Performance Characteristics of Oxy Hydrogen Gas on Two Stroke Petrol Engine

*G.Ajay Kumar[1] G.Venkateswara Rao[2]

[1]PG Student (M.Tech -TE), Dept.of ME, Bonam Venkata Chalamamaiah College of Engineering & Technology, Odalarevu, AP, India

[2]Assistant Professor, Dept.of ME, Bonam Venkata Chalamamaiah College of Engineering & Technology, Odalarevu, AP, India

Abstract: In order to conserve petroleum fuels for future and to eliminate the above limitations there is a need of alternative and innovative fuel. Amongst many alternative fuels available oxy hydrogen gas and producer gas are under study in this research work. Electrolysis of water can give us hydrogen in form of Brown's gas (HHO gas) or oxy-hydrogen gas, which can be used as an alternative fuel for any internal combustion engine. Various methods for the generation of oxy-hydrogen gas are discussed in the coming paragraphs. An agricultural waste like rice husk, wood dust, and dried coconut leaves etc can also be used as an alternative fuels. An attempt has been made in this work to use alternative fuel in two stroke petrol engine. Our fore most aim in selecting this project is to use nonconventional fuel against conventional fuel which is becoming scarce and costly now days. The combustion of a hydrocarbon fuel with air produces mainly carbon dioxide (CO2) and Water (H2O). However, internal combustion engines are not perfectly efficient, so some of the fuel is not burned, which results in the presence of hydrocarbons (HC) other organic compounds, carbon monoxide (CO) and forming mainly nitric oxide (NO).

Keywords: Two Stroke Petrol engine; Electrolysis; Oxygen Enriched hydrogen-HHO gas; emission characteristics.

1. Introduction

Decreasing supplies of fossil fuels and steadily rising concentrations of atmospheric carbon dioxide concentrations and levels of atmospheric pollutants are some of major challenges to the modern society. The scientific community is addressing these problems by an attempt to replace fossil fuels with cleaner and renewable sources of energy . The research conducted so far indicates the biomass-based fuels to be the best option because they do not require changes in the existing technologies in use. Probably the best alcohol that can be an alternative to petroleum is ethanol. Thus a new path has been opened for flex-fuel engines, i.e. engines that can operate with gasoline blended with anhydrous ethanol (18–25% vol/vol), 100% hydrous ethanol (4.0–4.9% vol/vol of water) or any blend of these fuels (Melo et al., 2012). The goal of this study was to elucidate the hypothetical synergistic combustion effects of various fuel mixtures including gasoline, ethanol, HHO gas and stabilized hydrogen peroxide, and offer the optimal fuel mixture for existing twostroke internal combustion engines with no modifications to existing injection and ignition systems.

Ethanol is interesting because of various reasons: a) the cost of fuel and minimal environmental effects b) can blend with gasoline and Petrol c) higher heats of vaporization and octane number, d) reduction in particulate emissions, e) can be made from wastes, agricultural crop residues and residues from processing. Ethanol was seriously considered in programs designed for conservation of natural resources.

Most of the research conducted so far focuses primarily on ethanol that contains 35% oxygen as a stand-alone fuel and as an oxygenated additive to hydrocarbon fuels to decrease emissions of nitrogen oxides (NOx), unburned total hydrocarbons (THC) and carbon monoxide (CO). The idea was superimposing oxidation over pyrolysis. Even though considerable research effort has been conducted in this, there are still many uncertainties associated to use of ethanol in flex-fuel engines and high octane- rated fuels (85/15 v/v ratio ethanol/gasoline) associated with high rates of emissions of particulate matter (soot). The role of hydrogen in emission reduction of gasoline and Petrol engines was also investigated. HHO gas is renewable and clean burning fuel that does not generate carbon dioxide. Hydrogen has about nine times higher flame speed than Petrol, and six times higher than that of the gasoline air mixture. Adding HHO gas beyond 5% does not have significant effect in enhancing the Petrol engine performance. Small amount of hydrogen addition produces an antiknock quality of fuel. In this study one of the goals was to test if the addition of HHO gas as source of active intermediate substances would result with measurable effects on engine operation and fuel consumption. In early 1960-ies some studies identified a blend of ethanol, water and stabilizer-free hydrogen peroxide (H_2O_2) to be as highly explosive. One of the goals of this study was to investigate if such a blend with stabilized hydrogen peroxide can be applied directly to an internal combustion engine and if the conditions in the compression chamber could initiate explosion of the mixture as a consequence of the oxidation of ethanol by hydrogen peroxide. Hydrogen peroxide is very strong, storable oxidizer/monopropellant. Hydrogen peroxide, oxygen enriched additive generates hydroxyl radicals in the thermal decomposition, and OH radicals can reproduce the HO_2 radicals. Iron complexes catalyze the decomposition of H_2O_2[3].

In this paper we present, apparently for the first time, various measurements on a mixture of hydrogen and oxygen called HHO gas produced via a new electrolyze (international patents pending by Hydrogen Technologies Applications, Inc. of Clearwater Florida), which mixture is distinctly different than the Brown and other known gases. The measurements herein reported suggest the existence in the HHO gas of stable clusters composed of H and O atoms, their dimers H–O, and their molecules H_2 , O_2 and H_2O whose bond cannot entirely be of valence type [1].Need for this paper arises because of the scarcity of the crude-oil resources in our mother nature for satisfying our multiplying demands. This paper draws the prime attention of the authors to develop an alternative mechanism, which can serve as a basis for driving the automobile [2].In order to reduce the atmospheric pollution emitted by automobiles, control devices are being incorporated in the vehicles in many countries. This has resulted in a reduced vehicle mileage to the extent of about fifteen percent. With- out the introduction of new technology, any further reduction in emission levels would be expected to extract payment in the form of further fuel economy losses [3].

This paper investigates on green transportation in India, where usage of vehicles is increasing day-to- day. Increase in vehicles will lead to fuel scarcity in the mere future. These lead researchers to think about alternate fuel that can be utilized for the vehicles. This paper talks about the project which is aimed at developing and marketing a product with conventional standard that help in solving this issue.

2. Experimental Setup and Machine Specifications

Oxy-Hydrogen is an enriched mixture of hydrogen and oxygen bonded together molecularly and magnetically. Oxy-Hydrogen Gas is produced in a common-ducted electrolyser & then sent to the intake manifold to introduce into combustion chamber of the engine. Oxy-Hydrogen gases will combust in the combustion chamber when brought to its auto-ignition or self ignition temperature. For a stoichiometric mixture at normal atmospheric pressure, auto-ignition of oxy hydrogen gas occurs at about 570°C (1065°F). The minimum energy required to ignite such a mixture with a spark is about 20 micro joules. At normal temperature and pressure, Oxy-Hydrogen gas can burn when it is between about 4% and 94% hydrogen by volume. When ignited, the gas mixture converts to water vapour and releases energy. The amount of heat released is independent of the mode of combustion, but the temperature of the flame varies. The maximum temperature of about 2800°C is achieved with a pure stoichiometric mixture, about 700°C hotter than a hydrogen flame in air. Oxyhydrogen gas has very high diffusivity. This ability to disperse in air is considerably greater than gasoline and it is advantageous in mainly two reasons. Firstly it facilitates the formation of homogeneous air fuel mixture and secondly if any leak occurs it can disperse at rapid rate. Oxy hydrogen gas is very low in density.

This results in a storage problem when used as a fuel in an internal combustion engine which is loaded on automobile. Producer gas is the gas generated when wood, charcoal or coal is gasified with air and it consists of around 45-50% combustible gases, N2, CO_2 and water vapour. The gas contains condensable oily substances, acids and dust as well. The main aim of the gasifier system is to generate a gas with a high proportion of combustible components and a minimum of impurities. There are different methods to produce the gas, three different types of arrangements can be used viz. Updraft Gasifier, Downdraft gasifier, Cross draft gasifier but the problem with all these type of arrangements while producing gas is presence of tar content in them, which when introduced in engine can damage the cylinder lining as well as can cause knocking problem [3, 4, 5]. In this research work instead of using conventional processes a Pyrolysis method is used for the production of producer gas. Exact analysis of the gas produced is carried out and is mentioned in this article.

Technical Specifications of the Engine:

Type: Tomos 4,
Spark: Ignition Engine
Cycle: Two stroke, air cooled
No. of cylinder: 1
Compression ratio: 10:1
Cubic capacity: 59.3 cu cm
Cylinder bore: 42 mm
Stroke: 43 mm
Rated output: 2.2 kW(3.0 HP) @ 5400 rpm
Engine speed: 3600 rpm
Ignition timing: Variable

No hardware modification in the engine is required for the supply of Oxy-Hydrogen gas. Only an inlet is to be given for the entry of the gas into the combustion chamber. This entry is provided S.I engine and after air cleaner in case of Petrol engine, so that the Oxy-Hydrogen gas will get sufficient time to adhere the fuel molecules. Thus the oxy hydrogen gas is brought inside the combustion chamber just because of engine suction pressure. Thus the Oxy-Hydrogen usage is compatible with any of the running engine. To make the complete Oxy-Hydrogen gas unit, components required are the Oxy-Hydrogen Generator or Electrolyser, Bubbler & Post Air Cleaner Joint. Oxy-Hydrogen Generator generates Oxy-Hydrogen gas as discussed earlier. Terminals of electrolyser are connected to the car battery by means of two insulated wires. Insulated wires are attached to the plates by means of hard soldering. Soft solder should be avoided as due to the rise in temperature there are chances that the solder may melt and the wires come in contact with adjacent plate leading to generation of spark & thus causing explosion of the generator / electrolyser. Bubbler is component used for the safety purpose in case of backfire from engine. It is filled with water, through which Oxy-Hydrogen gas is allowed to pass; also if steam is generated in the generator is condensed inside the bubbler. Thus it allows only pure gas to enter the engine. As its purpose is just to act as a safety device plastic bottle is sufficient it also reduces the cost and even if back fire occurs the plastic bottle will tear off quickly & avoid strong blast of it. It does not allow the ignited gas to reach the generator as the water present in it extinguishes the ignited gas.

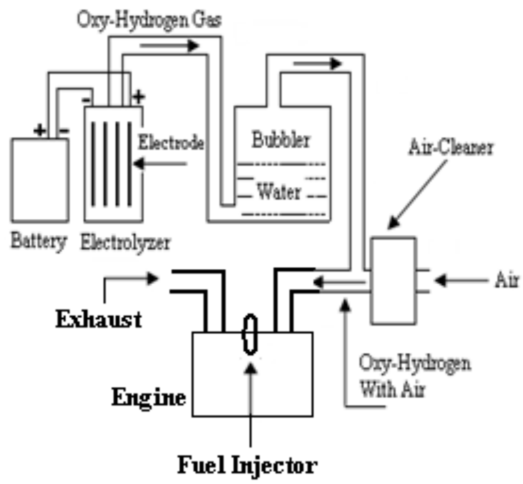

Figure 1 Block Diagram of Oxy-Hydrogen unit mounted on engine

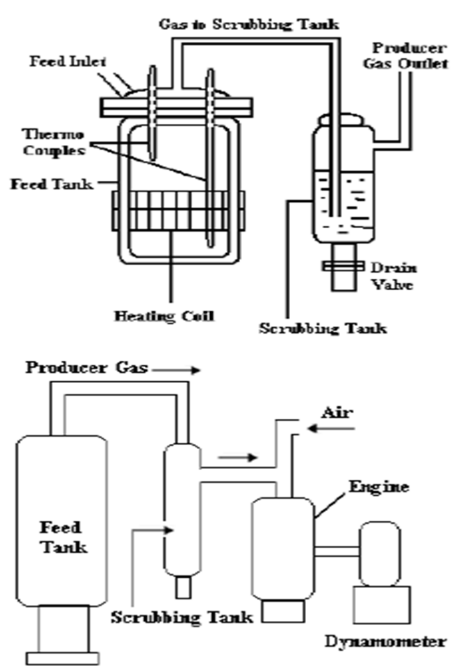

Figure 2 Producer Gas Unit – Constructional details and supply

Refer figure 1 for more constructional details of the assembly and flow of Oxy-Hydrogen gas through the circuit. The unit used in this research work for the generation of producer gas consists of a stainless steel body having geometry like a cylinder with a flange for fixing the head of cylinder having same flange [5]. The head of Pyrolyser unit has provision for introducing biomass and removal of gas produced in the unit.

It also has two thermocouples, a long and a short one the long thermocouple measures the core temperature whereas the short thermocouple measures the temperature of the gas produced at top inside the unit. Heating coils are fixed circumferentially to the pyrolyser unit from outside and insulation is provided over the unit circumferentially from outside. Scrubber tank is used to clean the gas and also to condense the condensable. It is partially filled with water; gas comes from top of the tank which is taken to the bottom of water through pipe so that it passes through water. There is an outlet for removal of gas. Also there is a provision for flushing out the water from the tank. Control unit is the unit from which we can set the temperature and also control the heating. From 1500C to 4000C of inner core there is continuous production of the gas. It requires 70 to 75 minutes to produce 700 gm of gas. Figure 2 below demonstrates the constructional details of producer gas unit.

3. Performance Evaluation

The components obtained during the gas chromatography resembles the constitution of producer gas, the amount of tar was very negligible. Generally calorific value of a producer gas is 7000 to 9000 kJ/kg.

The gas obtained during the pyrolysis was having calorific value 6918.26 kJ/kg. While producing the gas, if we used 1 kg of biomass almost 400 – 450 gm of gas along with remaining amount of charcoal is also obtained. Coal is obtained as by-product of the Pyrolysis process. The calorific value came out to be 2045.1426 cal/gm, which is good for domestic purpose.

To check the rate of oxy hydrogen gas generated with respect to rate of current rise, a loss of weight of electrolyser is noted for given period of time and current. Current passing through electrodes is increased from 1 ampere to 3 ampere in step of 1 ampere. Figure 3 shows that with increase in the time for which the current is flowing through electrolyser, weight of electrolyser decreases. Larger the weight loss larger is the gas generation weight. Also with increase in amplitude of current the rate of generation increases. For larger gas generation it is possible to increase the amplitude of current as well. As the engine keeps on consuming the oxy hydrogen the level of electrolytic solution in the electrolyser decreases which further decreases the weight of the electrolyser.

Fig 7 shows the exhaust gas analyzer, which is used for analyzing gases and percentage of CO, NOx and other HC gases that are released from the engine during the test. All the designs of electrolysers were tested on twin cylinder four stroke Petrol engines, technical specifications of which are listed earlier in this article. All of them showed the improvement in the operating characteristics of engines when blend of oxy hydrogen is send with conventional fuel. Whichever may be the generation method used for production of oxy hydrogen gas, there is little effect of it as far as change in the improved performance of the engine is concern.

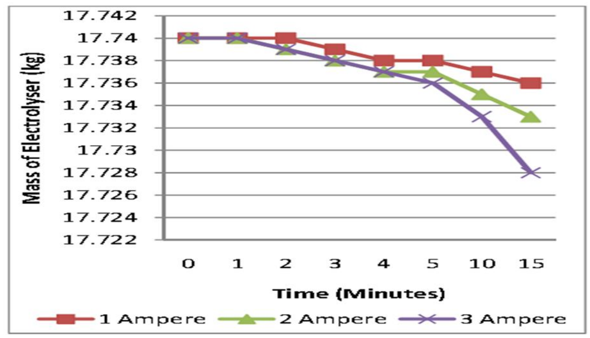

Figure 3 Time rate of gas generation with decreased weight of Electrolyser

In order to investigate the performance variation between oxy hydrogen gas and producer gas, amongst the various methods for oxy hydrogen gas generation, second design of first method is used. The reason for this is the very high rate of oxy hydrogen gas generation. To make comparison between both the alternative fuels discussed earlier, load tests are carried out the same twin cylinder Petrol engine. Brake Specific Fuel Consumption, Brake Thermal Efficiency, Speed and Load are the parameters which were kept under observation during the tests. Following graphs are used to discuss the comparison. Figure 4 shows the variation of brake specific fuel consumption with increase in load for both the alternative fuels.

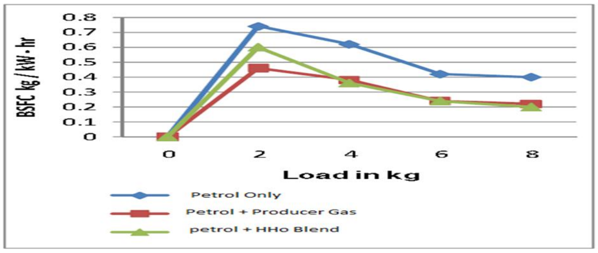

Figure 4 Variation of Brake Specific Fuel consumption in kg/kW-hr v/s load in kg

Same is the reason for the lower values of BSFC in case of producer gas and Petrol blend. Almost 11% of Hydrogen in the producer gas makes it possible again. Amongst both the alternative fuels the oxy hydrogen gas has shown larger decrease in the values of BSFC especially when the load increases. At the maximum load of 8 kg during testing almost 200 grams of less fuel is required to produce same power hour, with both alternative fuels, oxy hydrogen gas is having little more edge on the producer gas. Figure 5 shows the variation of brake thermal efficiency with increase in load for both the alternative fuels [9].

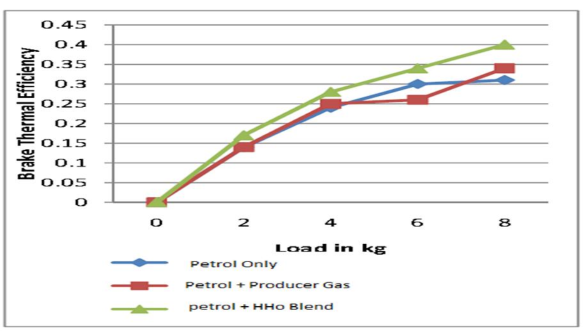

Figure 5 Variation of Brake Thermal Efficiency in % v/s Load in kg

From the graphs of Brake Thermal Efficiency v/s load it is clear that as the load on the engine increases, brake thermal efficiency further increases for the blend of both alternative fuels and Petrol compared to only Petrol. Presence of hydrogen releases greater energy during the process of combustion. That increases the brake mean effective pressure inside the combustion chamber. More work is done onto the piston which increases brake power of the engine as well. Increase in brake power increases the thermal efficiency of the engine. An increase of almost 10% in the efficiency is observed with the oxy hydrogen and Petrol blend, compared to only Petrol and an increase of almost 5% is observed with the producer gas and Petrol blend, compared to only Petrol [9].

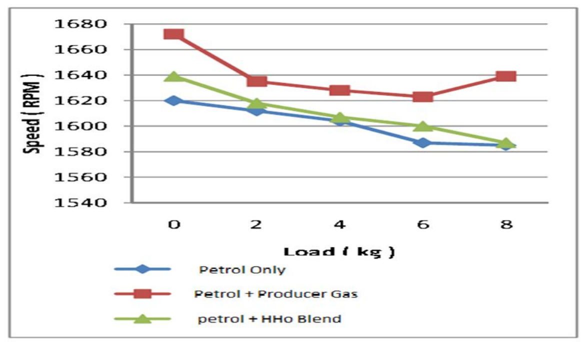

Figure 6 Variation of Speed in RPM v/s Load in kg

Figure 6 shows the variation in the speed of the engine with increasing load for both the alternative fuels.

Figure 7 Exhaust Gas Analyzer

Graph of Speed v/s Load shows same trend discussed earlier. At the same load condition the RPM of the engine increases for both the blends compared to only Petrol. As power developed by engine is directly proportional to the engine RPM, it is natural that with the blends power produced by the engine increases [9].

4. Conclusions

Oxy hydrogen gas has been generated by electrolysis process and producer gas by pyrolysis. Both the alternative fuels mixed with fresh air before entering the combustion chamber. BSFC, Brake thermal efficiency, speed and load are the performance parameters kept under observation. The following conclusions are drawn:

1. It is very easy to integrate both the alternative fuels with existing engine. No major hardware modification is required.
2. Combustion efficiency increases with both alternative fuels due to presence of hydrogen in the blend. Since hydrogen is present in larger quantity oxy hydrogen gas compared to producer gas, the oxy hydrogen and diesel blend has shown best combustion efficiency as a result of which larger values of BSFC and brake thermal efficiency are obtained for the same engine.
3. Presence of extra oxy in both alternative fuels helps to improve the combustion efficiency further more. Water vapour is one of byproduct of combustion process with oxy hydrogen and diesel blend. This decreases the combustion chamber temperature and thus decreases the chances of engine detonation. Very less amount of oxygen is available with producer gas and diesel blend hence it is not the case with this combination.
4. Cost of the producer gas generation is more compared to oxy hydrogen gas generation. Three phase AC power source is required for the generation of producer gas using pyrolysis process. Oxy hydrogen gas module requires only 12 V DC supply from the battery [9].

The size of the producer gas generation module is very large and nearly impossible to fit on automobile engines, hence best suitable for the stationary engines application like pump, generators etc. Coal is coming as one of the byproduct of the pyrolysis process, can be used for domestic purpose, and hence an added advantage [9].

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