

DESIGN AND FABRICATION OF BIOGAS SCRUBBING UNIT FOR NIE BOYS HOSTEL

Project Reference No.: 45S_BE_4609

College : *The National Institute Of Engineering, Mysore*

Branch : *Department of Mechanical Engineering*

Guide(s) : *Dr. Tejappanavara Raghavendra*
Prof. Shamsundar S

Student(S): *Mr. Nithin R D*

Mr. Manoj Ayachit

Mr. B M Yogendra

Mr. Dhanush Kumar

Keywords:

Biogas, carbon dioxide, hydrogen sulphide, amine scrubbing, di-ethanolamine and calorific value.

Introduction:

The Biogas has some of the constituents which reduce its calorific value. Carbon dioxide (CO₂) is a recalcitrant gas that decreases the calorific value and density of the biogas, but it is not toxic and corrosive like H₂S. H₂S is harmful to the environment and corrosive to the metallic parts of engines, pumps, compressors, gas storage tanks, valves and reduce the lifespan of process equipment.

This project deals with the design and fabrication a bio-gas scrubbing unit for NIE Boys' Hostel Biogas plant also focuses on investigation and optimization the techniques and strategies applied for the removal of Carbon Dioxide and Hydrogen Sulphide from Biogas. Further, efficiency and cost of different processes and the scope of these processes for different application studied. With all the considerations of various parameters affecting the efficiency and cost of the project, scrubbing of the biogas through amine solution is conducted and its results are determined in this project. Though there are many research papers on amine scrubbing process, this project is concentrated solely in the effect of the Di-ethanolamine and for this composition of the amine solution the scrubbing effect on the Biogas is analyzed. The project gives the details regarding chemical composition of the amine solution, the components required for scrubbing and the process of regeneration of the amine solution to reduce the long-term expenditure of the product.

Hence this project provides an economic and an efficient solution for the scrubbing of Carbon Dioxide and Hydrogen Sulphide from the Biogas in order to increase the Calorific value of the Biogas.

Objectives:

1. To determine an economically feasible method for scrubbing of biogas.
2. To design and fabricate a bio-gas scrubbing unit for NIE Boys' Hostel Biogas plant.
3. Scrubbing of biogas using Amine Solution to obtain high purity methane and to increase its calorific value.
4. To improve the efficiency of bottling process by removing unwanted gases like H₂S, CO₂ and moisture.

Methodology:

The NIE boy's hostel currently operates the biogas plant of 50 kg/day kitchen waste which produces 3 m³/day of biogas. The plant in a year saves 438 kg of LPG, reduces 1.33 tons of CO₂ emission, and converts 18.25 tons of waste to energy thus contributing to green energy.

1. The raw biogas from the reservoir is fed into the absorber tank through an air blower.
2. In the absorber tank, the biogas reacts with the amine solution in which the amine solution absorbs the carbon dioxide and hydrogen sulphide from the biogas and settles in the bottom of the tank, this amine solution is called rich amine.
3. The biogas due to its specific gravity rises above and gets accumulated in the bottling unit, whereas rich amine solution is transferred to the regenerator tank through a hydraulic pump.
4. In the regenerator, the rich amine is sprayed in the form of fine droplets through a spraying unit and the amine is allowed to pass through the steam generated by the two water vaporizers.
5. Hence the carbon dioxide and hydrogen sulphide is absorbed by the water vapour from the rich amine solution, this gas is now ejected through the outlet to the atmosphere.
6. The amine solution settled at the bottom of the regenerator can now be used for scrubbing, but the amine solution is heated because of the exothermic reaction. Therefore this lean amine solution is passed through a cooling unit before it reaches the absorber for further scrubbing process. The probable design of the amine scrubber is shown in the figure 1.
7. Materials: Materials used to carry out the project are copper tube, two 4.5lpm motor, Air blower, 15lpm motor, CPVC pipes, packing materials, Diethanolamine aqueous solution at 30%, Boiler.
8. Work done: Design of scrubbing unit for NIE Hostel Biogas plant, Thermal analysis and calculations of Heating and cooling unit, selection of materials.
9. Work to be done: Fabrication of Prototype.

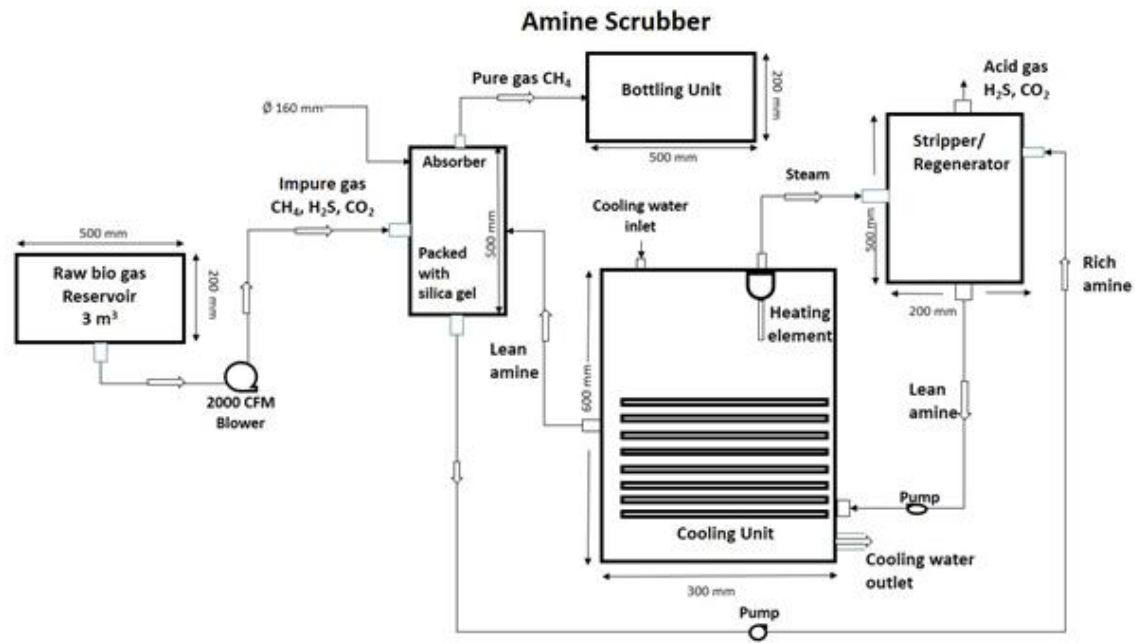


Figure 1: The amine scrubbing process

Conclusion:

High purity methane (90%) is obtained using amine solution. This improves the efficiency of bottling process as unwanted gases like H₂S, CO₂ and moisture are removed, and it also enhanced the calorific value of the raw biogas with a average value of 28000 KJ/KG to a maximum of 45000 KJ/KG as measured using gas calorimeter.

The answer to the energy challenges faced by any country is to create more dependency on renewables, such as biogas. The combustible biogas can be an alternative for vehicle fuels being used extensively now-a-days. This paper involves the assessment of calorific value of biogas being subjected to scrubbing process using amine solution for its purification to produce a better combustible gas. The purpose behind purification of biogas is to increase the percentage of the combustible gas available for use, which might affect the end users. CO₂ and H₂S are the main impurities which needs to be removed from the biogas. Among the various alternative technologies present for biogas purification, chemical scrubbing proves to have the highest biomethane purity level.

Scope for future work:

Biogas is a cheap, commonly available and renewable energy source that can be generated from organic feedstocks under anaerobic conditions. It is primarily methane and can be generated from various sources like animal manure, crops residues, municipal solid waste, etc. The disposable bio-waste in India is estimated to be around 600 million tonnes. If all of these are put into productive use, it will produce 25 times the CNG that we are using today, and replace more than 50 percent of the total fuel imports. The current use of fossil fuels is rapidly depleting the natural reserves and would be available to mankind only for a limited time due to

their diversified use in every country. Because of the natural formation of coal and oil however it is a very slow process which takes millions of ages to become so. Recently, sustainable solid waste management is becoming an issue of global concern due to the steady increase in population, urbanization, and industrialization. Therefore, the increasing concentration on the emission of greenhouse gases like carbon dioxide and methane having strengthened the interest for research effort is put into finding renewable fuels nowadays to replace fossil fuels. Renewable fuels are in balance with the environment and contribute to a far lesser extent to the greenhouse effect. Biogas is such a renewable fuel, an energy source that can be applied to its versatility of use in gas engines, microturbines, electricity generation, and fuel cells for continuous energy production. It is a combustible gas mixture produced by the anaerobic fermentation of biomass by bacteria and takes only a relatively short time to form.