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Enrichment of Calorific Value for low pressure biogas

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Abstract— Biogas is produced in many different environments, including in landfills, sewage sludge and during anaerobic degradation of organic material. Biogas is comprised of methane (CH4, about 45-75% by volume), carbon dioxide (CO2, 25-55%), and other compounds including hydrogen sulfide water, and other trace gas compounds. Methane is a powerful greenhouse gas if emitted into the atmosphere, but can also represent a valuable renewable energy source, with the potential to reduce GHG emissions when it is collected and substituted for fossil fuels. Biogas can be used directly to generate power, but the large volume of CO2 reduces the heating value of the gas, increasing compression and transportation costs and limiting economic feasibility biogas purification to remove carbon dioxide (CO2) and hydrogen sulfide (H2S), because H2S corrodes vital mechanical components within engine generator sets and vehicle engines if it is not removed. Feasible biogas purification technologies exist for large-scale sewage and biowaste digesters, and the technologies for upgrading biogas, compressing, storing and dispensing biomethane are well developed. If cost-effective methods for upgrading biogas could be developed for the farm-scale, biogas purification could provide dairy farmers with revenue to complement (or replace) cooking gas. Membrane based biogas purification consumes less energy and more methane recovery as compared to other available technologies. It also enables low pressure working conditions. The normal biogas production is around 1 to 1.5 bar pressure region since the low pressure purification is suitable for households and farm sectors it has a wide range of application

Index Terms—Biogas, Methane,

I. INTRODUCTION

Due to scarcity of petroleum and coal it threatens supply of fuel throughout the world also problem of their combustion leads to research in different corners to get access the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and
hydro sources of energy, biogas are all renewable energy resources. But, biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation.

Biogas is a renewable energy source like solar and wind energies. It is also a carbon neutral fuel produced from anaerobic digestion (AD) which is one of the most efficient ways to store energy. Solid and liquid digestants of AD are rich in nutrients for plants and soil microgram, such as nitrogen and phosphorus. Additionally, pathogens and parasites are inactivated during AD. Most of the time, the digestants simply need a stabilization post-treatment and their characteristics allow them to be used for soil amendment without sanitation risks, such as water borne diseases[1].

The substrates to produce biogas by means of AD are residual organic materials (ROM) issued from municipal, industrial, institutional and agricultural sectors. AD can take place in liquid or solid phase, but the most common digester operation is in liquid phase. The inlet solid concentration in the digester is usually in the 2–10% range.[2] AD technology is also cheaper and simpler than others to produce bio-fuels. It can also be found in a wide range of sizes. For example, small scale application is a common way to transform house wastes into biogas for heating and cooking in several countries. The production of biogas as a fuel does not contribute to the accumulation of greenhouse gases (GHG) in the earth's atmosphere because the carbon dioxide (CO2) produced during combustion was previously captured by plants. The production of biogas from ROM represents a controlled capture of methane (CH4) produced during AD, thus avoiding the emissions of this GHG to the atmosphere like in the case of landfilled ROM.[3] Biogas has a high calorific value (35–44 kJ g1) which is similar to diesel, kerosene and LPG. It is also higher than other energy sources like coal and wood.4 Typically, biogas contains 55–60% CH4 and 38–40% CO2. It can also contain small amounts of incondensable gases like nitrogen (N2), oxygen (O2) and hydrogen (H2), as well as traces of hydrogen sulphide (H2S) and volatile organic compounds (VOC). The acid compounds in the gas and the impurities are corrosive or have the potential to produce corrosive compounds during biogas combustion. These compounds will affect the metal parts of internal combustion engines and tubing.[5] Therefore, biogas purification is mandatory before corrosive compounds enter the natural gas grid or combustion engines. The purification costs can sometimes be so important that the production of upgraded biogas is economically less attractive than other biofuels. Nowadays, technological processes to clean-up biogas, as well as their optimization, are attractive to decrease biogas upgrading costs. Examples of these technologies are absorption, high pressure scrubbing, high pressure adsorption, as well as cryogenic separation and membrane separation. Among these technologies, the latter is potentially advantageous for biogas purification, as discussed in the present document.[6]

II. LITERATURE SURVEY

Technologies for biogas purification

Water and Polyethylene Glycol Scrubbing:

Water scrubbing is used to remove CO2 and H2S from biogas since these gases are more soluble in water than methane. The absorption process is purely physical. Usually the biogas is pressurized and fed to the bottom of a packed column while water is fed on the top and so the absorption process is operated counter-currently. The solubility of CO2 and H2S is much higher than that of CH4. Pressure affects the solubility of all compounds [7]. First, the biogas enters a separator at a pressure of 2 bar where water and compounds heavier than CH4 and CO2 condense. Then, the gas is compressed to 10 bar and injected into the bottom of a scrubber where water is sprayed to absorb CO2. The gas leaving the scrubber is sent to dry and CH4 concentration can reach 98%. Water is sent to a unit of desorption where the pressure decreases to 1 bar allowing water regeneration. The main advantage of HPWS is its simplicity and high efficiency of methane recovery (>97% CH4). This technique requires water and an absorption column. The main disadvantages are high investment costs, high operating costs, possible clogging because of bacterial growth, foaming, low flexibility toward variation of gas input, as well as important consumption of water and energy

CHEMICAL ABSORPTION

Chemical absorption involves formation of reversible chemical bonds between the solute and the solvent. Regeneration of the solvent, therefore, involves breaking of these bonds and correspondingly, a relatively high energy input. Chemical solvents generally employ either aqueous solutions of amines (i.e. mono-, di- or tri-ethanolamine) or aqueous solution of alkaline salts (i.e. sodium, potassium and calcium hydroxides). Biswas et al. (1977) reported that bubbling biogas through a 10% aqueous solution of mono-ethanolamine reduced the CO2 content of biogas 40 to 0.5–1.0% by volume [8]. MEA solution can be completely regenerated by boiling for 5 min and is then ready for re-use. The advantages of chemical absorption are complete H2S removal, high efficiency and reaction rates compared to water scrubbing, and the ability to operate at low pressure [9]. Because of these advantages, the process is commonly used in industrial applications, including natural gas purification. The disadvantages are the additional chemical inputs needed and the need to treat waste chemicals from the process [10].

Cryogenic separation

Cryogenic process is based on the principle that different gases liquefy under different temperature-pressure conditions. It is a distillation process operated under very low temperatures (close to _170 _C) and high pressure (around 80 bar). Therefore, the production of very pure CH4 can use this technology. Theprocess consists of cooling and compressing the raw biogas in order to liquefy CO2, which is then easily separated from the biogas. This process allows treating high flow rates of raw biogas reaching CH4 concentration in the range from 90% to 99%. Cryogenic processes require the use of a large amount of equipment and instruments such as compressors, turbines, heat exchangers, and distillation columns. It also requires high capital and operating costs [11].

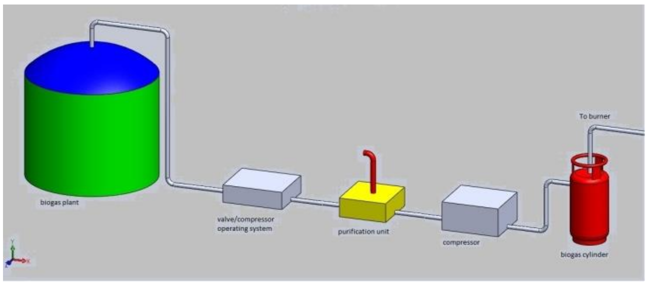
Membrane separation

The principle of membrane separation is that some components of the raw gas are transported through a thin membrane while others are retained. The permeability is a direct function of the chemical solubility of the target component in the membrane[12]. Solid membranes can be constructed as hollow fiber modules or other structures which give a large membrane surface per volume and thus very compact units[15]. Typical operating pressures are in the range of 25-40 bars. The underlying principle of membrane separation creates a tradeoff between high methane purity in the upgraded gas and high methane yield. The purity of the upgraded gas can be improved by increasing the size or number of the membrane modules, but more of the methane will permeate through the membranes and be lost.

Membrane separations are particularly appealing for biogas upgrading due to their lower energy consumption, good selectivity, easily engineered modules, and therefore lower costs. High CH4 recovery efficiency can be reached (>96%), while pure CO2 can be obtained. The main disadvantage of membrane separation is that multiple steps are required to reach high purity.[13] This technology for biogas upgrading is based on gas dissolution and diffusion into polymer materials (membranes). When a differential pressure is applied on opposing sides of a polymer film, gas transport across the film (permeation) occurs. The gas rate of permeation is controlled by the solubility coefficient and diffusion coefficient of the gas-membrane system. Polysulfone[16], polyimide or polydimethylsiloxane are the common membrane materials for biogas upgrading. In the mid-1980[14], Cynara (Natco), Separex (UOP), and Grace Membrane Systems were already selling membranes made from cellulose acetate to remove CO2 from CH4 in natural gas

III. PROPOSED METHOD

Membrane separation Membrane separations are particularly appealing for biogas upgrading due to their lower energy consumption, good selectivity, easily engineered modules, and therefore lower costs. High CH4 recovery efficiency can be reached (>96%), while pure CO2 can be obtained. The main disadvantage of membrane separation is that multiple steps are required to reach high purity.[13] This technology for biogas upgrading is based on gas dissolution and diffusion into polymer materials (membranes). When a differential pressure is applied on opposing sides of a polymer film, gas transport across the film (permeation) occurs. The gas rate of permeation is controlled by the solubility coefficient and diffusion coefficient of the gas-membrane system. Polysulfone, polyimide or polydimethylsiloxane are the common membrane materials for biogas upgrading[16]. He we used a combination of compressor , membrane and a solenoid valve to pressurize, purify and isolation of biogas from the digester



The gas from the chamber is first subjected to pressure test and when pressure range is in the desirable region the valve open and also the compressor started .The gas is being sucked and pass through the purification unit (hollow fiber membrane) ,the co_2 get separated and compressed to a storage tank . The purification unit remove the unwanted gases, it reduce the quantity which is to be compressed to the storage tank by the compressor

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