FUELS

HCV : is defined as the total amount of heat (including the heat product) produced, when unit mass or volume of the fuel has been burnt completely and the products of combustion have been cooled at Room temp.

LCV : It is defined as the net heat produced when unit mass or volume of the fuel is burnt completely and the products are permitted to escape.

LCV = HCV − Latent heat of water vapour formed.

Fuel
- Natural fuel
  - Solid (wood, coal, Peat, Wood, Dung)
  - Liquid (mineral oil)
  - Gas (Natural gas)
- Artificial fuel
  - Solid (Coke, charcoal, etc.)
  - Liquid (Petrol, Kerosene, spirit, LPG etc)
  - Gas (Coal gas, Producer gas, oil gas, water gas, semi water, etc)

Calorific Value (CF) :→ The quality of fuel is evaluated from its calorific value. CV of a fuel is the maximum amount of heat evolved upon complete combustion of one kilogram of fuel. It may be considered that the higher the carbon and hydrogen content in the fuel, the greater is its fuel value.

Units of heat :→ ① calorie is defined as the quantity of heat required to raise the temp. of 1 gm. of water through 1°C (at 15°C). The most commonly used unit is fuels is the large calorie or kilocalorie (kcal) which is equal to 1000 calories.

1 kcal = 1000 cal 1 (B.Th.U) 8 1 British thermal unit = 252 calories = 0.252 kcal.

1 kcal = 2.2 CHU (Centigrade heat unit) = 3.968 B.Th.U.

ie. LCV = HCV − Latent heat of water vapour formed.

Characteristics of a Good fuel :— ① It should have a high calorific value per unit weight ie., it should evolved 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.
② Its moisture content should be low so that it would have high heating value.
③ It should not produce harmful substances (COx, NOx, SO_2, H_2S etc) upon burning.
④ It should not give non combustible matter such as like ash, clinker so that heating value will be more offensive
⑤ It should not give any offensive odour
⑥ It should be economical and easily available.
⑦ It should have moderate velocity of combustion.

Comparison between Solid, liquid and Gaseous Fuels :—

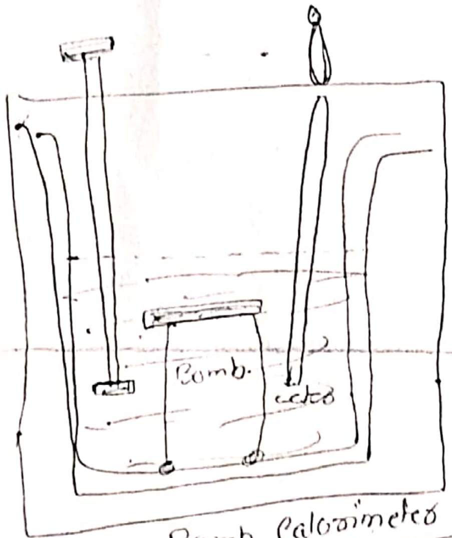
① Gaseous fuel Adv : ① They burns easily, leave no residue, Produce none little smoke, they can be used as internal combustion engine fuels, the combustion they have high calorific values, is easily controllable.

DIS → They are highly inflammable, storage cost is high.

Liquid fuels: Adv: They are highly calorific value, Leave no noncombustible substances like dust ash, clinkers etc; combustion is easily controllable, they require less amount of air for complete combustion, they can also be used in internal combustion fuel, It has less moisture content, It is economical, It has moderate ignition temp.
DIS: It is inflammable, cost of liquid fuel and its storage is high,

Solids: Adv: These are excellent adsorbent for gases, High calorific value, They are economical, easy to transport and easy to store, They have moderate ignition temp.
DIS: Their ash content is high, They leave the residuals after burning, High moisture content but lower than liquid or gas, Harmful products are formed, thermal efficiency is low.

BOMB CALORIMETER: with the help of B.C. we can calculate the calorific value.



Bomb Calorimeter

Function: A weighted sample is placed in a cup inside and the bomb is filled with oxygen at 30 atm pressure. The reaction is started by heating electrically a thin wire dipped into the sample. The reaction, once started, proceeds rapidly with evolution of a large amount of heat. The bomb is kept immersed in water and the amount of heat evolved is determined from temp. rise. The electrodes are then connected to 6 volt battery and circuit completed. The heat capacity of the system is predetermined by this electrical method or by burning a standard substance say benzoic acid (HCV = 6.325 Kcal/Kg) or naphthalene (HCV = 9.688 Kcal/Kg). Uniform stirring of water is continued. It is necessary to insulate the bomb and the water from the surrounding very carefully.

m : mass in gram of fuel sample taken in a cup
W : mass of water in the calorimeter water
w = mass of calorimeter system including water
T_1 = Initial temp. of water
T_2 = Final " " "

L = higher calorific value (HCV) in fuel in cal/gm.

Then the actual heat liberated by burning of fuel = mL

The heat absorbed by water and system is = (W + w)(T2 − T1)

$$mL = (W+w)(T_2 - T_1)$$

$$L = \frac{(W+w)(T_2-T_1)}{m} \text{ cal/gm.}$$

This is the HCV of the fuel.

LCV = HCV − latent heat of water produced.

LCV = L − (i)

The latent heat of water = 0.09 × 587 cal/gm.

where latent heat of steam = 587 cal/gm.

COAL :→ ~~Coal~~ Coal is a highly Carbonaceous ~~carbonaceous~~ fuel which is formed in nature as the final product of a series of decomposition of vegetable ~~tex~~ matter under the influence of heat and pressure in a limited supply of air.

(i) According to site, coal formed at the place of vegetation which is the pure form of the coal.

(ii) According to Drift → the organic matter, vegetable, trees etc. have been transported to deep depressions which under pressure and high temp. underwent gradual decomposition with the simultaneously liberation of gases like CH_4, C_2H_6, CO_2 etc.

(i) Peat coal (ii) Lignites coal (iii) Bituminous coal (iv) Steam coal (v) ~~Am Anthracite coal~~ Anthracite.

Bio-Gas :→ The gas produced by the degradation of organic matter by bacterial (anaerobic) action in absence of free oxygen is known as biogas. Mainly biogas is produced from the sewage waste, cattle dung and other organic wastes.

Gober Gas (Dung Gas) :→ In this process the fresh cattle dung and water mixed together thoroughly to make it slurry and put it into the tank in which the fermentation will take place by anaerobic bacteria in absence of free oxygen resulting in formation of methane and CO_2 etc. The maximum temp for this fermentation is 34 to 38°C. The calorific value of the Gobar gas is very low i.e. 1200 kcal/m³. Composition of gober gas is very low CH_4 50 − 55 %, H_2 = 5 to 7 %, CO_2 = 35 %, N_2 = 3 % and traces of H_2S.

Petroleum

→ Crude oil (Petra = rock , oleum = oil) is a dark greenish-brown viscous oil. It is a hydrocarbon (straight chain paraffin oil, cycloparaffin or naphthalene, olefines and aromatics) together small amount of organic compounds containing O, N, S. The oil is found upon a layer of brine and has a layer of gas on top of it. Composition is – ($C = 79$ to 87%, $H = 11$ to 14.8%, $S = 0.1$ to 3.5%, $N + O = 0.1$ to 0.5%)

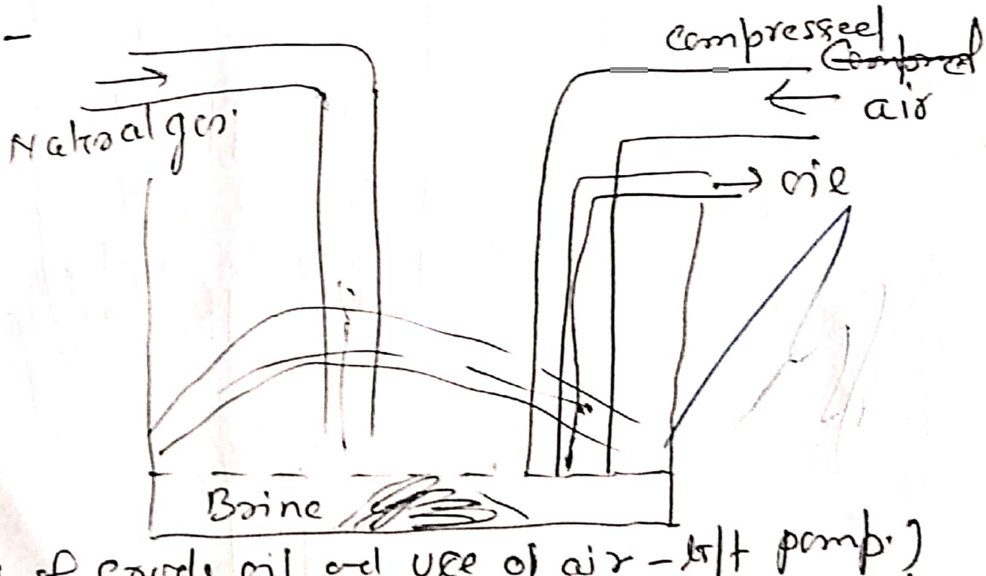
Classifications – ① Paraffinic-base type crude – saturated hydrocarbons from CH_4 to $C_{35}H_{72}$, Naphthalenes & aromatic. The hydrocarbon from $C_{18}H_{38}$ to $C_{35}H_{72}$ are semi solids, called waxes.

② Asphaltic-base type crude – cycloparafines or naphthalene and aromatic hydrocarbon.

③ Mixed base type – both of above.

Origin of Petroleum – Petroleum has resulted from partial decomposition of marine animals and vegetable organisms of pre historic forest. Due to intense heat and pressure during the age of time. The conversion of these materials into various hydrocarbons has been going on either influence of radio-active substances (like Uranium) or by the bacterial decomposition.

Mining of petroleum –



(Mining of crude oil and use of air-lift pump.)

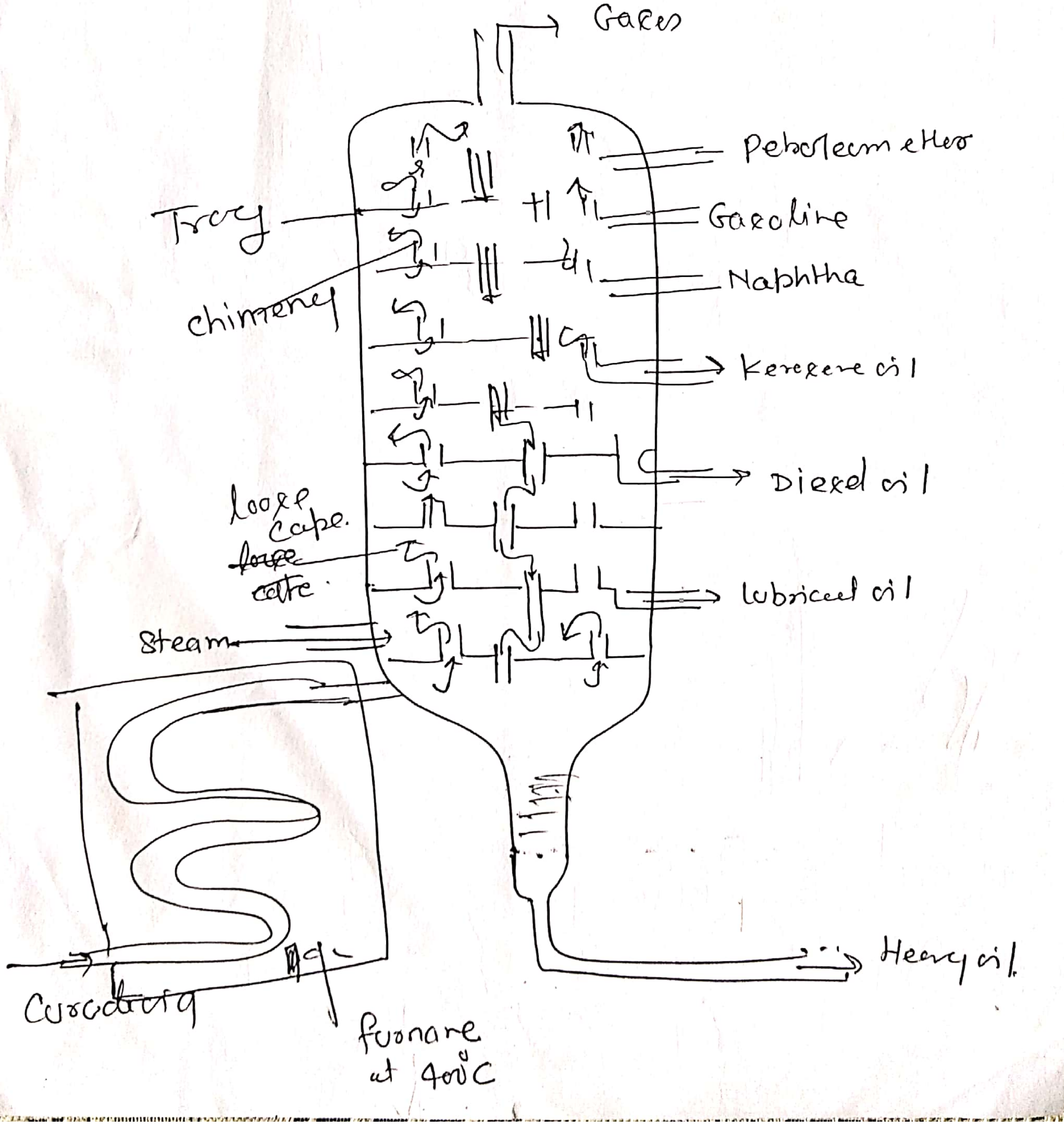
Refining of Crude Oil → This is separated by fractional distillation.

Ⓐ Separation of water – The colloidal water-droplets coalesce to form large drops, which separate out from oil.

Ⓑ Removal of harmful sulphur compounds – Treat with copper oxide. It give copper sulphide.

If solide, its remove by filtration.

(c) Fraction Distillation — The crude oil is heated ~ 400°C in an iron retort, whereby all volatile constituents except reside are evaporated. The hot vapours are passed up a fractional column, which is a tall cylindrical tower containing a number of horizontal stainless steel trays at short distances. Each tray is provided with small chimney, covered with a loose cap. As the vapours go up, they become gradually cooler and fractional condensation takes place at different height of column. Higher boiling fraction condenses first, while lower boiling turn-by-turn. (Table)



Fraction by distillation of crude

S. No.	Name of Fraction	Boiling Range	Composition of hydrocarbons	Uses ↓
1.	Uncondensed Gas	below 30°C	C_1 to C_4 iso- (ethane, propane, butane)	Domestic and industrial uses L.P.G.
2.	Petroleum ether	30 - 70°C	C_5 - C_7 →	As a solvent (organic)
3.	Gasoline or Petrol or Motor spirit	40 - 120°C	C_5 - C_9 → Cal. Val = 11,250 Kcal/Kg.	As motor fuel, solvent and in dry cleaning.
4.	Naphthalene or solvent spirit	120 - 180	C_9 - C_{10}	As solvent in dry cleaning
5	Kerosene oil	180 - 250 -	C_{10} — C_{16} C.V. = 11000, Kcal/Kg	Jet engine fuel, carburetted gas, As an illuminant,
6	Diesel oil or fuel-oil or gas oil	250 - 320°C	C_{10} - C_{18} -	Diesel engine oil.
7.	Heavy oil & This on refraction gives ↓	320 - 400°C	C_{17} - C_{30} -	For getting gasoline by cracking process.
	(a) Lubricating oil		-	As lubricant
	(b) Petroleum jelly		-	Cosmetics and medicines
	(c) Grease		-	As lubricant
	(d) Paraffin wax		-	In candles, boot polishes wax paper, tarpaulin cloth.
8	Residue may be either			
	(a) Asphalt -	Above 400°C	C_{30} or above	water proofing of roofs and road making
	or			
	(b) Petroleum Coke -			As a fuel and in moulding arc light rods.

(1) Gasoline — mixture of hydrocarbons such as C_5H_{12} (pentane) to C_8H_{18} (octane), ie. C = 84%, H = 15%, N+S+O = 1%.

(2) Kerosene oil — $C_{10}H_{12}$ to $C_{16}H_{34}$ (Hexadecane).... C = 84%, H = 16% with less the 0.1% S. — Due to high boiling range it not vaporise easily.

(3) Diesel oil — mixture of $C_{15}H_{32}$ to $C_{18}H_{38}$ —

(4) LPG → 27,800 kcal/m³.

Natural Gases — Is obtained from wells dug in the oil bearing region. When natural gas occurs along-with petroleum in oil wells,

$CH_4 = 70-90\%$, $C_2H_6 = 5-10\%$, $H_2 = 3\%$, $CO+CO_2$ = rest

CNG → high pressure ~ 1000 atms. pressure. A cylinder containing 15 kg — contains 2×10⁴ L or 20 m³ of natural gas at 1 atm. pressure.

Biomass → It's a waste organic matter (from the dead plants and animals) which used either as a source of energy (by burning or biogas production) and/or as a chemical feedstock. For eg. wood, cattle dung, bagasse (remaining part of sugar cane) poultry wastes, vegetable waste, waste paper, waste cotton cloths, plant wastes, dead animals, sewage etc. Biogas consist of carbon compound.
. Some are directly uses in chulhas for getting energy.
Biomass is converted into biogas,
Biogas → old notes.

Solar → The energy (heat and light) obtained from the sun, ie called solar energy. The sunlight falling on the earth during a day time delivers energy which is 50,000 times the total energy used all over the world in 1 year. ~ 0.64 kJ of solar energy reaches every square meter of earth's surface second.

Harnessing → Solar can collect in the form of concentrated. (because it's in scattered form

(i) Direct use → We know, solar cooker, heaters

(ii) Indirect harnessing – (a) Converted solar energy to chemical energy in plants (biomass)

(b) Solar Power Plant → Sun rays are reflected by huge concave on black painted coil-type pipes (containing water), kept inside dark boxes, painted black from inside. Infrared rays of Sun rays are traped inside the large box, and these heat up the water, and convert it into steam. The hot steam under pressure is then made to rotate a steam-turbine, which in turn rotates the armature of generator, thereby producing electricity.

Solar Cell → Two type (n & p-type) of semiconductors are used. Pieces of semiconductor materials of two types (called wafers) are so arranged that when light falls on them, then a potential difference (of about ~0.4–0.5V) is produced between them. In an actual, a large number of solar cells are joined together in a definite pattern to get solar cell panel, which is capable of providing sufficient electric power to lift water from deep well or light in a houses, ---