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Efficient Welding Torch by Hydrogen Fuel Cell

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Abstract: ***Mostly all the countries are doing research in the development of renewable sources of energy to replace the fossil fuel as it is lacking day by day. So there in this research paper we are going to discuss about the use of hydrogen fuel cell for welding torch. As most of the welding is done either by the gas or by electricity directly. This paper shows the use of an electrolysis process in which water splits into hydrogen and oxygen when electricity is supplied to it, which is further used as a flame for welding.***

Keywords: PWM, welding torch, flash port, flash back arrester, bubbler

1. Introduction

At the present time supply of fossil fuel is decreasing day by day whereas there is also increment ofcarbon dioxide in the atmosphere, to get over these problems there is need to implement renewable sources of energy which should be carbon free like hydrogen fuel cell. In this project we are going to focus on the use of hydrogen fuel for welding purposes. Basically it is an electrolysis process in which water is ionised with an electrolyte (NaOH) in the reactor which is made up of 118steel plates, each plate is of 16 gauge and in between the plates there is rubber gaskets the positive side is cathode and negative side is anode , when 220v electricity is supplied to the pulse modulation circuit (PWM) which is to control the supply of current to rectifier which converts the ac to dc current to the reactor in which ionisation process occurs and the water is split to hydrogen and oxygen in the form of gas which is being carried to the tank by the help of pipe from both sides. From the tank the hydrogen gas is carried out by another pipe to the bubbler by which extra particles are removed by water and pure hydrogen is carried out to the welding torch which gets flamed and further used for welding.

1.1 Hydrogen from Splitting of Water

Hydrogen is produced from water by various processes. In This paper we are going to discuss about two types of electrolysis to split water to hydrogen and oxygen.

Water electrolysis: Electrolysis of water is a process in which water is split into hydrogen and oxygen by the use of electrical energy, in water electrolysis, the total energy considerably exceeds with the increasing temperature, while the essential electrical energy decreases.

$$H_2O + \text{electricity} \rightarrow H_2 + 1/2O_2$$

Following reactions occur in the cell when a electrolyte is mixed with water.

Electrolyte: $4H2O \rightarrow 4H+ + 4OH-$
Cathode: $4\ H+ + 4e- \rightarrow 2H2$
Anode: $4OH- \rightarrow O2 + 2H2O + 4e-$

1.2 Splitting water with electricity to produce hydrogen and oxygen

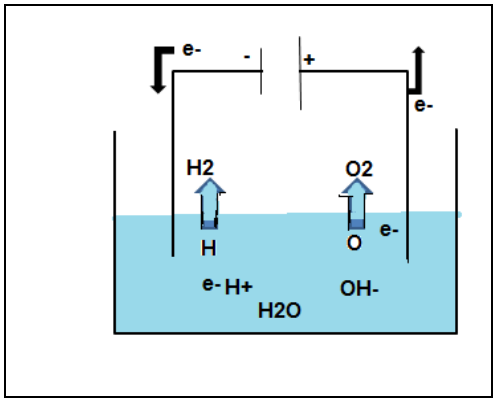


Figure 1: Electrolysis

2. Literature Review

The historical background of hydrogen fuel cell begins in nineteenth century, and the credit for the development of this tool goes to Sir William Robert Grove, a Welsh judge and beginner researcher, conceived in Swansea in 1796. In 1839, he found that blendingof hydrogen and oxygen in the vicinity of an electrolyte handled power and water. The term ―fuel cell for Grove's innovation was initially used in 1889 by Ludwig Mond and Charles Langer, who focussed to create a power module that uses mechanical coal gas and air as a source. The fundamental step they made was changing the fluid electrolyte with splashed up asbestos, the model to the strong electrolyte.

In 1932 a designer at Cambridge University, Francis T. Bacon manufactured an energycomponent which was focused around a less destructive antacid electrolyte and made it conceivable to utilize minimal effort nickel as the impetus. In 1959, Bacon demonstrated a stack of forty cells, which could handle 5kw of electric force and was equivalent to current energy units. In 1959, the first energy component vehicle, a tractor, was made by Allis-Chalmers ranch gear firm in Milwaukee, Wisconsin. The principal Proton Exchange Membrane Fuel Cell (PEMFC) was made in 1954 in USA by a physicist William Thomas Grubb from General Electric. At the point when the USA and USSR, the two superpowers of twentieth century, began the race for space,

energy units turned into a matter of incredible enthusiasm as the need developed for minimized vitality transformation gadgets locally available rocket. In the 1950's, NASA chose to utilize energy units to supply power throughout space flight for their manned space missions. NASA supported in excess of 200 exploration ventures on power device engineering and thusly, energy components have given ready for and water to the Gemini, Apollo and Space Shuttle missions. In 1983 a group headed by Geoffrey Ballard from Canada accepted a Canadiangovernment's solicitation to create a PEM energy component. Ballard is as of now a heading organization in the power device business and gives energy unit stacks and parts to numerous framework producers.

3. Methods and Equipments

Generally the hydrogen gas is produced by electrolysis method where the water splits into hydrogen and oxygen when power supply of 220 v is supplied to the pwm circuit. Then water splits and ionised in the form of gas which is further carried out through the bubbler to the welding torch where it gets flamed and used for welding purposes.

3.1 Power Supply Process

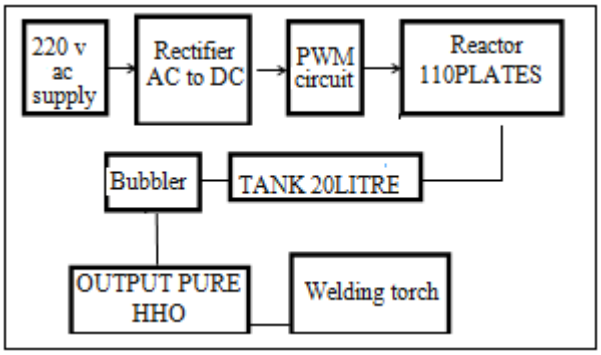


Figure 2: Complete setup of efficient welding torch by hydrogen fuel cell

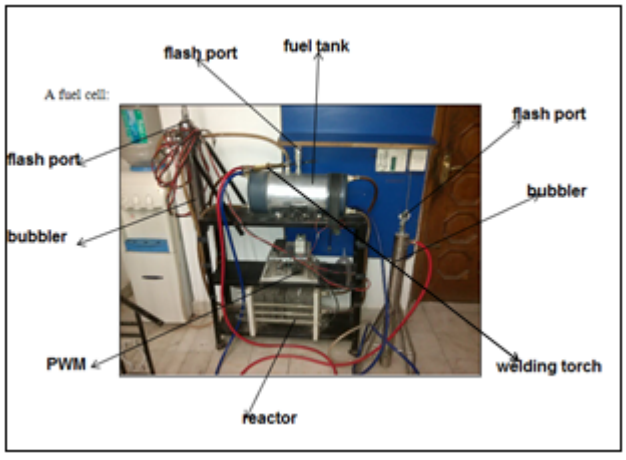


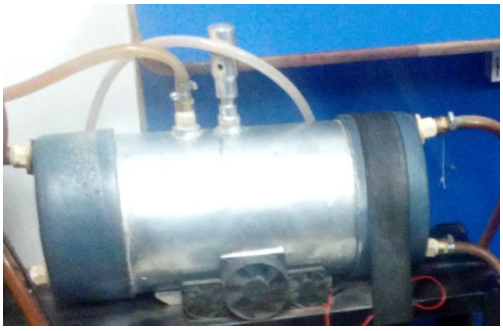
Figure 3: Complete Setup

3.2 Reactor Design

In the reactor there are 110 stainless steel plates which are of 16 gage. The stainless steel is used because they are non-corrosive. These steel plates can easily retain the temperature of 1000 degree c. supply of current to the reactor is 220 v so there will 2.2 voltage drop per plate which is best for the electrolysis process, In the process the plates are placed in series with a gap of 1mm , and in between the plates there is neoprene rubber gaskets are placed, these rubber gaskets can retain the temperature of 260 degree as they are having the thickness of 1.5-1.8mm, there are two side supporter used to provide support to the plates, these side supporter are made up of highly dense polymer i.e acrylic and two brassnozzles are attached for output and input. And the reactor is tight up of rods and bolts which are made up of mu material and they can bear upto 10.5 ton strength and they are non-corrosive as well.

3.3 Tank

The capacity of tank is 20 litre and it is made up of poly vinyl chloride, there are five brass nozzles attached to the tank, 2 nozzles from each side and 1 at the upper side of the tank. 1 flash port is also attached at the upper side of tank for the protection from back fire of hydrogen gas, as it releases the pressure.



3.4 Bubbler

It is a very important tool in this project , it is made up of stainless steel of 16 gage. It has two nozzles for output and input. It consist of flash port at the upper side of the bubbler and at the bottom there is a perforate plate for the dispersion of the hydrogen. Basically the bubbler has two main uses

- It prevents the burning gas to enter into the hho gas generating chamber and creating a explosion
- In case of back fire , the flash port cap will pop off to release pressure.

3.5 Flash Port

It plays a vital role in this project , as it is for the safety purpose. It is made up of poly vinyl chloride, it has pressure relief valve, as it pops off when there is back fire of hydrogen gas. It has usually two springs, one at the upper side and other at the bottom, a small glass ball is placed at the bottom spring. When hydrogen gas flash back the glass ball pops off to the upper spring and the pressure of the hydrogen gas is released at the open part of flash port.

3.6 Welding Torch

Welding torch is a usually made up of for the welding purpose. It is made up brass with a single nozzle with a hole of 1mm, there is a pressure controller for controlling the

pressure of the hydrogen gas. The two pipes is attached to it from bubbler to the welding torch, one for the hydrogen gas and the other is of oxygen gas.

4. Results

Calculation For Hydrogen
To get maximum efficient output - conditions are : (2-2.2 Volt per plate) with 0.54 Amps per inch^2 active surface area of the plate. In the model by using the result :
Plate size is: (7.5*7)" and circle diameter is 1.4 cm.
Rubber gasket is : (2*
Net active 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)
= 158.62 cm^2 = 24.58 inch.^{2}

Therefore, maximum current with its full efficiency can pass in the reactor is
= 24.58 x 0.54 = 13.27 Amp

For supply of (220 Volt DC, 11Amps)
H_2 output is : 12.6 LPM
In an hour, output HHO = 756 litres
H_2 =504 litres
O_2=252 litres

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.

Energy Generation By Hydrogen :

Consume energy is 220*11*3600 = 8.71 MJ/hr(Clean Energy)
Energy from the power plant is 8.71*3 = 26.13 MJ/hr
Hydrogen generation is 12.6 LPM*0.66*0.085 gm/lt.= 0.706 gm/mil
So the maximum efficiency of hydrogen gas we can get by this model is 12.6 lpm (litre per minute) by supplying the 220v at pressure of 4 to 6 psi

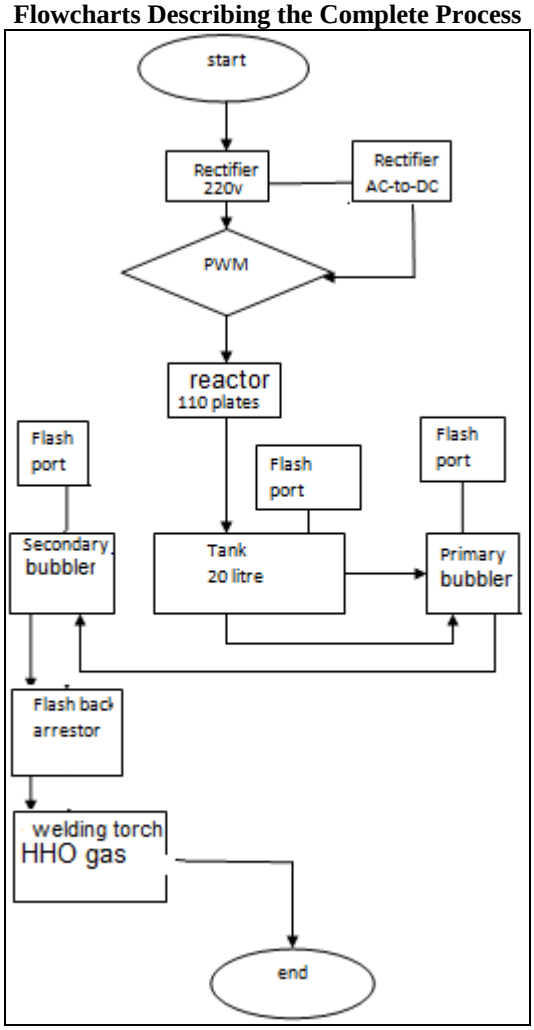
5. Conclusion

In all the developing country all the research and development team is trying to focus on carbon free environment and to replace fossil fuel with renewable sources of energy, like hydrogen gas , solar energy etc. India is also a developing country, many researches are being made for development of cheap and environment free sources of energy. Water electrolysis is a technology that deals with the production of hydrogen gas So the maximum efficiency of hydrogen gas on the supply of 220v, 11 ampere is 12.6 lpm(litre per minute) . To get the full efficiency the output condition should be 2- 2.2 volt drop at per plate, with maximum current of 0.54 amp per plate . , maximum current with its full efficiency can pass in the reactor is 13.27 ampere.

6. Future Scope

The future scope of this project is using hydrogen fuel cell in place of fossil fuel, as the fossil fuel is lacking day by day and it creates too much carbon, whereas it is carbon free and eco-friendly to the environment. It can be used for various purposes like cooking, welding, cutting etc. presently many companies are making use of it in vehicles like Hyundai and bmw have recently made such cars which can run on hydrogen fuel cell. Many developing countries have been researching on this project to use for electricity by the help of PEM (PROTON EXCHANGE MEMBRANE) it is a fuel cell used for making electricity by hydrogen fuel cell, so the basic scope of this project is to give larger efficiency at low cost.

Flowcharts Describing the Complete Process



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Suman Saurabh has completed the bachelor in technology (B.Tech) in Electrical Engineering from Suresh Gyan Vihar University. Presently I am pursuing M. Tech in energy from Suresh Gyan Vihar University. He has done this project under the guidance of Dr. P B L Chaurasia, Dean Engineering, Suresh Gyan Vihar University, Jaipur, India.