International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 01 , January 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

APPLICATION OF BIOGAS IN I.C ENGINE: A REVIEW

Maurya Kirti A[1], D.C.Gosai[2], Amit.V.Shah[3]

[1]P.G Student, [2]Assoc. Prof., [3]Asst. Prof., Mechanical Engg. Department, SVMIT Bharuch, (India)

ABSTRACT

The automobile vehicles are the major source of the air pollution and cause the environmental problems like Global Warming, Greenhouse gases and the acid rain. The addition of an alternative fuel like gaseous fuel with gasoline in the engine is one of the possible approaches for reducing this problem because of its constituent influences on engine emission characteristics. The aim of this paper is to present the potential role of biogas as an alternative fuel. There is abundance of raw material for producing biogas. Also municipal sewage can be use for this purpose. Biogas is produced from the process of anaerobic digestion of wet organic waste, such as cattle and pig slurries, food wastes and biomass. There is growing interest in the use of biogas as a fuel for automobile vehicles. Some of the reasons behind this are the increasing regulation and taxes on waste disposal, fuel crisis, an increasing need for renewable fuel sources, measures to improve local air quality and the need for clean transport fuels in urban areas. Through detail literature survey, the challenges to the gasoline fuel and biogas are studied and it is found that biogas is an effective method for reducing CO_2, CO, HC and NO_x emission.

Keywords: alternative fuel, biogas, biogas petrol blend, I.C engine, engine performance, emission

I. INTRODUCTION

Society is today facing the problem of an increased demand for energy. The conventional energy sources do not to be able to meet this ever increasing demand. In recent years, environmental pollution and energy resource depletion have become serious issues for the world like global warming, acid rain, etc. In particular, research into automobile industry has attracted growing interest in an effort to improve engine efficiency and reduce harmful exhaust emissions. So, there is needed to be development of engines that can operate using more environmentally alternative fuel. To save the conventional fuel by limiting its usage it is necessary to focus our attention towards renewable source of energy for power generation. The main sources of renewable energy in India are biomass, biogas, solar, wind and hydro power. Gaseous fuels have wide flammability limits and can easily form a homogeneous mixture with air for good combustion. The self-ignition temperature of biogas is high and hence it resists knocking which is desirable in I.C engines. Thus they will lead to very low levels of pollutants and can be effectively utilized in both spark ignition and compression ignition engines.[11] Biogas is a renewable alternative fuel for I.C engines that has several advantages over fossil fuels, including lower costs and reduced levels of harmful emissions. Biogas produce from the anaerobic decomposition or fermentation of

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

organic material like: Municipal waste or leftovers landfill gas, man and animal's biological activity waste, sewage gas, Energy crops etc.

India has the abundance of raw material for producing biogas. The methane separated from biogas use as a fuel will substantially reduce harmful engine emission and will help to keep the environment clean. The composition of biogas is within the following ranges: [12]

CH_4	CO_2	H_2	N_2
50–70%	25–50%	1–5%	0.3–3%

II. LITERATURE SURVEY

R. Chandra et. Al. [1] Present the performance results of a 5.9 kW stationary diesel engine which was converted into spark ignition mode and run on compressed natural gas (CNG), methane enriched biogas (Bio-CNG) and biogas produced from bio methanation of jatropha and pongamia oil seed cakes. The maximum brake power producing capability of the engine corresponds to 35° TDC ignition advance for compressed natural gas, methane enriched biogas and raw biogas at compression ratio of 12.65. The observed power losses due to conversion of diesel engine into spark ignition engine had been 31.8%, 35.6% and 46.3% for compressed natural gas, methane enriched biogas and raw biogas, respectively. The engine test results obtained in terms of brake power output, specific gas consumption and thermal efficiency on methane enriched biogas containing 95% methane has showed that the engine performance is almost similar to that of compressed natural gas. Thus, the gaseous fuel methane enriched biogas is as good as natural gas. Further, the biogas is renewable and CO_2 neutral fuel in terms of net emissions of carbon to the atmosphere.

Awogbemi et. Al. [2] Research is on the development and testing of a biogas-petrol blend to run a spark ignition engine. A20:80 ratio biogas: petrol blend was developed as an alternative fuel for spark ignition engine test bed to determine the effectiveness of the fuels. The performance test was carried out on a 5hp single cylinder four stroke Spark ignition Honda GX 140 engine AC dynamometer. The engine performance characteristics were monitored within the speed range of 1000rpm and 3500rpm varied incrementally by 500rpm. The result showed that the biogas contains 65.25%, 0.65%, 1.63%, 1.76%, and 30.71% of methane CH_4, ammonia NH3,carbon monoxide CO, hydrogen sulphide H_2S, and carbon dioxide CO2 respectively. It can therefore be concluded that biogas-petrol blend is a veritable and viable alternative for standalone spark ignition engine. A spark ignition engine fuelled with biogas-petrol fuel of proportion 20:80 generates more torque, brake power, indicated power, brake thermal efficiency and more brake mean effective pressure but with less fuel consumption and exhaust temperature. A biogas-petrol blend run on spark ignition engine is more economical, environmental friendly, and contributes to waste disposal and production of fertilizer.

H. H. Jawurek, et. Al. [3] Performance and combustion characteristics of a portable fixed-ignion-timing engine-alternator set, fuelled with simulated biogases (mixtures of CH_4, CO_2 and minor quantities of H_2) are presented. Maximum power output, at optimally adjusted air-fuel ratios, falls with increasing CO_2 content of the gas, the power losses (referred to pure CH_4) being severe with low-quality gases (e.g. 37% at 50% CO_2). Fuelling with gases of CO_2 content greater than 30% leads to harsh running; cylinder peak pressures are variable from cycle to cycle, low in amplitude and retarded in timing. Low power output, poor combustion and harsh running can be corrected by the simple technique of dual fuelling that is, supplying some petrol simultaneously with the gas.

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Such admixture of petrol is beneficial for all biogases, but particularly so, in small quantities and with very poor gases. For example, for a gas of 55% CO_2 content the admission of 10% petrol combustibles yielded a doubling in peak power output. Dual fuelling is possible at any gas/petrol ratio. Thus even small quantities of biogas, insufficient for normal gas fuelling, can be utilized with resultant savings in petrol.

Venkata Ramesh Mamilla et. Al. [4] Study and performance of 4-stroke petrol engine fueled with Bio gas /L.P.G blends. The various blends of L.P.G and Biogas are used and conducted the tests on 4-stroke, single cylinder, air cooled SI engine. The experimental results were analyzed for the selection of better blend of L.P.G and Biogas suitable for SI engine for better performance with reduced pollution. From the results, it is clear that at 50% blending of biogas the engine performance is found to be very appreciable. At this 50% blending trial particularly at full load the specific fuel consumption and brake thermal efficiency are high when compare to the petrol, LPG and the mechanical efficiency is high for the 50% blending with compared to the Petrol, L.P.G, and 40% Blending. And, also the emission values of CO, HC and NOx are minimum for the biogas when compared to the petrol, L.P.G. when the blending percentage increases the emission values are decreased. The petroleum fuel with its combustion products, pollute the air to great extent. In this case the intensity of pollution problem will be less because of blending this eco-friendly fuel biogas.

Ari Wardana et. Al. [5] Research to find conversion method from gasoline to biogas fuelled of the single cylinder four stroke engine of electric generator. For this purpose the biogas should be upgraded to the level of zero impurities of hydrogen sulfide H_2S, water (H_2O) and reducing up to zero level of CO_2 impurities. The carburetor of the gasoline engine was replaced and only component of the mixer of the fuel and air were used. The selected engine for this purpose was 4-stroke gasoline engine, air-cooled, and inclined single cylinder. The displacement is 196cc; the compression ration of the engine was increased from 8.5:1 to reach around 9:1. The ignition system was non-contact transistor ignition (TCI). By using desulfurizer the biogas can be upgraded to zero content of HS impurities that lead to avoid increasing acidity of the lubricant therefore the corrosion in the combustion chamber can be avoided. The elimination of the CO_2 impurities by flowing the biogas in to the solution of 10% NAOH in water (H_2O). The conversion methods that is developed in this research was successful to run the electric generator engine that previously fueled by gasoline to be converted by using biogas. The engine run stable and can produce electricity. The maximum RPM (revolution per minutes) that can be obtained by using biogas was found can reach the maximum RPM obtained by using gasoline fuel which is around 3600 RPM.

Cheolwoong Park et. Al. [6] In this study, an experimental investigation on a naturally aspirated (NA), 8-L spark ignition engine fueled by biogas with various methane concentrations which we called the N_2 dilution test, was performed in terms of its thermal efficiency, combustion characteristics and emissions. The engine was operated at a constant engine rotational speed of 1800 rpm under a 60 kW power output condition and simulated biogas was employed. In this study, N_2 dilution tests were conducted to assess the effects of inert gas concentration (and therefore fuel energy density) variations within biogas on performance and emission characteristics of a spark ignition engine operated at a fixed excess air ratio of 1. As a portion of inert gas in the fuel was raised, thermal efficiency was elevated due to a decrease in both pumping loss and cooling loss, resulting in as high as 31.1% efficiency at the 80% N_2 dilution. The increased N_2 also induced reduced NOx generation due to low combustion temperature, but caused a rise in THC emission by degraded in-cylinder

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

combustion quality. In terms of efficiency, however, a competition between enhanced combustion stability and increased cooling energy loss was observed with a rise in H_2 concentration, maximizing engine efficiency at 5-10% H_2 concentration.

Wladyslaw Papacz [7] Biogas is produced from the process of anaerobic digestion of wet organic waste, such as cattle and pig slurries, food wastes and grown wet biomass. To be used as a transport fuel biogas has to be upgraded to at least 95% methane by volume and it can then be used in vehicles originally modified to operate on natural gas. Biogas fuelled vehicles can reduce CO_2 emissions by between 75% and 200% compared with fossil fuels. The paper sets out the resource that is available for producing biogas, together with the basic details of production technology. It goes on to explore how this gas can be used in vehicles, describing the basic technology requirements. The energy data and the costs of producing on biogas as a transport fuel are presented. Natural gas used as a vehicle fuel gives 20-30 % lower CO_2 emissions. For biogas the reduction of greenhouse gas emissions can be as much as 100%. In fact, a reduction above 100% can be achieved when biogas produced from manure is utilized as a vehicle fuel. Methane, which is a strong greenhouse gas, is released into the atmosphere from manure in traditional manure storage. Biogas as a vehicle fuel can thus both decrease the leakage of methane from manure and decrease the emissions of fossil carbon dioxide. Another advantage is that vehicles running on upgraded biogas or natural gas have lower emissions of particles, NOx and SOx.

Omid razbani et. Al. [8] Through detailed literature review, the challenges such as lower flame speed (compared to natural gas) and biogas are investigated. Solution and lesson learnt such as advancing spark timing, increasing compression ratio, changing the bearing piston material and pre-chamber ignition systems are presented. Biogas engine have reached to 64000 working hours before major overhaul. An attempt is to develop a simple but yet precise biogas engine model would reduce to controller cost. Controlled mixing of biogas with natural gas will minimize the engine modification.

Cassiano Rossetto et. Al. [9] In this paper, an Otto cycle engine was evaluated on a dynamometer, fed with biogas, generating the characteristic curves of the engine for torque and power. First were made control tests, using the systems commercially available for these fuels, so they could serve as a comparative for the other tests. Next were made tests for the several combinations of ignition point, gas mixer and compression rate. It was observed that the converted engine with biogas can produce a maximum power above 45 kW, with this being able to be connected to a 35 kVA generator so obtaining a self-sufficient electrical power rural property. By the analysis of the results, it can be concluded that the highest engine power with biogas was obtained with a compression ratio of 12.5:1, long gas mixer and 45° spark advance, because on these conditions a maximum power 100% above original biogas was reached. The gain with the utilization of NGV (natural gas vehicle) in replacement of biogas can get to 15% at 3600 rpm engine speed, where the generator gives electrical power. The spark advance and compression ratio with the best results for biogas are also the same used with NGV.

A. Ramesh et. Al. [10] The influence of reduction in the concentration of CO2 in biogas on performance, emissions and combustion in a constant speed spark ignition (SI) engine was studied experimentally. The tests

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

covered the range of equivalence ratios from rich to the lean operating limit at a constant speed of 1500 rpm and at compression ratio of 13:1 with a masked valve to enhance swirl the real benefit of removal of CO2 from biogas is obtained when the engine is operated with lean fuel air mixtures in the range of equivalence ratios between (0.8 and 0.95). An equivalence ratio of around 0.95 and full throttle, the thermal efficiency improves from 26.2% with normal biogas to 27.1% and 30.4% with CO2 concentrations of 30% and 20%, respectively. The corresponding values of HC emissions are 1640 ppm with normal biogas and 1230 and 1150 ppm with CO2 levels of 30–20%. There is a significant increase in the heat release rate with reduced CO2 level and this necessitates retarded ignition timings. A reduction in the CO2 level by 10% seemed to be sufficient for reducing HC levels and the NO levels were also not significantly raised. The spark timings were to be retarded by about 5° when the CO2 concentration was decreased by 10% and the cycle by cycle variations in combustion are also reduced as result of reduced dilution by CO2 and faster combustion.

III. SUMMARY OF LITERATURE REVIEW

From the literature survey it is observed that the authors have worked on various A/F ratio, compression ratio, ignition advance BTDC for improving the engine performance, efficiency, combustion characteristic & emission. For that they considering various parameters like specific fuel consumption, brake thermal efficiency, brake power, ignition timing, indicated thermal efficiency, engine torque, volumetric efficiency, while exhaust emissions were analyzed for carbon monoxide (CO), Hydrocarbon (HC), Oxides of nitrogen (NOx) and carbon dioxide (CO_2). A Spark Ignition engine fuelled with biogas petrol fuel of proportion 20:80 at 3500 RPM increases brake power from 31158 KW to 31891 KW, mechanical efficiency increases from 0.96% to 0.99%, indicated thermal efficiency increases from 27.56% to 73.58%, friction power decreases from 11.73 KW to 4.40 KW.

IV CONCLUSION

After studying of research paper, it can be conclude that biogas is a most important renewable source of energy and it is produce from organic wastes. Biogas is a cheaply available in India. Methane, which is a strong green house gas, is released into the atmosphere from manure in traditional manure storage. Biogas as a vehicle fuel can thus both decrease the leakage of methane from manure and decrease the emissions of fossil fuel. By using of biogas in automobile/vehicle engine, it can reduce the exhaust emissions, increases the thermal efficiency and improved the engine performance as compared to the petroleum products. Dual fuelling is possible at any gas/petrol ratio. Thus even small quantities of biogas, insufficient for normal gas fuelling, can be utilized with resultant savings in petrol. By controlling the mixing of biogas with conventional fuel will minimize the engine modification. Therefore it is recommended to use biogas as alternate fuel in I.C engines.

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

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