Low Pollution Emission to Purify Fuel Cell Technology Comprehensively: A Review

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Abstract

In recent decades, scientists have been urged to build the new energy resources by depleting fossil fuel, high-energy demand and pollution. Being one of the principal alternative power devices, Thanks to the high energy conversion efficiency, the fuel cells have attracted growing attention, simple operation and low pollution emissions. This paper surveys the historical backdrop of the power devices, the energy unit activity, and sorts of energy units, their points of interest, inconveniences and applications.

Keywords: *toxicity; Fuel cells, Energy resources, High-energy efficiency, easy to convert operation, Low pollution emission.*

Introduction

Energy is the most necessary to rise for every nation on this planet and energy usage per capita is steadily growing. The energy security, economic growth and protection of the ecosystem are the national energy policies of the countries [(1)]. The rapid increase of energy consumption, the fossil fuel depletion and the rising of greenhouse gas emission have led to an energy security issue over the worldwide. During the last decades, scientists and researchers have made efforts to find solutions for these problems by utilizing more efficient and effective power generation systems and finding cleaner and renewable energy sources [(2, 3)]. In line with energy generation systems development; the cogeneration systems, and produce the power heat, have been received much attention. The history of cogeneration technology comes back to 1977 when the coal and oil were used as the fuels, but with increasing the fuel price, it became gloomy[(4)]. However, this technology became more popular in the last decade on finding out new, renewable, clean and economical Energy sources like thermal photovoltaic Panels, Stirling engines and fuel cell. Among these systems, fuel cells are among the most suitable devices that can produce continuous electricity and heat. Energy is an instrument that changes directly from a vessel's vitality to electrical energy. The one-step conversion process has several advantages compared to the multi-step processes, which are engaged with burning based warmth engines. The combustion-based energy generation systems are very harmful to the eco-system and they are contributed to many environmental problems, for example, environmental change, acidic rains, ozone layer depletion and vegetation cover reduction. Also, combustion-based energy generation technologies are dependent on limited sources of fossil fuels. Then again, Give efficient and clean fuel cells way for converting energy. Also, energy components are perfect with renewable sources such as hydrogen. Therefore, they are promising candidates as the energy conversion devices in the future[(5)]. The operation of the fuel cells is quiet and they can replace by and wide with traditional power generation equipment such as portable, stationary and power generation for transportation. Nevertheless, further looks into are required to decrease the fuel cell costs, increase their durability and enhance their performance. A proper understanding of the operation principles of the module power in conjunction with the current condition perspective of the module power industry necessary for overcoming the problems and the development of fuel cell technology. This paper gives the standards of the force module activity, attributes, points of interest, types and zones of utilizations.

Fuel cell history

The main logical research on the power module was led in 1838 by the Swiss-German researcher Christian

Frank Schonbein [6]. In 1839, Sir William Robert Grove built up the principal energy component dependent on the turning around electrolysis of water by drenching two platinum terminals in a sulphuric corrosive arrangement[7]. At the point when he associated the two terminals, the present streaming the other way expended the oxygen and hydrogen gases, thus, considered this a Battery for Gas. Fig. 1 shows the Grove's gas battery. Ludwig Mond invested the vast majority of his energy for creating mechanical science innovation. In 1889, Mond and his associates, Car Langer presented a procedure for getting ready nickel by utilizing a battery for gas [8]. Friedrich Wilhelm Ostwald photographed the interconnections between various parts of the power unit including electrolyte, cathode, oxidation, cations, and anions, and that was in 1893. [9]. In 1896, William W. Jacques developed the principal down to earth energy component[10]. The artistic energy units came later with the revelation of strong oxide electrolytes by Nernst in 1899 [11] and 1900, he utilized zirconium as the strong electrolyte. The primary clay energy component was worked at 1000 °C in 1937 by Baur and Preis[12]. Francis Bacon at Cambridge University at that point delivered the initial 5 kW soluble energy unit in 1950[13]. During the 1960s the International energy units built up an energy unit power plant to create power and water for the drink apollo shuttle the excursion towards the moon. At that point, the International energy components built an all the more impressive (12 kW) soluble power module for NASA's space transport Orbiter during the 1970s[14]. Fig. 2 speaks to NASA's space transport Orbiter power device. In the mid-1980s, the United States of America, Canada, and Japan supported creative energy unit research[15]. In 1990, Ballard put its energy units into a progression of model transports. In the late 1990s, six Ballard-constructed energy component means of transport were utilized in Chicago and Vancouver. Today, energy units are regular in spaceflight, transportation, versatile force, home force age and enormous force age.

Fuel cell structure

Any kind of energy component needs three essential segments that are[1]:

1-Anode: anode is a permeable material that permits hydrogen fuel to enter in contact with the electrolyte and it disperses the hydrogen similarly over its surface without it is devoured or eroded.

2-Cathode: cathode permits oxygen to enter in contact with the electrolyte and scatters oxygen onto its surface without itself is expended or eroded.

3-Electrolyte: The principle part of any energy unit is the electrolyte. The electrolyte, for example, phosphoric corrosive, strong oxide or polymer decides the nature, attributes and temperature working of the energy unit and it is utilized to forestall the electronic contact of the two terminals by hindering the electrons. Additionally, electrolyte permits the relocation of particles from one anode to the next to keep the parity of the general electrical charge.

Fuel cell operating standards

The starting unit for fuel cells is an electrochemical device which converts from synthetic biofuel cells to electric biofuel cells. Any fuel can be utilized in power modules, however, from the outset, it should pass a reformer to frame unadulterated hydrogen[16]. The energy component is like a battery, anyway in battery reactants are put away inside and when they are utilized, the battery must be supplanted or revived. In contrast to the battery, in a power device, the reactants, which are expended during the electrochemical responses, are consistently renewed so that there is no compelling reason to energize the phone. A power device is a galvanic cell where the free vitality of a synthetic response is changed over into electrical vitality. The difference in the Gibbs free vitality of a compound response is identified with the voltage of the cell through the accompanying connection:

$$\Delta G = \pm nFE \quad (1)$$

In which n is the electron number engaged with the response, And (F(is the Faraday constant, (E) is the cell voltage for the thermodynamic balance without current [17]. The activity of an energy component has appeared in Fig. 3[18]. A power device is made out of a layer of electrolyte in contact with two cathodes on either side. The two cathodes comprise of a permeable material, which is secured with an impetus layer. The hydrogen fuel is taken care of persistently to the air anode and oxygen are taken care of consistently to the cathode. At the anode, hydrogen is oxidized to hydrogen particles

and electrons. Electrolyte layer allows the hydrogen particles to spill out of anode to cathode and the electrons move To the cathode by an electric circuit outside. The electrons and hydrogen at the cathode particles respond With the oxygen used to frame the air. Anode and cathode reactions are given and the general reaction is as follows:

Anode reaction:

$H_2 \rightarrow 2H^+ + 2e^-$ (2)

Cathode reaction:

$1/2\ O_2 + 2H^+ + 2e^- \rightarrow H_2O$ (3)

Overall reaction:

$H_2 + 1/2\ O_2 \rightarrow H_2O + W_{ele} + Q_{heat}$ (4)

heat and water are by-products and they must be removed continuously for the ideal generation of electrical energy. Therefore, thermal and water management is a key factor in fuel cell design and operation.

Fuel sources

The fuel cells used must contain hydrogen but most of them also contain carbon. Some fuel cells reform the fuel to produce the pure hydrogen but some automatically reform the fuel. These outlets include:

• Methane: gas drilling, rubbish decay, sewage or gas hydrates

• Methanol/ethanol: Natural gas or biomass hydrolysis

• Hydrogen: electric dissociation of water molecules through the use of solar cells that dissociate molecules from light.

Hydrogen sources and methods of production

Note that hydrogen good competitor for replacing petroleum derivatives to create vitality. Hydrogen can be gotten from a wide scope of sources, including biomass, petroleum derivatives, electrolysis of water and a portion of the mechanical side-effects. The decision of the source relies upon the various variables including the area of assets, accessible stores, cost of creation, transportation and usage. The strategy which is utilized for creating hydrogen from the source relies upon the improvement of innovation, required foundation venture, the proficiency of the technique, area and reasonableness of provisions.

Co-generation heat & strength

The simultaneous use of the heat and electricity which are produced in Co-generation is called the energy conversion method. Such energy use is more efficient than electricity use alone since heat is generated considerably in most systems. The utilize of the produced heat for generating more power from a gas or steam turbine or to store heat and warm water in the plant raises efficiency overall the energy conversion system as follows:

$E_{overall} = Q + E/Q_0$

Where Q is the usable heat energy, E is the electrical energy and Q_0 is the fuel heat material. This type of energy conversion is applicable in fuel cell technology since they can generate heat depending on the system at different temperature ranges. Especially, co-generation can be used for providing electricity and heat at homes[19].

Important Reactions

Oxidation of hydrogen

The reaction of hydrogen atoms to oxidation occurs outside Pt-based impetuses. The hydrogen oxidation energy is quick at the platinum surface and it is typically constrained by the mass exchange restrictions in a power device. The oxidation response of hydrogen includes the gas adsorption particles on the impetus surface field, which is trailed the separation of hydrogen atoms and electrochemical response as follows:

$2\ Pt_{(s)} + H_2 \rightarrow Pt\text{-}H_{ads} + Pt\text{-}H_{ads}$ (5)

$Pt\text{-}H_{ads} \rightarrow H^+ + e^- + Pt_{(s)}$ (6)

The adsorbed H-atom at the Pt surface where Pt(s) are in the free surface of Pt and Pt-Had. The overall reaction is:

$H_2 \rightarrow 2H^+ + 2e^-\ U^0 = 0V$ (7)

Even though the oxidation response of hydrogen is quick at the outside of the Pt impetus, there are a few issues when the unclean hydrogen is utilized. The

unadulterated hydrogen is costly and hard to store. Normal sources, for example, petroleum gas, propane and alcohols are the best wellsprings of unadulterated hydrogen. However, these materials need to be reformed into hydrogen and sometimes after reforming the gas some contaminants are still present in the fuel, such as carbon monoxide. Carbon monoxide (CO) poisons the catalyst surface through blocking the active sites. As of late, a few investigations have been done to Boost the strength of Pt-based impulses by alloying platinum with the second metal[20, 21].

Oxidation of methanol

Thanks to the superior strength density, Methanol is among the most common promising candidates for fuel; high activity and nearly complete electrooxidation to the final product of CO_2 [22]. To date, platinum has been wildly used as a powerful anodic catalyst for electrooxidation of methanol[23]. Many studies have been carried out on the methanol fuel cells in the literature[24, 25].

The overall methanol oxidation reaction is to:

$$CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^- \; U^0 = 0.046 \text{ V} \quad (8)$$

Conclusion

Fuel cells are energy storage devices, which are simple, efficient and environmentally friendly. These properties make a range for a wide of applications for fuel cells. Fuel cells have the real potential as a promising technology from which electricity can be produced with harmless by-products. With increasing the energy demand, it becomes urgent to find new ways of meeting it safely. In the past, the limiting factors of renewable energy were the storage and transport of that energy. With using the fuel cells, electrical energy can be generated efficiently, cleanly and sustainably from renewable energy sources.

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