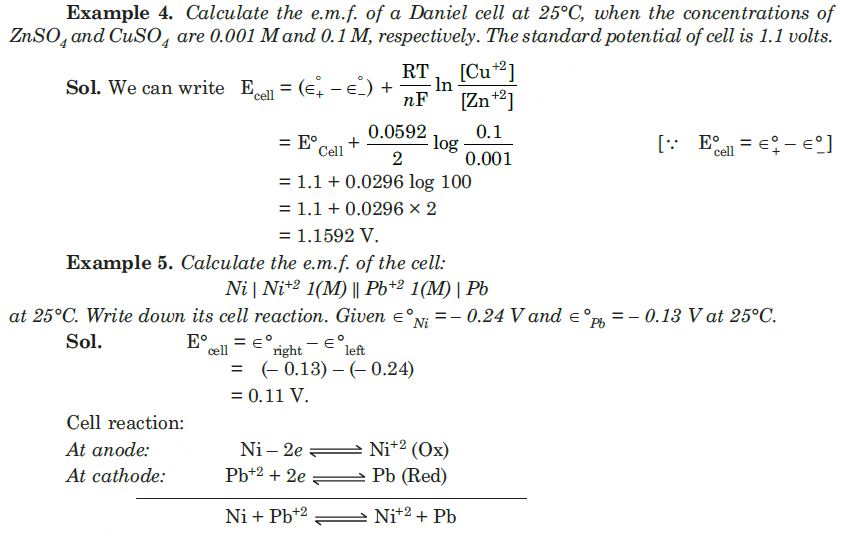
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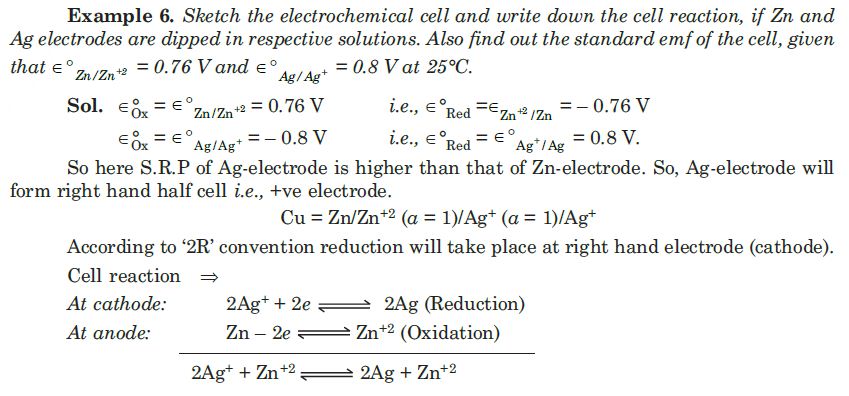
**ELECTRO CHEMISTRY SOLVED PROBLEMS**

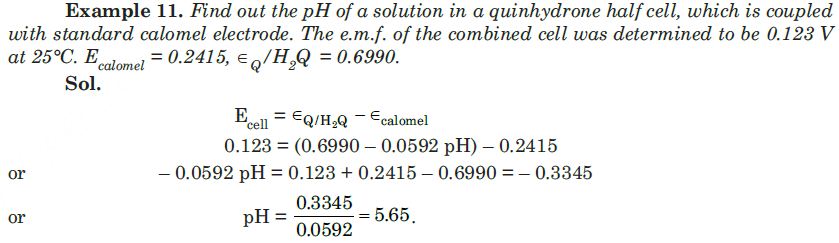
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