IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9736

Fuel cell and their types

Miss Niyati Patel[1], Prof Vishal V. Mehtre[2]

Student, Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be) University College of Engineering, Pune, Maharashtra, India[1]

Assistant Professor, Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be) University College of Engineering, Pune, Maharashtra, India[2]

Abstract: As we know, the new generation is only relying on electricity and their storage devices like batteries, cell etc. so this paper is reviewing fuel cell and their types that's help us in the future. A fuel cell is an electrochemical cell that convert chemical energy intoelectricity energy through chemical reaction like redox and oxidation reaction. Fuel cells are different from most of the batteries in requiring a continuous source of fuel and oxygen to sustain the chemical reaction, whereas in a battery the chemical energy usually comes from metals and their ions or oxidesthat are commonly already present in the battery, except in flowbatteries. Fuel cells continually produce energy if oxygen is provide to fuel cell.

1. INTRODUCTION:

There are many types of fuel cells, but they all consist of anodeand cathode, and an electrolyte that allows ions, often positively charged hydrogen ions, to move between the two sides of the fuel cell. At the anode a catalyst causes the fuel to undergo oxidation reactions that generate ions (often positively charged hydrogen ions) and electrons. The ions move from the anode to the cathode through the electrolyte. At the same time, electrons flow from the anode to the cathode through an external circuit, producing direct current electricity. At the cathode, another catalyst causes ions, electrons, and oxygen to react, forming water and possibly other products. Fuel cells are classified by the type of electrolyte they use and by the difference in start-up time ranging from 1 second for proton-exchange membrane fuel cells (PEM fuel cells, or PEMFC) to 10 minutes for solid oxide fuel cells (SOFC). A related technology is flow batteries, in which the fuel can be regenerated by recharging. Individual fuel cells produce relatively small electrical potentials, about 0.7 volts, so cells are placed in series, to create sufficient voltage to meet an application's requirements.[4] 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 between 40 and 60%; however, if waste heat is captured in a cogeneration scheme, efficiencies of up to 85% can be obtained.

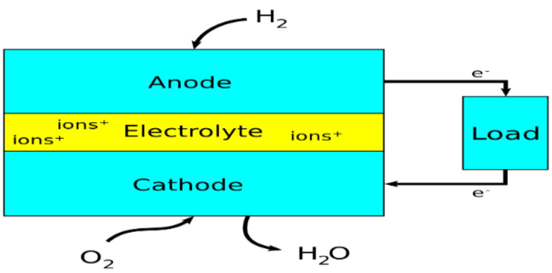

Figure1

2.Types of fuel cell:

Fuel cells come in many varieties; however, they all work in the same general manner. They are made up of three adjacent segments: the anode, the electrolyte, and the cathode. Two chemical reactions occur at the interfaces of the three different segments. The net result of the two reactions is that fuel is consumed, water or carbon dioxide is created, and an electric current is created, which can be used to power electrical devices, normally referred to as the load.

IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9736

At the anode a catalyst oxidizes the fuel, usually hydrogen, turning the fuel into a positively charged ion and a negatively charged electron. The electrolyte is a substance specifically designed so ions can pass through it, but the electrons cannot. The freed electrons travel through a wire creating the electric current. The ions travel through the electrolyte to the cathode. Once reaching the cathode, the ions are reunited with the electrons and the two react with a third chemical, usually oxygen, to create water or carbon dioxide.

(I) Proton-exchange membrane fuel cells (PEMFCs):

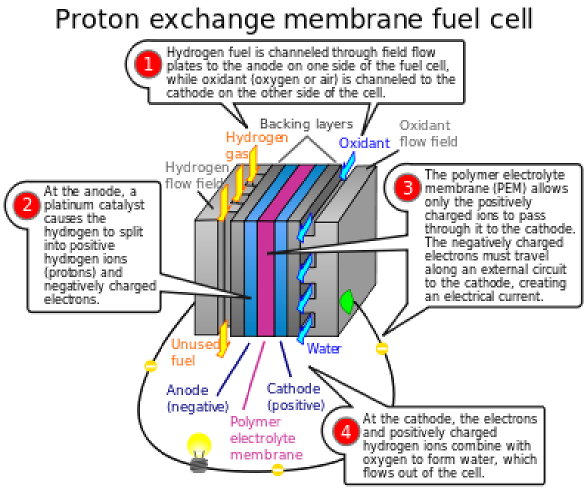

Figure 2

In the archetypical hydrogen–oxide proton-exchange membrane fuel cell design, a proton-conducting polymer membranecontains the electrolyte solution that separates the anode and cathode sides. The proton-exchange mechanism was well understood.On the anode side, hydrogen diffuses to the anode catalyst where it later dissociates into protons and electrons. These protons often react with oxidants causing them to become what are commonly referred to as multi-facilitated proton membranes. The protons are conducted through the membrane to the cathode, but the electrons are forced to travel in an external circuit (supplying power) because the membrane is electrically insulating. On the cathode catalyst, oxygen molecules react with the electrons (which have travelled through the external circuit) and protons to form water.In addition to this pure hydrogen type, there are hydrocarbon fuels for fuel cells, including diesel, methanol (see: direct-methanol fuel cells and indirect methanol fuel cells) and chemical hydrides. The waste products with these types of fuel are carbon dioxide and water. When hydrogen is used, the CO_2 is released when methane from natural gas is combined with steam, in a process called steam methane reforming, to produce the hydrogen. This can take place in a different location to the fuel cell, potentially allowing the hydrogen fuel cell to be used indoors—for example, in fork lifts.

(II) Phosphoric acid fuel cell (PAFC)

In these cells phosphoric acid is used as a non-conductive electrolyte to pass positive hydrogen ions from the anode to the cathode. These cells commonly work in temperatures of 150 to 200 degrees Celsius. This high temperature will cause heat and energy loss if the heat is not removed and used properly. This heat can be used to produce steam for air conditioning systems or any other thermal energy consuming system.[38] Using this heat in cogeneration can enhance the efficiency of phosphoric acid fuel cells from 40 to 50% to about 80%. Phosphoric acid, the electrolyte used in PAFCs, is a non-conductive liquid acid which forces electrons to travel from anode to cathode through an external electrical circuit. Since the hydrogen ion production rate on the anode is small, platinum is used as catalyst to increase this ionization rate.

A key disadvantage of these cells is the use of an acidic electrolyte. This increases the corrosion or oxidation of components exposed to phosphoric acid.

IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9736

(III) Solid acid fuel cell (SAFC)

Solid acid fuel cells (SAFCs) are characterized by the use of a solid acid material as the electrolyte. At low temperatures, have an ordered molecular structure like most salts. At warmer temperatures (between 140 and 150 °C for $CsHSO_4$), some solid acids undergo a phase transition to become highly disordered "super protonic" structures, which increases conductivity by several orders of magnitude. The first proof-of-concept SAFCs were developed in 2000 using caesium hydrogen sulphate ($CsHSO_4$).Current SAFC systems use caesium dihydrogen phosphate (CsH_2PO_4) and have demonstrated lifetimes in the thousands of hours.[41]

(IV) Alkaline fuel cell (AFC)

The alkaline fuel cell or hydrogen-oxygen fuel. It was used as a primary source of electrical energy in the Apollo space program.The cell consists of two porous carbon electrodes impregnated with a suitable catalyst such as Pt, Ag,etc. The space between the two electrodes is filled with a concentrated solution of KOH or NaOH which serves as an electrolyte. H_2 gas and O_2 gas are bubbled into the electrolyte through the porous carbon electrodes. Thus, the overall reaction involves the combination of hydrogen gas and oxygen gas to form water. The cell runs continuously until the reactant's supply is exhausted. This type of cell operates efficiently in the temperature range 343–413 K and provides a potential of about 0.9 V. AAEMFC is a type of AFC which employs a solid polymer electrolyte instead of aqueous potassium hydroxide (KOH) and it is superior to aqueous AFC.

3. APPLICATION OF FUEL CELLS:

(A) Automobiles:

By year-end 2019, about 18,000 FCEVs had been leased or sold worldwide.Three fuel cell electric vehicles have been introduced for commercial lease and sale: the Honda Clarity, Toyota Mirai and the Hyundai ix35 FCEV. Additional demonstration models include the Honda FCX Clarity, and Mercedes-Benz F-Cell. As of June2011 demonstration FCEVs had driven more than 4,800,000 km (3,000,000 mi), with more than 27,000 refuelling's. Fuel cell electric vehicles feature an average range of 314 miles between refuelling's.They can be refuelled in less than 5 minutes. The U.S. Department of Energy's Fuel Cell Technology Program states that, as of 2011, fuel cells achieved 53–59% efficiency at one-quarter power and 42–53% vehicle efficiency at full power, and a durability of over 120,000 km (75,000 mi) with less than 10% degradation. In a 2017 Well-to-Wheels simulation analysis that "did not address the economics and market constraints", General Motors and its partners estimated that per mile travelled, a fuel cell electric vehicle running on compressed gaseous hydrogen produced from natural gas could use about 40% less energy and emit 45% less greenhouse gasses than an internal combustion vehicle.[104]

In 2015, Toyota introduced its first fuel cell vehicle, the Mirai, at a price of $57,000.Hyundai introduced the limited production Hyundai ix35 FCEV under a lease agreement.[106] In 2016, Honda started leasing the Honda Clarity Fuel Cell.[107] In 2020, Toyota introduced the second generation of its Mirai brand, improving fuel efficiency and expanding range compared to the original Sedan 2014 model.

(B). Portable power systems

Portable fuel cell systems are generally classified as weighing under 10 kg and providing power of less than 5 kW.The potential market size for smaller fuel cells is quite large with an up to 40% per annum potential growth rate and a market size of around $10 billion, leading a great deal of research to be devoted to the development of portable power cells.Within this market two groups have been identified. The first is the micro fuel cell market, in the 1-50 W range for power smaller electronic devices. The second is the 1-5 kW range of generators for larger scale power generation.

Fuel cells for use in larger scale operations also show much promise. Portable power systems that use fuel cells can be used in the leisure sector, the industrial sector i.e. power for remote locations including gas/oil wellsite's, communication towers, security, weather stations), and in the military sector. SFC Energy is a German manufacturer of direct methanol fuel cells for a variety of portable power systems.Ensol Systems Inc. is an integrator of portable power systems, using the SFC Energy DMFC.The key advantage of fuel cells in this market is the great power generation per weight. While fuel cells can be expensive, for remote locations that require dependable energy fuel cells hold great power. For a 72-h excursion the comparison in weight is substantial, with a fuel cell only weighing 15 pounds compared to 29 pounds of batteries needed for the same energy.

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

IJIREEICE

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9736

REFERENCES:

1. Saikia, Kaustav; Kakati, Biraj Kumar; Boro, Bibha; Verma, Anil (2018). "Current Advances and Applications of Fuel Cell Technologies". Recent Advancements in Biofuels and Bioenergy Utilization. Singapore: Springer. pp. 303–337. doi:10.1007/978-981-13-1307-3_13. ISBN 978-981-13-1307-3.

2. ^ Khurmi, R. S. (2014). Material Science. S. Chand & Company.

3. ^ Schmidt-Rohr, K. (2018). "How Batteries Store and Release Energy: Explaining Basic Electrochemistry", J. Chem. Educ., **95**: 1801–1810. https://doi.org/10.1021/acs.jchemed.8b00479

4. ^ Nice, Karim and Strickland, Jonathan. "How Fuel Cells Work: Polymer Exchange Membrane Fuel Cells". How Stuff Works, accessed 4 August 2011

5. ^ Jump up to:[a b c d e f g h i] "Types of Fuel Cells" Archived 9 June 2010 at the Wayback Machine. Department of Energy EERE website, accessed 4 August 2011

6. ^ Prabhu, Rahul R. (13 January 2013). "Stationary Fuel Cells Market size to reach 350,000 Shipments by 2022". Renew India Campaign. Archived from the original on 8 March 2019. Retrieved 14 January 2013.

7. ^ "Mr. W. R. Grove on a new Voltaic Combination". The London and Edinburgh Philosophical Magazine and Journal of Science. 1838. doi:10.1080/14786443808649618. Retrieved 2 October 2013.

8. ^ Grove, William Robert (1839). "On Voltaic Series and the Combination of Gases by Platinum". Philosophical Magazine and Journal of Science. **XIV** (86–87): 127–130. doi:10.1080/14786443908649684.

9. ^ "On the Voltaic Polarization of Certain Solid and Fluid Substances" (PDF). The London and Edinburgh Philosophical Magazine and Journal of Science. 1839. Archived from the original (PDF) on 5 October 2013. Retrieved 2 October 2013.

