Bio Mass Energy

→ Bio mass is an organic matter which include all plant, tree, animals and micro-organism Grown on land and water and their derivative.

→ Plant matter is created by process of photosynthesis is called bio mass and photosynthesis process drives energy from solar radiation hence it is a indirect form of solar energy.

→

$$CO_2 + H_2O \xrightarrow{E = h\nu = \frac{hc}{\lambda}} CH_2O + O_2$$

* The varies resources of bio mass is classified as.

1. Concentrated waste/Residue (High energy content)
   eg. → Municipal residue
2. Dispersed waste
   eg. → Crop Residue
3. Harvested Residue
   eg.- standing Residue.

Methods to obtain Bio mass energy :-

1.) Thermochemical Methos -(a) Combustion Method
(b) Gasification Method.

(a) Combustion Method :- wood is the one of primary biomass which is directly burnt to obtain thermal energy from its chemical energy.

→ Very less efficiency $\eta_{eff} \approx 10\%$.

→ High level of pollution

(b) Bio-mass Gasification Method :-

→ Bio mass gasification is the process of partial combustion in which solid biomass usually in form of residue is converted into combustible gases.

→ It passes through the following process in the gasifier.

(i) Drying :- The biomass is first dried and its moisture is removed and its temp is about 120°C

(ii) Pyrolysis zone :- Biomass in this zone is heated upto 600°C for the exothermic reaction by which it's structure will be broke down.

(iii) Oxidation :- During this process a predetermined air is supplied through the nozzel for the combustion reaction of the bio mass.

→ As a result of combustion reaction the

resultant product is CO_2 and H_2O vapour are formed and temp. reaches to 1200°C.

(iv) Reduction :- The product of Combustion is further passed and it's temp. will decrease as a result of endothermic reaction because of Reduction of biomass and produces gas as form, which calorific value is 1700 KJ/kg. Producer gas can be use as fuel in ic engine, in si-engine may be directly but in ci engine it is used as dual fuel.

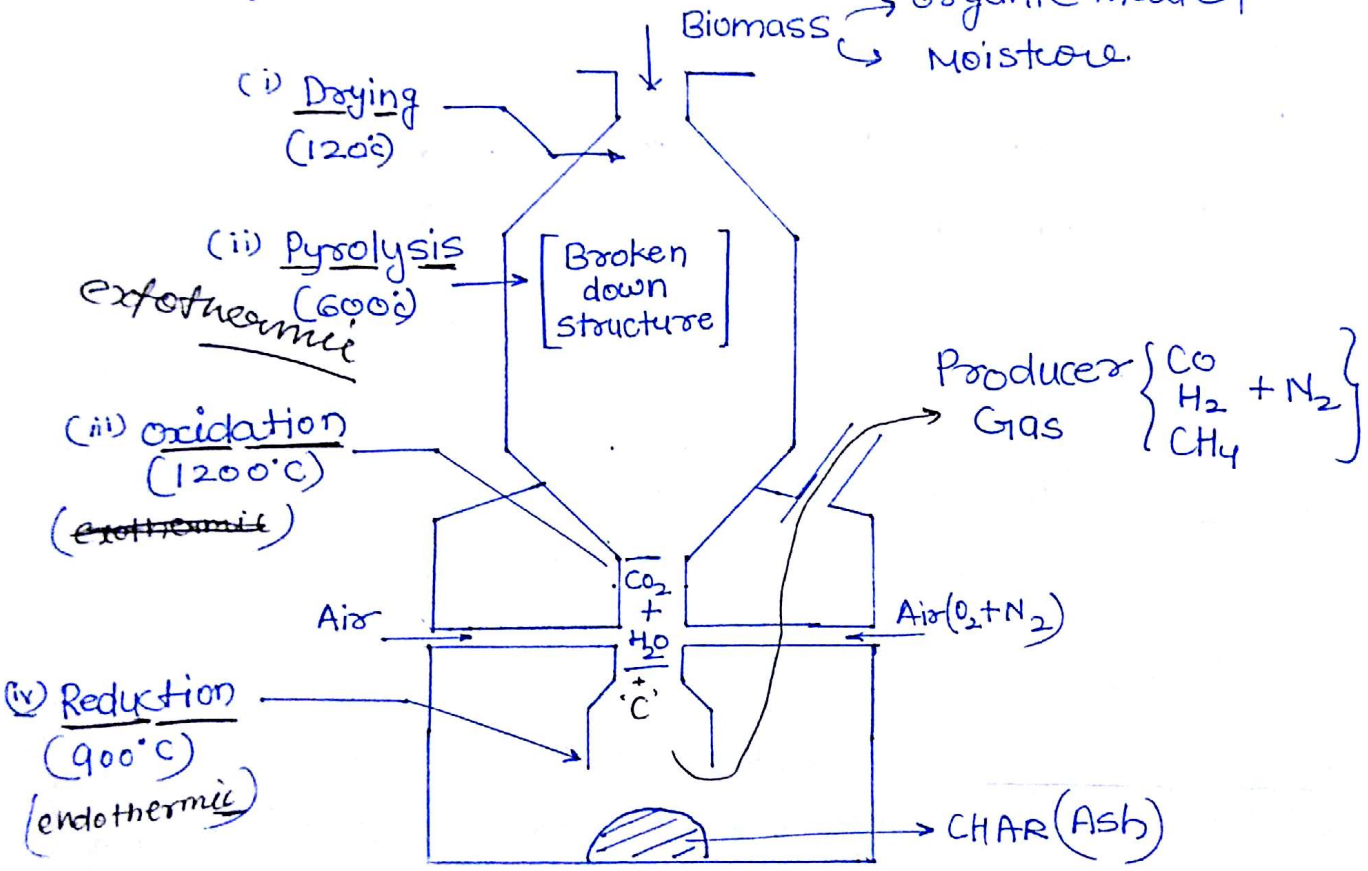


Fig:- Bio Mass Gasifier

Note:- At the end of reduction zone biomass is fully consumed and it gives produces Gases.

Reduction:-

$$C_{O_2} + C \longrightarrow 2CO$$

$$H_2O + C \longrightarrow CO + H_2$$

$$2.H_2 + C \longrightarrow CH_4$$

Imp temp. order:-

Oxidation > Reduction > Pyrolysis > Drying

(1200°C) (900°C) (600°C) (120°C)

Note:- $C \xrightarrow[\Delta C_1]{O_2} CO \xrightarrow[\Delta C_2]{O_2} CO_2$ $(\Delta C_2 >> \Delta C_1)$

$$\Delta C_1 + \Delta C_2 = \Delta C$$

Problem:-
A biomass gasifier is used to run a CI engine based diesel cycle. The engine operates in dual fuel mode with 80% diesel replacement. The Gasifier engine system produces 200 kW of power IF the overall engine efficiency is 35%. if the Calorific value of the producer gas is 16800 kJ/kg. and the efficiency of Gasifier is 75%, then determine the rate of producer gas requirment in (kg/hr) and also bio mass feeding rate in (kg/hr)

Soln B.P. = 200 kW

$$\eta_{overall} = 35\% = \frac{B.P.}{(HA)}$$

$$HA = \frac{(200)}{0.35} \times \text{[illegible]} = 571.42 \text{ kW}$$

HA = 571.42 kW

80% diesel replacement. (Biomass).

$(HA)_{producer} = (571.42)(0.80) = 457.14$ kW

$(HA)_{producer} = \dot{m}_f \times (CV)_f$

$457.14 = \dot{m}_f \times (16,800)$

$(\dot{m}_f)_{producer\ Gas} = 0.027$ kg/sec. $= 97.95$ kg/hr.

$\eta_{gasifier} = 75\% = \dfrac{(\dot{m}_f)_{producer}}{\dot{m}_{biomass}}$

$(\dot{m})_{biomass} = \dfrac{97.95}{0.75} \Rightarrow (\dot{m})_{biomass} = 130.7$ kg/hr.

Also determine the compression ratio if cut off ratio is 2.5 & relative efficiency 60%.

$\eta_{relative} = \dfrac{\eta_{brakethermal}}{\eta_{diesel}} = 60\%$ (brakethermal $\rightarrow$ 35%)

$\eta_{diesel} = 0.5833 = 1 - \left(\frac{1}{r}\right)^{\gamma-1} \cdot \dfrac{(\rho^{\gamma}-1)}{r(\rho-1)}$

$= 0.5833 = 1 - \left(\frac{1}{r}\right)^{1.4-1} \dfrac{(2.5^{1.4}-1)}{1.4(2.5-1)}$

$\gamma = 15.31$

If the clearance volume is $V_c = 300\ cm^3$ then determine the cylinder dimension if the engine ratio is 1.5.

$$\frac{V_s}{V_c} = \gamma - 1 \Rightarrow \frac{V_s}{300} = (15.31 - 1)$$

$$V_s = 4,293\ cm^3$$

Engine Ratio $L/D = 1.5 \Rightarrow L = 1.5\,D$

$$V_s = \frac{\pi}{4} D^2 L = 4293$$

$$\frac{\pi}{4} \times D^2 \times 1.5\,D = 4293$$

$$D = 15.39\ cm$$

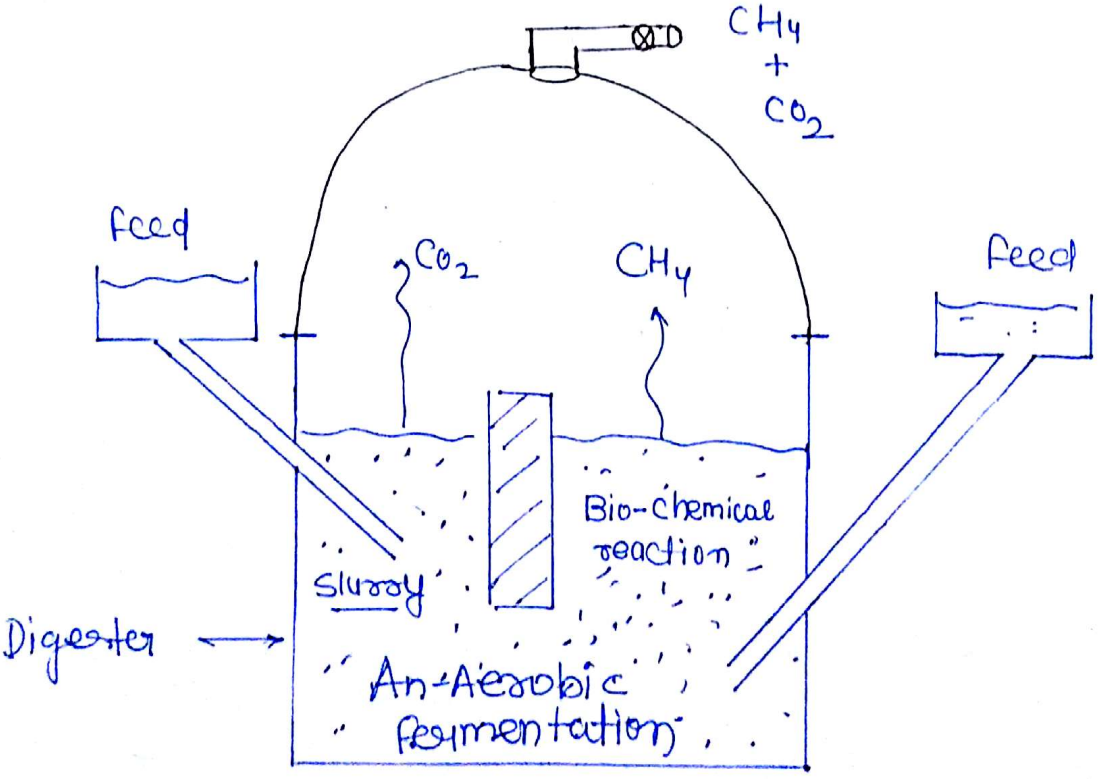
$$L = 1.5D \Rightarrow L = 23.09\ cm.$$

2. Bio-chemical Method :-

Fermentation and digestion :- Bio gas is produce by anaerobic (No O_2)

Fermentation of wet-life stock and the plant use for bio-Gas production is known as biogas plant.

→ It contains two major part one is digester in which gas generation takes place because of fermentation and the Gas is collected in the second part which is known as dome.



Note :- The Biogas by Biochemical reaction is having 4 to 5 times the Colorific value as compare to producer gas.

Bio Ethanol & Bio Diesel :-

Bio ethanol & Bio diesel are the alternative fuel which having the potential to replace diesel and petrol and it is obtained by fermentation of special biomass (special plant)