International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Home Gas by Hydrogen Fuel Cell

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Abstract: ***This paperrepresent about Hydrogen Fuel Cell which consist of a fuel tank and is filled with demineralized water (DM) having zero conductivity and sodium hydroxide (NaOH). This fuel cell is designed to operate on the method of Electrolysis by separating hydrogen and oxygen. The fuel cell uses electrochemical process to split hydrogen and water and recombine to form HHO gas (hydroxyoxygen), which we can further use for generating heat and electricity. Hence gives us a conclusion of using the resultant heat for various purposes like welding, cooking etc. But this paper gives a brief explanation about HHO gas for the purpose of cooking.***

Keywords: electrolysis, home gas stove, burner, Hydrogen gas, bubbler.

1. Introduction

Nowadays, as the environment are becoming more and more contaminated because of the increasing carbon dioxide and pollutants an immediate action must be taken .This paper tries to overcome these problem by showing the pros and corns of using "home gas by hydrogen fuel cells". It deals with the use of hydrogen gas instead of LPG(liquefied petroleum gas) for the purpose of cooking.

1.1Properties of hydrogen

- Density: 0.0899g/l at STP and 0.085g/l at 15^{o}C
- Energy density : 120-140 MJ/kg at STP
- Critical pressure : 12.96 bar
- Triple point temperature : -259.19^{o}C
- Critical temperature : -240^{o}C
- Molecular weight : 2
- Triple point pressure : 0.077 bar
- If hydrogen gas doesn't leak, it'll produce 3X much energy comparison to natural gas.
- Octane no. : +130

1.2 Hydrogen Production Method

This paper uses electrolysis process for splitting of water into hydrogen and oxygen. Here the fuel tank is filled with demineralized water having zero conductivity and sodium hydroxide (NaOH). As the reactor gets DC supply it will ionize the molecules of hydrogen and oxygen and will separate it and will form hydrogen and oxygen and further recombine to form hydroxyoxygen (HHO).

HHO- hydroxyoxygen (HHO) is a diatomic structure made from the molecules of two atoms of both the gases oxygen and hydrogen.

HHO is emission free and considered as environmental friendly as it does not produce any carbon and other pollutants into the atmosphere when burned.

During the production of hydrogen following reaction occur in the cell:

1.3 Hydrogen Fuel Cell Diagram

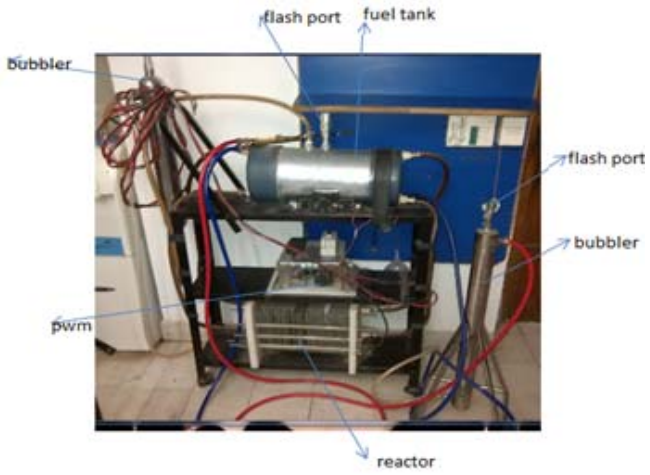


Figure 1: Fuel Cell

1.3.1 Reactor

It is made up of stainless steel and consists of 220 volts and 110 plates with gap less than 1mm. The input to the reactor is water and NaOH. Thus the output obtained is HHO gas.

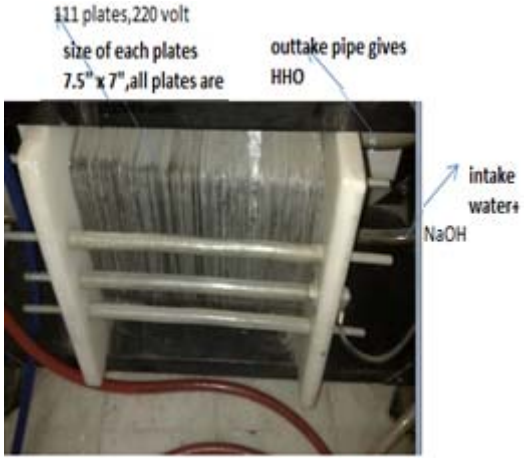


Figure 2: Reactor

1.3.2 Bubbler

It is also made up of stainless steel .It has two nozzles for intake and outtake. It consists of a flash port at the top and flash port has glass ball inside so whenever the pressure get rise glass ball will pup-up and release the pressure.

Sometimes a water gauge is attached to the bubbler to indicate the water level i.e. generally half of the complete bubbler size. Rest part of the bubbler is filled will brass wool to make fill of area so there must be no extra pressure built inside of hydrogen.

1.3.3 Fuel Tank

A flash port on the fuel tankis made up of (CPVC) Chlorinated polyvinyl chloride. It is a thermoplastic produced by chlorination of polyvinyl chloride (PVC) resin.It has intake and outtake of gas inside, the upper pipe of fuel tank is connected with upper pipe of reactor and similarly lower pipe of fuel tank is connected with lower pipe of reactor on the both side. Here we have used NaoH and water but KOH can also be used in place of NaoH.As we know KOH has more pressure than NaoH and also it is a bit costlier than NaoH so here in this paper we are dealing with NaoH.

Figure 3: Fuel Tank

1.3.4 PWM

Pulse width modulation (PWM),a part of the fuel cell is for controlling the flame of HHO. PWM is also known for increasing the production of HHO gas without increasing the current rating (amp).

1.3.5 Gas stove

The flow rate of HHO can be varied from 2-13 liter per minutes. This gas can be used straight or with the combination of LPG. As LPG gas has carbon so there is no risk of flash back.

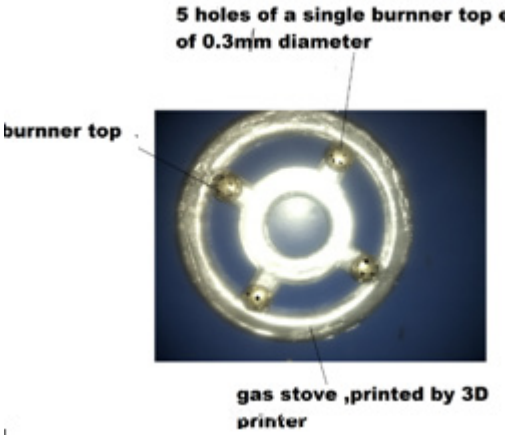


Figure 4: Home Gas Stove

Diameter of each hole in the stove is 0.3mm. There are 5 holes on a single burner top and there are total 4burner top. This gas stove is printed by a 3D printer.

Figure 5:3D Printer

1.3.6 Flash Pot

It is used for safety purpose of the HHO Generator. It is made of Poly-vinyl chloride (PVC). Flash Port is a type of pressure release faucet. It blows off the extra pressure during back fire. It consist springs which is placed inside the end cap As hydrogen flash back, glass ball pop-off and thus hydrogen releases from the space provided on the flash port into the surrounding environment and protect the device for bursting .Hence also known as safety guards.

2. Literature Survey

In 1802, Sir Humphrey Davy created the first simple fuel cell based on compound like NH3/O2/C, C/H2O which was delivering an inadequate electrical shock. So this fuel cell was not acceptable .The first fuel cell was firstly imagined by Sir William Robert Grove in 1839, that why he is also known as the father of the fuel cell. He has done an experiment by mixing hydrogen and oxygen in the existence of an electrolyte and helped in the production of electricity and water. In 1882, a power generation attempt was made by Thomas Edison. He built a power generation by burning coals. Fuel cell is named as fuel cell by Ludwig Mind and Charles Langer who has built the first fuel cell device using industrial coal gas and air, in 1889.In 1993, Sir Francis Bacon started to work on fuel cell and developed a high density AFC at very high pressure

3. Problem Definition

As we know hydrogen is a very explosive gas so the problem in using hydrogen is the risks of fire or bursting. So this paper deals with that problem by implementing the use of flash back arrestor. With the help of this flash back arrestor, at the time of back fire the entire system will be protected from the fire causing no harm to the humans as well as environments. Another problem of hydrogen includes storage and its production cost. But this paper also gives a good explanation about hydrogen production, as here we are using water for hydrogen production which is abundant in nature

4. Methodology

This paper uses the method of electrolysis for the production of hydrogen gas or HHO gas by splitting of water into oxygen and hydrogen. Here as the fuel cell reactor gets the DC supply it will ionize the molecules of hydrogen and oxygen and will separate it and will form hydrogen and oxygen and further recombines to form hydroxyoxygen (HHO).

$$2H_2O\,(l) + NaOH\,(aq) \rightarrow 2H_2\,(g) + O_2\,(g) + Na^-(aq) + OH^-(aq)$$

This gas will goes to the upper portion of the fuel tank and from their it will go to the bubbler through the pipe on its top. And from the first bubbler the gas will goes to the another bubbler through the other pipe. And this gas from the second bubbler can be used for producing heat. so we can use this heat for burning our home gas stove for the purpose of cooking.

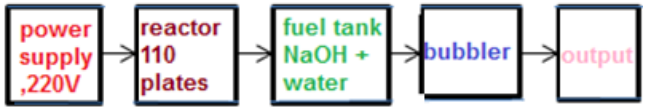
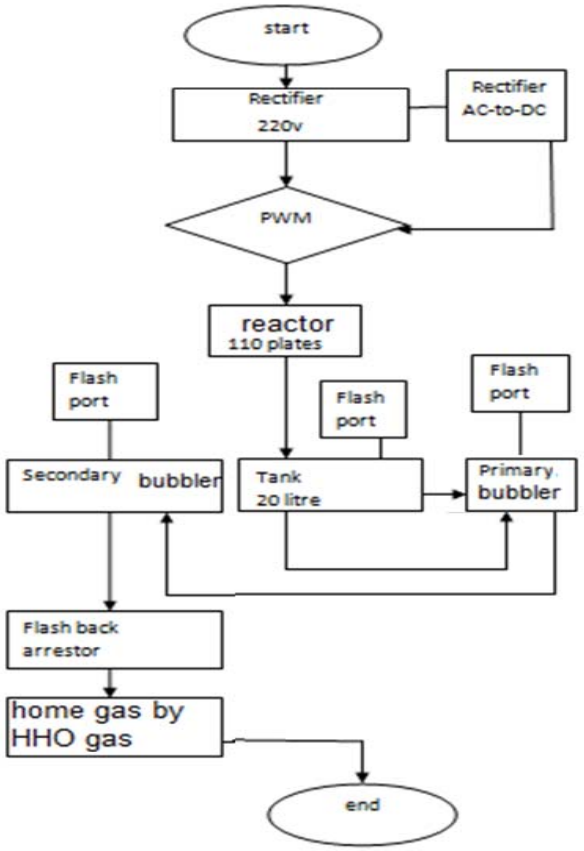


Figure 6: Complete setup process

This method can be well understood with the help of a flow chart describe in the following figure:

Flow chart describing the methodology of hydrogen fuel cell



5. Results and Discussion

This paper shows that we can use hydrogen in place of LPG.

If we consider a domestic LPG: This can be very well understood with the help of an example. As we see in our homesvarious equipments and their rating, and here we are considering the following:

Table 1

S. No	*Equipments*	*Ratting*
1	Cooking burner	9MJ
2	Gas heater	15MJ
3	Continuous flow hot water heater(geyser)	130MJ
	Total	154MJ

If we consider subsidized cylinder:
14.2 kg LPG=194.54 (KWH) = 700344KJ
{194.54 KWH explanation:

Composition of LPG in a cylinder is -
40% propane – 13.83 Kwh\kg (calorific value)60% butane – 13.62 Kwh\kg (calorific value)Domestic LPG cylinder weight- 14.2kg.

Net calorific value- 13.83*0.4 + 13.62*0.6= 13.70kwh/kg .**Therefore,for a cylinder 14.2*13.70 =194.54 KWh}.**
So this cylinder will last: 700.344MJ\154MJ = 4.54hr. In India, subsidized cost of LPG = Rs.425. per unit production cost will be = Rs2.18.So accordingly, cylinder will consume 154MJ = 42.5 unit. So cost of cylinder will be 42.5*2.18 = Rs92.65

Table 2:

City	Chennai	Kolkata	Mumbai	Delhi
Subsidized cylinder cost in Rupees	432	440	435	414
Cost in Rupees for 154mz	94	95	94	90
Non- Subsidized Cylinder cost in rupees	1234	1270	1264	1240
Cost in rupees for 154MJ	269.5	277.45	276.13	270.85

I.e. since 700.344Mj = Rs435 (subsidized cylinder cost in Mumbai)so,1Mj = 425\700.344 .Therefore for 154mj= 435* 154\700.344 =94(approx.)

Hydrogen calculation: To get a desirable output**,** we must consider:

- Plate- 2-2.2 volt per plate
- Current- 0.54amp per inch^{2}active surface area of the plate.

Let the plate size be (7.5*7)", diameter of circle is 1.4cmand gasket is 2*.
Therefore surface area = (rectangle area) - {(4*triangle area) + (2* circle area) +area exposed to $H_{2.}$}.
(14*12.8) – (4*0.5*2.8*2.5) – (2*3.14*0.7*0.7) – (7.8*0.9*0.5) = 158.62cm^2.

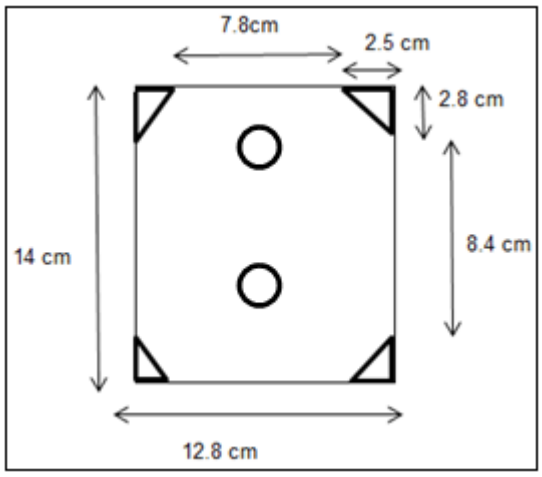


Figure 7: H_2 calculation

Maximum current which can pass in the reactor (with its full efficiency) is
Current =24.58*0.54 = 13.27 amp.
For 220 volt DC supply, having 11amp:

- H_2 output is: 12.6 LPM
- Output HHO: 756 liters
- H_2: 504 liters
- O_2:252 liters in an hour.

- Energy density of H_2=130MJ/kg
- Density of H_2 = 0.085 gm/l at room temperature.

So, Energy output = 504*0.085*0.001*130 = 5.57 MJ/hr. To attain 154MJ, this HHO fuel cell will take 27.64 hr.If we calculate for average electricity cost in India (250KWH) then cost is 3.70 Rs/units = 3.70*(2.42*27.64) = Rs245.44.This provide us result that presently H_2 is more economical.

6. Conclusion

Home gas by hydrogen fuel cells gives us a wonderful conclusion by discussing the use of HHO gas for cooking purpose. As already discussed above, the HHO gas in the hydrogen fuel cell is prepared by the electrolysis process by splitting of water. So, the primary source used in the production of HHO gas is water which is well known for its abundance. So fuel cell helps in dealing with one of the major problem by reducing the production cost of hydrogen. Hence by the use of "home gas by hydrogen fuel cell" we can save money up to a great extent. And we also know the hydrogen gas is eco-friendly, thus it is emission free and produces no carbon during the use. In this way we can also save LPG for future.

7. Future Scope

We all know that generally fuel cell is used for transportation purpose and in portable uses. Here, in this paper we have shown the use of hydrogen fuel cell for cooking. Sometimes, we are facing lack of LPG so it can be imagined that there may be no LPG for the future use, so this home gas by hydrogen fuel cell can be used in future for cooking in the absence of LPG. On other hand, the fuel cell can be very helpful for supplying power to ours cars in future, by replacing petrol with hydrogen. It can be used for generating electricity by electrochemical process. Fuel cell can power any portable device like laptops, computer, cellular phone etc. Among all, the best part of using hydrogen fuel cell is **"the use of hydrogen fuel cell provides us a greener future."** As hydrogen is considered as ecofriendly, non-toxic which provide us clean energy.

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