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MAR ATHANASIOS COLLEGE FOR ADVANCED STUDIES TIRUVALLA
(MACFAST)
Thiruvalla - 689101

LIQUID WASTE MANAGEMENT

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The college has installed two biogas plants in the campus. The amount of bio waste being generated from the time of installation is 250 kg per day. The plant installed in the campus applies different technologies for treating different types of organic wastes according to the nature and type of waste. The Geo membrane bioreactor plant is fully pre-fabricated and the accessories include Geo Membrane reactor, Gas Scrubber and Pressure booster. The gas generated from the digesters could be collected in a single gas collector. By applying Bio-methanisation, a universally accepted and proven technology for bio-energy generation from bio waste, fast decomposing waste materials like food waste, fruit and vegetable waste, fish and meat waste etc. are treated hygienically. The liquid and major bio degradable wastes from the mess of both boys' and girls' hostels and college canteen are collected and are processed through the bio-gas plants in the campus and used for cooking.

PRODUCTION OF BIOGAS

Raw Materials Required

- Human excreta
- Kitchen wastes (Vegetable peels, waste food materials)
- May be used along with water

Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic conditions. Natural generation of biogas is an important part of bio-geochemical carbon cycle.

Composition of biogas

Component	Concentration (by volume)
Methane (CH_4)	55-60 %
Carbon dioxide (CO_2)	35-40 %
Water (H_2O)	2-7 %
Hydrogen sulphide (H_2S)	20-20,000 ppm (2%)
Ammonia (NH_3)	0-0.05 %
Nitrogen (N)	0-2 %
Oxygen (O_2)	0-2 %
Hydrogen (H)	0-1 %

PRINCIPLE

Biogas is produced as a result of anaerobic fermentation of biomass in the presence of water. Organic substances exist in wide variety from living beings to dead organisms . Organic matters are composed of Carbon (C), combined with elements such as Hydrogen (H), Oxygen (O), Nitrogen (N), Sulphur (S) to form variety of organic compounds such as carbohydrates, proteins & lipids. In nature microorganisms, through digestion process breaks the complex carbon into smaller substances.

Anaerobic digestion

It is also referred to as biomethanization, is a natural process that takes place in absence of air (oxygen). It involves biochemical decomposition of complex organic material by various biochemical processes with release of energy rich biogas and production of nutrious effluents.

Biological process

1. **HYDROLYSIS**
2. **ACIDIFICATION**
3. **METHANOGENESIS**

HYDROLYSIS: In the first step the organic matter is enzymolysed externally by extracellular enzymes, cellulose, amylase, protease & lipase ,of microorganisms. Bacteria decompose long chains of complex carbohydrates, proteins, & lipids into small chains. For example, Polysaccharides are converted into monosaccharide. Proteins are split into peptides and amino acids.

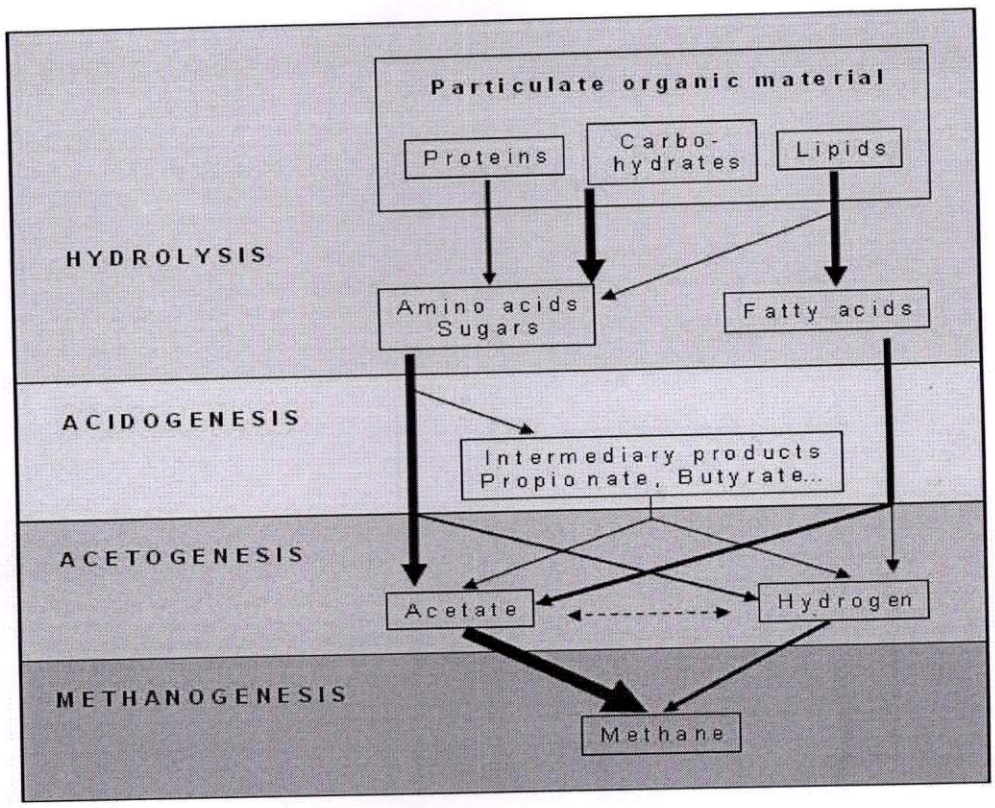
ACIDIFICATION: Acid-producing bacteria, involved this step, convert the intermediates of fermenting bacteria into acetic acid, hydrogen and carbon dioxide. These bacteria are anaerobic and can grow under acidic conditions. To produce acetic acid, they need oxygen and carbon. For this, they use dissolved O2 or bounded-oxygen. Hereby, the acid-producing bacteria creates

anaerobic condition which is essential for the methane producing microorganisms. Also , they reduce the compounds with low molecular weights into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane. From a chemical point, this process is partially endergonic (i.e. only possible with energy input), since bacteria alone are not capable of sustaining that type of reaction.

METHANOGENESIS: (Methane formation) Methane-producing bacteria, which were involved in the third step, decompose compounds having low molecular weight. They utilize hydrogen, carbon dioxide and acetic acid to form methane and carbon dioxide. Under natural conditions, CH4 producing microorganisms occur to the extent that anaerobic conditions are provided, e.g. under water (for example in marine sediments),and in marshes. They are basically anaerobic and very sensitive to environmental changes, if any occurs. The methanogenic bacteria belongs to the archaebacter genus, i.e. to a group of bacteria with heterogeneous morphology and lot of common biochemical and molecular-biological properties that distinguishes them from other bacterias. The main difference lies in the makeup of the bacteria's cell walls.

Symbiosis of bacteria:

Methane and acid-producing bacteria act in a symbiotical way. Acid producing bacteria create an atmosphere with ideal parameters for methane producing bacteria (anaerobic conditions, compounds with a low molecular weight). On the other hand, methane-producing microorganisms use the intermediates of the acid producing bacteria. Without consuming them, toxic conditions for the acid-producing microorganisms would develop. In real time fermentation processes the metabolic actions of various bacteria acts in a design. No single bacteria is able to produce fermentation products alone as it requires others too.



Flow chart of anaerobic digestion

CONSTRUCTION

A typical biogas system consists of the following components:

Mixing tank: The feed material (biogradable waste like toilet waste, food partilcles, kitchen waste) is collected in the mixing tank. Sufficient water is added and the material is thoroughly mixed till homogeneous slurry is formed.

Inlet pipe: The substrate is discharged into the digester through the inlet pipe/tank.

Digester: The slurry is fermented inside the digester and biogas is produced through bacterial **action.**

Gas holder or gas storage dome: The biogas gets collected in the gas holder, which holds the gas until the time of consumption.

Outlet pipe: The digested slurry is discharged into the outlet tank either through the outlet pipe or the opening provided in the digester.

Gas Pipeline: The gas pipeline carries the gas to the point of utilization such as a stove or lamp.

WORKING

- The various forms of biomass are mixed with an equal quantity of water in the mixing tank. This forms the slurry.
- The slurry is fed into the digester through the inlet chamber. The temperature of the slurry must be maintained around 35 °C. Any drop in temperature will reduce the anaerobic activity and hence the yield of biogas.
- When the digester is partially filled with the slurry, the introduction of slurry is stopped and the plant is left unused for about two months
- During these two months, anaerobic bacteria present in the slurry decompose or ferment the biomass in the presence of water
- As a result of anaerobic fermentation, biogas is formed, which starts collecting in the dome of the digester.

- As more and more biogas starts collecting, the pressure exerted by the biogas forces the spent slurry into the outlet chamber.
- From the outlet chamber, the spent slurry overflows into the overflow tank.
- The spent slurry is manually removed from the overflow tank and used as manure for plants.
- The gas valve connected to a system of pipelines is opened when a supply of biogas is required.
- To obtain a continuous supply of biogas, a functioning plant can be fed continuously with the prepared slurry.

BENEFITS OF BIOGAS TECHNOLOGY

- Production of energy.
- Transformation of organic wastes to very high quality fertilizer.
- Improvement of hygienic conditions through reduction of pathogens.
- Environmental advantages through protection of soil, water, air etc.
- Micro-economical benefits by energy and fertilizer substitutes.
- Macro-economical benefits through decentralizes energy generation and environmental protection.

Details of Biogas Plant

Size of Plant	35 cm^3
Gas holding Capacity	17500liters
Cost of installing biogas plant	4 Lakhs
Maintenance and operating cost	Rs 600 per month
Minimum quantiy of waste	250Kg/day
Renewable energy from the biogas plant	68%
Biogas production m^3/year	12600