

A Review of Performance Investigations in Hydrogen – Oxygen Generator for Internal Combustion Engines

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Abstract:

The decrement of fossil fuels plays a wide challenge to all industrial sectors. The energy required for manufacturing processes is obtained from petroleum products, solar energy, wind energy, bio gas etc., In the current scenario, hydrocarbon fuels like petroleum products, ethanol are utilized to run the industries for power generation. Due to the reduction of the natural sources, several researches were conducted in hydrogen generation. Water is the major source of hydrogen energy; This article reveals the investigations carried out to obtain hydrogen and oxygen from water through electrolysis. Hydrogen is unstable in nature and it is highly explosive. Oxygen enhances the combustion of hydrogen; hence water is the suitable source which can produce hydrogen and oxygen. This review article exhibits that the challenges of hydrogen energy production and the importance of hydrogen and fuel cell technologies. By identifying the marketing strategies of hydrogen generator, many countries have commercialized plans with such hydrogen generator technologies. The hydrogen and oxygen gas generator is called as fuel cell. The fuel cell is often used for conversion of chemical energy to Electrical energy. Energy conversion system that will eventually become the first choice for power production. The fuel cell has zero emission nature and it is completely clean. Catalyst and accelerators enhances the rate of HHO generation. Varying the current supply in the electrolysis process will affects the quantity of the hydrogen and oxygen gas.

Keywords: *Hydrogen, Hydrocarbons, Emission, Generator.*

1. Introduction:

Automobile is the field where the largest amount of fossil fuel is consumed. Since it is a non renewable form of energy, further utilization of this fuels will last no longer. Hydrogen has a wide range of flammability when compared to all other forms of fuels. Therefore, hydrogen can be burned in an I.C engine along with air fuel mixture. HHO gas can also be used with petrol which will further reduce the emission. The usage of HHO gas reduces hydrocarbons,

carbon dioxide and carbon monoxide in the NO_x emission into the atmosphere.

Building of hydrogen generators nucleates the challenges of storage. It is essential to ensure that the less amount of energy given to the cell to split the water molecules. In order to overcome this challenge, we need to utilize the electrical energy as efficient as possible. This include the research outcomes with a creative design to get as much hydrogen out with least amount of current.

2. Water electrolysis using catalysts:

Pure water electrolysis using direct current is less efficient than electrolysis of water added with catalyst. In general, from the previous researches, it was observed that, sodium bicarbonate, sodium chloride are commonly used catalysts. *Sazilin. M et al.* Evaluated effect of plate electrode characteristics on engine speed performance in application of HHO generator for four stroke engine. Since petrol engines are not environmentally friendly, Natural gas Spark ignition engines are used. These engines also consumes less fuel. Since hydrogen has stable lean burn characteristics, Hydrogen Compressed Natural Gas technology is the best replacement to conventional compressed natural gas engines. An experiment was performed on Spark Ignition engines to study the effect of electrode plate characteristics on engine speed performance. Statistical analysis of engine speed performance was examined. It exhibits the thickness of the electrode plays the key role in generation of hydrogen and oxygen gas. Increasing of thickness of electrodes reduces the volume of hydrogen generated. In addition, the results exhibit the engine rpm is found to be increased by 30-50% with HHO compared with synthetic fuel.

Prasetya. H.E.G et al. conducted an experimental study of wet cell HHO generator with $Ba(OH)_2$ as catalyst. In this experimentation, the performance and exhaust gases emissions of four stroke engine 120cc are revealed. In addition, the statistical data of contribution of fuel oil to industry and transportation sector in 2015 is exhibited, It shows that 42% of fuel is utilized in automobile sector and the remaining quantity was contributed to industry sectors. Only possible solution that can be made to reduce

the fuel consumption is adding hydrogen and oxygen gas on the four stroke. Hydrogen gas is obtained from the electrolysis process using HHO (2 Molecule of hydrogen and one molecule of oxygen – separated from one water molecule H_2O). The wet cell HHO generator is a device which decomposes water into hydrogen and oxygen by passing electric current. The produced hydrogen gas is mixed with gasoline fuel in the combustion process of the four stroke engine. A HHO generator of size 20 x 10 x 20 cm using $Ba(OH)_2$ as catalyst. In variation of concentration of catalyst such as 1,3,5,7 and 9g/l. The torque, effective power, thermal efficiency and specific fuel consumption of the four stroke engine is measured. The results show that addition of catalyst barium hydroxide $Ba(OH)_2$ in the HHO generator can increase the performance and reduce the emission on the engine.

Rimkus. Aetal A investigated the efficiency by using O_2 and H_2 in a diesel engine operating on diesel and biodiesel. In a compression ignition engine, the power generated is fed to an electric generator to measure the performance of the engine. The chemically active hydrogen starts to ignite at the end of compression stroke when the pressure and temperature rises to fuel injection into the cylinder. When the HHO gas is added to biodiesel, the efficiency of the engine changes. This also reduces the exhaust gases and smoke levels. Collectively, this research exhibits the adding of hydrogen and oxygen gas with the biodiesel increases the efficiency in perspective of emission and performance.

Conker. C proposed a technique based on safe operation oriented control technique for driving HHO dry cell system based on PEM duty cycle. Its main aim is to protect the HHO

generator from extreme temperature effects while increasing the hydrogen production. It mainly focuses on protecting the generator from adverse effects on over heating problems. The controller takes up two parameters like temperature and the flow rate and optimizes the operation of the reactor. The advantage of the controller is that it protects the reactor and allows continuous production of HHO gas. It leads to less damage of the reactor and uninterrupted operation due to overheating.

Al-Rousan. A et al published a journal on increasing the fuel consumption efficiency through HHO gas injection in diesel engine. HHO gas can be used as a supplement to any working engine since it is a non toxic gas. Here HHO is mixed with the fuel and increase the mileage and performance of the engine. In this experimentation it is found that mixing HHO will also reduce the emission rates. HHO gas was directly injected into the single cylinder diesel engine and the speed was varied from 1500 to 3000 rpm in the diesel engine. The experiment results in fuel consumption reduction from about 13.87 to 15.48 % , lowers the exhaust temperature and constant reduction in pollution. Further study also provides proof for the improved combustion efficiency and brake thermal efficiency by an average of 17.1%.

3.hydrogen – Oxygen generator with NaOH and KoH as calatyst.

Kuracina. M et al studied the selected characteristics of a dry cell hydrogen generator in conditions of long term operation. HHO generator is simple device where oxygen and hydrogen are produced by the electrolysis of water. NaOH and KOH are mixed with water instead of pure water. This is because these

solutions have higher electric conductivity. A current of 2 Ampere was supplied for three hours and increasing of volume of hydrogen gas using potassium hydroxide as catalyst. In the fuel cell, potassium hydroxide (KOH) is used as catalyst and appropriate changes were monitored. Due to the chemical stability of potassium hydroxide, KOH solution is used as catalyst.

Kuracina. M et al studied the characteristics of HHO generator cells using various concentrations of NaOH solutions. The objective of this research was to carry out the study of the conditions for efficient HHO gas production. Eight stainless electrodes were used and NaOH is used as the electrolyte. NaOH solutions of concentration 5% , 10% and 15% were used and the results were compared. KOH solution is used as the best available electrolyte but however NaOH solution provides higher efficiency of HHO gas production.

Rimkus. A et al conducted an experimentation on betterment of ecological parameters of a diesel engine using Browns gas.(The hydrogen and oxygen gas generated from the fuel cell generator is named as Brown's gas). Since hydrogen increases the combustion efficiency of the air fuel mixture, in addition, this research suggests the brown's gas can be used as additive for petrol for automobiles. The Brown gas mixture is supplied to the petrol engines intake manifold through carburetor. The automobile engine test rig was experimented using fuel - air combustion mixture and fuel - air - HHO combustion mixture. The results were found that additional injection of HHO gas reduces the carbon monoxide, NoX emissions.

Madyira.D.Met alcarried out an experiment on effect of HHO generator on four stroke engine performance. Research for alternative energy sources focuses mainly on electric, hybrid and hydrogen power. A HHO generator was constructed and mounted on the engine compartment of a 1989 Ford Laser vehicle. The experiment was carried out by varying the speed range from 1000 to 3500 rpm. Results suggested that the emission of hydrocarbon was reduced and exhaust gas emission and fuel consumption was reduced after adding the HHO gas in to the engine combustion chamber. The power output was also found to be increased with the supply of HHO gas.

*Krishna.V.M*conducted an experiment on emission control and performance characteristics of spark ignition engine with oxy hydrogen blending.It depicted that the importance of alternate energy resources, reduction of fossil fuels. The HHO gas is produced in the gas generator which is connected to spark ignition engine without making any modification to the engine.The HHO gas is produced and then it is fed to the petrol engine. Engine speed was maintained within the range of 700 to 1500 rpm. Mileage tests werealso conducted to find the fuel consumption and performance of HHO gas. It was depicted that the HHO generator increases the performance of engine on emission characteristics and performance based in loads.

Patil.N.Net alcarried out an experiment in generation of oxy-hydrogen gas and its effect on performance of spark ignition engine. In this experimentation, investigations was carried out to evaluate the performance of hydrogen gas ratio to the petrol fuel. HHO gas was generated from the electrolysis of water.

KOH (Potassium hydroxide) solution of 3 molar concentration is used as catalyst which speed up the production of HHO gas. By varying the current the quantity of gas supplied to the engine can be controlled. It was observed that the engine performance was improved by injectingthe HHO gas.

4.Experimentation of vibration characteristics of hydrogen powered engines.

Uludmar.E et alconducted an experimentation of hydrogen engine to investigate the vibration parameters. The vibration characteristics was observed in a HHO gas generator installed diesel engine fuelled with different diesel-biodiesel blends. HHO gas is produced from the electrolysis of water. The engine vibration performance was investigated with the diesel engine on addition of HHO gas. The vibration data was collected between 1200 to 2400 rpm with 300 rpm as an interval. Artificial Neural Network approach was conducted to predict the fuel properties and HHO amount on engine vibration level.It concludes that the vibration level was reduced after using of HHO generator, it increases the smooth running of engine and chattering effects are reduced.

5.Conclusion:

On studying the usage and demand of fossil fuels, it may no longer be available in the upcoming years. The fossil fuels are used in a large amount in the transportation and automation. Thus hydrogen is an alternative resource which can satisfy the need of energy requirement.from the literature study, it was concluded that the catalyst increases the performance and volume of hydrogen and oxygen gas generated. The increasing of electrode plate thickness decreases the

generation of volume of hydrogen gas in the hydrogen generator. Some of the catalysts used in hydrogen generator are sodium chloride, sodium bicarbonate, potassium hydroxide, barium chloride etc., The emission characteristics are also improved which reduces the NoX and CO emissions. Moreover the hydrogen powered engines reduces the vibration level. From the previous researches, it was concluded that hydrogen is the best alternative source in the perspective of energy, emission and vibrations.

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