

A Controlled Hydrogen Generator; Alternate Fuel Source for Vehicles

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Abstract— In recent years, hydrogen has been expected and used as a next-generation energy source from the viewpoint of reducing the use of fossil fuels. Research on hydrogen utilization technologies have been conducted actively for IC engine. There are two methods for the hydrogen-powered generation system: fuel cells and hydrogen engine generators. This work proposes design of a new hydrogen engine generator that has characteristics of low cost and higher durability compared to a fuel cell. The proposed hydrogen generator has the capability to control the generation and flow of hydrogen electronically so as to avoid the risk of explosion. Since if the hydrogen flow rate of the hydrogen engine generator is not controlled appropriately, RPM is dropped and the engine operation becomes unstable, or the fuel efficiency becomes worse. Therefore, it is necessary to control the output of the hydrogen engine generator by adjusting the hydrogen flow rate depending on the output power. Hence, this project proposes an automatic system to control the output of hydrogen engine.

Keywords—Alternate fuel source, Hydrogen generator, IC engine vehicle, Monitoring system, LCD display.

1. INTRODUCTION

In a hydrogen-powered generation system which is one of hydrogen utilisation technologies used in various automotive, there are fuel cells and hydrogen engines [1]. Most of the automotive majors are working seriously to be the first to make commercially viable cars powered by the revolutionary fuel cell technology. Automotive companies also know that fossil fuels are nearing to an end and need a new fuel source to run the vehicles in near future.

As one kind of new energy vehicles, hydrogen fuel cell vehicles can not only provide energy for vehicle operation efficiently, but also have zero pollution, no noise, long life and easy maintenance. However, hydrogen fuel cells have disadvantages such as slow dynamic response, long start-up time and soft output characteristics. Therefore, auxiliary energy sources need to be coupled to provide power support for vehicles in high power demand stages such as climbing and acceleration. At present, the auxiliary energy sources mainly used in hydrogen fuel cell vehicles include batteries and super capacitors. However, the battery has the disadvantages of producing large heat, short service life, and high self-discharge rate, which make the economy and reliability of hydrogen fuel cell vehicles low. The energy density of super capacitors is low, which makes the driving range of hydrogen fuel cell vehicles significantly reduced. The proposed system is the key to improve the dynamic performance and fuel economy of a vehicle to generate the required power among by formulating a reasonable and effective control strategy to control the flow of hydrogen generation. The use of auxiliary energy storage devices improves the dynamic performance and efficiency of fuel cells.

A hydrogen engine generator needs to control the hydrogen flow rate to output a constant voltage with high efficiency [1, 2]. An extensive literature review was done to study the reaction efficiency in the various hydrogen generators, the flow rate observed was 95%. It was understood that the output power of the engine generator has a close relationship with the hydrogen generation rate. The work presented in [3, 4] stated that the hydrogen was generated in the engine using NaBH₄ as a solvent but as the solvent used to generate hydrogen is not easily available so it is difficult to use this technique in vehicle.

In the study presented in [5, 6] a hydrogen reactor designed for fuel cell vehicles has been developed and used Raney Nickel catalyst to accelerate hydrogen generation.

This project has used a control unit, which controlled the hydrogen flow and hydrogen generation on the basis of parameter such as temperature and pressure in a HHO container. In the proposed system caustic soda (NaOH) as a solvent is used to increase the productivity of water for hydrogen generation. The NaOH helps to generate more hydrogen in water using electrolysis process where hydrogen and oxygen molecule are separated and the hydrogen is then passed down to the combustion engine to run the vehicle. In most of the vehicles where the hydrogen is used as a fuel source the hydrogen generator is made up of the titanium plates to increase the generator life but the cost of it is very high, therefore the price increases a lot. Instead this system uses stainless steel plates (317L) to reduce the cost without compromising the efficiency.

2. BLOCK DIAGRAM AND ITS DESCRIPTION

The block diagram presented in figure 1 shows that supply is first given to ESP 32 and HHO generator where the hydrogen gas is produced. And then generated hydrogen is passed on to air filter to remove the moisture from hydrogen. The pressure and temperature sensors are used with the container in which the hydrogen is generated. The pressure and temperature of the is displayed on LCD display. By observing the values displayed on LCD further controlling will be done by ESP 32. The system is able to produce the controlled hydrogen gas for IC engine to run the vehicle. ESP 32 is a tiny single-board computer, which is used in this work.

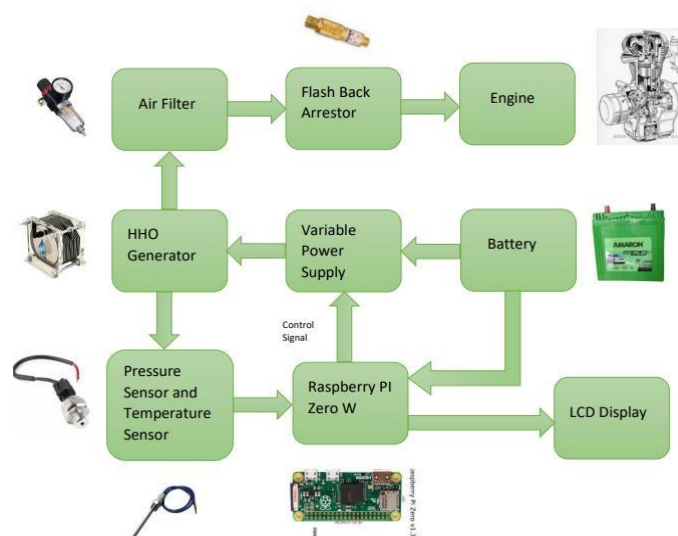


Fig 1 Block diagram of proposed system

The HHO generator shown in figure 2; works on the principle of water electrolysis with NaOH catalyst used to produce HHO gas [4] which is a gas consisting of 2 hydrogen molecules and 1 oxygen molecule and the hydrogen gas generated in this way can be used as fuel. HHO generator (dry cell) is consisting of fifteen electrode plates bound within two acrylic sheets connected together to form one unit of hydrogen generator. The design of Hydrogen generator as shown in figure 2. Each plate has the dimensions of 110mm *110 mm*1mm where there are five positive, two negative and eight neutral plates. Each individual cell (space between two plates) functions at 12 V. Design of a single electrode plate used in hydrogen generator is as shown figure 3. One of the most important aspects of a dry cell design is the number of electrode plates.

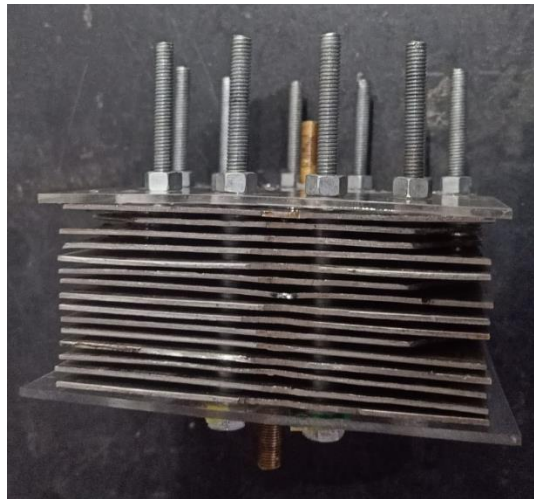


Fig 2 HHO generator



Fig 3 Steel Electrode Plate

The efficiency of a dry cell increases with increase in number of the plates. The side holes on the plates are for fitting purpose and the central holes are used for flow of water between the cells. It is the size of the surface of the neutral plates that is essential for hydrogen generation and that is what makes an efficient, well-designed Hydrogen cell.

3. PROTOTYPE DEVELOPED

The prototype developed is shown in figure 4. The developed HHO generator with ESP 32 unit and sensors including pressure sensor, temperature sensor is mounted on vehicle (Bajaj Discover 100T). As per the testing done on prototype shown in figure 4, hydrogen is generated within HHO generator after electrolysis and generated hydrogen gas is supplied to the engine of vehicle for combustion of air fuel mixture. Figure 5 shows the assembly of ESP 32 along with the sensors. The proposed system was successful in generating controlled hydrogen fuel and was able to drive the vehicle.



Fig 4 Proposed system with vehicle



Fig 5 Proposed system with ESP32 and sensors.

4. RESULTS AND DISCUSSION

Proposed system including HHO generator, ESP 32 unit and sensors are implemented with vehicle (Bajaj Discover 100T), it is observed that the hydrogen is generated as result of electrolysis process done inside the HHO generator. After the hydrogen generated it is maintained under the required pressure and temperature by controlling the power supply of hydrogen generator using PWM.

The variable power supply is used for the electrolysis process to control hydrogen generation. The ESP 32 unit works with ECU (Electronic Control Unit) and is used for monitoring the temperature and pressure sensor output and display the output on the LCD display connected to ESP32. The tests were conducted with the system and it is observed that generated hydrogen was passed to engine and used as alternate fuel.

This proposed system can help to reduce fossil fuel consumption and provide an alternate source of fuel.

5. CONCLUSION

This paper proposed the controlled method of hydrogen generator with incorporating the hydrogen flow rate controlling scheme. It has been confirmed that hydrogen flow rate can be controlled by ECU. As per the experimental verification results, it was shown that the hydrogen flow rate can be controlled using proposed scheme. The proposed system avoids the storage of hydrogen gas and also avoids the resulting issues with it, like explosion. The system successfully developed a hydrogen generator and implemented on vehicle engine

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