ELECTRIC POWER GENERATION USING ALUMINIUM AIR FUEL CELL FOR ELECTRIC VEHICLE

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ABSTRACT

A battery is a device which converts chemical energy into electrical energy, consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric vehicles. With the continuous development of electric vehicles, the demand for electric vehicle power supply is becoming more and more urgent. In order to meet the needs of both energy and power, the hybrid power generation using aluminium air fuel cell is studied in this paper and the matching parameters are analyzed and calculated. The power generation strategy includes. The aluminium-air batteries are said to be an alternative to lithium-ion batteries offers multiple benefits such as lower cost, eco friendly, more energy-dense etc., Aluminum-air batteries generate electricity using chemical reaction of oxygen in the air with mixture of distilled water and aluminum. This chemical reaction based electricity generations supports the robust design with socio-economical benefit. The comprehensive research work on the design of these Aluminium-air batteries may extend multiple applications.

KEYWORDS*: Power Generation, Aluminium, Fuel Cells, Air Cathode, Battery.*

1. INTRODUCTION

Nowadays, automobiles have gradually been household necessities around the world. Due to the environmental impact of the petroleum-based transportation infrastructure, more and more people pay their attention to an electric transportation infrastructure - electric vehicles (EVs). EVs first came into existence in the 19th century, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. But the process of development of EVs did not run smoothly. It has many bottleneck problems. The short driving range is one of them. With the development of advanced batteries, more and more new batteries emerged. Among them, Aluminum air fuel cells have higher energy capacity than most other practical batteries, and it is an effective way to extend the driving range of the electric vehicle. But the downside of the aluminum air fuel cell is low specific power. So the single Aluminum air fuel cell cannot be used as the driving power of the EVs. Along with the development of research on modern electronics, Super capacitors have been found with some good performance of high specific power, fast charge and discharge, and it could be used as an auxiliary power supply of Aluminum air fuel cell.

2. PROBLEMSTATEMENT

During the last few decades, environmental impact of the petroleum-based transportation infrastructure, along with the fear of peak oil, has led to renewed interest in an electric transportation infrastructure. Internal combustion engines create air pollution by releasing primary pollutants directly into the atmosphere and by releasing direct emissions that create secondary pollution when they react chemically with elements of the atmosphere. The vapors given off when gasoline evaporates and the substances produced when gasoline is burned (carbon monoxide, nitrogen oxides, particulate matter, and unburned hydrocarbons) contribute to air pollution. Burning gasoline also produces carbon dioxide, a greenhouse gas.

3.OBJECTIVES

To design a hardware model using electrochemical reaction between air cathode, salt water and aluminium anode. Aluminium–air batteries are primary cells, i.e., non-rechargeable. Once the aluminium anode is consumed by its reaction with atmospheric oxygen at a cathode immersed in a water-based electrolyte to form hydrated aluminium oxide, the battery will no longer produce electricity. However, it is possible to mechanically recharge the battery with new aluminium anodes made from recycling the hydrated aluminium oxide. Such recycling would be essential if aluminium–air batteries were to be widely adopted. Aluminium-powered vehicles have been under discussion for some decades. Hybridisation mitigates the costs, and in 1989 road tests of a hybridised aluminium–air/lead–acid battery in an electric vehicle were reported.

4. AIR CATHODE

The cathode material most frequently used in this type of battery is carbon. The names of air cathode batteries typically come from the metal that comprises the anode side of the battery combined with the air cathode itself. For example, lithium or Li-air batteries have a lithium anode, and zinc or Zn-air batteries contain zinc anodes; both have a carbon-based air cathode. Air cathodes are generally positive, though they absorb oxygen as a potential power source; they emit the byproduct of the chemical reaction as electrical current. In this electrode, the main subject to analyze is the increase of the speed of the reaction in both directions, during the reduction of the oxygen (discharge) and during the oxidation of water to evolve again that gas (charge). The cathode derives oxygen used to initiate the reaction from the air or from an aqueous solution. Manufacturers refer to these types of power sources as air batteries.

Figure 1: Activated Carbon(Cathode)

5. SALT WATER ELECTROLYTE

The material used between cathode and anode is electrolyte. Where in the molecules react with the ions of the anode to generate an electrical current. A saltwater battery is a type of battery which involves salt and water as its electrolyte. Unlike traditional batteries, saltwater batteries are non-flammable and do not pollute as much. This makes them an eco-friendly energy storage solution. In saltwater batteries, a liquid solution of salt water is used to capture, store, and eventually discharge energy. Whereas a traditional lithium-ion battery uses the element lithium as its primary ingredient for conducting electricity, a saltwater battery uses sodium, the same element found in table salt.

Figure 2: Salt Water Electrolyte

6.ALUMINIUM ANODE

Aluminium Anode is a type of anode that can be used safely in all types of water. It has very high current capacity which makes it very attractive in terms of cost and weight saving. It is highly recommended for use in low resistivity applications. The oxidation reaction of the Aluminum in discharge creates some compounds which passivate the surface of the electrode and some others which are dissolved in the electrolyte. For the reversibility of this reaction we need to influence in some Aluminum additives with some other metals to allow patterns in the electrode to reduce the oxidized species in a reversible way and to add some compounds to the electrolyte for facilitating the deposit of the dissolved species in the electrode surface again and with the same morphological structure.

Figure 3: Aluminium(Anode)

7.METHODOLOGY

Batteries convert chemical energy into electrical energy. They have two electrodes—called a cathode and an anode—where chemical reactions that either use or produce electrons take place. The electrodes are connected by a solution—called an electrolyte—through which ions can move, completing an electrical circuit. In this activity, the salt provides ions that can move through the wet paper towel and transfer charge. To generate electrical energy, this battery relies on oxidation of aluminum at the anode, which releases electrons, and a reduction of oxygen at the cathode, which uses electrons. The movement of electrons through an external circuit generates an electric current that can be used to power simple devices. A diagram of the battery and equations for the half and overall reactions are given.

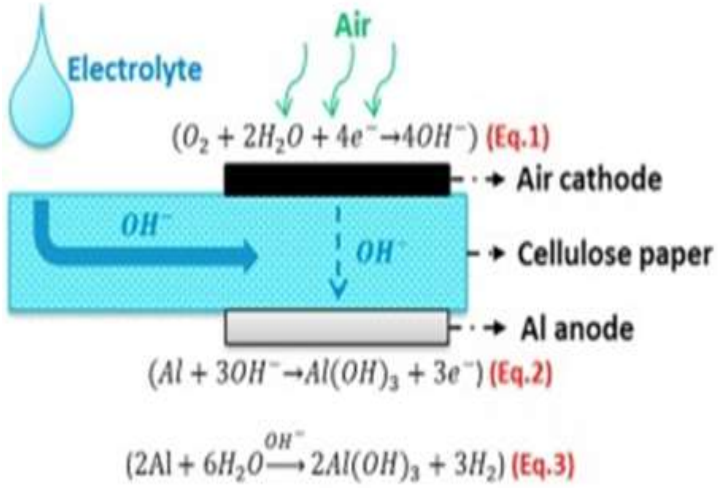

Figure 3: Aluminium-Air Battery Schematic Diagram

8.EXPERIMENTAL RESULT

Model-1 Observations

The voltage and current readings of 6 aluminium cells noted in the absence of air and in the presence of air are compared and represented in the below table.

Test Cases	Activated Carbon(Cathode)	Salt Water(Electrolyte)	Aluminium(Anode)	Voltage	Current
Case-1(In the absence of air)	60gms	65ml	60gms	0.6V	1.5ma
Case-2(In the presence of air)	60gms	65ml	60gms	0.8V	2.0ma

Table 1: Comparision of aluminium cells in the absence of air and in the presence of air

The above table comprises the quantity of the materials used, voltage and current. The cell prepared with 60gms of activated carbon, 65ml of salt water, and 60gms of aluminium foil gives 0.6V and 2.0ma in the absence of air. Whereas the same quantity of the materials mentioned above gives the increased voltage 0.8V and 0.05A in the presence of air.

Voltage Observation:

The prototype battery which we made is tested. A single cell produced 0.8V at an instant. After few minutes it produced the voltage up to 1.5V.

Figure.4:Voltage at starting in the Absence of air

Figure 5:Increase in voltage in the presence of air

Current Observation:

- The prototype battery which we made is tested. The cells produced 0.6v with the current reading of 1.5ma. In the presence of air, the voltage is increased to 0.8v in the addition to it the current has increased to 2ma.
- It is observed that the voltage and current readings are increased when the cells are exposed to air.

Figure 6: Current at starting in the Absence of air

Figure 7: Increase in current in the presence of air

Model-2 Observation

The voltage and current readings of 6 aluminium cells noted in the absence of air and in the presence of air are compared and represented in the below table.

Test Cases	**Activated Carbon (Cathode)**	**Salt Water (Electrolyte)**	**Aluminium (Anode)**	**Voltage**	**Current**
Case-1(In the absence of air)	90gms	95ml	90gms	3V	3ma

Case-2(In the presence of air)	90gms	95ml	90gms	6V	5ma

Table 2: Comparision of aluminium cells in the absence of air and in the presence of air

The above table comprises the quantity of the materials used, voltage and current. The cell prepared with 90gms of activated carbon, 95ml of distilled water, 90gms of aluminium foil gives 3V and 3.0ma in the absence of air. Whereas the same quantity of the materials mentioned above gives the increased voltage 6V and 5.0ma in the presence of air.

Voltage Observation:

- The prototype battery which we made is tested. The cells produced 3V at an instant. After few minutes it produced the voltage up to 6V in the presence of air.

Figure 8: Voltage at starting in the Absence of air

Figure 9: Increase in voltage in the presence of air

Current Observation:

- The prototype battery which we made is tested. The cells produced 3v with the current reading of 3ma. In the presence of air, the voltage is increased to 6v in the addition to it the current has increased to 5ma.
- It is observed that the voltage and current readings are increased when the cells are exposed to air.

Figure 10: Current at starting in the Absence of air

Figure 11: Increase in current in the presence of air

9.CONCLUSION

The Al–air battery has proven to be very attractive as an efficient and sustainable technology for energy storage and conversion with the capability to power large electronic devices and vehicles. This review has summarized recent developments of Al anode, air cathode, and electrolytes in Al–air batteries.

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