# Concept of Biogas Energy Using Automation

Patel Priyal B[1],Shah Kairavi R[2],Patel Nishtha M[3]

[1,2,3] *Department of Instrumentation and control, Government engineering college, Gandhinagar, Gujarat, India.*

***Abstract:* - There are multiple options are available to serve the requirement using energy sources as due to limited availability of various non-renewable sources. Among them renewable source fits today's utility. Biogas is found to be new searching field in place of non-renewable source. Biogas produces energy through agricultural waste (manure), industrial organic waste and various other biodegradable sources. The goal of biogas concept is to convert close to 100% of the incoming biomass into energy or valuable products, such as biogas, purified enriched biogas, 97% methane, organic waste, sustainable transport fuel, renewable natural gas(RNG),Compressed Natural Gas etc . By implementing modern control technology using advanced automation technology to operate biogas plant more efficiently and reliably. Moreover, it provides all the required functions, including instrumentation and drive technology, safety technology, and energy management, in an integrated solution to minimize space, cost, training and operator time.**

***Keywords: Biogas plant, Automation, technology.***

## I. INTRODUCTION

Biogas typically refers to a gas produced by the breakdown of organic matter in the absence of oxygen. It is a renewable energy source, like solar and wind energy. Furthermore, biogas can be produced from regionally available raw materials such as recycled waste and is environmentally friendly. Biogas is produced by anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. Biogas comprises primarily of methane (CH4) and carbon dioxide (CO2) and may have small amounts of hydrogen sulphide (H2S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, the same way natural. Biogas has the potential to generate up to 17,000 MW of electricity in India. Despite government initiatives & support in the 1980s, biogas has not achieved its potential due to a number of reasons. The primary reason for biogas not taking off in India has been lack of a viable business model.

## II. MATERIAL AND METHODS

*A. Anaerobic Digestion:*

AD is a microbiological process of decomposition of organic matter in absence of oxygen. The main products of this process are biogas and digestate. Biogas is a combustible gas, consisting primarily of methane and carbon dioxide. Digestate is the decomposed substrate, resulted from the production of biogas.

During AD, very little heat is generated in contrast to aerobic decomposition (in presence of oxygen), like it is the case of composting. The energy, which is chemically bounded in the substrate, remains mainly in the produced biogas, in form of methane.

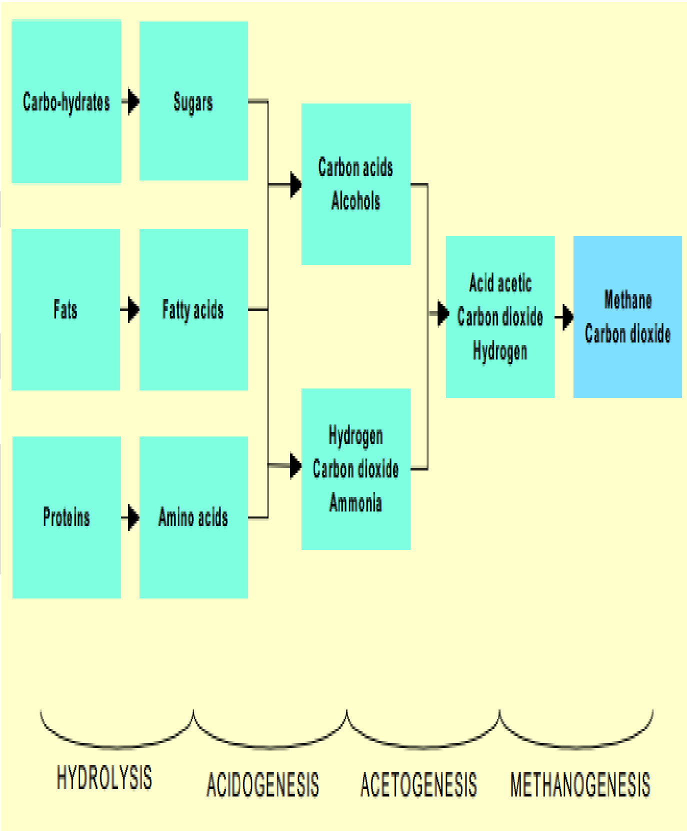


Figure-1.The simplified diagram of the AD process

1) Hydrolysis : Hydrolysis is theoretically the first step of AD, during which the complex organic matter (polymers) is decomposed into smaller units (mono- and oligomers). During hydrolysis, polymers like carbohydrates, lipids, nucleic acids and proteins are converted into glucose, glycerol, purines and pyridines. Hydrolytic microorganisms excrete hydrolytic enzymes, converting biopolymers into simpler and soluble compounds.

A variety of microorganisms is involved in hydrolysis, which is carried out by exoenzymes, produced by those microorganisms which decompose the undissolved particulate material. The products resulted from hydrolysis are further decomposed by the microorganisms involved and used for their own metabolic processes.

2) Acidogenesis:- During acidogenesis, the products of hydrolysis are converted by acidogenic (fermentative) bacteria into methanogenic substrates. Simple sugars, amino acids and fatty acids are degraded into acetate, carbon dioxide and hydrogen (70%) as well as into volatile fatty acids (VFA) and alcohols (30%).

3) Acetogenesis:- Products from acidogenesis, which cannot be directly converted to methane by methanogenic bacteria, are converted into methanogenic substrates during acetogenesis. VFA and alcohols are oxidized into methanogenic substrates like acetate, hydrogen and carbon dioxide. VFA, with carbon chains longer than two units and alcohols, with carbon chains longer than one unit, are oxidized into acetate and hydrogen. The production of hydrogen increases the hydrogen partial pressure. This can be regarded as a "waste product" of acetogenesis and inhibits the metabolism of the acetogenic bacteria. During methanogenesis, hydrogen is converted into methane. Acetogenesis and methanogenesis usually run parallel, as symbiosis of two groups of organisms.

4) Methanogenesis:-The production of methane and carbon dioxide from intermediate products is carried out by methanogenic bacteria. 70% of the formed methane originates from acetate, while the remaining 30% is produced from conversion of hydrogen (H) and carbon dioxide (CO2). Methanogenesis is a critical step in the entire anaerobic digestion process, as it is the slowest biochemical reaction of the process. Methanogenesis is severely influenced by operation conditions. Composition of feedstock, feeding rate, temperature, and pH are examples of factors influencing the methanogenesis process. Digester overloading, temperature changes or large entry of oxygen can result in termination of methane production.

*B. Outline with Anaerobic Process:*

AD is a biochemical process during which complex organic matter is decomposed in absence of oxygen, by various types of anaerobic microorganisms. The process of AD is common to many natural environments such as the marine water sediments, the stomach of ruminants or the peat bogs. In a biogas installation, the result of the AD process is the biogas and the digestate. If the substrate for AD is a homogenous mixture of two or more feedstock types (e.g. animal slurries and organic wastes from food industries), the process is called "co–digestion" and is common to most biogas applications today. For getting purposed biogas, automation such as PLC and SCADA make process easy.

The main process steps in a biogas plant are outlined:

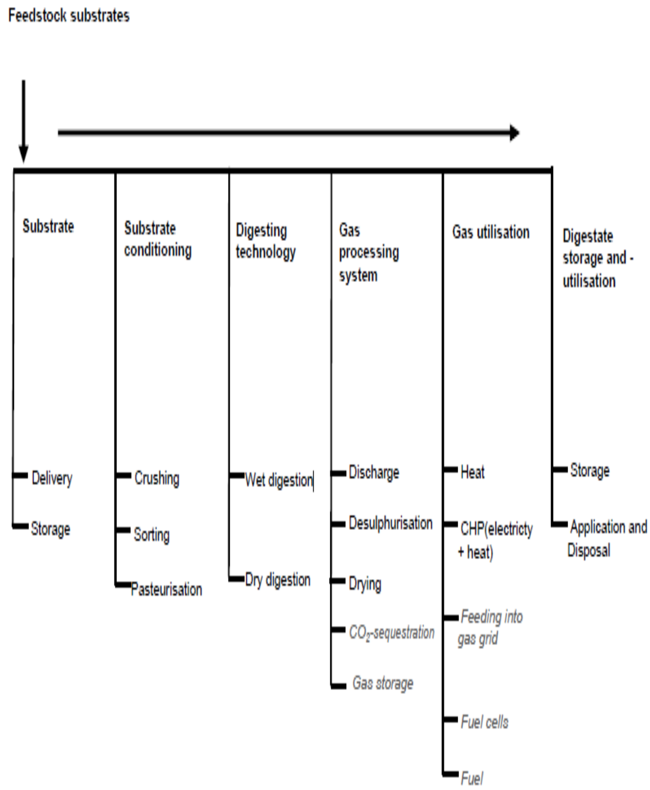


Figure 2. Process steps of biogas technologies

## III. INSTRUMENTATION AND CONTROL AUTOMATION

The plant is equipped with numerous online measurement devices , powerful programmable logic controllers (PLC) and a modern PC-based supervisory control and data acquisition (SCADA) system. Furthermore, it is possible to operate the plant via remote control. The system is also equipped with a digital process field bus . The data can be used for numerous different ICA applications, e.g. a virtually complete automatic balance of solid, fluid and gaseous material flows (volume, weight) is possible. The type of substrate can also be recorded. Energy balances (electricity, heat) can be calculated. A comparison of calculated and measured biogas/methane yields is possible. All this information is very important for controlling and benchmarking as well as for plant operation. The temperature, which is measured continuously in digester/post-digester, can be controlled by automatic control of the heating system. The changing of the biogas composition and the biogas flow rate can also be used to avoid/identify critical operating conditions. In case of agricultural applications it is already possible to measure on-line and off-line concentrations of (organic) dry matter, proteins, crude fibres as well as fat content by using NIRS. Due to the fact that these parameters are also very important for (agricultural) biogas plants, there is a good chance that full-scale biogas application (e.g. monitoring of input substrates) are also feasible in the near future.

## IV. RESULT AND DISCUSSION

Biogas plants equipped with modern equipment and reliable/adapted machineries and engines, can reach very good operational results. Efficiency close to 100% methane can produce base load electricity/heat and can be an alternative to large centralized power plants. E.g. modern automation is possible to connect numerous biogas plants into one vast plant. Biogas have more capability as compared to other renewable energy as its energy can be stored in large scale then another sources like wind energy, solar energy. Moreover, the production of biogas leads also to an increase of the agricultural value-added chain and– as a regional energy resource– to an increase of supply security. Thus, biogas plant is cost efficient option for rural areas where product is of more important.

## REFERENCES

1. Lens P, Hamelers B, Hoitink H & Bidlingmaier W (Editors) 2004. *Resource Recovery and Reuse in Organic Solid Waste Management, Integrated EnvironmentalTechnology Series.* ISBN 1-84339-054-X, IWA Publishing, UK.
2. Lise Appels, Jan Baeyens, Jan Degrève & Raf Dewil. Principles and potential of the anaerobic digestion of waste-activated sludge. Energy and Combustion Science. 2008; 34:755-781.
   3) Muller J.A. Pre-treatment processes for recycling and reuse of sewage sludge, Water Sci. Technol 2000; 42:167–174.
3. 4)El-Mashad, H.M., Zeeman, G., van Loon, W.K.P., Bot, G.P.A., Lettinga, G. Effect of temperature and temperature fluctuation on thermophilic anaerobic digestion of cattle manure. Bioresource Technology 2004; 95, 191.
   5) Delgenes JP, Penaud V, Torrijos M. & Molletta R. Investigation of the change in anaerobic biodegradability and toxicity of an industrial biomass induced bythermochemical pre-treatment. Water Sci Technol. 2000; 41(3):137-144.
   6)Tilche, A. & Malaspina, F. Biogas production in Europe. Paper presented at the 10th European Conference Biomass for Energy and Industry, W•urzburg, Germany;1998.
4. 7)Weemaes, M., Grootaerd, H., Simoens, F. & Verstraete, W. Anaerobic digestion of ozonized biosolids. Water Research .2000; 34 (8), 2330–2336.
5. 8)Carr`ere H., Dumas C., Battimelli A., Batstone D.J., Delgen`esJ.P., Steyer J.P.& Ferrer I. Pretreatment methods to improve sludge anaerobic degradability: a review, Journal of Hazardous Materials; 2010.