Investigating the Efficiency of Hydrogen Fuel Cells as Alternative to Standard Batteries

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Introduction

Apparent now more than ever is the imminent global catastrophe brought about by the global demand for energy and the irresponsible means by which we have in produced it in the past and primarily produce it currently. China alone produced 500 million tons of solid waste resulting from the production of lithium ion batteries, only accounting for a fraction of global waste of this kind. For the previous decades I've been tormented by the constant warnings from the abundance of scientist which consistently appear in many forms of media. My intent is to put forth efforts of my own in order to educate myself so that maybe I may contribute to the relief of future catastrophes and suppress present worries. Potentially knowledge contained within the technology I'm about to discuss with you will prove to hold merit and attract interest from others to join the efforts as I am to resolve this unpleasant feeling of self-imposed destruction that our species is forced to face.

It is possible to produce electricity, a form of energy by which we generally have the capability of using to power any device we wish, by using hydrogen and oxygen. This can be done using a hydrogen fuel cell. In such a device oxygen is introduce into a chamber located on the anode side of the proton exchange membrane. This membrane which is commonly made from a hydrated polymer allows the hydrogen's proton to pass through it into another chambered where oxygen has been introduced. The chemical properties which explains the attraction between hydrogen and oxygen and their tendencies to form water and the pressure difference between the two chambers is what drives the hydrogen to the oxygen chamber. The hydrogen's electrons are not allowed through this membrane. Instead the electrons find an easier path traveling through the anode located on the hydrogen side of the membrane where these electron then flow through a circuit where they can do work before entering the oxygen chamber, through the cathode, where they now complete the reaction of hydrogen and oxygen to form pure water as the only product.

The ability to manage our energy needs while dealing with a minimum of toxins is the challenge that the future generations of aspiring engineers and scientists face. Broadening the applications of fuel cell technology will expand our capabilities to manage this challenge and improve the future climate of tomorrow. My intention behind this research is to identify issues that this tech currently faces when being applied to small scale consumer applications i.e. small mainly handheld devices.

Methodology

1. Several week intensive research into electrical and fuel cell fundamentals. This included learning basic concepts of electricity, history and development of fuel cells, current applications. I also found it useful to read up on current research being done around Hydrogen fuel cells.
2. Collected electrical data on fuel cell when generating electricity and when producing hydrogen while performing electrolysis of water. By comparing the energy produced by a certain volume of hydrogen to the energy required to produce that same amount I was able to calculate an efficiency percentage.
3. Compose a theoretical fuel cell to replace a power system in a typical cell phone and compare the two in value and weight.
4. Evaluated the fuel cell used for my research and determined advantages and disadvantages of using this technology in small scale application.
5. Identify challenges and problems that must be addressed and solve in order to implement micro fuel cell technology as efficient, ecological portable power system.

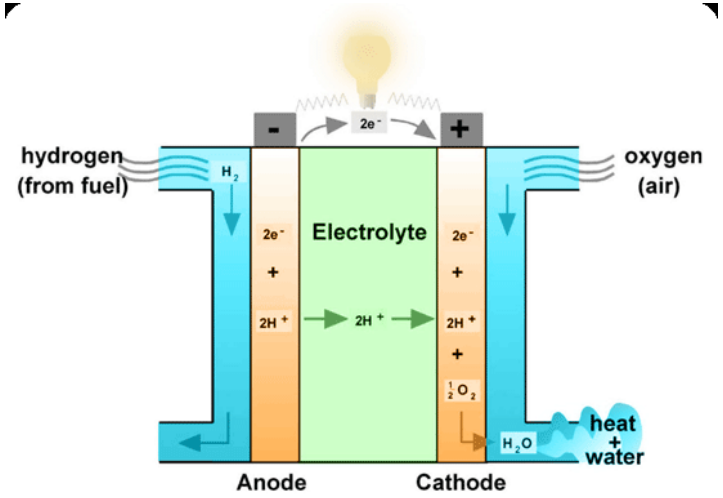

Fig. 2. Schematic of a PEM fuel cell operation. Source: World Fuel Cell Council.

Conclusion

By scaling down a fuel cell produced by a well-known automotive manufacture producing 600Wh/kg, and comparing it to the average AA alkaline battery (145Wh/kg) and the more efficient lithium ion battery (249Wh/kg) is was apparent that the fuel cell dominated its competitors in the power to weight ratio. But as I began to test the efficiency of a simple fuel cell from a kit that I ordered from online it became apparent that mass management was a major problem. In my experiments the oxygen side of the cell flooded with water and prevented any further gas exchange to occur. Developing mechanical parts capable of performing and managing micro mass flow would be a challenge and from my research hasn't had much popularity amongst researchers. An interesting thought would be to potential "grow" these microscopic mechanical elements like valves and tubing much like we do with body parts and lab grown meat.

Looking at more of the functionality of improving the design itself, the proton exchange membrane (PEM) or Polymer Electrolyte Membrane is usually made from expensive noble metals catalysts like platinum because of the acidic nature of the electrolytes within the membrane. Engineering materials or design that would reduce precious metal needs, aimed to reduce overhead of designs is necessary before this tech can be applied on a size of scale that the common battery now occupies. Much of the efficiency of the fuel cell is dependent on the level of resistance that the proton experiences while flowing through it. Again, engineering materials that can allow speedy and nearly frictionless travel for the proton while still blocking electron travel will do a great service to this technology increasing evermore an already highly efficient and clean way to meet energy demands and power portable devices responsibly..

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