D: ....../....../......

FUELS

Classification of fuels:

(1.) On the basis of occurence
(2.) on the basis of physical state

(1.) On the basis of occurence :

- Natural or primary fuels
  - which occur in nature as such. like wood, coal.
- secondary or derived fuels.
  - These are derived from natural fuels. eg. petrol

(2.) On the basis of physical state/state of aggregation:

(Natural)

- solids
  eg. wood, coal
- liquids
  eg. petroleum
- gaseous
  eg. Natural gas

(Secondary)

- Solids
  eg. coke
  charcoal
- liquid
  eg. kerosene
  petrol
- gases
  eg. coal gas
  water gas.

D1......./......./.......

(x) calorific value : (CV)

One of the most imp. characteristic of the fuel. It is a measure of the efficiency of the fuel:
calorific value of a fuel is " The total quantity of heat liberated when a unit mass (or volume) of a fuel is burnt completely.

Units

	Solids / liquid	Gaseous
CGS	calories/g	calories/cm^3
MKS	Kcal/kg	kcal/m^3
BTU	BTU/lb	BTU/ft^3

1 cal = 4.18 Joule

calorific value :

Gross calorific value/ (GCV) (HCV)
high calorific value

Net calorific value (NCV)/
Lower calorific value (LCV)

NCV = GCV − Latent heat

It is done in a ~~a~~ closed system, so latent heat is released as fuels carry hydrogen The product of combustion do not escape.	It is carried out in an open system, so no latent heat is released as the product of combustion ~~is~~ escape.

Niharika

Dt......./....../.......

GCV = It is the amount of heat generated when a unit amount of fuel is completely burnt in O_2 and the products of combustion are not allowed to escape and cooled down to ~~room~~ room temp (15°C or 60°F).

Usually all fuels have sufficient amount of H_2, the H_2 present during combustion is converted into steam. As the products of combustion are not allowed to escape & are cooled down to Room Temp. The steam gets condensed into water and latent heat of steam is evolved which also gets included in the measured heat. Thus, gross calorific value is also known as HCV.

NCV = It is defined as the net heat produced when a unit quantity of fuel is completely burnt in O_2 and the products of combustion are allowed to escape.

In actual practice, when the fuel is burnt, the water vapour formed due to the presence of Hydrogen in the fuel is not condensed and escapes along with the hot ~~combustion~~ combustion gases. Hence, a lesser amount of heat than GCV is available. Therefore this is also known as Lower calorific value (LCV)

Dt……/……/……

1.25 mA

LCV = HCV − Latent heat of steam

$H_2 + 1/2\,O_2 \longrightarrow H_2O$

LCV = HCV − weight of H_2 × 9 × Latent heat of steam

= HCV − weight of H_2 × 9 × 587 cal/g

= HCV − 9/100 H × 587 cal/g

LCV = HCV − 0.09 H × 587 cal/g or kcal/kg

Determination of calorific value :

(1.) Bomb's calorimeter (experimental method)

(2.) Dulong's formula (Theoretical method)

Theoritically, calorific value of a fuel can be calculated if the percentage of the constituent elements are known, acc to Dulong, the calorific value of a fuel is the sum of the calorific values of its constituents.

Constituent	H	C	S
HCV kcal/kg	34,500	8080	2240

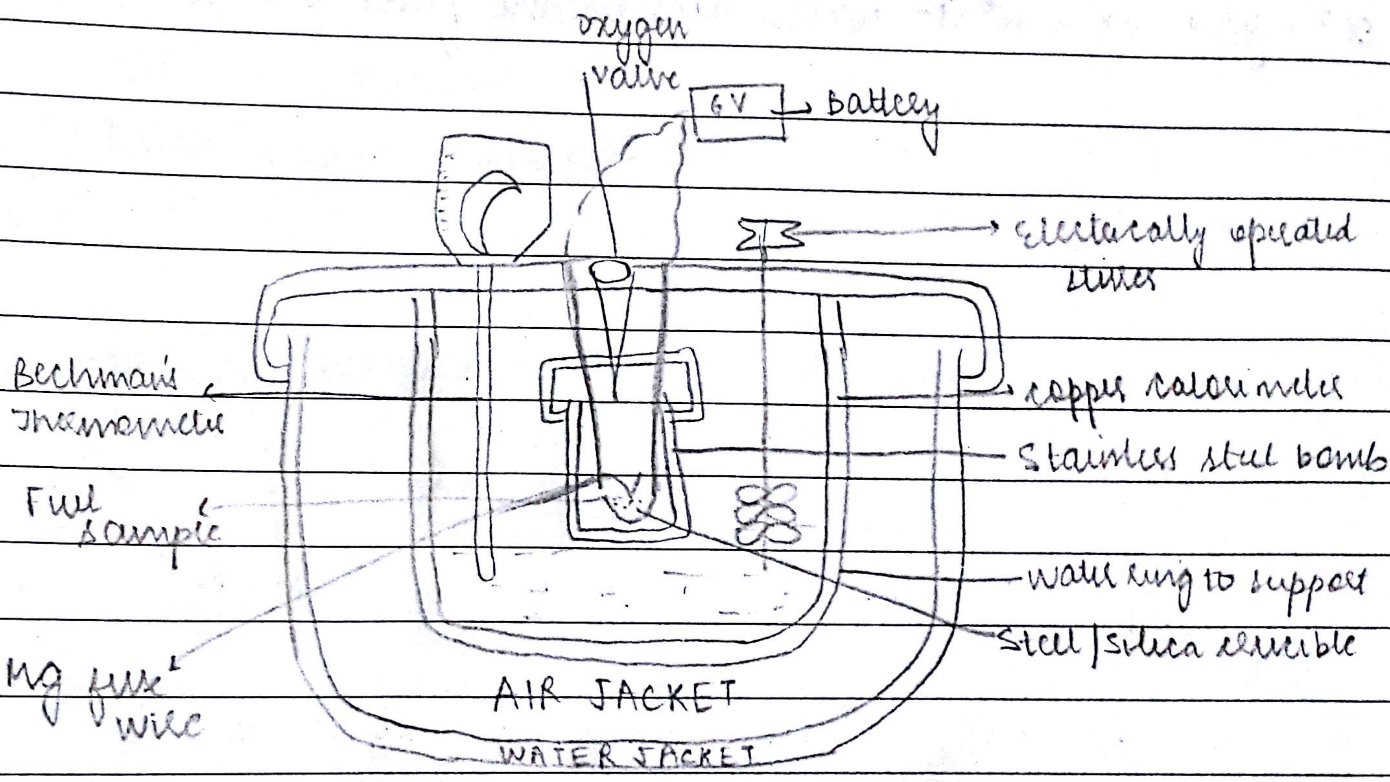
$$HCV = \frac{1}{100}\left[8080C + 34{,}500\left(H - \frac{O}{8}\right) + 2240S\right] \text{kcal/kg}$$

(C, H, S, O are in percentage)

LCV = GCV − 0.09 H × 587 kcal/kg

~~$\vec{F} = 18z\hat{i} - 12\hat{j} + 3y\hat{k}$ and S is a surface of the plane $2x + 3y + 6z = 12$~~

Determination of calorific value (Bomb calorimeter)



- To measure CV of non-volatile liquids and solids

Principle - Law of conservation of energy

Heat gained = heat lost.

Dt....../....../.......

- The bomb calorimeter consists of one stainless steel bomb with air tight lid
- Cu calorimeter containing known amount of water
- crucible made of ~~silica~~ stainless steel / nickel
- Stirrer
- Thermometer
- Electrodes (stainless steel)
- The calorimeter is surrounded with air and water jackets.

(*) WORKING:

A known amount of fuel is taken in the crucible (in g). A fine mg wire touching the fuel sample is secured across the electrodes. Bomb lid is tightly screwed. Bomb is filled with O_2 at 25 atm pressure. It is lowered in the calorimeter containing water. Electrodes are connected to a 6V battery. Sample burns and heat is liberated. Uniform stirring of water is done, and max temp attained is recorded with Beckman's Thermometer.

x = mass of fuel in grams of fuel sample taken in crucible.

W = water equivalent of calorimeter, stirrer, thermometer etc (apparatus)

water equivalent =

No. of calories ~~requied to~~ required to heat the calorimeter to one degree.

(*) ~~write a programme to insert the record in a file by using the structure or union.~~

(*) ~~fscanf and fprintf~~

~~fscanf (f-n, f-s, v)~~ → filename, file structure, variable

~~fprintf (f-n, f-s, v)~~

t_1 = initial temp of water (°C)
t_2 = final temp. of water

$\left.\begin{matrix} t_1 \\ t_2 \end{matrix}\right\} t_2 - t_1 = \Delta t$

Heat liberated by fuel $= x \times HCV$

Heat gained by water $= W \times (t_2 - t_1) \times 1$

Heat gained by calorimeter $= \cancel{W_2}\ w \times (t_2 - t_1)$

Total heat gained by water and calorimeter :-
$(W + w)(t_2 - t_1)$

Applying principle of conservation of energy

Heat loss = Heat gain

$x \times HCV = (W + w)(t_2 - t_1)$

$$\boxed{HCV = \frac{(W+w)(t_2 - t_1)}{x}} \text{ cal/g}$$

$$\boxed{LCV = HCV - 0.09H \times 587} \text{ cal/g}$$

Dt......./....../....

Corrections

(1.) fuse wire correction (t_f) (−) → This is subtracted

(2.) Acid correction (t_a) (−) → This is also subtracted

(3.) cooling correction (t_c) (+) → This is added

Acid correction :

$$S + O_2 \longrightarrow SO_2$$

$$2SO_2 + 2H_2O + O_2 \longrightarrow 2H_2SO_4$$

$$2N_2 + 5O_2 + H_2O \longrightarrow 4NO_3$$

Exothermic reaction

The loss

$$HCV = \frac{(W+w)(t_2 - t_1 + t_c) - (t_a + t_f)}{x}$$