A Review On Renewable Energy Sources: Investigation On The Treatment And Up gradation Of Biogas

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Abstract

As there is a severe shortage and crisis of electric energy around the world in the recent days, it has become very essential for the scientists and the researchers to work on finding ways to overcome this shortage and crisis by finding resources that can last longer and which does not cost the public more than the present electricity. Due to this increasing energy demand, the Danish energy agency has decided to try to achieve a production of 17 PJ of biogas energy by 2020. But due to lack in the investment on construction of biogas plants the goal set by the Danish energy association is looking to be doubtful. This brings in the idea of reduction in the losses that takes place in the production of the biogas energy. And to reduce the losses in the production of the bio energy it becomes important to know about the procedure and the ways of production of the biogas.

1.Introduction

For the reduction of losses, it becomes important not just to study about the production but it also becomes important to study about the storage of bio energy and the transportation of the bio energy. The production of energy using biogas is a huge process and this process is further divided into sub categories that are named after the major methods and major important processes that are being done in a very well defined and stipulated manner. These processes stand of a major importance in giving a high quality and a very efficient form of energy that can be used for a longer and a higher period. With increasing population, there in a rapid increase in the production of energy and this production of energy cannot be increased using the renewable products so there stands a high importance to increase the production of energy using the non-renewable energy to fulfil the needs of the future upcoming generation [12,14,15]. And it also becomes important for us to do that with a very low cost that can be managed without sacrificing much. Various countries around the world have put their scientists under the work of finding such energy and among one of those recently developed energy forms come the energy producing biogas. But even after using biogas as the main product the energy needs cannot be reached so it becomes highly necessary to improve the idea of biogas and bring in some development which would help the goal of reaching the energy need soon.

2. Biogas Purification

The first level of the chain of supply of the biogas are the farmers [2]. Manure or crop wastes or water wastes from the farm are the basic input for the biogas chain. These basic inputs go through various treatments before going further into the process. These various treatments include procedures such as anaerobic respiration, decomposition etc. [11,13].

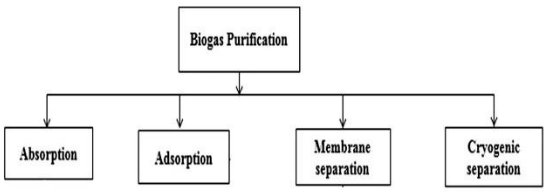

Figure.1 Flow chart on methods of biogas purification

The treated input is now called as the digestant or the biogas itself. The various types of treatments that can be done are absorption, adsorption, membrane separation, cryogenic separation.

2.1 Absorption

The main factor on which the absorption depends is the solubility of gas components in the liquid solvent. The first level biogas is passed through a chamber where these gases encounter a liquid surface with some mixed additives that is used to increase the surface contact between the gas and the liquid. The gas that comes out of this chamber now has a higher concentration of CH_4 compared to the concentration of CO_2 as it is more liquid soluble when compared to the methane gas and the liquid leaving the chamber comes out with a higher concentration of Carbon Dioxide [2,18]. The absorption method is further divided into two namely the physical absorption which has various processes such as the high-pressure water scrubbing and organic physical scrubbing. In physical absorption, most work is done by physical process using machines or labour and the gases are processed through various procedures which finally results in the final biogas. The second type of absorption is named as the chemical absorption, where most processes that take place are using chemicals.

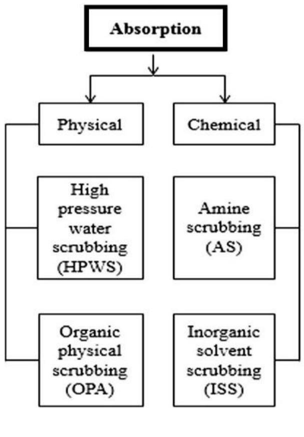

Figure.2 Types of Absorption

The gases are passed through various chemical reactions before taking the gas to the next process of the biogas purification. Processes such as amine scrubbing and inorganic scrubbing comes under the chemical absorption.

2.2 Adsorption

The procedure of adsorption can be a more accurate and better treatment method compared to other methods if the choice of the adsorbent is done correctly. The most commonly used adsorptive materials are molecular sieve materials such as the activated carbon or zeolites. These materials make the flow of CO_2 easy whereas stops the flow of other gases such as CH_4. The absorbents should be chosen wisely with different aspects in view, such as easy to desorb materials, materials that absorb moisture quickly, materials that attract CO_2 etc. should be chosen for the process [1,17]. The most used types of adsorptions are temperature swing adsorption, pressure swing adsorption, electrical swing adsorption.

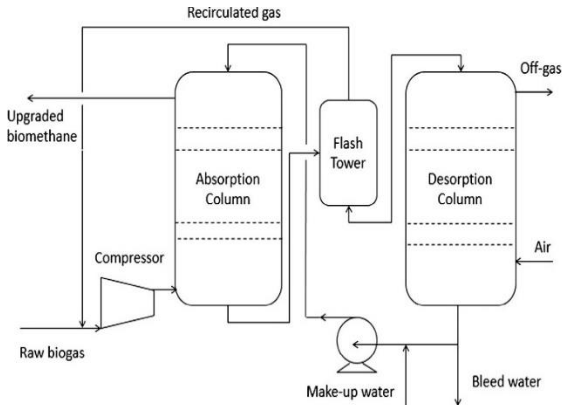

Figure.3 Flow diagram of high pressure water scrubbing adsorption

2.3 Membrane Separation

Membrane separation is the most commonly used method of treatment in the recent days. In this method, the membrane acts a blocking wall or barrier that separates the compounds completely by allowing only a few certain molecules to pass through while blocking the other molecules. These membranes control their permeability based on the driving force that is being applied by different molecules. The molecules have a difference in concentration, pressure, temperature and electric charges etc. These differences make it easy for the membrane to differentiate between different molecules which makes it easier to separate these molecules. In membrane separation method, the CO_2 molecules left to penetrate through the membrane whereas the CH_4 molecules get trapped in the membrane. CH_4 here is known as the retentate. The membrane separation method can be made more effective if the flow of the gas is low and the inlet of CO_2 is higher. The cost for the membrane separation method is cheap compared to most other methods of treatment. This method usually needs a very small cost input to start with and it also requires a very low energy to run the process which gradually results in a decrease in the cost or maintenance. The membrane separation is further classified into three division namely inorganic, polymer and MMMs.

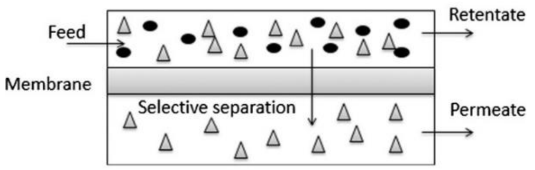

Figure.4 Schematic diagram of membrane separation process

2.4 Cryogenic Separation

Different gases liquefy at different temperature and pressure conditions. In this method of treatment, the CH_4 is liquefied and separated from carbon dioxide as the boiling point of CH_4 is much lower when compared to that of CO_2 which makes it very for this separation to take place. This process consumes a lot of energy due to various working processes. The operating conditions need to be maintained throughout to achieve a more effective separation of gases. The cryogenic separation mainly undergoes four main steps of separation where moisture, dirt particles, halogens and other unwanted components are separated. In the second step the gas is compresses and cooled gradually. In the third step the gas is further cooled to a lower temperature and CO_2 is liquefied and separated from the gas and finally CO_2 is further cooled until it completely solidifies and is taken out from the mixture.

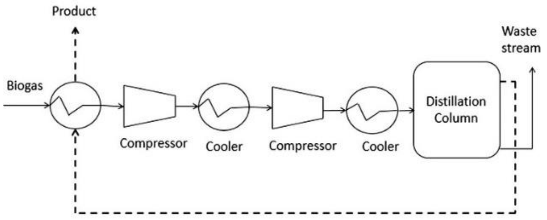

Figure.5 Flow chart of cryogenic separation

2.5 Purification of Biogas by Biomass Ash

The advancement of gas from landfills by using ignition deposits is a method that is being employed to eliminate undesirable compounds such as sulphur compounds, aromatic compounds and halogenated volatile organic chlorinated compounds which are present in the gas [3]. In every refining procedure of biogas, it has become very important to remove CO_2 [19] and to make the gas rich in CH_4. But least importance is given to the removal of H_2S but it stands of a very high importance to remove H_2S and ash from the biogas as it can corrode the power system through production of sulphur oxides when the gas is combusted which also affects the efficiency of the system when the fuel is used. [4] Removal of H_2S from biogas was credited to the reaction of iron oxides with H_2S when steel slag is used for purification of biogas in a fixed bed reactor. During experiments with ferrous oxides it was observed that a mathematical model of reactive conveyance was utilized to test the consideration that sulphur oxides formed on the ferrous oxide surfaces reduces access of H_2S to the reactive when it is passed on the ferrous oxide surface [5].

2.5.1 Methodology

2.5.1.1 Newstift Demonstration Pilot-Plant

A demonstration plant was built with a small-scale biogas plant where organic wastes were treated. A few test runs were taken to study the fittingness of the organic ash as material for biogas purification. The construction of the pilot-plant has a block for dividing the flow was constructed in the existing biogas plant to split the biogas flow and it was connected to the pump with a

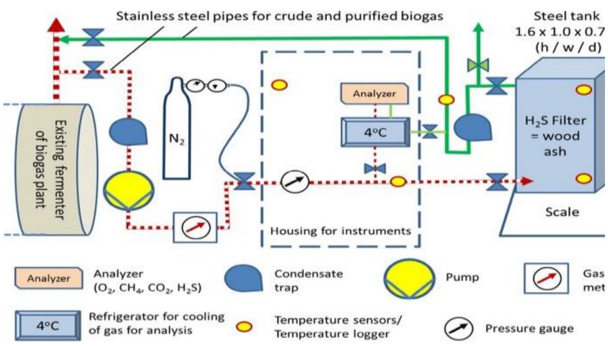

Figure.6 Flow chart of newstift demonstration pilot-plant

speed regulator. The volume flow was monitored with a flowmeter. Nitrogen was flushed with ash and the whole bypass system at the launch of each test run to evade development of explosive gas mixtures. While flushing, the gas was not recycled into the main biogas pipe, but let out by opening the flushing valve until oxygen concentration dropped to less than 1.0% during further main parts of the test the gas was recycled [20]. Tests on biomass-ash based processing of biogas did not produce a constant gas composition of the decontaminated gas. However, a continuous removal of H2S was detected, and so, organic ash can be used as a net for trapping the H_2S gas from the biogas in small quantity biogas plants, but they could not remove CO_2 as it required high filter rates. Considering the current cost of iron and its compounds it is still a cheaper method, therefore we can say that in case the biogas-treated ash could be used in agriculture, the presented technique could be economically attractive [6].

2.6 Removal of Other Compounds from Biogas

Other than CO_2 and CH_4 there are other chemical compounds in biogas that needs to be removed before further usage of the biogas. Other compounds such as moisture or H_2S can cause a very rapid decrease in the efficiency of the machines by corroding or causing initial rust on the surface of the pipes through which the biogas is circulated. This can cause a high and rapid loss in the production of the biogas energy. The moisture in the pipes should be removed as the pipe starts to corrode due to simultaneous presence of both moisture and oxygen in the biogas. Therefore, it becomes necessary to remove the moisture from the biogas to increase the efficiency. Silica gel, activated carbon and aluminium oxides play a major role in the removal of moisture from the biogas. Silica gel also plays a major role in the removal of silicon components. It can remove most of the organic silicon components. The other compounds that are present in the biogas are siloxanes these are present in most of the industrial biogases. Siloxanes are present in shampoos, paper coating and textile industrial biogases [2]. Siloxanes are most commonly reported to be removed by the process of adsorption.

2.7 Life Cycle Assessment of Biodiesel Upgrading Machines

As stated under ISO 14040 and 14044 standards, the LCA is carried out often in four stages as shown in the figure below. The impacts caused in the life cycle is further divided into three namely First impact, Use impact and End of life impact [7]. Life cycle assessment (LCA) is a functioning implement usually used to assess the energy and environmental performance of a product or system throughout life. LCA considers all environmental consequences of a product, including exploitation of the resources, transport, manufacturing, emissions and disposal. The emission from the entire biogas production to energy conversion measures the environmental impacts for any processing technology.

Furthermore, LCA techniques provide the base for the evaluation of GHG emissions. LCA also demands the industries to decrease the wastes and to adapt a recycle of the gases to produce energy this way the shortage of energy can also be reduced and a better atmosphere can be obtained and the GHG emissions can be reduced. [2] The GHG (Green House Gases) mainly consist or gases like CO_2, CH_4, N_2O and HFCs. These greenhouse gases play a major role in harming the environment and this can be reduced by reusing and recycling the harmful gases that are produced in the industries to produce renewable energy.

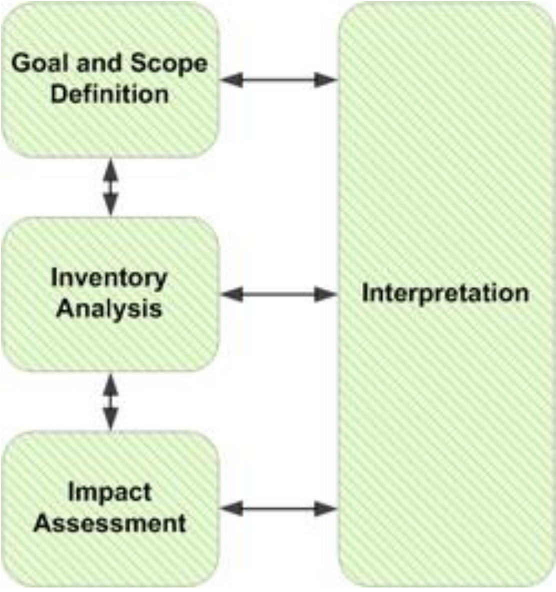

Figure.7 Phases involved in a Life Cycle Analysis

2.8 Innovative Ways of Treatment of Biogas

The treating of biogas is very important towards producing clean energy and it is also vital to reduce the losses during the production of the biogas energy. Froths present in the gas can decrease the efficiency of the plant by causing corrosion and other defects as discussed and concluded by various authors[21]. Though various methods of treatment of biogas is available it becomes important to find various other methods which can be more effective and low in cost compared to other methods. Here we discuss about an innovative technique of biogas treatment which is a biological method by hydrogenotrophic methanogenesis which gives new ways of producing renewable energy source [8].

$$4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$$

Here hydrogen molecules are reacted with carbon dioxide to form methane gas that has a concentration of about >98% of CH_4 with water as a by-product [9]. The main way of producing H_2 biologically and in an environment friendly way is by the electrolysis of water. The electrolysis of water can be done by using the excess power from the solar and wind power plants [10].

Conclusion

Reduction of cost only does not stand of high importance in the production of renewable energy using the biogas as the input. The treatment and various other processes should be done keeping various factors other than cost in mind. Each process of treatment studied above results in a different grade of gas. And different grade of gas can be used to produce a different form of energy which makes it important to study different treatment technologies in the current period. It also stands of a high importance to reduce the losses that occur in the cycle due to presence of different unwanted gases in the mixture of biogas. Study on these various technologies shows different methods to reduce these losses and in turn it helps us to increase the efficiency of the cycles which helps in production of a higher amount of energy which can be supplied to reduce the current shortage in the energy. This study also stands of high significance in decreasing the use of non-renewable which is in the danger of being exhausted soon. This study finally helps in increasing the opportunity of finding newer ways of treating the biogas which will not just decrease the cost of production but instead result in the increase in efficiency of the cycle.

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