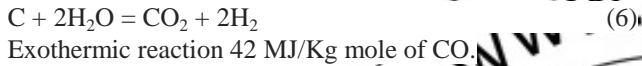


Endothermic reaction 130 MJ/Kg atom of carbon. This practice is termed "wet-gasification" and has the added advantage of dropping the temperature in the immediate vicinity of the hearth and reducing the formation of clinker.

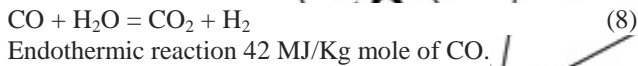
This equation(4) is very important in producer gas generation as it can enrich the gas manufactured with hydrogen, thus enhancing its calorific value. The other reaction with carbon/steam occurs at lower temperature and predominated between 500-600°C.



A further steam reaction which occurs in the gas producer with an excess of steam is the water gas shift reaction. This should be avoided in the producer gas generation as it reduces the cold gas efficiency, though, on the other hand, it reduces the CO which is highly toxic in the fuel gas distribution for public use.



Factors affecting gasification are air velocity, zone thickness, particle size and chemical composition of the feed. In the process design the after-treatment of the gas is also very important that the CO leaving the reduction zone should be cooled rapidly to below 600°C as it breakdown, to soot predominated at high temperatures. This cooling down of the hot gases reduces the deposit of soot and is called "Freezing the equilibria".



7. Design Details

Fuel : Coconut Shell
 Power rating: 5 kW

7.1. Properties of coconut shell

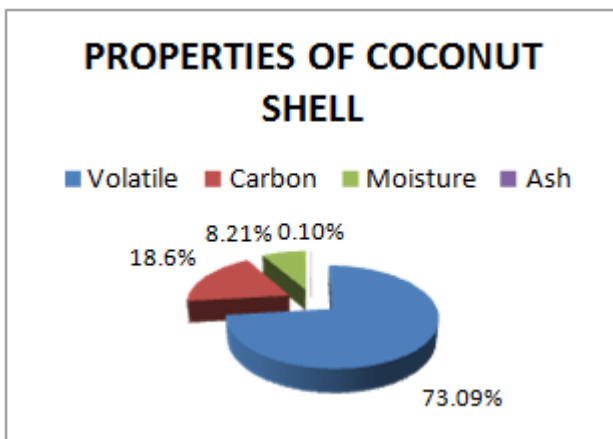


Figure 4: Properties of coconut shell

7.2 Element analysis by weight

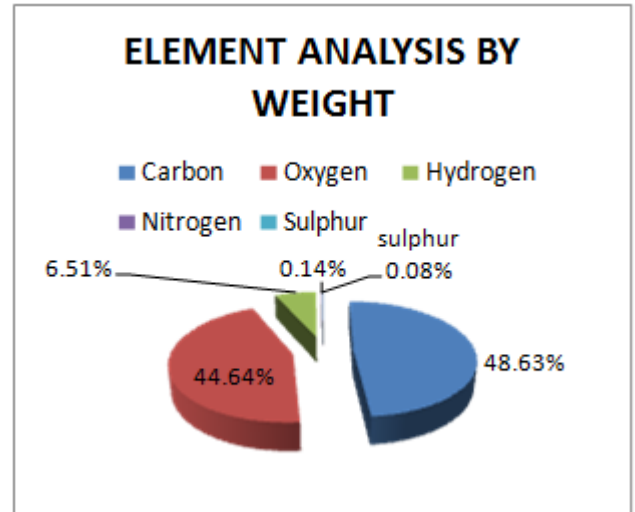


Figure 5: Element analysis by weight

7.3. Air consumption

$$= \frac{100}{23} \left[2.67 \times C + 8 \left(H - \frac{O}{8} \right) \right]$$

$$= \frac{100}{23} \left[2.67 \times 0.4863 + 8 \left(0.0651 - \frac{0.4464}{8} \right) \right]$$

$$= \frac{100}{23} [1.2984 + 0.0744]$$

$$= 5.65 \text{ Kg of air / Kg of fuel.}$$

7.4. Gasification air requirement

By taking 30% of total air requirement for incomplete combustion and gasification.

$$= \frac{30}{100} \times 5.65$$

$$= 1.695 \text{ Kg of air / Kg of shell.}$$

7.5. Sizing of hearth

Specific gasification rate = 900 Kg/m²hr .

Gas generated per Kg of Coconut Shell

$$= 0.9 \times 1.695$$

$$= 2.595 \text{ Kg of gas / Kg of shell.}$$

For 5 Kg of Coconut Shell

$$= \text{Total gas generated / Hr}$$

$$= 5 \text{ Kg} \times 2.595$$

$$= 12.975 \text{ Kg of gas.}$$

7.6. Area of hearth grate

$$= \text{Total gas rate / SGR}$$

$$= 12.975 / 900$$

$$= 0.0145 \text{ m}^2.$$

7.7. Diameter of hearth

$$\text{Area} = \frac{\pi}{4} d^2$$

$$0.0145 = \frac{\pi}{4} d^2$$

$$d = 13.5 \text{ cm .}$$

7.8. Size of inlet nozzle

Considering the air velocity as 6 m/s

Air requirement for one hour
 = 1.695 × 5 Kg of shell
 = 8.295 Kg of air.

$$\text{Area of inlet nozzle} = \frac{\text{Total air}}{\text{Velocity of air}}$$

$$\frac{\pi}{4} d_1^2 = \frac{8.295}{6 \times 3600}$$

$$d_1 = 0.022 \text{ m (or) } 22 \text{ mm.}$$

7.9. Design of hopper

Time between 2 feed = 5 Hr
 Density of coconut shell = 300 Kg/m³
 Length / Height of hopper = l_h
 Diameter of hopper = d_h

Considering Slenderness ratio

$$d_h / l_h = \frac{100}{23} d_h$$

$$\text{Storage volume} = \frac{\pi}{4} d_h^2 \times l_h$$

$$\frac{5}{300} = \frac{\pi}{4} \times (1/4)^2 \times l_h$$

$$l_h = 0.697 \text{ m (or) } 69.7 \text{ cm.}$$

Height of Hopper = 69.7 cm.
 Diameter of Hopper = 69.7 / 4 = 17.43 cm.
 Distance between Inlet nozzle and Grate = 10 cm.

7.10. Overall dimensions of gasifier

Table 1: Overall dimensions of gasifier

Hearth Diameter	13.5 cm + Insulation
Inlet Air Nozzle Diameter	2.2 cm + Insulation
Diameter of Hopper	18 cm + Insulation
Height of Hopper	70 cm

Figure 6 shows the designed downdraught gasifier for coconut shell.

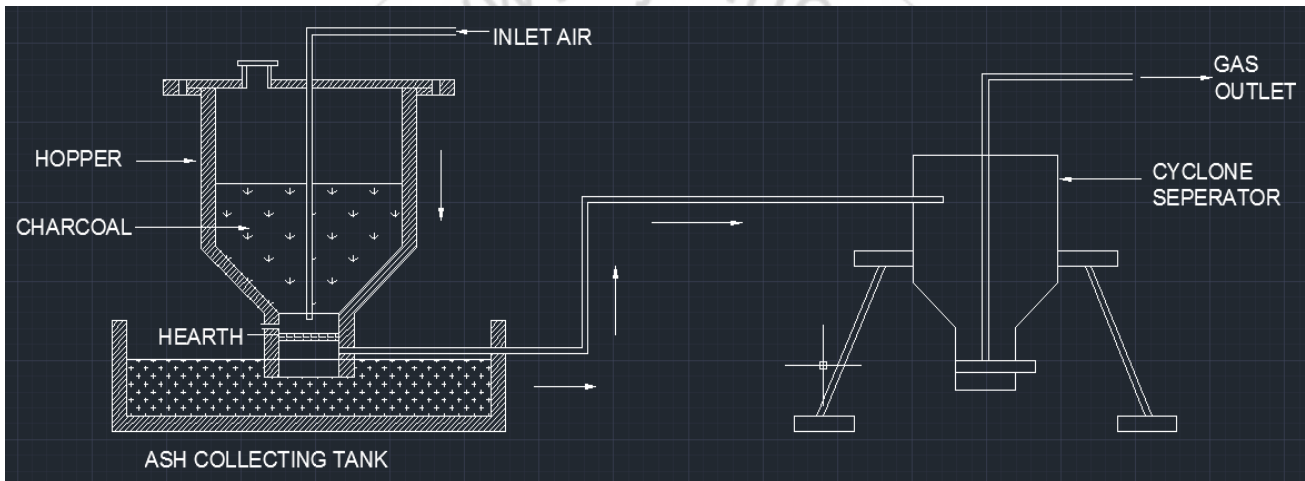


Figure 6: Downdraught gasifier for coconut shell.

8. Applications

8.1 Small Size Gasifier (upto 10 kW)

Normally this type of gasifiers shall find applications in rural areas, especially for providing shaft line power to agriculture pumps, processing, machinery and agriculture-processing machineries like Thrashers, straw choppers, etc.

8.2 Medium Size Gasifier (10kW - 50kW)

This type of gasifiers can easily meet the shaft line power requirements of various rural industries like saw mills, carpentry workshops, mechanical fabrication shops as well as small rice mills. They can also be used as a source of electrical energy in milk chilling centers, primary health coverage centers and for rural electrification.

8.3 Large Size Gasifier (50kW and above)

This type of gasifiers can be used in urban industries, besides being a source of decentralized electrification. They

can meet the shaft power requirements directly or indirectly of various industries like dairy, oil mill, mineral processing, brick manufacturing, ceramics, pottery industries, etc. These gasifiers can also be used in mining operations, forest based wood processing units, well drilling, etc.

9. Conclusion

The biomass gas is useful in many ways.

- Using for domestic application.
- Used as fuel for running IC engines.
- Research and Development work is going on for developing Wankel engine with biomass fuel.

Many industries are now exploring with greater enthusiasm in adopting gasifier for generating thermal energy for industrial use as an alternative.

10. Acronyms

Table 2: Acronyms.

A/F	Air Fuel ratio
C	Carbon
CO	Carbon monoxide
CO ₂	Carbon dioxide
H ₂	Hydrogen
HC	Hydrocarbon
H ₂ O	Water
N ₂	Nitrogen
MT	Million Tones

11. Nomenclature

Table 3: Nomenclature.

cm	Centimeter
°C	Degree Celsius
g/hr	Grams / hour
Hr	Hours
Kg	Kilogram
Kg/m ³	Kilogram per cubic meter
Kg/hr	Kilogram per hour
Kg/min	Kilogram per minute
kJ/Kg	Kilo joule per Kilogram
J	Joule
kJ	Kilo joule
MJ	Mega joule
kW	Kilowatt
m	Meter
m ²	Square meter
m/s	Meter per second

Reference

- [1] "Nonconventional energy sources" by G.D. Rai
- [2] "Renewable energies for rural area" by Astra

Author Profile



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