

Feasibility Study of use of Water as a Fuel

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Abstract— Hydrogen is the future scope of Energy as the prices of fossil fuels is increases day by day. The main source of hydrogen is water. Hydrogen production will be done by alkaline water electrolyser using direct electricity. An acrylic box of 160 mm × 120 mm × 120 mm is used as reactor body. A set of 5 SS electrodes on anode as well as on cathode of size of 85 mm × 100 mm × 2 mm are connected to power supply and joined to a SS plate by welding it with the other plates. Two Plastic casings of size of 65 mm × 100 mm × 100 mm are used to capture the processed gases generated from anode and cathode. The solution of 27.5% by weight of KOH solution which works as an electrolyte is fed with water from the bottom of the reactor. There are mainly two types of electrolysers were used: A) Two separate chambers with two separator wall and 10 mm gap between them and, B) Two separate chambers with one common separator wall of size of only 8 mm. The generated hydrogen is then fed to the stove by maintaining proper pressure and flow. The oxygen is left to the surrounding. From this process 98.8% pure hydrogen is generated.

Key words: Water, Fuel

I. INTRODUCTION

In today's society, the seeking of alternative energy is highlighted due to the price of the fossil fuels that was increased in the recent last years. The fossil fuels reserves are also limited. Because of technological advancement two main activities have raised due to the complexity between the energetic problems, technological, economic, environment, politic and social aspects. The smart use of the energy is the first activity. Promote savings, avoid wasting and development of more efficient equipments are done in this portion. The development of the renewable energies is come under the second portion. The production of green energy has increased impressively in the last years, especially in the wind and solar fields^[9].

Hydrogen is carbon free fuel so it is an environmental friendly fuel. Hydrogen is present naturally in combined state; in both organic as well as inorganic compounds on Earth. It is present in as hydrocarbons, water and other substances. Hydrogen is scarcely present in the free molecular form; therefore, the elemental hydrogen is artificially produced. Hence its safe and environmentally friendly production is most important. Electrolysis of water is one of the most efficient technique by which hydrogen can be produced. An electrolyser uses electricity and breaks water into hydrogen and oxygen. In this process of electrolysis, hydrogen can be considered as a direct energy source for fuel in automobiles and other applications where fossil fuel is used; and oxygen can be considered as a safe by-product^[2].

A. Electrolyser

An 'electrolyser' is a cell which breaks water down into hydrogen and oxygen gasses by passing an electric current

through the water. The gas generated through the process is called 'hydroxy' gas. Hydroxy gas is a mixture of hydrogen and oxygen. Hydroxy gas is highly explosive. It is much more explosive than hydrogen, and it is very much more dangerous than petrol vapour, which burning at least 1,000 times faster. A slightest spark will set it off immediately and exploding as little as a single cup full of hydroxy gas produces an explosion so loud that it can cause permanent hearing damage^[10].

The safety devices and techniques which must be used with electrolyser is the most important. The main objectives during electrolyser operation are to keep an absolute minimum amount of hydroxy gas actually present in the system, and to prevent any spark reaching the gas.

The result of efficiency of the engine can be improved from the output from a simple electrolyser can be mixed in with the air used into the engine. This will reduce much pollution emissions. The eco-friendly hydrogen gas leads to removal of carbon deposits inside the engine, which promotes longer engine life. An advanced electrolyser is difficult to build and is likely to be heavy. There are many different types of electrolysis cells have been constructed. The different electrolysis cells can be divided into groups based on the electrolyte. Following table presents an overview of the different types of cells. All the cells presented in table are using water as reactant to produce hydrogen.

Type	Alkaline	Acidic	Polymer electrolyte	Solid Oxide
Charge Carrier	OH ⁻	H ⁺	H ⁺	O ²⁻
Reactant	Water	Water	Water	Water, CO ₂
Electrolyte	Sodium or Potassium hydroxide	Sulphuric or Phosphoric Acid	Polymer	Ceramic
Electrodes	Nickel or SS	Graphite with Pt, Polymer	Graphite with Pt, Polymer	Nickel, ceramics
Temperature	80°C	150°C	80°C	850°C

Table 1: Types of Electrolysers and Operating Conditions

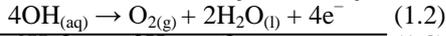
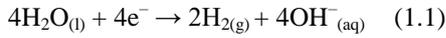
II. METHODOLOGY

Alkaline electrolyser (AEC) is a very mature technology that can be used as the current standard for large-scale electrolysis. The material that can be used as anode and cathode materials in these systems are made of nickel-plated steel or steel. The electrolyte in these systems is a highly caustic solution of potassium hydroxide (KOH). The ionic charge carrier is the hydroxyl ion, OH⁻. A porous membrane

to hydroxyl ions is used, which will not allow to pass hydrogen and oxygen which will also provide gas separation.

Key advantages of this technology are its maturity and its durability. Key disadvantages are its use of a highly caustic electrolyte and its inability to produce high pressure hydrogen. This inability to produce high pressure hydrogen for storage will lead to the need of a compressor, which leads to addition of cost and complexity to the system.

The cell reactions are:



The main difference between original design and my design is that original design has a diaphragm or nothing, while, my design have two plastic casings that separate the generated gases with each other which did not generate hydroxy gas and pure hydrogen gas and oxygen gas is produced separately. So there is no need of any other separating mechanism.

The electrolyte is an alkaline solution in water, typically 30% potassium hydroxide. It is contained in a porous felt separator traditionally made of asbestos. The electrodes are made of nickel or nickel plated metal on which a catalyst is applied.

The performance of the alkaline electrolyser and the electricity to hydrogen efficiency can be increase by increasing the operation temperature to above 200 °C significantly. But, this will lead to lower stability of materials for operating at elevated temperature. To develop a suitable water electrolyser cell for large scale plant, it is necessary to develop suitable materials for the cell^[11].

There are two types of electrolyser I designed.

A. Two separate chambers with two separator wall and 10 mm gap between them:

The two chambers which have size of 65 mm × 100 mm × 100 mm are joined in such way that the chambers have gap of 10 mm from every side. So the overall gap between two last electrodes is 36 mm.

B. Two separate chambers with one common separator wall of size of only 8 mm.

The two chambers which have size of 65 mm × 100 mm × 100 mm are joined in such way that the chambers have only one common wall thick of 8 mm. So the overall gap between two last electrodes is 18 mm.



Fig. 1: Design of Electrolyser of A module



Fig. 2: Design of Electrolyser of B module

Transformer of 12 V, 20 A is used to supply DC power supply to the electrolyser. The water with KOH is fed and the electric current is passed through electrodes. The gases are generated from the upper side of the electrolyser. The gases are passed through flame arrester and non-return valve so that if the flame or spark is there in pipeline than it could be saved. Oxygen gas is released to the environment.



Fig. 3: Electrolyser Set-up

III. RESULTS

The power supply is supplied from direct grid which is passed through transformer which gives power of 240 W (12 V, 20A) of DC current. The water with KOH is fed and the electric current is passed through electrodes. The gases are generated from the upper side of the electrolyser. The gases are passed through flame arrester and non-return valve so that if the flame or spark is there in pipeline than it could be saved. Oxygen gas is released to the environment.

Input Voltage (AC), V	Output Voltage (DC), V	Power Consumption (kwh)	Hydrogen Production (gms)
244	11.83	0.66	5
244	11.93	0.68	6
240	11.69	0.64	4
250	11.87	0.66	5
Average		0.66	5

Table. 2: Power consumption and hydrogen generation of system A

Input Voltage	Outout Voltage	Power Consumption	Hydrogen Production
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(AC), V	(DC), V	(kwh)	(gms)
244	11.93	0.78	8
244	11.64	0.78	8
250	11.83	0.80	8.5
240	11.87	0.76	7.5
	Average	0.78	8

Table 3: Power consumption and hydrogen generation of system B

There are two electrolyser systems used (A and B). The system A using 0.66 kwh of power averagely and producing 64 grams of hydrogen gas from 1 litre of water. Thus, the efficiency of A system is 57.66%. The system B using 0.78 kwh of power supply averagely and producing 102.5 grams of hydrogen gas from 1 litre of water. Thus, the efficiency of this system is 92.34%. The total cost to produce 1 kilogram of hydrogen is Rs. 474 in system A and in system B it is Rs. 390 per kilogram of hydrogen generation.

IV. CONCLUSION

These processes for producing hydrogen is not feasible currently but in near future with some modifications to the instruments could make it feasible to use as cooking fuel. These processes for producing hydrogen is not that much feasible currently as system A and system B producing hydrogen gas at Rs. 474 per kg and Rs. 390 per kg respectively. The cost to produce the LPG is approx. Rs. 30 per kg while, the cost to produce PNG is Rs. 40 per kg. Generally, a household cylinder of 14.2 kg is works for a month that means averagely 0.5 kg of LPG is used daily, which, compared to hydrogen gas the daily usage is 0.1 kg.

In near future with some modifications to the instruments and electrolyser cells and materials can make it feasible to use as cooking fuel. These modifications are changes in electrode material, changes in electrolyser cell, Changes in electrodes size to decrease power losses.

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