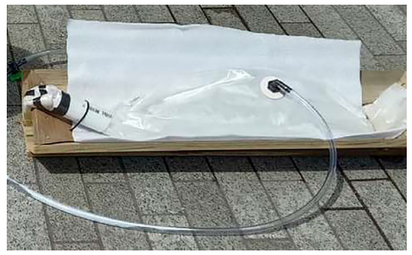
Simple Digesters

Both the Chinese Fixed Dome and Indian Floating Drum designs are Tank digesters, with some digestate in contact with outside air leading to methane leakage and possible odour problems. Both designs also have mixing by gas bubbles, due to the height of the tank.

This means that there is a reasonable chance that some of yesterday's input may be circulating near the outlet during feeding the next day, so be swept out of the digester almost untreated. Other input from yesterday may still be circulating in the digester for over 6 months, giving very little biogas but taking up space unnecessarily.

A small Chinese Fixed Dome Digester (left) and an Indian Floating Drum Digester (right)

In a Plug Flow digester (which is totally enclosed, so very little biogas or odour can escape and is like our intestine) there is very little mixing as each input is pushed along the digester by the subsequent feeds. As a result of this different action all the influent will have close to the desired retention time, so very little untreated influent is discharged, and very little space is wasted.



A Plug Flow Digester

A one cubic meter digester fed with 10 litres of food scraps per day should provide about two hours of cooking per day.

Recommendations

1. A Plug Flow digester gives more thorough treatment of the waste and is more robust in operation.

2. Gas storage capacity should approximately equal to one day's biogas production.

Do you want:

- ☐ Energy from waste
- ☐ Organic fertilizer
- ☐ Pathogen reduction
- ☐ Less Fossil Fuel use
- ☐ Methane to Carbon Dioxide
- ☐ All the above

Then you may need a Biogas Digester!

RED OCHRE DIGESTERS

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BIOGAS DIGESTER

Energy from waste

Organic fertilizer

Pathogen reduction

Less Fossil Fuel use

Methane to Carbon Dioxide

What is Biogas?

Biogas is typically 60% Methane (20-80 times worse that Carbon Dioxide as a Greenhouse Gas) and 40% Carbon Dioxide (from the microbial processes), with traces of water vapour, Hydrogen Sulphide and Volatile Organic Carbon compounds.

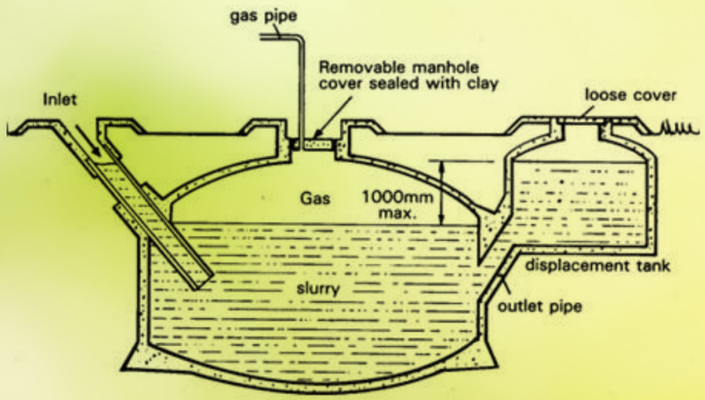
This variable composition is the result of microbial action on easily degradable organic matter when no oxygen is present (Anaerobic Conditions), considered as four stages – Hydrolysis, Acidogenesis, Acetogenesis and Methanogenesis, where a range of microbes, including Archaea (one of the oldest life forms) which produce methane from both Acetate and Carbon dioxide, by different processes.

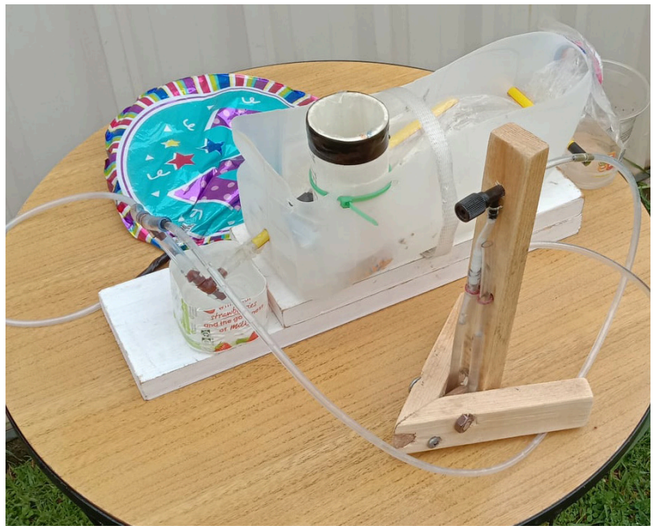
This process can occur in swamps, marshes, the Arctic Tundra, and ocean bottoms (the Psychrophilic range of temperatures), in animal digestive systems at about 35 C (called mesophilic temperature) and in warmer places up to approximately 60 C, like volcanoes (called Thermophilic temperatures).

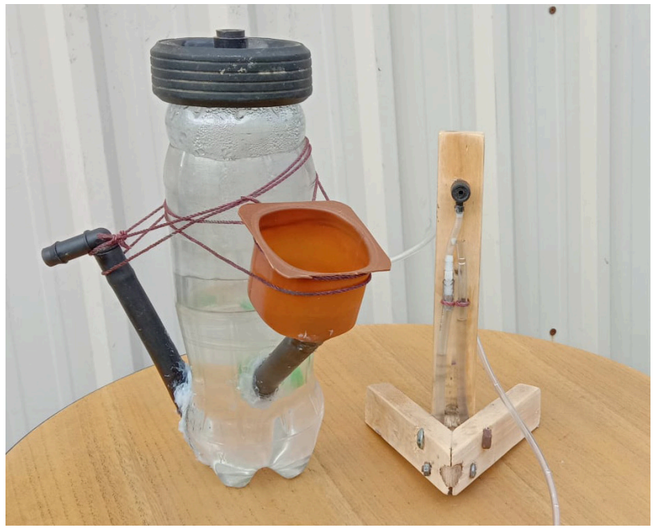
Storage of Biogas

Because microbes work 24-7 producing biogas but use is often very irregular (as in cooking three meals a day) it is normal practice to store approximately a day's worth of biogas production.

Biogas will not liquify at room temperatures, so very high pressures are used to get reasonable energy density for storage and mobile use. This requires a lot of energy and heavy cylinders (like Oxygen/Nitrogen cylinders), with associated equipment costs. This means that variable volume storage (cylinders are variable pressure storages) must be used for simple storage systems. This can be by "Floating Drum", "Flexible Bag" or "Water Displacement" storage units.







Uses of Biogas

Because of the low energy density of gaseous fuels Biogas is best used directly if possible. Cooking, Lighting and Absorption Refrigeration (kero and caravan fridges) are all possible with Biogas, accounting for most of household energy requirements. Solar, Wind and Micro-Hydro units can provide electricity for electronics and lower powered devices if necessary.

In the past large centralised systems, such as sewage works, where staff could operate, monitor and maintain large units made sense. With advances in electronics making remote sensing and automatic operation easy it is now possible to have multiple smaller units. Decentralised units minimise transport costs, as the waste is treated and used locally, and also mean that any problems are also localised, so that a mistake by one person does not have consequences for a large number of users.

To use biogas for electricity production or automobile uses you need to have an IC engine, which is running at under 20% efficiency (dictated by the Otto, Rankine or Diesel thermodynamic cycles, with higher compression ratio diesel engines having slightly better efficiencies) you actually need at least 5 times the biogas energy input to get the desired energy output. This means that to power an average house consuming 1 kWHr of electricity per day you need over 5 kWHrs of biogas energy, so you need at least 5 times the digester capacity or you could have 5 gas powered houses instead of just one house running on electricity.

As well as biofuel production Biogas Units provide plant friendly fertiliser that can be applied directly to plants (like aerobic compost, but aerobic compost requires energy input), reduce pathogens by over 90% at ambient temperature (Aerobic composting requires temperatures over 60 C to kill pathogens) and kill weed seeds at ambient temperature. Combustion converts Methane to Carbon Dioxide (reducing Greenhouse gas effects) and reduces fossil fuel use.