Generation of Biogas using Fixed-Dome Anaerobic Digester for Small-Scale Industrial Applications in New Zealand

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Climate change is clearly becoming perceptible by its adverse effects to the environment. New Zealand is an agriculturally focused nation, it has the capacity to generate a large amount of organic animal and farm waste (e.g., wood, crops, and food waste) to produce renewable energy resources such as, Biogas. Biogas is a sustainable substitute for a range of small-scale industrial applications such as, Natural Gas for cooking, electricity generation and fuels (Biodiesel) for Diesel Engines.

Biogas is generated from Anaerobic Digestion that consists of five stages of organic matter breakdown, disintegration, hydrolysis, acidogenesis, acetogenesis and methanogenesis. The organic waste gets fed to the digester at the disintegration stage, which breaks down organic polymers such as lipids, carbohydrates, and proteins. In the hydrolysis stage, organic polymers from disintegration are hydrolysed (depolymerised) by various enzymes. The carbohydrates, proteins and fats are then converted to their respective monomers such as, sugar, amino acids, and lipids. In acidogenesis, group of microorganisms converts monomers to a mixture of alcohols, volatile fatty acids, and other organic compounds. In acetogenesis, volatile acids produced are transformed to acetic acid, carbon dioxide and hydrogen by a group of acetogenic bacteria. Lastly, methanogenesis stage consists of methanogenic bacteria that munches on the organic matter in a desperate search of oxygen, which breaks down the complex structures to its simplest form, resulting in the formation of Biogas (composed of methane and carbon dioxide).

A single-phase fixed-dome digester is chosen due its cost and ease of maintaining the mesophilic temperatures bands from 25°C to 45°C and pH scale from 5 to 7. The sizing of the digester was computed using the Organic Loading Rate, Hydraulic Retention Time, and Volume of Farm Dairy Effluents formulas. From the calculations, it was found that the digester produces approximately 55% of CH_4 and 45% of CO_2.

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