Aim 41

To Study Biogas Production Plant

Introduction

Biogas

Biogas is a mixture of gases produced by anaerobic digestion of organic matter. It consists of 65-85% methane, 15-35% CO_2 and traces of H_2 and other gases including N_2 and H_2S. Product of agriculture, animal husbandry, domestic etc. waste would contain variable proportion of non-biodegradable matter.

The microorganism

Several hundred species of microorganism are involved in biogas production. Microorganism can be divided into four groups :-

1) **Hydrolytic and fermentative bacteria**:- This group include both obligate and facultative anaerobes and may occur upto 10^8-10^9 cells/ml of the sewage sludge digester. These bacteria remove the small amount of O_2 present and create anaerobic condition. This bacteria hydrolyses and ferment the organic material like cellulose, starch, proteins, lipids and produce organic acid, gases, carbon dioxide and hydrogen.
2) **Syntrophic H_2 producing bacteria** :- This group is called obligate H_2-producing syntrophic bacteria to produce acetate, CO_2 and H_2.
3) **Methanogenic Bacteria** :- This group of bacteria convert acetate and CO_2 + H_2 into methane. They remove the H_2 produced by H_2-producing syntrophic bacteria by

lowering the H_2 partial pressure and enabling H_2 mehanogenic bacteria. They may occur upto 10^6-10^9 cells/ml of the slurry in digesters.

$$\text{Formulate/acetate} + H_2 + CO_2 \longrightarrow CH_4 + CO_2$$

4) **Acetogenic bacteria**:- these bacteria oxidized hydrogen by reducing CO_2 to acetic acid which is then used up by methanogens to generate CH_4, $CO_2$and H_2. Thus acetogenic bacteria also remove H_2 and enable the obligate H_2 producing bacteria to continue their function.

The digester: - The digester deign generally depends on the type of waste to be handled and the level of operation i.e. small burial or large industrial operation.

Low technology digester

These digester simple in design and consist of the following provision :- a) A digester.

b) A tank for the preparation of the substrate for feeding the digester.

c) An effluent transfer tank.

d) A biogas storage tank.

An example of such a digester is the "the biogas plant "designed to produce biogas from cow dung. It consists of an underground circular pit lined with cemented brick wall which serve as the digester. The pit is covered with an inverted and vertically movable which serve as biogas storage tank. A tank is made from brick on a raised platform above the ground. This serve as cow dung mixing tank to feed the digester through inlet pipe that deliver the cow dung slurry near the bottom of the digester. The spent cow dung slurry is removed to a drying bed and is ultimate used as manure. The gas flow out through an outlet pipe which has a provision of drainage of an excess mixture.

The process of biogas production

The process of bio gas production can be explained by the process of gobar gas production. The excreta of animal which is having about 20 % inorganic particles or dust particles. The level of dust particles can be reduced by 10% by mixing the dust with H_2O in 1:1 ratio. The feeding rate of which typical dung loose, biogas, plant is at the rate of 3500 kg/dung/day.

Generally, the spent slurry at about 2 % of the fresh dung slurry is added back to maintain the microbial population. Calcium ammonium nitrate at the rate of 1% wt/wt. of the dung is added to have a better growth of microorganism.

The optimum temperature for biogas production is 35 - 38^0C. If temperature of digester is lowed to 15^0C, the biogas production is also lower. The biogas production during winter and colder region required thermal insulation or heating of the digester. The pH of slurry should be around maintained at around 7. Under favorable condition the biogas yield may be up to 4-5 liter of methane/kg of the reactor material.