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Effective hydrogen generator testing for on-site small engine

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Abstract

We propose a new concept of hydrogen generator testing for on-site small engine. In general, there is a trade-off between simpler vehicle design and infrastructure issues, for instance, liquid fuels such as gasoline and methanol for small engine use. In this article we compare the hydrogen gases combination the gasoline between normal systems (gasoline only) for small engine. The advantage of the hydrogen combines gasoline for small engine saving the gasoline 25 %. Furthermore, the new concept of hydrogen combination for diesel engine, bio-diesel engine, liquid petroleum gas (LPG), natural gas vehicle (NGV), which is discussed in details.

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Keywords: Higrogen energy; Alternative energy; Hydrogen generator

1. Introduction

Alternative energies are critical energy resources that re-energize weakened energy demand for long life energy consumer. One of the interesting alternative energies is the hydrogen (HHO) gas [1-4], it is made by electrolysis and is well-known and has been proven science for roughly a hundred years. Thousands of "average Joes" globally have been used hydrogen generators to run their cars with water for the past 30 years [5]. *The "Bacon fuel cell"* significant work on fuel cells began again in the 1930s, by Francis Bacon [6], a chemical engineer at Cambridge University, England. In the 1950s Bacon successfully produced the first practical fuel cell, which was an alkaline version as shown in Fig. 1. It used an alkaline electrolyte (molten KOH) instead of dilute sulphuric acid. The electrodes were constructed of porous sintered nickel powder so that the gases could diffuse through the electrodes

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to be in contact with the aqueous electrolyte on the other side of the electrode. This greatly increased the contact area contact between the electrodes, the gases and the electrolyte, thus increasing the power density of the fuel cell. In addition, the use of nickel was much less expensive than that of platinum [7].

In this manuscript, we present the development of a bacon hydrogen generator (52mm x 126.3 mm x 1.5mm) with a self-regulating control by integrated gate bipolar transistor [IGBT] circuit. The control scheme enables the hydrogen generator to automatically stop generating hydrogen when it is not consumed by the battery 70 A and IGBT circuit control. The volume of the control mechanism is less than 50 mL (approximately 0.4% of the device volume). This technology has enabled created of the simple system by application for small engine, gasoline and diesel engine in the future. In Fig. 1, when disconnected the battery from the electrolyser and connected the two electrodes together, we observed a current flowing in the opposite direction, consuming the gases of hydrogen and oxygen.

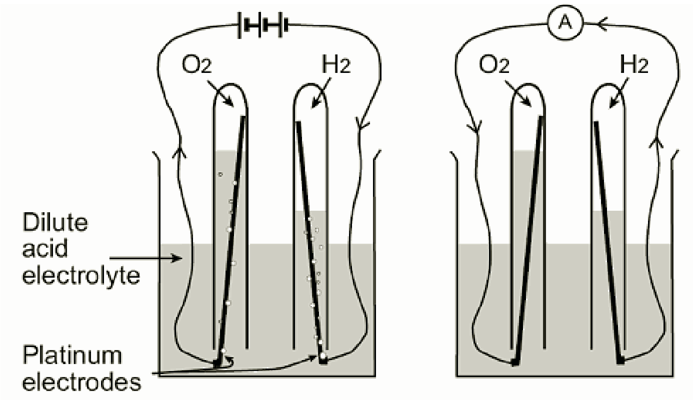

Fig.1. Illustration of a principle of an electrolyser of a fuel cell [6].

2. Background

A fuel cell by definition is an electrical cell, which unlike storage cells can be continuously fed with a fuel so that the electrical power output is sustained indefinitely. They convert hydrogen, or hydrogen-containing fuels, directly into electrical energy plus heat through the electrochemical reaction of hydrogen and oxygen into water. The process is that of electrolysis in reverse.

$$\text{Overall reaction: } 2\,H_2\,(\text{gas}) + O_2\,(\text{gas}) \rightarrow 2\,H_2O + \text{energy} \qquad (1)$$

Because hydrogen and oxygen gases are electrochemically converted into water, fuel cells have many advantages over heat engines. These include: high efficiency, virtually silent operation and, if hydrogen is the fuel, there are no pollutant emissions. If the hydrogen is produced from renewable energy sources, then the electrical power produced can be truly sustainable.

The two principle reactions in the burning of any hydrocarbon fuel are the formation of water and carbon dioxide. As the hydrogen content in a fuel increases, the formation of water becomes more significant, resulting in proportionally lower emissions of carbon dioxide. As fuel use has developed through time, the percentage of hydrogen content in the fuels has increased. It seems a natural progression that the fuel of the future will be 100% hydrogen.

The overall cell efficiency η is given by the equation

$$\eta = \eta_g \eta_v \alpha$$

where η_g is the Gibbs efficiency, η_v is the voltage efficiency, and a is the fraction of fuel used.

$$\eta_g = \Delta G / \Delta H = nFE_0 / \Delta H$$

$$\eta_v = E / E_0 = (E_0 - IR_c) / E_0$$

where E_0 is the open circuit voltage, and ΔH is the heat of the overall cell reaction. Thus

$$\eta = nF(E_0 - IR_c)\alpha / \Delta H$$

R_c is the area specific resistibility of the cell components (electrolyte, anode and cathode) [2].

3. Results

Fig. 2 shows a schematic of the Proton Exchange Membrane (PEM) hydrogen generator and its principle of operation. The water separates of hydrogen and oxygen gas in the system. This is the foam gases in cavity and the output hydrogen gases go on small engine. Fig.3 shows a schematic of the test setup for measuring the valve performance. It shows the battery, water chamber and Proton Exchange Membrane (PEM) of the setup, which can apply to small engine concept system. Fig. 4, the comparable between the temperature and time of the combination electrolyser put in the water crumble, (a) hydrogen cell 4 cells, (b) hydrogen cell 6 cells and (c) hydrogen cell 8 cells. Fig. 5, the comparable between the current and time of the combination electrolyser put in the water crumble, (a) hydrogen cell 4 cells, (b) hydrogen cell 6 cells and (c) hydrogen cell 8 cells.

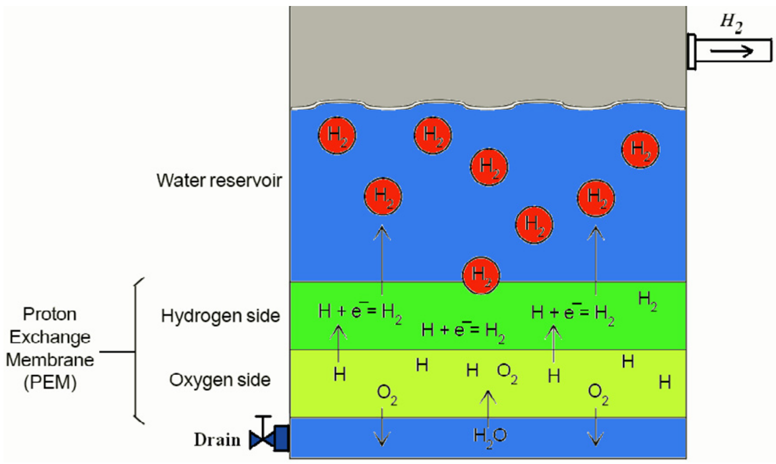

Fig. 2. Shows a schematic of the Proton Exchange Membrane (PEM) hydrogen generator.

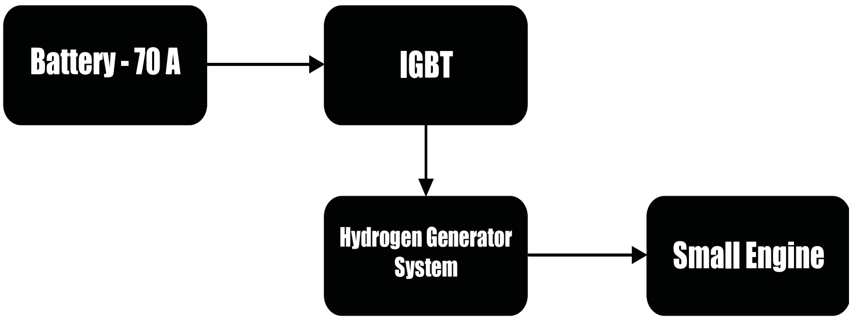

Fig. 3 . Shows a schematic of the test setup for measuring the valve performance.

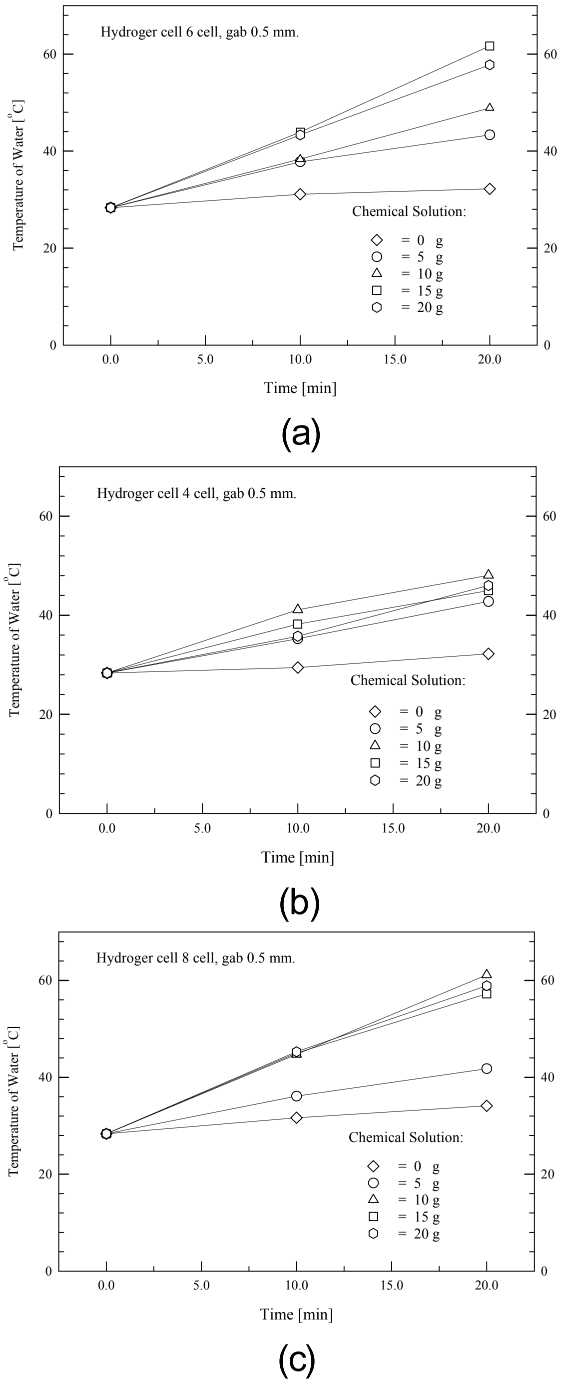

Fig. 4. Comparable results between the temperature and time of the combination electrolyser, where (a) 4 cells, (b) 6 cells and (c) 8 cells.

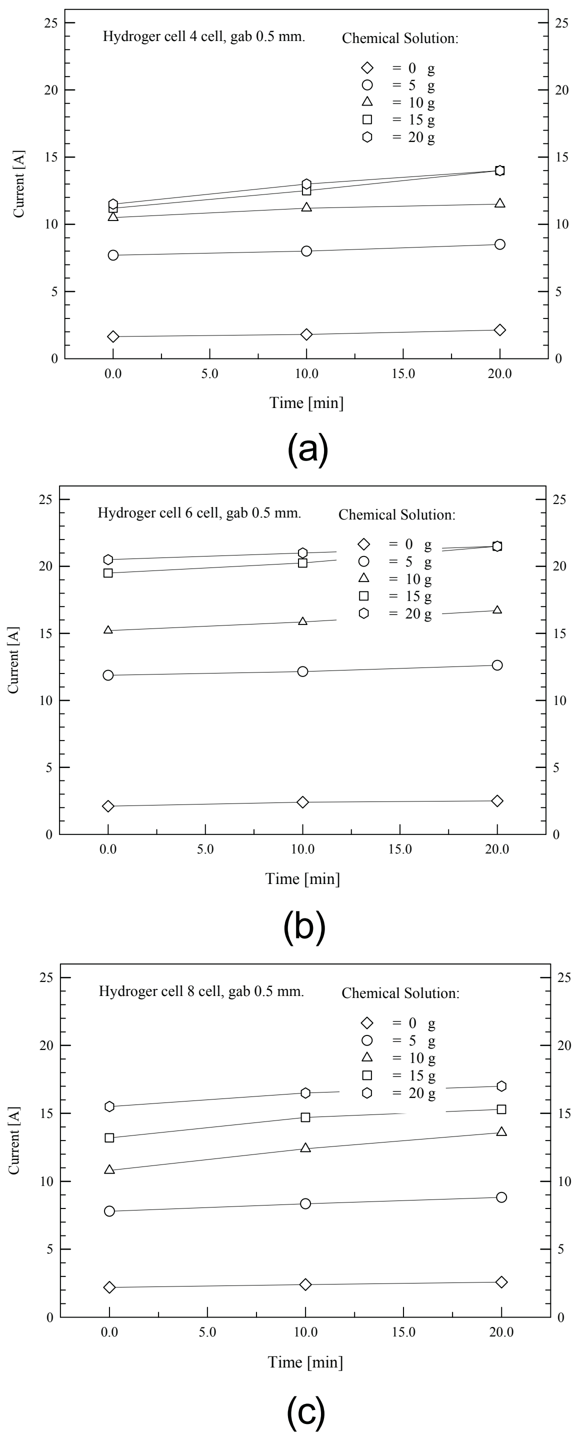

Fig. 5. Comparable results between the current and time of the combination electrolyser, where (a) 4 cells, (b) 6 cells and (c) 8 cells.

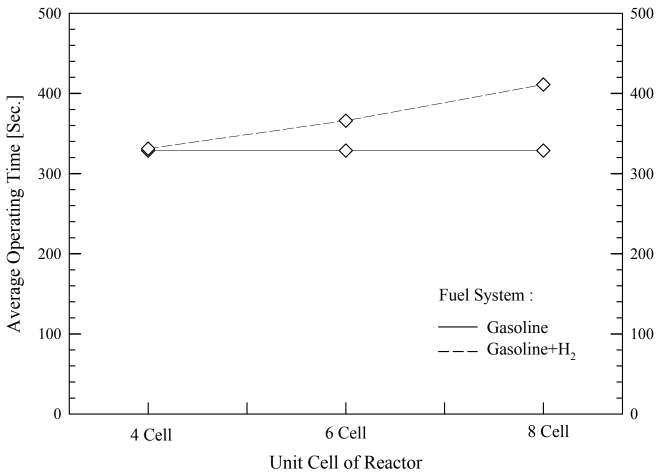

Fig.6. Shows graph between to the average operating time and cell reactor.

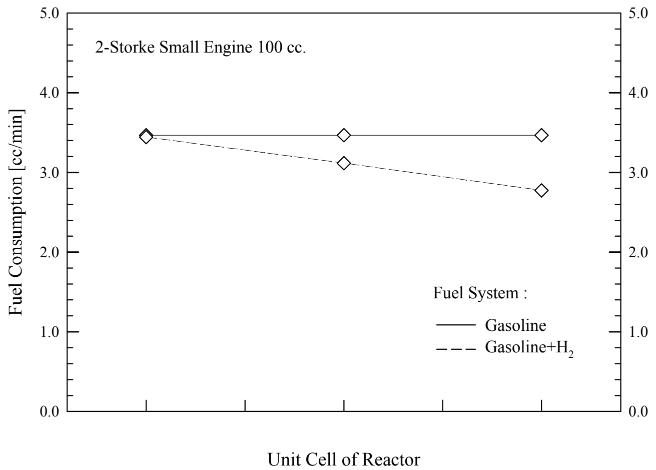

Fig.7. Shows graph between to the fuel consumption and cell reactor.

Fig. 6 shows the results of the engine testing when the supplied gasoline with 18 cc for 4 cell , 6 cell and 8 cell, the operation times of 325, 360 and 420 seconds, whereas the combination between hydrogen and gasoline of the low gear engine can be last longer with 100 seconds. This is equivalence to 320 seconds operation time with gasoline. Fig. 7 shows the unit cell reactor energy consumption, where the different consumptions have seen when the operation with 4 cell, 6 cell and 8 cell, the consumption rates are 3.4 cc/min, 3.2 cc/min and 2.8 cc/min, respectively. This is equivalence to 25 percent of gasoline consumption.

4. Conclusion

Since, normal vehicle does not run with water (H_2O) single-handedly. The HHO fuel is used in conjunction with the gasoline you already use. Once the two are fused, the mixture burns much more easily than gas by itself. Hence, significantly increasing in fuel-efficiency and total engine performance is seen. We have shown that the use of hydrogen generation for small engine and can be applied fuel cells and hydrogen technology, electrical power from renewable energy sources can be delivered where and when required, cleanly, efficiently and sustainable. The control mechanism takes advantage of capillary forces to maintain water inside a confined volume connected to a water reservoir. It delivers water vapour to the hydride reactor when hydrogen pressure inside the hydride reactor is low and relies on deflection of a membrane to seal off the water reservoir from the hydride reactor when the reactor pressure increases due to excess generation of hydrogen over that consumed by the fuel cell. However, near future we can application for vehicle gasoline, diesel, LPG and NGV engines.

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