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Sustainable Communities Running on Anaerobic Digesters

(Zabaleen community in Egypt)

Young Scholars Forum - EWACC2012/Building Bridges

Presented by:Rana Samir

Zabaleen community

- Refers to Garbage collectors.
- Has a population of around 20,000 - 30,000.
- Supported themselves by collecting trash door-to-door from the residents of Cairo for nearly no charge.
- Many sources state that the Zabbaleen have created one of the most efficient recycling systems in the world, which recycles up to 80 percent of all the waste that they collect.




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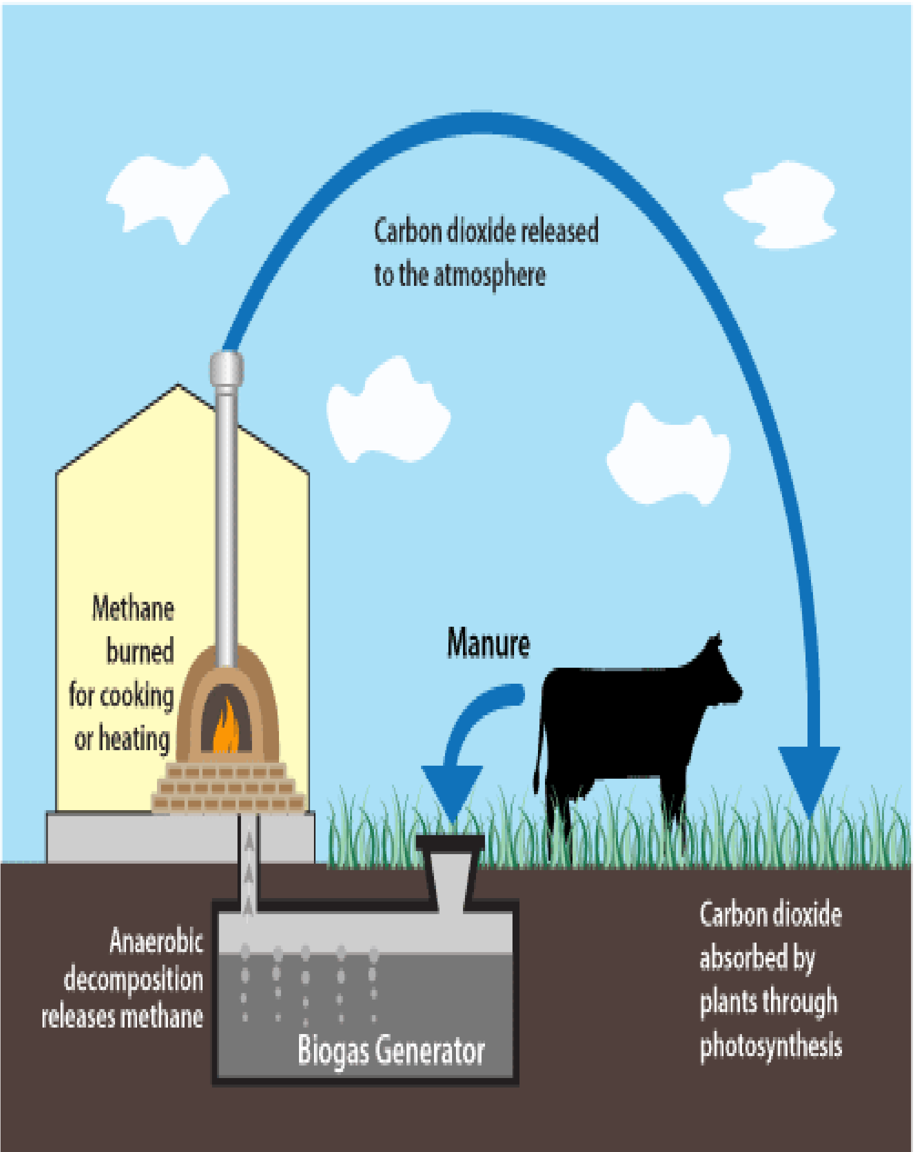
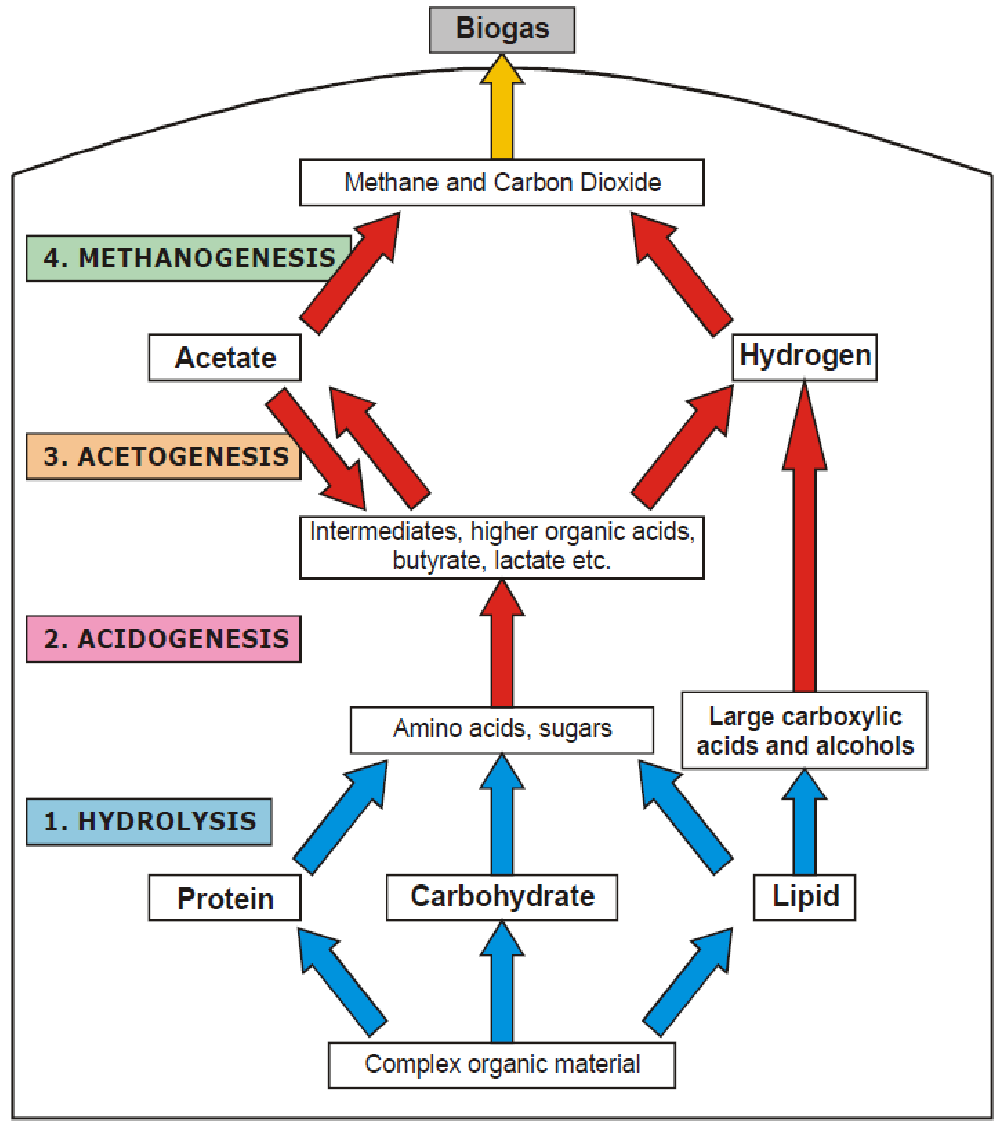
Biogas Formation Process





Anaerobic Digestion Control Factors

PH

- Acetogenic bacteria prefer PH <6.8
- Methagnic bacteria prefer PH 6.8-7.5

Temperature (4-75°C)

Temperature Bands	Temperature Range	Reaction Rate	Required Retention Time	Bacteria Biodiversity
Psycophilic	4-20	Least	Greatest	Greatest
Mesophilic	20-42 (Optimum 35)	Middle	Middle	Middle
Thermophilic	40-75 (optimum 55)	Greatest	Least	Least

Anaerobic Digestion Control Factor

Nutrients

- C:N:P ratio 100:2.5:0.5 is the optimum for biogas formation
- Nitrogen limits < 1700mg/ liter of substrate.

Organic Loading Rate (OLR)

- The quantity of organic matter fed per unit volume of the digester per unit time in kg VS m–3 d-1/ COD

OLR (kg COD m^{-3} d^{-1})	Total biogas production (l d^{-1})	Methane composition (%)
2.16	16	62
3.36	19	65
5	26	67
13.38	62	75

biogas production and methane composition profile at steady state under different loading conditions (Baloch, et al. 2006)

Feedstock

- Agricultural feedstock materials
- Animal manure
- Crop residues (e.g. sugar beet tops)
- Energy crops (e.g. corn-silage, maize, sunflower, grass, sudan grass)
- Municipal waste
- Industrial organic wastes

Biogas Properties

- 55-75% CH4, 25-45% CO2and 1% impurities such as H2S, H2, H2O
- Heating value of 21 MJ/Nm3 equivalent to 1000 BTU/Nm3 for 65% CH4

Constituents	Unit	Natural gas	Biogas	Landfill gas
Methane (CH_4)	Vol %	91	55–70	45–58
Ethane (C_2H_6)	Vol %	5.1	0	0
Propane (C_3H_8)	Vol %	1.8	0	0
Butane (C_4H_{10})	Vol %	0.9	0	0
Pentane	Vol %	0.3	0	0
Carbon dioxide (CO_2)	Vol %	0.61	30–45	32–45
Nitrogen (N_2)	Vol %	0.32	0–2	0–3
Volatile organic compounds(VOC)	Vol %	0	0	0.25–0.50
Hydrogen (H_2)	Vol %	0	0	Trace to less than 1%
Hydrogen sulphide (H_2S)	ppm	~ 1	~ 500	10–200
Ammonia (NH_3)	ppm	0	~ 100	0
Carbon monoxide (CO)	ppm	0	0	Trace

Source: Monnet (2003).

Anaerobic Digesters

Advantages:

- Power generation.
- Protecting the environment by reducing pollutants uncontrolled waste.
- Production of an excellent fertilizer.
- Waste doesn't need treatment before inclusion in the digester.
- Operation is simple and does not require sophisticated maintenance.
- Its cost is relatively low and will quickly pay.

Disadvantages:

- Safety concerns

Overall Objective

- Design and Construct an Anaerobic Digester made from local materials in Egypt that would sustain a neighborhood in Zabaleen community

- Collect average yield and COD removal experimentally using small scale experimental digester.

- Use data to profile the performance of the reactor for future scalability.

Experimental Conditions

- Batch Flow Reactor
- 5 Liter Reactor vessel- Packed Volume of 4L
- 35 KG of Food wastes with 7500-8000 mg/L COD Feed.
- Solid Content Less than 1%
- Feed Rate of 1.7L/day for 14days
- Retention Time 6 days
- PH maintained between 6.8-7.5
- Mesophilic operating conditions

Results

- Loading Rates:

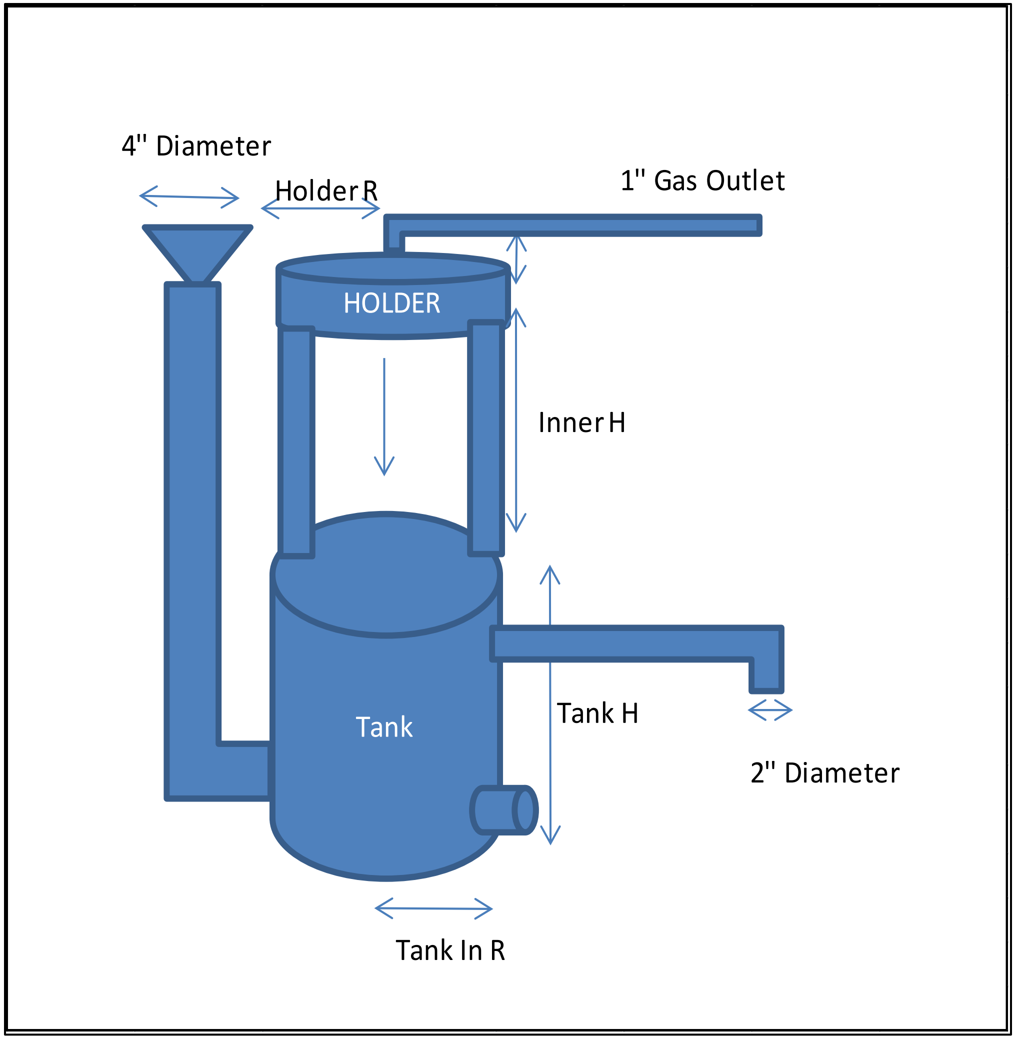
  COD LR(g/day)= COD concentration (g/L) * VFR(L/day)

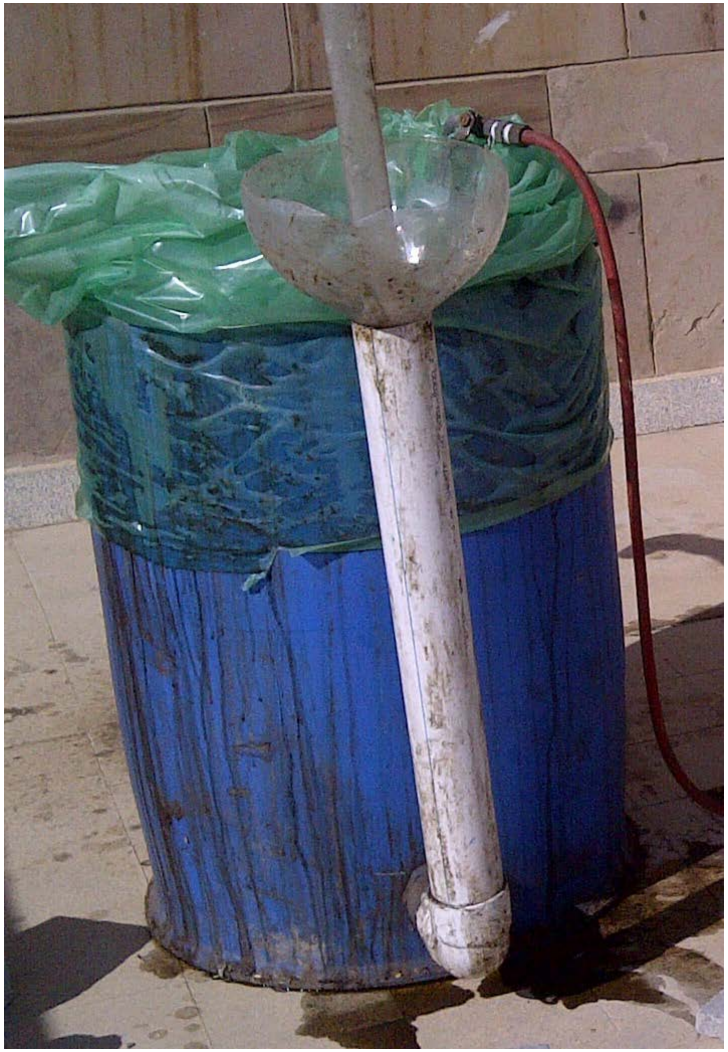
- %COD Removal=

  [(CODin(mg/L)- CODout(mg/L))/CODin (mg/L)]*100

Biogas Production Rate	0.0012 Nm3/day
COD Influent Loading Rate	13.2 g/day
COD Effluent unloading Rate	1.6 g/day
COD Removal	88 %

Biogas Digesters





Enviromental Benefits

- Biogas technology underutilized in Egypt
  - Deficient investment
  - Alternate cheaper fuel options
- Global warming reduction
- Reduced incineration rates
- Reduced dependence on external waste management services
- Reduction of pathogens
- Reduced dependence on fossil fuels

THANK YOU
Q&A