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OVERVIEW OF DESIGN CONSIDERATIONS FOR BIOGAS OPERATED INTAKE DEVICE

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ABSTRACT:

In today's growing world, cleanness of waste material is one of the biggest challenges. Such as treatment and disposal of biological waste are biggest problem for many industries. Anaerobic fermentation—a superior alternative to composting—provides a exclusive Created during anaerobic fermentation, The biogas contains characteristics like renewable fuel and a high-energy that can be used as a replacement for fossil fuels. Biogas engines helps to recover waste management, as well as it also used to generate an economical energy supply.

The decomposition of putrescible organic material is used to formed biogas. Biogas combined heat and power or cogeneration, usually in a biogas engine, for the production of useful heat and electricity, at high efficiency. Energy distributor Clarke is of GE Jenbacher biogas engines are designed for strong operation on difficult gases like biologically-derived ones.

KEYWORDS: Biogas, Intake System, SI Engine, Integration of renewable energy systems, Emission analysis; Electric generator

INTRODUCTION:

All kinds of vehicle engines work with fuels produced from petroleum. However, petroleum stocks in the world are limited and expected to be exhausted in about 41 years. Limited energy sources warn of a potential lack of energy in the future. Depletion of fossil fuels and environmental considerations have led engineers and scientists to anticipate the need to develop a clean, renewable and sustainable energy system (yutsel et al 2003). The renewable sources such as hydro, wind, solar and biomass are gaining more and more importance in terms of research and development as well as implemented systems. In order to meet the energy requirements, there has been growing interest in alternative fuels like biodiesels, ethyl alcohol, biogas, methyl alcohol, produce rand hydrogen gas to provide a suitable fuel substitute for internal combustion engines (Bhanpurmath et al.2008). To overcome the problem of limited source of petrol, biogas can be used as a fuel for the petrol engine.

Biogas has been a major source of energy and it is also a renewable source of energy. The biogas is easily developed under specific climatic and socio-economic conditions and the cost of production of biogas is very low. It is widely used in rural communities in the developing countries to serve energy needs for cooking and for limited industrial use. Biogas can also be used as an alternative fuel for internal combustion engines like SI engines. To run the SI engine on biogas some modifications are required to be done in engine system as well as intake system. The strong reason behind need of modification in SI engine to suit for biogas is that petrol and biogas fuel properties are not identical. Hence the SI engine without modification will not perform optimum on biogas fuel.

Therefore the study proposes to design the modified intake system for biogas operated SI engine. The carburetor is to be redesigned to cope up with the problem and be able to use a biogas as a fuel by volume.

In today's world due to limited sources of petroleum energy many companies are trying to fulfill energy requirements from renewable sources. The renewable sources such as hydro, wind, solar and bioenergy are growing faster now days. In order to meet the energy requirements, interest has been taken in alternative fuels like biogas. Biogas is a clean burning fuel and with some modifications it can be effectively used for SI engines in automobile. Also the properties of petrol and biogas closely match or similar to each other, so biogas can be easily used as fuel for SI engines with some modification in intake system as well as engine system.

The main reason behind this adjustment is to attain the same power output using biogas while compared to LPG.

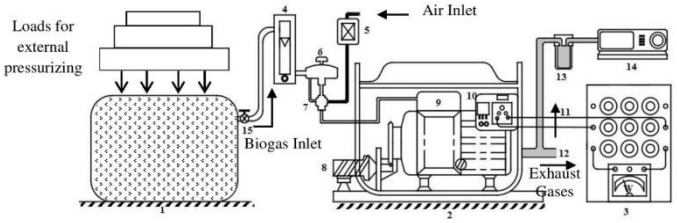

Fig. 1 Schematic representation of the experimental setup

LITERATURE SURVEY:

This section includes the literature survey of earlier research work made by various researchers on use of various types of alternative fuels and their blends with conventional fuels for variety of engines. Various researchers presented the different alternative fuels and design approaches for the development of intake system. Following are the some literatures with research works.

Mardani.2004 developed the intake device for improvement of performance of compressed natural gas spark ignition engine. Also he was improves the flow strategy in the intake device of the engine to produce better Compressed Natural Gas engine performance. Three components were studied, designed, simulated, developed, tested and validated in this research. The components are: the mixer, swirl device and fuel cooler device. The work included design and fabrication of the engine test rig, the CNG fuel cooling device, fitting of instrumentation and measurement device for the performance testing of both gasoline and CNG modes. The overall improvement on engine performance of power and torque was about 11% and 13 % compared to the original mixture.

Arali et al. 2014design and analyse the fuel intake device for biogas operated spark ignition engine. Improving the biogas engine performance by implementing the pressurised turbulent flow,due to this pressurised flow the volume of flow increase. This causes improve the volumetric efficiency and the turbulence will increase the homogeneity of mixture also improve the flame propogation speed. They focuses on the design and analysis of the fuel intake device as economical devices without major modification.

Yuksel et al. 2003 designed the intake device for ethanol-gasoline blend as a fuel in SI engine. By using ethanol–gasoline blend, the availability analysis of a spark-ignition engine was experimentally investigated. Sixty percent ethanol and fourty percent gasoline blend was exploited to test the performance, the fuel consumption, and the exhaust emissions. It had been found that such type of ethanol-gasoline blends have some advantages over gasoline, such as better anti-knock characteristics and reduction of CO and UHC emissions. In the study, the carburetor was redesigned to solve the phase problems of fuel and be able to use a 60% alcohol–gasoline blend by volume. Carter type of carburetor had been replaced and made a special type of carburetor which was having two float chambers, one for ethanol and other for gasoline fuel.

As a result of this study, it is seen that a new dual fuel device could be serviceable by making simple modifications on the carburetor and these modifications would not cause complications in the carburetor device.

Phan Minh Duc et al.2007 study and experimental investigation of a small IDI biogas premixed charge diesel dual fuelled CI engine used in agricultural applications. Engine performance, diesel fuel substitution, energy consumption and long term use have been concerned. The attained results show that biogas–diesel dual fuelling of this engine revealed almost no deterioration in engine performance but lower energy conversion efficiency which was offset by the reduced fuel cost of biogas over diesel. The long term use of this engine with biogas–diesel dual fuelling is feasible with some considerations.

Banapurmath et al. 2008 made comparative performance studies of a 4-stroke CI engine operated on dual fuel mode with producer gas and Honge oil and its methyl ester (HOME) with and without carburetor In order to meet the energy requirements they found that there has been growing interest in alternative fuels like biodiesels, methyl alcohol, ethyl alcohol, biogas, hydrogen and producer gas to provide a suitable diesel oil substitute for internal combustion engines. They use biomass energy for CI engine, solid biomass can be converted into a mixture of combustible gases, and subsequently utilized for combustion in a CI engine.

Pikunas et al. 2003 made study on influence of composition of gasoline – ethanol blends on parameters of internal combustion engines also they investigate experimentally and compare the engine performance and pollutant emission of a SI engine using ethanol–gasoline blended fuel and pure gasoline. They found that the heating value of blended fuel increases or decreases with percentage of ethanol added to it, when ethanol–gasoline blended fuel is used, the engine power and specific fuel consumption of the engine slightly increase CO emission decreases dramatically as a result of the leaning effect caused by the ethanol addition HC emission decreases in some engine working conditions; and CO_2 emission increases because of the improved combustion.

LimSoo King et al. 2014 can use gasoline – ethanol blends for internal combustion engine and he tested various percentage of ethanol blends for various compression ratios for example 10%, 20%, 30% and 40% ethanol of blended fuels in a variable-compression-ratio engine. After that study they found that the increase of ethanol content increases the octane number, but decreases the heating value. The 10% addition of ethanol had the most obvious effect on increasing the octane number. Under various compression ratios of engine, the optimum blend rate was found to be 10% ethanol with 90% gasoline.

Sachin Singla et al. 2015 studied For a better performance of an internal combustion engine, design of

intake manifold is one of the important factor. It is required that equal mass of air fuel mixture is delivered to each cylinder of the engine. Unequal distribution of charge reduces the efficiency of the engine. Presented study aims at the design modification of the intake manifold so that almost equal velocity can be obtained at the end of each runner. For the study purpose Intake manifold of Maruti Wagnor was used. Experimental study was conducted on the manifold and variation in outlet velocity and outlet pressure was recorded at different inlet velocities. Further, three dimensional drawing of the intake manifold was made and CFD simulation was conducted using ANSYS FLUENT. Two models were studied by making some modifications in the actual manifold and thus an improved manifold design was suggested. Results show that nearly equal velocity was obtained at all the runner outlet and flow velocity at outlet 1 increased by 16%, and velocity in other outlets improved by approximately 5% to 7% as compared to actual model.

Wei-Dong Hsieh et al. 2001 use ethanol–gasoline blended fuels with various blended rates (0%, 5%, 10%, 20%, 30%). Fuel properties of ethanol–gasoline blended fuels were first examined by the standard ASTM methods. Although the emission of aldehyde will increase when we use ethanol as a fuel, the damage to the environment by the emitted aldehyde is far less than that by the poly-nuclear aromatics emitted from burning gasoline. Therefore, higher percentage of alcohol in blended fuel can make the air quality better in comparison to gasoline.

The above cited work has aimed at designing the intake systems mainly for different conventional fuels for optimum performance of engine. This region or point needs to be identified which call for application of Analytical Method, Experimental Method or Computational Method under different load conditions on engine. This study proposes to design of the intake system for one of the renewable energies viz. biogas for 4-S SI Engine performance.

NEED OF INTAKE SYSTEM DESIGN:

In SI engine the air and fuel is mixed in carburetor and the homogenous mixture of air and fuel is then admitted into the combustion chamber. The fuel used for this engine is petrol which is in the form of liquid. Air comes through the air filter and fuel comes from fuel tank into the float chamber of carburetor and gets mixed with each other into throat of carburetor. This carburetor is specially designed for the stable liquid phase fuels. If it is need for fuels like biogas, it cannot be effectively used for the biogas. The major problem with the biogas as a fuel for SI engine is phase difference, the biogas exists in the form of gaseous phase. Besides, biogas is required to be stored at high pressure in the tank and when high pressure biogas comes to the intake manifold large amount of fuel is entered into the combustion chamber due to high pressure. So as to overcome these problems, the intake system is needed to be designed for biogas fuel.

Fig. 2 Experimental set up of LPG generator functioning using biogas

PROPOSED WORK:

An intake system is to be designed and analysed for biogas operated SI engine. For the same, analytical and computational approaches are to be used and optimum results are to be found out. From the results the optimized intake system is to be designed for biogas operated engine.

OBJECTIVES:

- To design analytically the intake system and fluid flow for biogas operated SI engine.
- To prepare CAD models of designed intake system, using suitable CAD modeling software
- To analyse computationally the CAD models of intake system, using suitable CFD package.
- To compare the results from analytical and computational findings for optimum results.
- To optimize of the intake system for biogas operated SI engine.

With the backdrop of these objectives, for designing intake system using biogas as a fuel in petrol engine, we need to make modifications in engine. Major modifications required are as follows,

1) **Modification in Intake System**
   A) Carburetor design
   B) Intake manifold design
2) **Modification in Engine**
   A) Valve timing
   B) Compression ratio
   C) Spark(Ignition) timing

D) Turbulence in combustion chamber
E) Flame propagation

Before directly going to design an engine, it is logical to design intake system. In the study, focus is limited to the intake system related design and modifications. One of the major problems for the successful application of air and biogas mixtures as a motor fuel is the realization of a gaseous phase. To overcome this problem, a new carburetor is to be designed. By designing a new carburetor the phase problem can be solved. Also one of the reasons to modify or design a new carburetor is property of fuel, petrol and biogas have different properties over each other. The area, where actual modification is required is given in figure 3

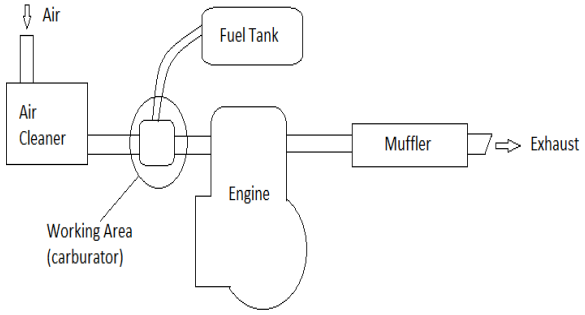

Fig 3 Block Diagram with working area

METHODOLOGY:

PHASE I – ANALYTICAL DESIGN:

Based on the requirements, some co-ordinate geometry designs would be prepared for further analysis. Analytical model will be generated by using analytical and mathematical equations, from these equations we find out output results of some empirical parameters like mass flow rate of fuel blends, velocity of fuel blends and output turbulence of charge etc.

PHASE II – CFD ANALYSIS:

The proposed CAD model of intake system for biogas fuel for SI engine will be generated using suitable CAD software. The generated proposed design of intake system is then analyzed using appropriate finite element model software. In CFD analysis actual flow of air and biogas will be analyzed. Also, the parameters like mass flow rate of fuel blends, velocity of fuel blends, and output turbulence of charge will be analyzed into the CFD analysis and results will be plotted down.

PHASE III – ANALYSIS OF CFD RESULT AND COMPARISON WITH ANALYTICAL RESULTS:

This is a final stage in which the CFD results will be analyzed and then analytical results and CFD results will be compared with each other and final conclusion can be made for actual manufacturing of intake system and experimentation purpose.

CONCLUSION:

Biomass is measured a fundamental substitute to fossil fuels and can be used for a wide range of energy needs. From biomass energy get produced in three different ways likes

- Direct burning of biomass to get the energy
- Convert biomass to methanol and ethanol to be used as liquid fuels in engines
- Ferment biomass anaerobically to achieve a gaseous fuel known as biogas

To replace the chemical fertilizers biomass and its derivatives like animal excreta and crop residues are converted to organic manures. It takes simple aerobic fermentation to convert this biomass to organic manure. However, when biomass is treated an aerobically, biogas is formed, leading to the production of high value enriched organic manure. Biogas is a mixture of carbon dioxide and Methane in a ratio of about 60:40 and it contains traces of gases like Nitrogen, Hydrogen Sulphide etc. The calorific value varies from 20 – 25 MJ / M3.

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