Design and Development of Biogas Plant for Powering IC Engine

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Abstract: ***The fuels what we are using nowadays majorly for our transport and electricity requirements are mainly fossil fuels. Like a big populated country like INDIA it is difficult to avail for the fossil fuels(petrol, diesel, coal, etc,.) for a long period because they are under crises. And moreover the important factor concerned with their usage, is the pollution. And on other side nuclear energy requires very carefully handling technique. To overcome these obstacles we must look into some alternative options for the fossil fuels. Alternating to the renewable energy resources (biomass, biogas, wind, hydro power, etc.,) is the only way to cope up with the increasing demand and pollution. Biogas has the properties which make it possible to use conveniently for IC engines. And also, the wastes collected after the production of can be used as a very good fertilizer in the fields. Thus, using biogas as a fuel not only reduces the atmospheric pollution but, also increases the food production by using the waste products as a energy rich manure. The production of biogas also generates local employment to thousands of people and also increases the rural economy.***

I. INTRODUCTION

The breakdown of organic matter in the absence of oxygen produce a mixture of different gases is refer to as biogas. The agriculture wastes, manures, municipal wastes, sewages, food wastes, etc., are the raw materials which can produce biogas. It's a renewable energy source. Biogas is obtained from decomposition or fermentation of wastes under anaerobic conditions or in a closed system. The closed system is called as the anaerobic digester or the bio digester or the bio reactor. India is a largest cattle breeding and a food consumer country. There is an abundant of raw material for producing biogas. Biogas majorly contains methane(CH_4), carbon dioxide(CO_2), some trace amounts of hydrogen sulphides, water vapour and siloxanes. The highest calorific value of the methane paves the way to use it as fuel for the internal combustion engines. It can also be used in a gas engine to convert the energy into electricity and also useful for cooking purposes. The use of biogas which contains the quantity of methane above 95% will reduce the automotive emission from 75% to 90%. As a fuel, biogas decreases the leakage of methane from manure and decreases the emissions of fossil CO_2.

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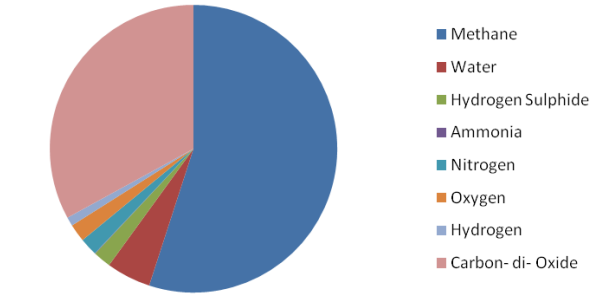
On running it lowers the emission of Nox and Sox. The main challenges for biogas are lowering heating value and transportation of fuel. The papers aim is to design a biogas production plant and using the fuel in an IC ENGINE and studying the properties of gas while operating in that and to improve the characteristics by compressing the biogas at a required property level and studying the pollution levels associated with it.

II. BIOGAS PRODUCTION

The biogas production by the bio degradation of wastes can be done by two methods. They are, Aerobic Digestion (presence of oxygen), and Anaerobic Digestion (absence of oxygen). Out of these Anaerobic Digestion is chosen. Because, absence of oxygen generates very little heat inside the digester. And , the energy bounded is released as methane(CH_4) of 5200 to 5800 KJ/m^3 CV. And, the gas produced by this method is environmental friendly against fossil fuels. Aerobic respiration is not chosen because, large amount of heat is generated due to the presence of oxygen, which results in the production of mixture of gases having large amount of CO_2. It is also one of the "green house" gases responsible for global warming.

III. COMPOSITION OF BIOGAS



IV. DIGESTER

The core of a biogas plant is the digester. An air proof reactor tank where the decomposition of feedstock takes place in the absence of oxygen. This process tends to produce a biogas.

V. PROCESS INVOLVED IN ANAEROBIC DIGESTION

The process are in linked steps. Initial materials are continuously broken down into smaller units. In each steps, the specific groups of microbes are involved.

As per the previous steps, the products are successfully decomposed by these microbes. The process involved are,

A. Hydrolysis,
B. Acidogenesis,
C. Acetogenesis,
D. Methanogenesis.

A. Hydrolysis

It is the first step. The complex organic matters are decomposed into smaller units(monomers). Hydrolytic microbes excrete hydrolytic enzymes is converting the biopolymers into a simpler and solubility compounds. The exo-enzymes produced by microbes decompose un-dissolved particulate matters. The products are again decomposed by microbes. So that, it can be used for the metabolic process.

B. Acidogenesis

Products of Hydrolysis are converted by acidogenic (fermentation) bacteria into methanogenic substrates.

C. Acetogenesis

The Products achieved from the process of acidogenesis cannot be directly converted into methane by methanogenic bacteria. The products are first converted into methanogenic substrates. The production of hydrogen increases the H_2 partial pressure.

D. Methanogenesis

Methanogenesis is a critical step. It is the slowest biochemical reaction process. The production of CH_4 and CO_2 is carried out by methanogenic bacteria. Overall methane formed is, 70% from acetate, and 30% from conversion of CO_2 and H_2.

VI. PROBLEMS IN USING BIOGAS IN AN ICENGINE

- The higher content of CO_2 tends to reduce the power output and uneconomical transport fuel. By washing the gas with water is the possible way to remove CO_2. By washing out the CO_2, acidic solution is produced and it needs a careful disposal.
- If H_2S is not removed within a matter of hour it can cause a corrosion to engine parts because of it's acidic nature. By passing the H_2S gas through Fe_2O_3 or ZnO, it can be easily removed.
- Even though the smell of H_2S is unpleasant, the materials can be re-generated on exposure to the air.
- It can cause starting problems due to high residual moisture.
- The quality and pressure of a gas can vary.

VII. BIOGAS UPGRADING

Corrosive H_2S is enough to destroy mechanisms. All other contaminants are removed and methane percentage is increased from the usual 50-70% to more than 95%. This upgrading of biogas is named as BIOMETHANE. Some of the methods are,

A. Water washing,
B. Condensation,
C. Oxidation.

A. Water Washing

The high pressure gas flows into a column where the CO_2 and other trace elements are scrubbed by water running counter-flow to the gas. It produces 98% of methane with 2% loss. And, 3% to 6% energy loss.

B. Condensation

Condensation in the gas storage or on the way to the engine removes water vapor.

C. Oxidation

Injection of small amount of oxygen, leads to oxidation of H2 and eliminates 95% of sulphur in the cheapest way.

VIII. BIOGAS IN A DIESEL ENGINE APPLICATION

The biogas cannot be directly used in a CI engine because it has a high self-ignition temperature and so, it is used in dual fuel engines. The dual fuel engines in which a gaseous fuel is inducted with air as a primary fuel into the engine cylinder. Due to high octane number, the air and fuel mixture does not auto ignite. For promoting combustion, the small amount of diesel is usually called an pilot fuel. The primary fuel is homogeneously mixed with air in a dual fuelling system that leads to produce low level of smoke. The pilot fuels are having high cetane. Biogas and vegetable oils can be used as a pilot fuel in dual fuel mode. It normally leads to deterioration in performance and emission characteristics.

The ignition delay of the pilot fuel increases and this will lead to advance the ignition timing. In a biogas used engine, injectors opening pressure and rate of injection are playing a major role, in which vegetables oil is used as a pilot fuel.

IX. CHANGES TO BE MADE IN AN IC ENGINE SETUP FOR RUN WITH BIOGAS:

- Providing biogas fuel metering system.
- Removal of normal fuel injection system.
- Reduction in compression ratio.
- While using in a diesel engine the fuel injectors needs to be replaced by a suitable spark plug.
- Addition of biogas carburetor for air-fuel mixing.
- Modification of compression ratio from 16:1 to 8:1.
- Biogas should be upgraded to a zero impurities of H_2S, H_2O and CO_2.

X. CONCLUSION

Hence, in this research paper attempts were made to know what a biogas means, and the role played by methane in the biogas , and the various steps involved in the production of biogas from a biogas digester, and the negative effects of biogas when, it is used inside an IC engine, and the changes to be made in an IC engine to run in a biogas fuelled system.

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