Experimentation Procedure for Purification of Biogas using Membrane Technology

Anant Dattatray Awasare[1]*, Sanjay D. Yadav[2]
[1]Research Scholar, [2]Professor
[1]Department of Technology, Shivaji University, Kolhapur, Maharashtra, India
[2]Department of Automobile Engineering, Rajarambapu Institute of Technology, Rajaramnagar, Maharashtra, India

****Corresponding Author***
E-Mail Id: *anant280@gmail.com*

ABSTRACT
The use of energy that is both clean and renewable is drawing more and more attention as a means of meeting the demands of expanding economies while also taking into account the consequences for the environment. Utilizing biogas is one way to meet these growing demands. Waste materials are used in this; which are deposited daily by agriculture, sewage, and households to generate energy that can be used for transportation, heating, electricity, and other necessities of daily life. Nano-structured ceramic membranes could be used in this paper to transform biogas into a high-value fuel that can be used for a variety of applications. The use of membranes has many advantages, including low operating costs, high efficiency, and no need for the gas to change its phase. Different membranes with varying pore sizes were used in experiments to determine which would be most suitable for use in terms of product gas yield and permeability. In comparison to carbon dioxide, the 16-nm membrane had the highest methane exit.

Keywords: *Biogas, waste material, membrane pore size, gas yield*

INTRODUCTION
Biogas systems can be used for cooking, electricity generation, and transportation. Food waste, including food processing waste, household food waste, and waste from cafeterias and restaurants, is one of the most crucial components of municipal solid waste. In addition, the majority of Ethiopians are farmers, and over 84% of them live in rural areas. Thus, it is possible to generate energy for rural communities by combining agricultural, animal, and food waste. As a result, biogas is a technology that is recommended for converting organic waste into energy. When organic material is broken down in a digester under anaerobic conditions, biogas is produced. Biogas is mostly a mixture of methane and carbon dioxide that is made by bacteria breaking down waste, manure, garbage, or plant crops [1]. Methane (CH_4, 55–77 percent) and carbon dioxide (CO_2, 26–40.55 percent) are the main components of raw biogas. Other components include water (H_2O, 5–10 percent), hydrogen sulfide (H_2S, 0.006–2.2percent), ammonia (NH_3, 1 percent), oxygen (O_2, 0–1.2 percent), carbon monoxide (CO, 0.66 percent), and nitrogen (N_2, 0–2.3 percent). A biogas's lower heating value ranges from 31 to 36 MJ/kg on average [2]. However, pure methane has a calorific value of approximately 56 MJ/kg. CO_2, which is the incombustible component of biogas, is the cause of the difference in the calorific value. The presence of CO_2 in biogas not only lowers its calorific value but also raises the costs of compression and transportation [3]. As a result, purified methane can be put to use in a variety of ways: internal combustion

engines, compressed gas, and electricity generation, among other things.

EXPERIMENTAL PROCEDURE BY USING MEMBRANE TECHNOLOGY

Absorption, adsorption, membrane separation, and cryogenic separation are the most recent cutting-edge methods for upgrading biogas. Scrubbing with chemicals or force can help absorb the substance. In the case of water scrubbing, biogas is injected into the bottom of the absorption column, where water that flows from the top at high pressure absorbs carbon dioxide [4]. In order to improve the gas-liquid contact, random packing is used to fill the absorption column.

In order to achieve a high level of process efficiency, liquid and gas must flow in a countercurrent direction. Carbon dioxide and some methane are physically absorbed in water during the process, and the process's selectivity is dependent on the much higher solubility of carbon dioxide in water than of methane. Finally, using air at atmospheric pressure as the stripper medium, the carbon dioxide is released once more from the water in the desorption column. Chemical scrubbing is similar to water scrubbing, but the solubility of carbon dioxide in an organic solvent is about five times higher than in water. This indicates that the system requires a significantly smaller volume of solvent.

Changes in pressure within a system that cause each gas to move or be adsorbed at a different rate can also be used in the pressure swing adsorption method to remove undesirable components from biogas. It's possible that the adsorbents are equilibrium ones, which take in more carbon dioxide than methane [5]. Due to controlled diffusion rates, it may also be kinetic, adsorbing carbon dioxide at a faster rate than methane. Activated carbons, natural and synthetic zeolites, titanosilicates, silica gels, and carbon molecular sieves are a few examples of common adsorbent materials.

In membrane technology, a barrier restricts the flow of some biogas components, allowing the restricted gas to be removed from the produced gas. The ability to separate gases at extremely high pressures and low temperatures is made possible by cryogenic technology, which is still relatively new. Because of their high gas recovery and low gas loss, research has shown that membrane technology and absorption are the most cost-effective and effective methods. They also have a high potential for scaling up to achieve an effective and profitable upgrade method.

Absorption by chemical scrubbing is currently widely used to improve biogas, but this creates a lot of waste that needs to be properly disposed of, which raises costs. The use of membrane technology as a method for upgrading biogas is the subject of this investigation [6]. Because there is no energy used in the latent heat of evaporation and there is little chance of methane slippage or losses, the energy consumption is lower than that of conventional upgrading methods. Other advantages include their compatibility with temperature-sensitive materials, their lack of chemical modification, and their lack of phase change during separation, the versatility of membranes, high separation efficiency, ease of operation, and membranes' high selectivity and permeation rate [1].

CONCLUSION

The paper summarized that membrane was inserted into the centre of the tube and sealed with graphite seals to study three distinct membrane modules with varying pore sizes. Finally, analysis of methane and carbon dioxide gases at various temperatures and pressures.

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