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POWER GENERATION USING HYDROGEN FUEL CELL FROM BIOGAS

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Abstract - ***Energy is the lifeblood of today's society*** *and economy. Traditional fossil energy sources such as oil are ultimately limited and the growing gap between increasing demand and shrinking supply will, in the not too distant future, have to be met increasingly from an alternative primary energy source. One excellent source of energy is biogas. Biogas is a fuel which is produced from the breakdown of organic matter. Methane is the main component of natural gas, is also an important greenhouse gas and is a major contributor to the global warming problem.*

Fuel cells generate electricity by an electrochemical reaction in which oxygen and a hydrogen-rich fuel combine to form water. Unlike internal combusted, the energy instead being released electrocatalyically. This allows fuel cell to be highly energy efficient and even higher efficiency can be gained with cogeneration. A typical fuel cell produces a voltage from 0.6-0.8 V at full rated load. Fuel cells can be developed for portable electronic device.

Key Words: Fuel cell, Methane gas, Anode and Cathode

1. INTRODUCTION

A fuel cell is a device that converts the chemical energy from a fuel in to electricity through a chemical reaction with oxygen or another oxidising agent. Hydrogen produced from the steam methane reforming of natural gas is the most common fuel, but for greater efficiency hydrocarbons can be used directly such as natural gas and alcohols like methanol. Fuel cells are different from batteries in that they require a continuous source of fuel and oxygen/air to sustain the chemical reaction whereas in a battery the chemicals present in the battery react with each other to generate an electromotive force (EMF). Fuel cells can produce electricity continuously foras long as these inputs are supplied. The first fuel cells were invented in 1838. The first commercial use of fuel cells came more than a century later in NASA space programs to generate power for probes, satellites and space capsules. Since then, fuel cells have been used in many other applications. Fuel cells are used for primary and backup power for commercial, industrial and residential buildings and in remote or inaccessible areas.

There are many types of fuel cells, but they all consist of an anode, a cathode and an electrolyte that allows charges to move between the two sides of the fuel cell. Electrons are drawn from the anode to the cathode through an external circuit, producing direct current electricity. As the main difference among fuel cell types is the electrolyte, fuel cells are classified by the type of electrolyte.

Individual fuel cells produce relatively small electrical potentials, about 0.8 volts, so cells are "stacked", or placed in series, to increase the voltage and meet an application's requirements. In addition to electricity, fuel cells produce water, heat and, depending on the fuel source, very small amounts of nitrogen dioxide and other emissions. The energy efficiency of a fuel cell is generally between40–60%, or up to 85% efficient in cogeneration if waste heat is captured for use.

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2. PARTS OF A FUEL CELL

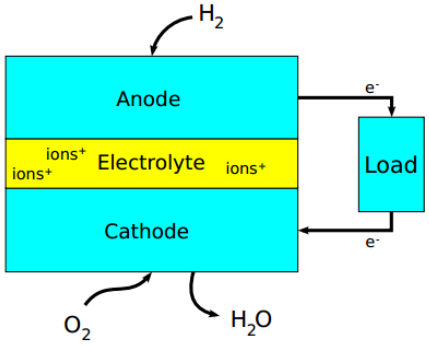

Fig 1: Parts of fuel cell

- Anode

  The negative post of the fuel cell, which conducts the electrons that are freed from the hydrogen molecules so that they can be used in an external circuit. The etched channels disperse hydrogen gas over the surface of catalyst.

- Cathode

  The Positive post of the fuel cell, Which Conducts electrons back from the external circuit to the catalyst and recombines with the hydrogen ions and oxygen to form water. The etched channels distribute oxygen to the surface of the catalyst.

- Electrolyte

  The Proton exchange membrane, which is the specially treated material and only conducts

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positively charged ions. The electrons are blocked by the membrane.

- Catalyst

The special material that facilitates reaction of oxygen and hydrogen. Usually platinum powder very thinly coated onto carbon paper or cloth. It is rough & porous maximizes surface area exposed to hydrogen or oxygen.

3. FUEL CELL OPERATION

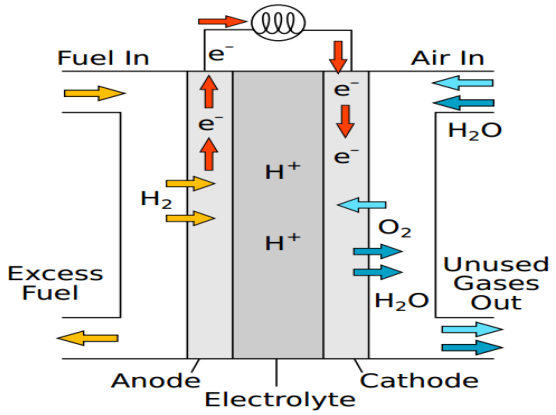

Fig 2: Operation of Fuel Cell

Pressurized hydrogen gas (H_2) enters cell on anode side. The Gas is forced through catalyst by pressure.

› When H_2 molecule comes in contacts with platinum catalyst, it splits into two H^+ ions and two electrons (e-).

Electrons are conducted through the anode

› They make their way through the external circuit (doing useful work such as turning a motor) and return to the cathode side of the fuel cell.

On the cathode side, oxygen gas (O_2) is forced through the catalyst

› Forms two oxygen atoms, each with a strong negative charge. The negative charge attracts the two H^+ ions through the membrane and Combine with an oxygen atom and two electrons from the external circuit to form a water molecule (H_2O).

4. METHODOLOGY OF HYDROGEN FUEL CELL

Fuel cells produce electrical energy by chemical reaction. While they can use such feeder fuels as alcohol, gasoline or methane, fuel cells used in spacecraft and other specialized applications use hydrogen to fuel the creation of electricity because it reacts with oxygen to produce water as a byproduct. To understand how a fuel cell works, you can build a simple fuel cell with mostly common household materials. Here are the steps to build your own fuel cell.

Material Required

- One foot of platinum coated nickel wire, or pure platinum wire. Since this is not a common household item, we carry platinum coated nickel wire
- A Popsicle stick or similar small piece of wood or plastic.
- A 9 volt battery clip.
- A 9 volt battery.
- Some transparent sticky tape.
- Beaker filled with water.
- A multi meter.

4.1 CONSTRUCTION PROCEDURE

4.1.1 STEP 1

Cut two 6-inch (15-centimeter) strip of platinum-coated nickel wire.

Fig 3: Strip of Platinum Coated Nickel Wire

4.1.2 STEP 2

Winding each wire strip around thin metal rod to shape it into a spring. The two springs will serve as the fuel cells electrodes.

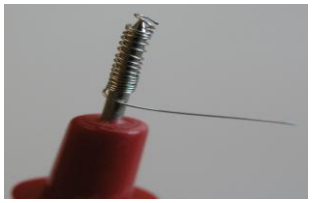

Fig 4: Winding of Platinum Wire

4.1.3 STEP 3

Attach the exposed wire ends to the electrode coils. Twist each of the battery clip leads around the end of one of the coils free.

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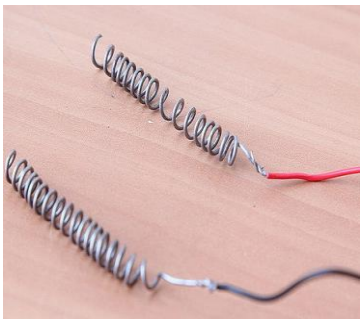

Fig 5: Attach Electrode to Insulation Wire

4.1.4 STEP 4

Tape the electrodes to a stick or dowel and lay the stick over the mouth of the beaker containing water. Connect a 9-volt battery's terminals to the battery clip to send an initial current through the wire.

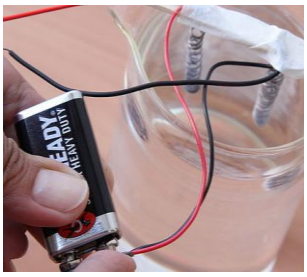

Fig 6: Immersing the Electrodes in Water

4.1.5 STEP 5

Electrolysis process for separating hydrogen molecules from the oxygen molecules present in water.

Fig 7: Electrolysis Process

4.2 FILLING METHANE GAS INTO THE CONTAINER

A known volume of scrubbed methane gas is collected in a 2 litre capacity of volumetric flask as shown in fig

Fig 8: Methane container

Volumetric flask containing methane gas is connected to a conical flask of 1 liter capacity which is filled with 200 gms of activated charcoal in order to separate the carbon content if present in methane gas as shown in figure

Fig 9: Flask filled with charcoal

4.3 CONNECTING OF FUEL CELL TO THE SETUP

Separated methane gas from carbon is passed to fuel cell as shown in figure to a Constructed Hydrogen fuel cell set up respectively.

Fig 10: Overall Setup

4.4 CONNECTING DIGITAL MULTIMETER

A multimeter is an electronic measuring instrument that combines several measurement functions in one unit.

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A typical multimeter would include basic features such as the ability to measure voltage, current and resistance. A multimeter is connected to get the output voltage reading as shown in figure

Fig 3.10: Multimeter Showing Results in Volts

The methane gas is passed to the conical flask containing activated charcoal which separates hydrogen molecules from the carbon molecules. The separated hydrogen molecules passed to the fuel cell setup where the electrolysis process takes place and the positively charged hydrogen molecules generating voltage in the multimeter.

5. RESULTS

Cycle no	Volume of methane gas passed (m^3)	Power generated (volts)
1	0.6	0.835
2	0.6	0.8
3	0.6	0.815

Table: 1 Table Showing Power Generation

The above table depicts that 0.6 m^3 of methane gas is passed to obtain a voltage of 0.835 V, 0.8 V, and 0.815 V respectively which is the maximum efficiency that can be obtained using a Hydrogen fuel cell. As per survey it is observed that hydrogen fuel cell is the cheapest and same voltage can be obtained compared to the other fuel cells.

6. CONCLUSIONS

Hydrogen can be produced in an environmentally friendly manner. Fuel cells can be developed for portable electronic devices. The cell create energy through electrochemical process, and do not burn fuel, they are fundamentally more efficient than combustion systems. A typical fuel cell produces a voltage from 0.6V to 0.8V at full rated load. A hydrogen fuel cell produces electricity without any pollution in environmental friendly manner.

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