Hydrogen Fuel Cells as Green Energy

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EXECUTIVE SUMMARY

To reduce reliance on fossil fuels and increase demands for clean energy technology worldwide, there is currently a growing interest in the use of fuel cells as energy-efficient and environmentally-friendly power generators. With this inevitable depletion, fossil fuels will not be able to respond to energy demand for future. Among all major types of fuel cells, hydrogen fuel cells (HFCs) are in the forefront stage and have gained substantial attention for vehicle and portable applications, which is composed of a cathode, an anode, and a PEM. The heart of the fuel cells is membrane electrode assembly (MEA). An electro-deposition technique for preparing the nano-catalyst layer in PEMFCs has been designed, which may enable an increase in the level of Pt utilization currently achieved in these systems. Functionalization process has been done using a mixture of concentrated nitric acid and sulfuric acid in refluxing condition. The hydrocarbon-based polymer membrane has been used as electrolyte part.

BACKGROUND INFORMATION

Today, when many legal restrictions are applied for environmental pollution and human health, while other technologies are increasing the cost too much, the environmental friendliness of this system is a valuable alternative.

Figure 1. Alkaline fuel cells

Anode reaction: $$2H_2 + 4OH^- \longrightarrow 4H_2O + e^- \quad (1)$$

Cathode reaction: $$O_2 + 4e^- + 2H_2O \longrightarrow 4OH^- \quad (2)$$

Overall reaction: $$2H_2 + O_2 \longrightarrow 2H_2O \quad (3)$$

Fuel cells, as highly efficient and environmentally friendly energy conversion devices, have been in the spotlight of energy research in the last few decades. Their origin can be dated back to the 19th century, when Christian F. Schonbein first discovered in 1838 that, once connected by electrodes, hydrogen and oxygen or chlorine could react to generate electricity, which is named as the polarization effect. Shortly afterwards in the 1800's Sir William Grove discovered by accident during an electrolysis experiment. When Sir William disconnected the battery from the electrolyzer and connected the two electrodes together, he observed a current flowing in the opposite direction, consuming the gases of hydrogen and oxygen. He called this device a 'gas voltaic battery'. His gas battery consisted of platinum electrodes placed in test tubes of hydrogen and oxygen, immersed in a bath of dilute sulphuric acid. It generated voltages of about one volt. In 1842 Grove connected a number of gas batteries together in series to form a 'gas chain'. He used the electricity produced from the gas chain to power an electrolyzer, splitting water into hydrogen and oxygen. However, due to problems of corrosion of the electrodes and instability of the materials, Grove's fuel cell was not practical. As a result, there was little research and further development of fuel cells for many years. Significant work on fuel cells began again in the 1930s, by Francis Bacon, a chemical engineer at Cambridge University, England. In the 1950s Bacon successfully produced the first practical fuel cell, which was an alkaline version. It used an alkaline electrolyte (molten KOH) instead of dilute sulphuric acid (Figure 1).

In the early 1960s, General Electric (GE) also made a significant breakthrough in fuel cell technology. Through the work of Thomas Grubb and Leonard Niedrach, they invented and developed the first polymer electrolyte membrane (PEM) fuel cell. It was initially developed under a program with the US Navy's Bureau of Ships and U.S. Army Signal Corps to supply portable power for personnel in the field. In 1983, Geoffrey Ballard a Canadian geophysicist, chemist Keith Prater and engineer Paul Howard established the company, Ballard Power. Ballard took the abandoned GE fuel cell, whose patents were running out and searched for ways to improve its power and build it out of cheaper materials (Brian, 2001).