

Development of Water Scrubber for Removal of CO₂ from biogas

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Abstract: Biogas technology provides not only clean fuel to burn but it also gives highly nutritious slurry for farming. Biogas is a renewable source of energy can be used as a substitute for fossil fuels. Biogas can be produced from food waste/refuse or peelings, agricultural and animal waste. In India the fossil resources are limited, and they impose a high burden on the environment therefore looking at the ecological and economical perspectives, biogas is an important source of energy. Due to its limited use biogas until now is not produced at a considerable amount. The main problems associated with the commercialization with biogas are its low energy content per unit volume, it is difficult to liquefy and it is not produced in large amount at a same place. For the use as a commercialization of the biogas, it is required to increase the energy content per unit volume of biogas. It is important to make it portable and compatible for various commercial purposes. For that, the energy content for a particular volume must also be increased. Energy content of the biogas can be increased by purifying the gas, i.e. to remove incombustible gas present in biogas. Water scrubbing is used for CO₂ removal. It is the cheapest technology for purification. The raw biogas is introduced from the bottom of the column and flows upward, while fresh water is introduced from top of the column, flowing downward over a packed bed. The CO₂ saturated water is continuously withdrawn from the bottom of the column and cleaned gas exits from the top.

Keywords: Biogas, water scrubbing process, energy content

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I. Introduction

Biogas is a renewable source of energy which not only gives clean gas as a fuel but it also gives nutrient rich slurry. Large quantity of cattle dung can be easily managed through biogas production. It also provides sustainable solution of replacing use of diesel fuel in transport and agricultural sector. India is rich by livestock population. In rural India, cattle dung cake is a primary source of fuel for cooking purpose. It produce smoke while burning. Instead of using cattle dung cake, biogas is a solution for reducing the air pollution. This results in reduction of consumption of fossil fuel and also reduce the dependency of chemical fertilizer. Approximately 25kg of dung required for production of 1m³ of biogas. Biogas is a mixture of gases which contains approximately 50 to 70% of methane (CH₄), 30 to 45% of carbon dioxide (CO₂), traces of water vapor and hydrogen sulfide (H₂S).⁽¹⁾ The quantity and composition of biogas depends on the nature of feedstock and environmental conditions. Biogas is a cheap and clean fuel for cooking, lighting and running engines for producing power. Biogas has low calorific value because of high percentage of CO₂ in it. To increase the calorific value of biogas, amount of CO₂ is to be removed. Various methods are used to remove the CO₂ from biogas. Water scrubbing, chemical absorption, pressure swing adsorption, membrane purification, cryogenic separation are the different methods of purification of biogas. Among these, water scrubbing is the cheapest method of removal of CO₂ from biogas. This method significantly remove the CO₂ from biogas and hence, calorific value of biogas increases.⁽²⁾⁽⁶⁾⁽⁷⁾

II. Materials And Methods

The fabrication of the scrubber was done in the College of Renewable Energy & Environmental Engineering. The scrubber (packed column) was fabricated from the PVC pipe having height 8 feet, diameter 8 inch and 3 mm thickness. Both ends of the scrubber were kept closed by using PVC cap. Two holes were made at the centre of each end of the cap for water inlet and outlet purpose. Provision for water inlet was provided at the top while water outlet was at bottom. Two holes were made on top and bottom of the scrubber for gas inlet and outlet. Uniform distribution of water was done with the help of water distributor. It was fixed on the top

inside the scrubber. Packing material placed inside the scrubber to increase the contact time between biogas and water so that efficient scrubbing process takes place.

III. Biogas Scrubbing Process

Water scrubber is a technique based on the physical effect of gases dissolve in liquids. Water scrubbing can be used to remove CO₂ from biogas since this component is more soluble in water than in CH₄. This absorption process is fully physical process.⁽⁵⁾

The process was carried out in a packed bed column (scrubber) in which biogas was passed from the bottom of the scrubber directly from biogas plant. Water was sprayed from the top of the scrubber with the help of centrifugal pump. Counter-current flow of gas and water was maintained inside the scrubber. As biogas comes in contact with water in the scrubber, CO₂ present in the biogas was dissolved in the water.⁽²⁾ Purified biogas was come out from the top of the scrubber while CO₂ dissolved water was come out from the bottom of the scrubber. The contact time between gas and water was increased by providing the packing material inside the scrubber. Composition of raw biogas and filtered (purified) biogas were measured with the help of Orsat apparatus. Gas flow rate at the inlet and outlet of scrubber was measured with the help of gas flow meter (wet type). Complete process was took place at ambient temperature. As biogas is a mixture of mainly methane, carbon dioxide and traces of other gases. But during the analysis it was assumed that biogas contains only carbon dioxide and methane only.⁽⁴⁾



Scrubber for biogas purification

IV. Results

Sr. no.	Type of gas	CO ₂ concentration, % by volume	CH ₄ concentration, % by volume	Calorific value*, Kcal/nm ³
1.	Raw biogas	38%	62%	5300
2.	Purified biogas	19%	81%	6941

Note: * Calorific value is calculated by volume % of methane in biogas, Net calorific value of methane is 8570 Kcal/nm³

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