EFFICIENT USE OF OXY-HYDROGEN GAS (HHO) FOR HEATING APPLICATIONS

Vikas Verma[a], *Dr. Rajesh Kumar*[b]

[a,b]Department of Mechanical Engineering, Faculty of Engineering, Dayalbagh Educational Institute, Agra, India – 282005

Abstract

Recently some researches concerning how to produce HHO gas using electrolysis have been conducted by using several methods and parameters. The problems were the conditioning of hydrogen generator to produce HHO gas that can affect the efficiency of electric current applied on the equipment. The surface of the anode and cathode used in a hydrogen generator have to be considered. Based on Faraday Law, the number of particles produced by the electrode is proportional to the amount of electric current applied to the electrolysis cell. An efficient/optimal system is supposed to produce a large volume of hydroxy gas using a very little power and to analyze its performance by varying electrolytes and their concentration.

Keywords: HHO generator, electrolyte, electrodes.

Authors	Topic	Applications	Conclusion
Z Jannah and S H Susilo 2021	**Design of HHO generators as producers of water fuel (HHO generator product analysis based on electric current and catalyst)**	As a fuel	Variations in electric current, particularly 20 amperes and 30 amperes, significantly impact the discharge of HHO gas, especially on the most significant current. Large currents can speed up HHO gas discharge, but can also heat generators. NaHCO3 content doesn't significantly affect gas discharge, but the largest discharge was obtained with 25% NaHCO3 (1000gr) electrodes.
Rusdianasari et al 2019	**HHO Gas Generation in Hydrogen Generator using Electrolysis**	As a fuel	Based on the result and discussion above, they concluded that water electrolysis device was designed to produce HHO gas using stainless steel electrode 316 with s i x stacks, where each stack gas a coupli n g electrode with surface contact 66 mm2. The current efficiency of the hydrogen generator is 89.13 %. The highest volume of resulted gas from electrolysis process is 0.9250 LPM at the 0.05 M solution concentration in 15 A. Chromatography gas analysis showed that the average hydrogen content in sample products are 65.432 %; oxygen 33.106%; and nitrogen 1.444 %.
Indah Puspitasari1*, Noorsakti Wahyudi2, Yoga Ahdiat Fakhrudi3, Galih Priyo Wicaksono4	**Design of Generator HHO Dry Cell Type and Application on 110 Cc Engined Vehicles Towards Gas Emissions**	110 Cc Engined Vehicles Towards Gas Emissions	The study explores the impact of electrode variations on power performance, production rate, and efficiency of dry cell type HHO generators. It reveals that the more holes needed, the higher the power consumption, the higher the production rate, and the higher the efficiency. The lowest CO emission is found in hole plate 2, while the lowest HC emission is in hole plate 4.
I Putu Darmawa ,Ikeh Wiryanta , and I Nyoman Sutarna	**Development of Hydrogen Gas Generator Prototype Model for Vehicle Fuel with Electrolysis Method**	For Vehicle fuel	From the discussion, it has been concluded that the HHO generator that has been made can work properly. The generator can produce enough HHO gas that can be use in motorcycle engine. The test result of uses HHO gas to the engine showed that the use of HHO generator can reduce the emission of exhaust gas (CO and HC) compared to the standard which uses RON 90 fuel. The average concentration of CO gas decreasing about 0.47%, and the average emission of HC decreasing about 34.5%.
Samuel Pamford Kojo Essuman*, Andrew Nyamful, Vincent Agbodemegbe, Seth Kofi Debrah	**Experimental Studies of the Effect of Electrolyte Strength, Voltage and Time on the Production of Brown's (HHO) Gas Using Oxyhydrogen Generator**	Fuel	The study examined the impact of electrolyte strength, voltage, and time on the volume of hydrogen peroxide (HHO) gas produced using a designed HHO generator. The optimal yield rate was 2.27 cm3/s at 13 V with 0.025 M KOH. Other factors like electrode surface morphology, neutral plate configuration, and temperature also enhanced HHO gas production by 41.85%, 69.74%, and 71.96%, respectively. The increase in gas yield was explained by ohm's law, mass transfer principle, ionic mobility, and generator unit resistance.
Noor Alam and K. M. Pandey 2017	**Experimental Study of Hydroxy Gas (HHO)**	Fuel	It is observed in the present experimental work that as voltage increases through regulated DC power supply, consequently current also increase and it follows ohms law. But increase in current at constant voltage, results

	Production with Variation in Current, Voltage and Electrolyte Concentration		higher power consumption. The optimal result is obtained at 1A current and 5V potential with 1 mole electrolytic concentration. The hydroxy gas production rate is increased by 30% to 40% with a reduction of electrical energy consumption about 35% (at ambient temperature and pressure). The production rate is also increased 10% to 15% more when temperature of alkaline solution increased from 25°C to 40°C with same parameters.

1. Introduction

The largest energy demand occurring in Indonesia today is the use of fossil fuels. One of the fossil fuels is oil. Oil is a non-renewable natural resource. Many aspects of life are being affected, and petroleum fuels are becoming increasingly scarce. The increase in the price of kerosene should make us realize that oil reserves are gradually being depleted. The aim is, for example, that efforts must be made to explore and develop alternative energy sources [1]-[5]. An alternative energy source is the use of hydrogen gas (H_2), which is environmentally friendly and saves the use of kerosene in vehicles [6]. Hydrogen is a widely occurring element in nature, but it exists not in the form of a gas but in the form of compounds such as water and coal. The aim is to obtain hydrogen gas, which is not available in free form. This can be achieved through industrial production, so the final price of hydrogen is determined by the production results used. Hydrogen can be obtained or produced using water electrolysis [2, 6-8]. Hydrogen is different from energy from fossils. Fossil energy is extremely abundant in nature. In addition to abundant energy, fossil energy can also be mined.

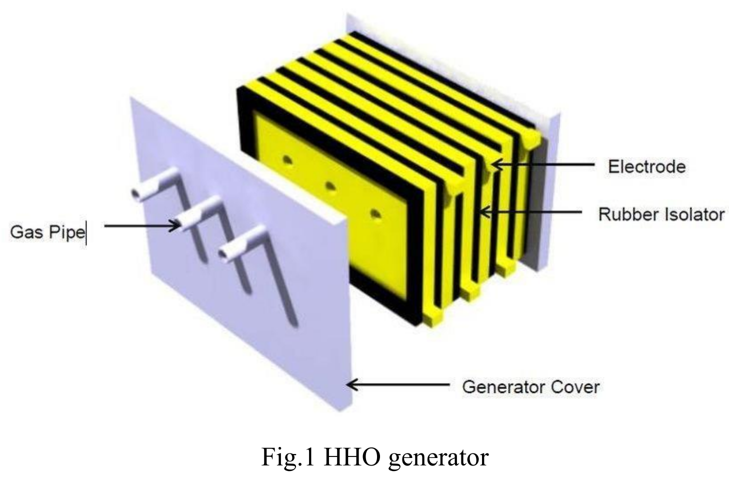

Fig.1 HHO generator

This is very different from hydrogen, which must first be produced by electrolysis of water [3, 9, 10]. Hydrogen gas is an environmentally friendly alternative energy source and can be used as a blended fuel in cars. The use of hydrogen in engine heating oil is still largely unknown [8,11,12]. Using hydrogen as an alternative to engine oil saves fossil fuels. Hydrogen can be used in fuel cells and has advantages such as high energy efficiency, no soot particles that are harmful to humans, and low noise levels. Gupta and Pant [13], Susilo and Anis [14], Sudrajat et al. [15] stated that the use of hydrogen in vehicle heating oil can reduce harmful exhaust gases such as CO_2 by 59.93%.This value is high enough to make hydrogen an excellent material to use as a replacement or blend for automotive fuels.

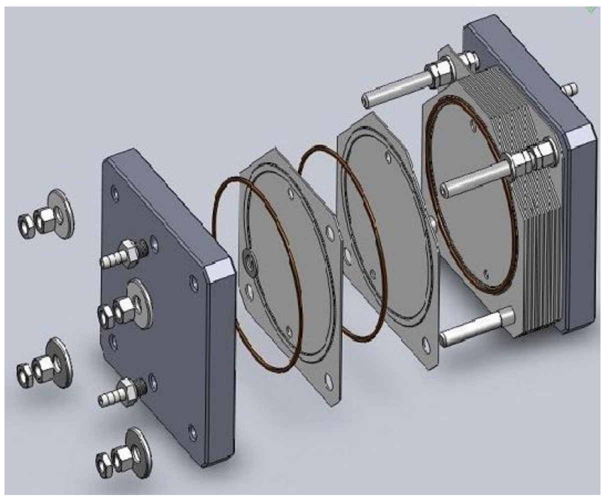

Fig 2. Components of dry HHO cell

2. Comparison between dry and wet cell HHO generator:

Parameter	Dry cell	Wet cell
1. Design	i. There are usually multiple plates separated by insulators. ii. Plates remain dry during operation. iii. Compact design, often used for special installation.	i. Involves the plates in an electrolyte solution. ii. Using a liquid electrolyte, usually a mixture of water and a small amount of electrolyte. iii. Simpler models compared to dry cells.
2. Efficiency	i. Tends to be more efficient in terms of gas production per unit of energy input. ii. Less heat is generated during operation, contributing to increased efficiency.	i. Can be less efficient compared to dry cells. ii. More heat is generated due to the presence of the liquid electrolyte, which may affect overall efficiency.

3. Maintenance	i. Generally requires less maintenance. ii. Plates remain dry, reducing the likelihood of scale buildup or corrosion.	i. May require more maintenance. ii. The liquid electrolyte can promote scale buildup on the plates, necessitating periodic cleaning.
4. Safety	i. Considered safer in terms of reduced risk of electrolyte spills. ii. Lower risk of corrosion-related issues due to the absence of a liquid electrolyte.	i. Requires careful handling to prevent electrolyte spills. ii. The liquid electrolyte may increase the risk of corrosion over time.
5. Cost	i. Can be more expensive to manufacture initially.	i. Generally less expensive to build.
	ii. However, the long-term efficiency may justify the higher upfront cost.	ii. Lower initial cost but may have higher maintenance costs over time.
6. Ease of Construction	i. More complex construction compared to wet cells. ii. Requires careful assembly of plates and insulators.	i. Simpler construction, making it more accessible for DIY enthusiasts. ii. Requires less precision during assembly.

3. Materials used:

- Separators: It is made up of stainless steel. There are varying number of plates that we are going to use in our model in which one is acting as a positive, one negative and other neutral plates.
- Electrodes: It should be made up of a Stainless steel.
- Gasket: Gaskets are used to separate each neutral plate from one another and also to separate the electrodes from the consecutive neutral plates and also to make gap between the end plates and the electrodes.
- Gas outlet: Gas outlets are used in upper portion of the housing as an outlet of hydrogen gas from the housing into a small container for storing purpose.
- Battery: Battery is used for performing water electrolysis. In this model we are using 9V battery.
- Nuts & bolts: These are used for tightening of the plates and plastic washers using small nuts.
- KOH (Electrolyte): Potassium Hydroxide (KOH) is used as an electrolyte in the reaction. Using this we can improve the performance of the reaction and can produces more HHO gas.
- Housing: Housing is used to place the generator inside it to store HHO gas for a temporary time. It will provide safety to the generator.
- PVC Plate: These plates use at both ends of the cell.

4. Methodology:

The complete picture of the HHO generator is shown in figure [17-19], which is the new design of the existing HHO generator. In given figure, the water inlet valve is used to provide water to the generator, and the outlet valve is used to supply HHO gas; the two end plates act as insulators and also assist each other with the use of nuts and bolts. Electrodes are used in the electrolysis process, and the gasket (plastic gasket) is the insulator between the electrodes and the middle plate. There is a gap between the plates due to the gaskets (plastic gaskets) that form the water and gasfilled chamber. When the system uses electricity, each of the middle plates is charged and electrolysis occurs in each cell of the generator.

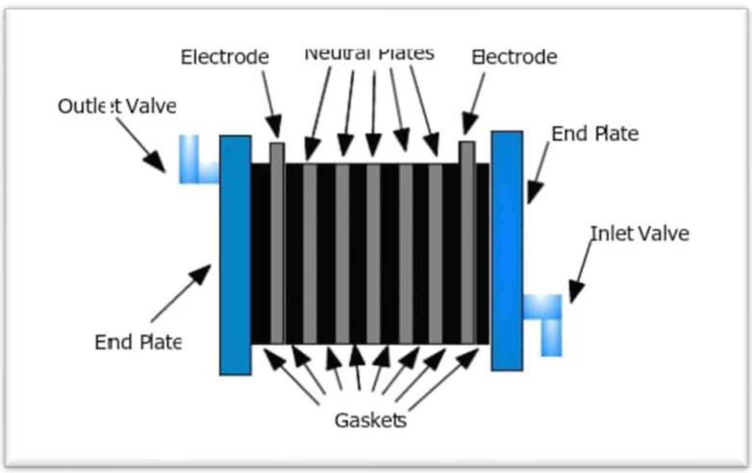

Fig. 3 Cross sectional view of proposed generator

The electrolyte used in this process is distilled water. In order to increase the efficiency of the HHO generation a catalyst has been mix with the distilled water. This catalyst acts as an distributor of ions and increase the conduction of electricity through the generator. Commonly used catalysts in HHO generation are Potassium Hydroxide (KOH) Sodium Hydroxide (NaOH), Sodium Chloride (NaCl), etc. The best choice of catalyst judge by its ability to remains unchanged during the production of HHO.

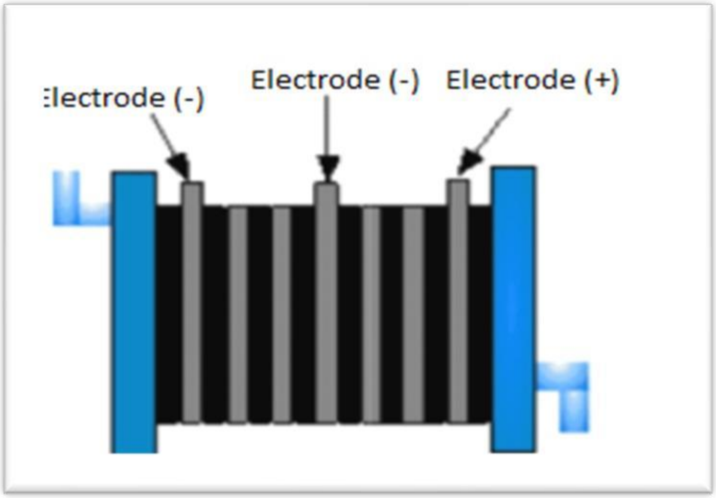

Fig. 4 HHO generator using extra electrode

That means the ideal catalyst is a substance that enables the reaction of electrolysis process to increase the flow of current without becoming a part of the reaction [20-21]. The process of electrolysis can be increased by introducing an extra electrode in the middle of cell, which causes to increase the production of HHO than using two electrodes. The modified design is shown in the fig. below:

5. Electrolysis process:

We use hydroxyl gas as additional source of gas in the preparation method. This gas mixes with air before entering the combustion chamber. Hydroxy gas is also known as HHO, Brown gas, water gas and green gas. HHO stands for hydrogen-hydrogen-oxygen. As the name suggests, hydroxyl gas has hydrogen and oxygen particles in a 3:1 ratio. The main idea of this HHO production process is to separate the hydrogen and oxygen atoms in water molecules. The output of this HHO process produces a mixture of hydrogen and oxygen called oxyhydrogen. HHO can be produced by electrolyzing water. In this process, water molecules are separated using two electrodes as shown in Figure 2. As the amount of filtered water increases, the efficiency of the electrolysis process increases. Water containing small amounts of impurities: Rainwater, spring water and tap water all contain large amounts of impurities. A medical doctor will identify these foods and remove any residue and other contaminants. When this impure water is subjected to electrolysis, the impurities precipitate as brown, black and green substances. These foreign materials can also cause electrode clogging. To overcome this problem, distilled water, i.e. water free of impurities, is used during electrolysis [22].

Whenever the system is powered up water molecules dissociate into hydrogen (H_2) and oxygen (O_2) were they emits as gases from the cathode and anode respectively. The stoichiometric equation of this process can be expressed as:

Electrolysis: $2H_2O$ ❼ $2H_2 + O_2$

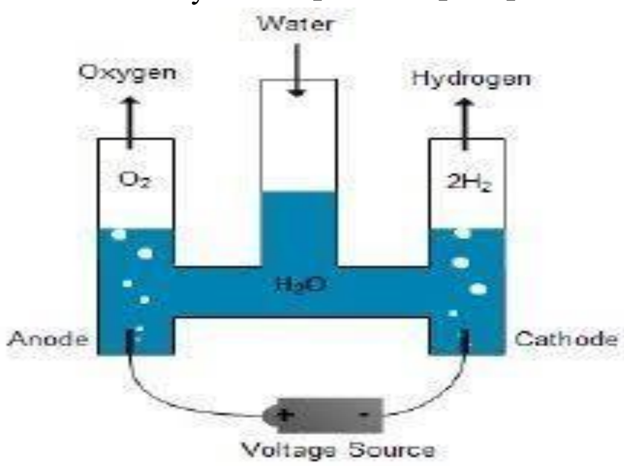

Fig. 5 Electric circuit of HHO cell

The gas produced in the electrolysis process, Le. HHO will combust when it is brought to its ignition temperature. For a stoichiometric mixture in normal atmospheric pressure the ignition occurs at 570 °C. The energy required to ignite such a mixture is about 20 p1 the burning process starts when the percentage of Hydrogen is between 4% - 95% of the volume of the HHO mixture. During the HHO ignition, the gas mixture releases energy and converts into water vapor which causes to sustain the reaction in (2). The energy produced by this ignition process is 241.8 KJ for every mole of HHO burned. The amount of heat generated in this combustion process varies according to the mode of the combustion engine [23]. In practice HHO gas can be introduced as a highly ignite source of power which will provide much higher energy compared to an ordinary ignition process in a combustion engine.

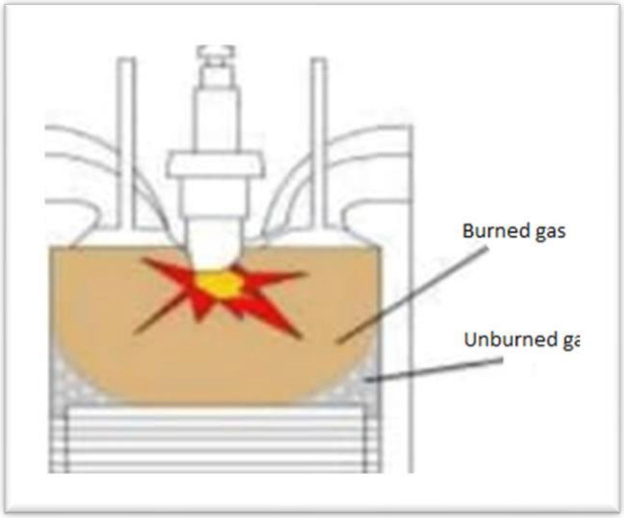

Fig. 6 Flame propagation in chamber

6. Cost Analysis:

Table 1 Cost analysis

S No	Component	Approximate Cost (INR)
1.	Electrodes(Stainless Steel)	1000
2.	Separators(Stainless Steel)	1000
3.	Gaskets	100
4.	Water Inlet	800
5.	Gas Outlet	200
6.	Battery	8000
7.	KOH	500
8.	PVC Plates	400
9.	Housing	500
10.	Nuts & Bolts	100
12.	Gas Knob	300
13.	Hollow Cylinder(2)	1600
14.	Miscellaneous	500
	Total Estimation Cost	**15000**

7. Conclusion and Future Work:

In this study, we propose a simple and practical method to produce HHO generators. According to laboratory analysis, when the available supply increases, H_2O also increases. Additionally, cell temperature increases HHO production. In order to create an efficient HHO generator, the distance between the plates, the electrodes used, the materials used, the number of plates and electrodes used must be determined. In plan, the amount of current passing through the generator increases with the temperature of the generator, which causes the battery to drain quickly. Considering this fact, future research will focus on limiting the current passing through the generator to achieve optimal HHO production. The next step in this research is to measure the vehicle's fuel efficiency and detect carbon dioxide, carbon monoxide, etc. is to connect the HHO generator to an internal generator (e.g. an electric generator) to measure the reduction in air emissions.

8. Proposed work:

Oxy-hydrogen will be produced through HHO generator then it will be used as a heater. By the help of a burner, knob and a reflector we can get a low cost radiative heater, which can be very cheap and useful for industrial applications but it can be risky for home appliances, so for that we will used a reservoir to store gas and will control the flow rate with the help of knob to make it safe to use in home also.

Fig. 7 Application of HHO generator

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