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BioGas Basics

By David Cilliers



What is BioGas?



- This gas production occurs naturally through decomposition in the absence of oxygen (Anaerobic).
- A methane rich gas.
- Commercially generated from waste.
 - In some countries crops are grown for the specific purpose of producing biogas.
- Used to replace fossil fuels.

What is BioGas?

- It is also called Marsh or Swamp gas.
 - Naturally occurs in these places.
- Most organic waste left to decompose will produce BioGas.





BioGas description

- BioGas is not a single gas.
 - Methane 45-65%
 - Carbon Dioxide 35-55%
 - Other gasses less than 5%
 - Water vapour
 - Hydrogen Sulphide
 - Nitrogen
 - Oxygen
 - Ammonia



BioGas description

- Methane is the most important gas.
 - Combustible and therefore valuable as fuel.
 - Tasteless, odorless and colorless.
 - Lighter than air, safety bonus compared to LPG.
 - Often people think they are smelling methane, but are in fact smelling H_2S .
- Hydrogen Sulphide (H_2S) is foul smelling and corrosive gas.



Organic Waste



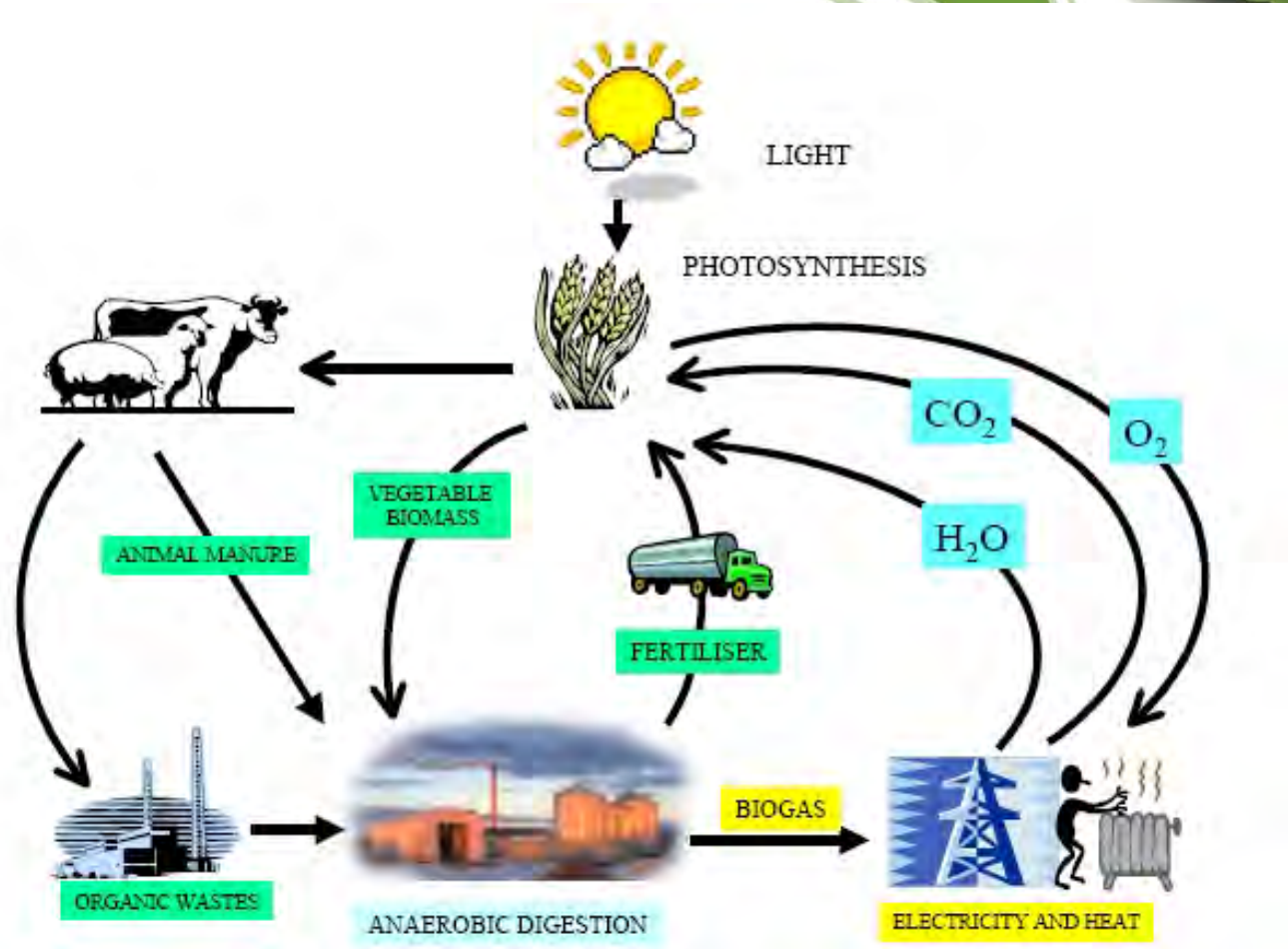
- Organic *def.* – Relating to or derived from living matter.
- With the exception of a few substances all organic matter is suitable for BioGas production. Incl:
 - Fruit and Veg (and related waste).
 - Agri waste (Plant matter).
 - Manures.
 - Waste waters (containing organics).

Triple Benefit of BioGas



- It is important to view the BioGas process with regard to its three benefits and not purely as fuel.
 1. Combustible gas for fuel
 2. Responsible waste disposal
 3. Nutrient rich by-product used as fertilizer
- In rural applications also has major health benefit when compared to wood burning.

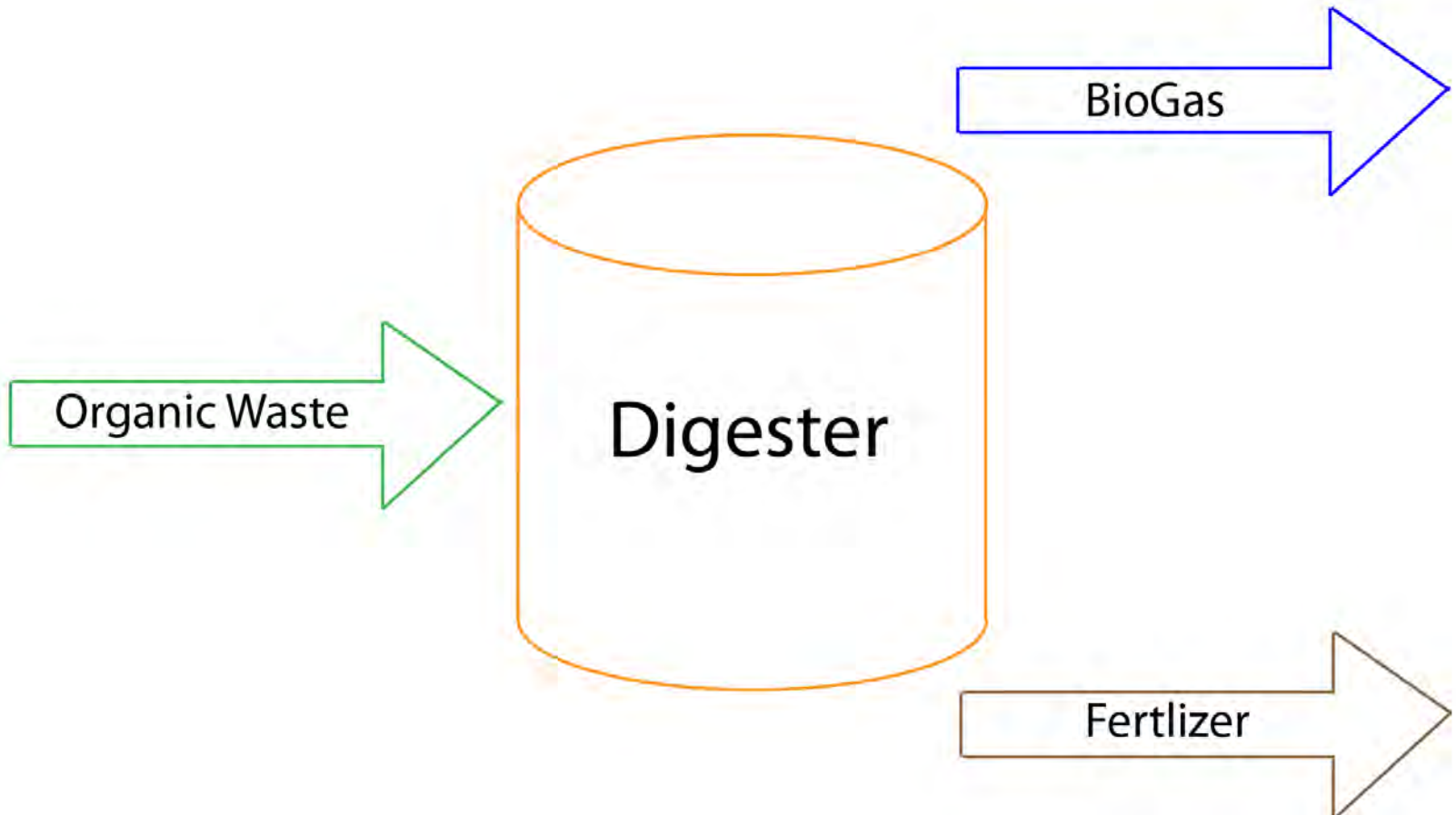
Completing the cycle



Anaerobic Digestion (AD)



- Organic matter broken down by micro-organisms in the absence of air.
- Air is toxic to bacteria.
- Many different variable to control in order to maintain efficiency.
- Waste and bacteria housed in air-tight tanks – digesters.
- Importance of quality development.



The potential of one cow



Electricity

791 kWh/Cow/Yr

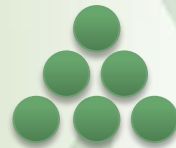
Value @ R1/kWh = R791



Heat

1144 kWh/Cow/Yr

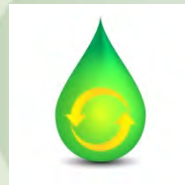
Value @ R0,25/kWh = R286



Solids

4 ton/Cow/yr

Value of Phosphate R900



Liquid Effluent

14 ton/Cow/yr

Value of N,K R1100

1 Dairy Cow



Potential value of ONE dairy cow = R3 077

3 phases of AD



- Different bacteria play different roles.
- Generally 3 phases happen concurrently.
 1. Hydrolysis
 2. Acidification
 3. Methanogenesis
- Each stage requires specific bacteria.
- Each bacteria requires correct conditions.

3 phases of AD



Hydrolysis

- Complex compounds made water soluble

Acidification

- Formation of acids from simple compounds (Acetic and other)

Methanogenesis

- Acids converted into CH_4 and CO_2

3 phases of AD



- Each of these phases requires their own set of parameters.
- What is good for one phase may not be good for the other.
- A fine balance is important to achieve best results.
- Phases can be done concurrently or separately.

Variables

- A digester is considered a living organism.
- NB parameters:
 - Temperature
 - pH
 - Rate at which organic are loaded
 - Time spent in digester
 - Solid content
 - Degree of mixing
 - C:N ratio

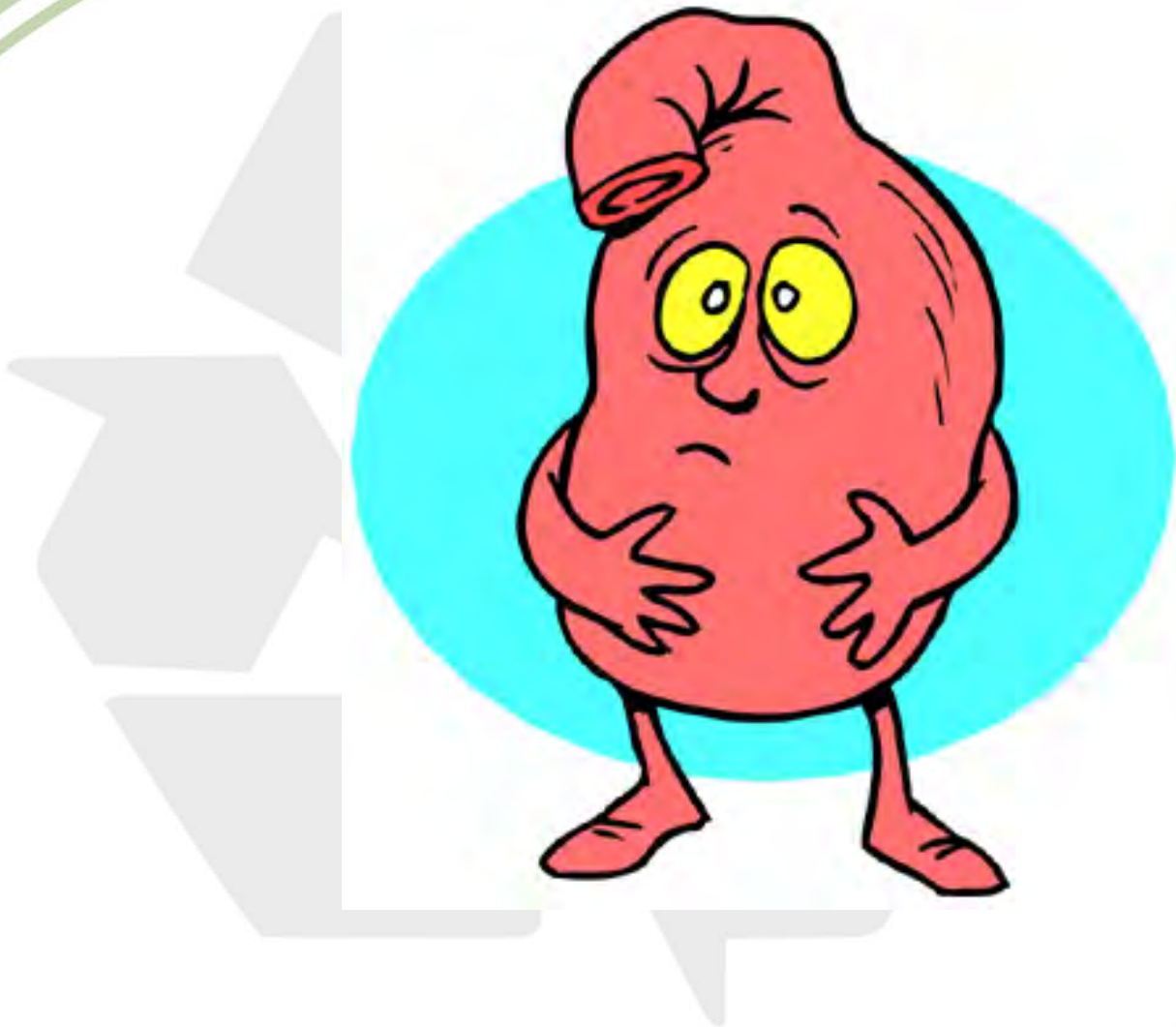


Variables

- Process parameters differ based on:
 - Feedstock
 - Digester design
 - Climate



The stomach analogy



The stomach analogy

- Easy to look at digester like a stomach.
- We take in liquid and solids – output liquid, solid and gas!
- To keep our stomach's healthy we need the right amount of solid and liquid, acids and bases.
- Durban Curry = Just Flames, no gas.



Digester Design



- As with most technologies, there are a variety of designs available to accomplish a task with varying degrees of success.
- Choice is based on:
 - School of thought
 - Budget
 - Required efficiency
 - Application

Digester design

- Two main categories of digester:
 1. Continuously fed
 2. Batch fed
- Both of which can be:
 - Underground
 - Above ground



Continuously Fed

- Waste added at consistent intervals.
- Digester can hold 15-40 'intervals'.
- When waste is added, slurry is removed.
- Waste is generally in liquid form.
- Solid content of 8-15%.
- Commonly
 - CSTR type
 - UASB type

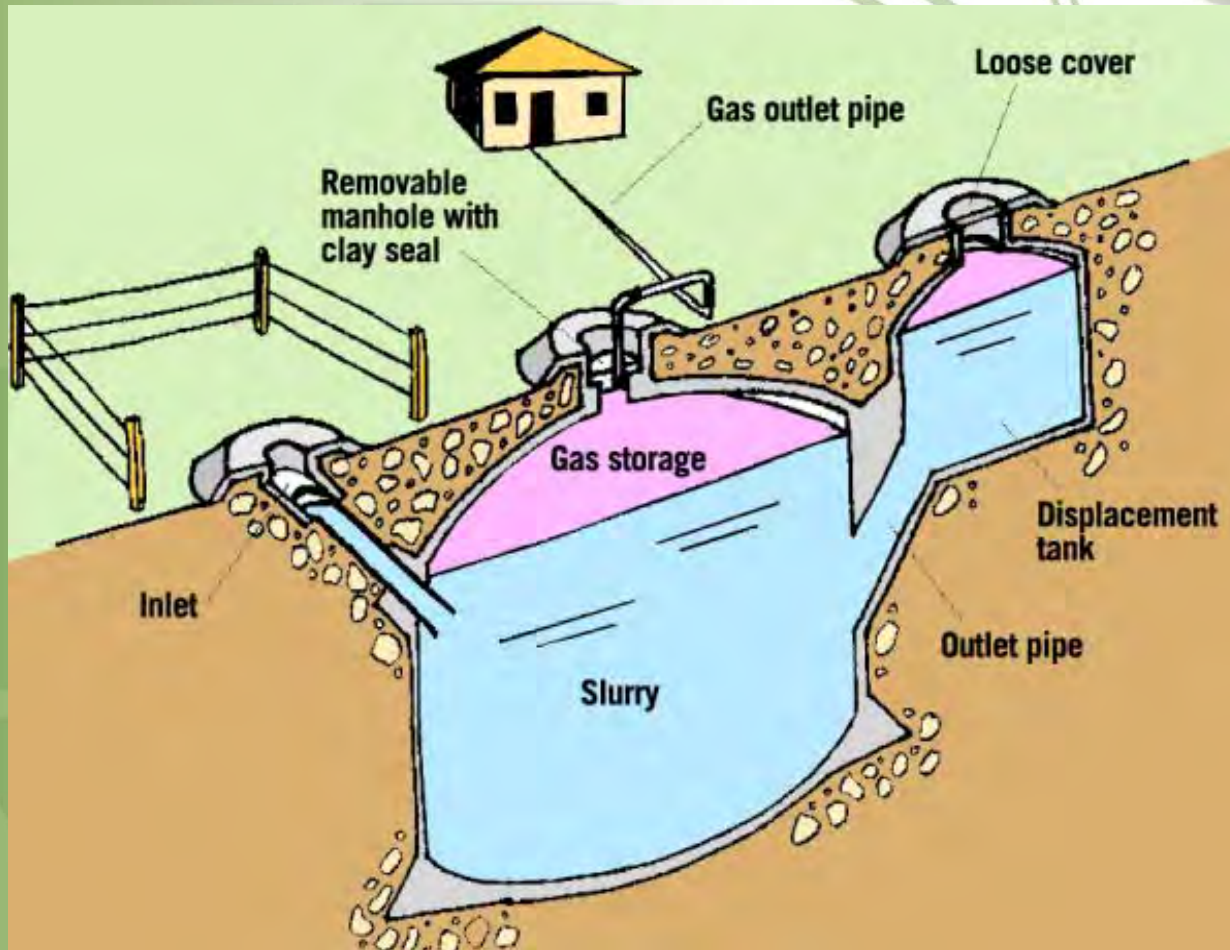


Batch Fed

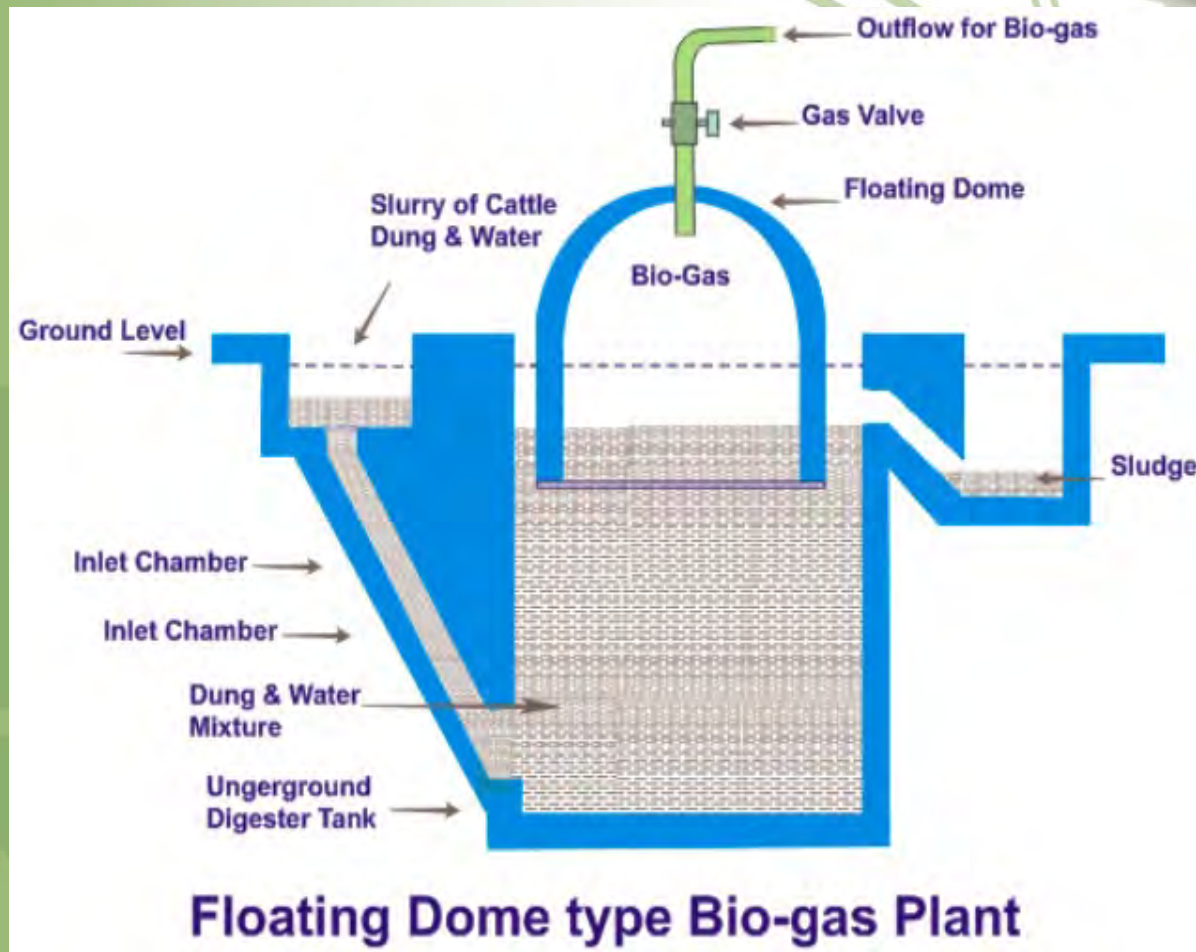
- Waste is added, and then left to completely digest.
- For applications when waste is not available every day.
- Digester is big enough for one 'batch'
- Once digested, emptied and filled with new waste.
- Often higher solid content.



Chinese fixed dome

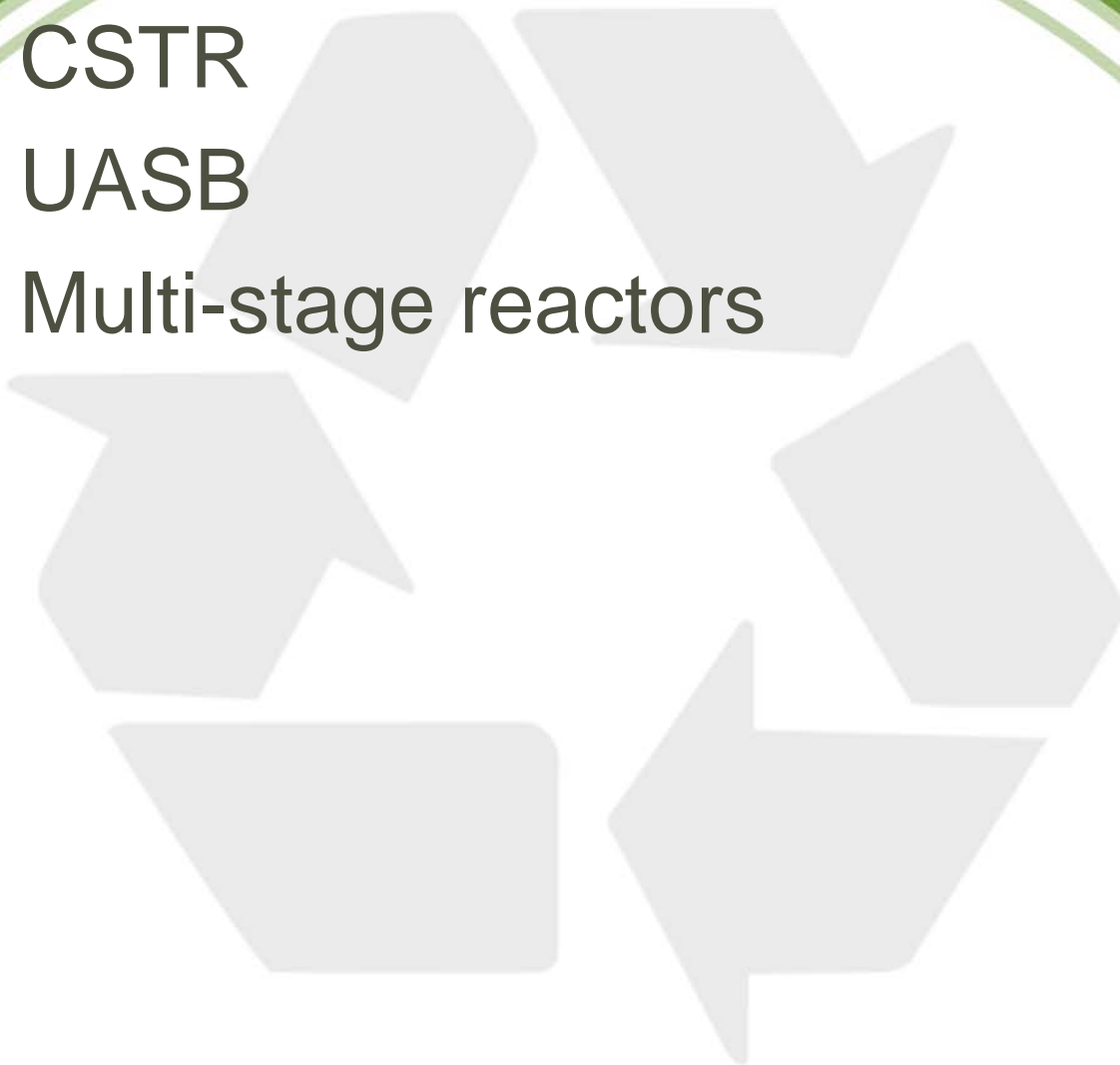


Indian Floating Drum

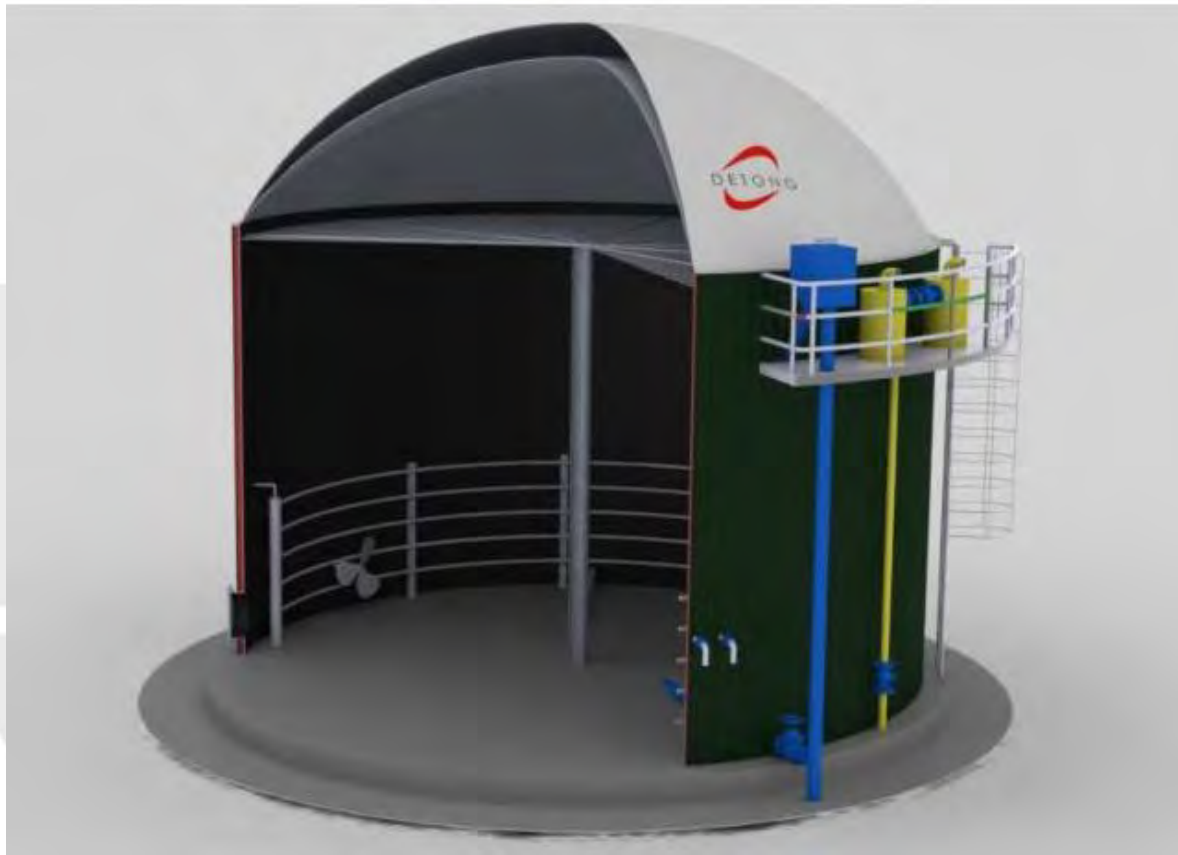


Advanced Designs

- CSTR
- UASB
- Multi-stage reactors



CSTR



BioGas purification

- Reasons for purification:
 - H_2S is poisonous in certain quantities.
 - H_2S is a corrosive gas.
 - CO_2 has no calorific value and therefore consumes storage space for no benefit.
 - When H_2S is combusted it releases harmful SO_2 into the atmosphere.



Storage



- CO₂ prohibits large volumes of storage.
- If CO₂ removed, biomethane can be compressed and stored in the same way as natural gas. High energy req.
- Domestic applications may store up to 60% of daily produce.
- Commercial generally only 5%.
- All depends on application.

Uses of BioGas



- Fed into appliances for cooking fuel.
- Scrubbed and used in CHP engine (elec.)
- Scrubbed, Purified for natural gas pipeline.
- Scrubbed, Purified, Compressed for vehicle fuel (CNG)
- Further compressed for easier and more efficient use (LNG)

Uses - Cooking



Uses – Electricity Gen.



Uses – Vehicle Fuel



Why does BioGas suit SA?

- Can be very simple or very technical, depending on application.
- Cheap and effective means of rural energy
- Brownie points and financial gain for commercial installations.
- Waste mitigation.
- Ease dependency on National generator.



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Thank you!

Biogas is the answer, not a question!