Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 01, January-2022

Review Paper on Fuel Cell Technology

Prem Gajjar[1]
Student
Department of Mechanical Engineering,
LDRP-ITR Gandhinagar, India.

Priyanshu Jha[2]
Student
Department of Mechanical Engineering,
LDRP-ITR Gandhinagar, India.

Dhruvil Jadawala[3]
Student
Department of Mechanical Engineering,
LDRP-ITR Gandhinagar, India.

Umar Valiullah[4]
Student
Department of Mechanical Engineering,
LDRP-ITR Gandhinagar, India.

***Abstract*: - The increase in greenhouse gas emission through various means has resulted our world in advancing towards irreversible climate changes, which poses a great threat to the survival of mankind. It has been well established that we would require a new renewable fuel source to help our home planet rejuvenate. This project aims to demonstrate the use and efficiency of hydrogen fuel cell in place of conventional petroleum products. It can offer the prospect of supplying the world with clean, sustainable electrical power to overcome the increase in pollution and greenhouse gases. This review shows that challenges around cost and performance remain, and considerable improvements are still required fro hydrogen fuel cell truly competitive. But such competitiveness in the medium-term future no longer seems an unrealistic prospect, which fully justifies the growing interest and policy support for these technologies around the world.**

Keywords: - Electrolytes, Proton Exchange Membrane Fuel cell, AC Charges, DC Charges

INTRODUCTION

Although Hydrogen fuel cell technology has been invented in 19th century, not much work has been done in this field compared to I.C. Engine and EV's. Along with rise of EV Hydrogen fuel cell technology will be next game changer in field of renewable energy sources. Fuel Cells come in many varieties; however they all work in the same manner. They are made up of three adjacent segments: the anode, 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 current devices, normally referred to as the load.

HISTORICAL BACKGROUND OF HYDROGEN FUEL CELL

Due to abundance availability of hydrogen in the world and universe, it has drawn attention of scientist and industrialist toward it.Research has been going on to extract energy from hydrogen since start of the 20th century to power prime movers and machines but not much success has been achieved.Various space agencies like NASA has been using hydrogen to power their satellites and space capsules. In 1932, English engineer Francis Thomas Bacon successfully developed a 5-kW stationary fuel cell. The alkaline fuel cell (AFC), also known as the Bacon fuel cell after its inventor, is one of the most developed fuel cell technologies, which NASA has used since the mid-1960s. In the 1920s, fuel cell research in Germany paved the way for the development of the carbonate cycle and solid oxide fuel cells of today. In October of 1959, Harry Karl Ihrig, an engineer for the Allis - Chalmers Manufacturing Company, demonstrated a 20-horsepower tractor that was the first vehicle ever powered by a fuel cell.There are still issues with hydrogen-fueled engines and power plants. Transport, storage and safety problems need to be addressed.

CLASSIFICATION OF FUEL CELLS

Fuel cells are classified primarily by the kind of electrolyte they employ. This classification determines the kind of electro-chemical reactions that take place in the cell, the kind of catalysts required, the temperature range in which the cell operates, the fuel required, and other factors. These characteristics, in turn, affect the applications for which these cells are most suitable. There are several types of fuel Cells currently under development, each with its own advantages, limitations, and potential applications.

APPLICATION OF FUEL CELL

Fuel cells have been researched and developed for use in several applications since the early 1990's. Fuel cells can be used for portable, backup, transportation, and stationary power applications. This article briefly describes some of these uses for fuel cells.

PORTABLE POWER

Portable fuel cells are lightweight, long-lasting, portable power sources that prolong the amount of time a device can be used without recharging. In comparison, secondary (rechargeable) batteries have battery charger systems that consist of AC chargers that require an outlet to be charged or DC chargers that will recharge your batteries from other batteries. Rechargeable batteries are not practical for certain portable and military electronic applications because they can be heavy and not meet the power requirements. Some portable fuel cell applications include laptops, cellular phones, power tools, military equipment, battery chargers, unattended sensors, and unmanned aerial and underwater vehicles. A notable difference between rechargeable batteries and fuel cells is that a fuel cell needs

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 01, January-2022

a continuous supply of fuel. Some fuel types that have been used with fuel cells include metal hydrides, methanol, formic acid, ethanol, and of course, hydrogen. For portable fuel cells, methanol and ethanol can be supplied to the fuel cell as fuel or a fuel reformer can also be attached to the fuel cell package.

BACKUP POWER

Backup power systems provide power when the primary power source is disrupted. Fuel cells used for backup power come in many sizes and types and typically use hydrogen as their fuel. Backup fuel cells can be commercialized more quickly than other fuel cells because they do not depend on upon the implementation of a hydrogen infrastructure. Some backup power applications include computer systems, manufacturing facilities, homes, and utility substations. The PEM fuel cell with compressed hydrogen fuel is the most popular fuel cell type used for backup power applications. There are many fuel options available such as compressed hydrogen, liquid hydrogen, propane, natural gas as well as many other fuel types. An electrolyzer system is a good option for backup power applications because it can produce hydrogen on demand. The electrolyzer can be used with electricity generated by solar panels, a wind source, a nuclear source or electricity generated by the local power company.

TRANSPORTATION APPLICATIONS

Fuel cells can be used for many transportation applications including automobiles, buses, utility vehicles, and scooters and bicycles. Many fuel cell demonstration vehicles have been created for each of these vehicle types.

AUTOMOBILES

Most automobile manufacturers have been developing fuel cell vehicles for at least a couple of decades. Automotive manufacturers are interested in fuel cell technology because it is a "next-generation" technology that could have fuel reproduced from local sources and low or zero emissions. Fuel cell vehicles usually use compressed hydrogen as the fuel type, although several manufacturers have also demonstrated a fuel cell vehicle with methanol. Automotive fuel cells can have one or more of the following: A fuel cell can be used for start-up only or to provide all the power to a vehicle.

A fuel cell supplies a constant amount of power, so for vehicle acceleration and other power increased power needs, additional devices are connected to the fuel cell. A fuel cell can be used as the secondary power source. The operating temperature of an automotive fuel cell is between 60 to 80ºC due to the utilization of the polymer membrane, which limits the temperature to below 100ºC.

UTILITY VEHICLES

Utility vehicles have been a successful early adapter of fuel cell technology because the competing technology for these vehicles is often lead-acid batteries which require maintenance and charging. Demonstrations of fuel cell utility vehicles show that they offer lower operating cost, reduced maintenance, lower downtime, and extended range. Fuel cell– powered utility vehicles can also be operated indoors because there are no emissions. Utility vehicles that can be powered by fuel cells are forklifts, golf carts, lawn maintenance vehicles, airport movers, wheelchairs, unmanned vehicles, boats, small planes, submarines, small military vehicles. The first fuel cell utility vehicles were demonstrated in the early 2000s. Like the fuel cell automobiles, the fuel type most often used is compressed hydrogen, although methanol, metal hydrides, and sodium borohydride have also been demonstrated. The most common type of fuel cell used is the Proton Exchange Membrane Fuel Cell (PEMFC), but Direct Methanol Fuel Cells (DMFC) and Alkaline Fuel Cells (AFC) have also been used.

SCOOTERS AND BICYCLES

In countries with large populations, scooters, and bicycles are popular forms of transportation. Fuel cells have been positively demonstrated for these applications with compressed hydrogen and methanol. Hydrogen storage is still an issue for these vehicles; therefore, metal hydrides and electrolyzer have been researched during the last decade.Many manufacturers demonstrated their first fuel cell scooters and bicycles in the early 2000s, which is later than many of the fuel cell automobile and bus demonstrations. Like the fuel cell automobiles, the fuel type most often used is compressed hydrogen, although methanol, metal hydrides, and zinc have also been demonstrated. The most common type of fuel cell used is the PEMFC, but DMF Cs and Zinc-Air Fuel Cells (ZAFC) have also been used.

STATIONARY POWER APPLICATIONS

Fuel cells for stationary applications have been used commercially for over twenty years. The main difference in these fuel cell systems is the choice of a fuel cell and fuel and the heating and cooling of the stacks. Stationary fuel cells can be used as a primary power source. It is often used to power houses that are not connected to the grid or to provide supplemental power.In hybrid power systems, fuel cells can be connected to photovoltaics, batteries, capacitors, or wind turbines, providing primary or secondary power. Fuel cells can also be used as a backup or energy power generator providing power when the grid is down.A standalone system may require another source of energy for peak periods.

These can be batteries and super capacitors, or a combination of both.Many manufacturers began demonstrating their stationary power stations in the 1990s. Unlike other fuel cell applications, the fuel type most often used is natural gas. Other common fuel types are propane, compressed hydrogen, biogas, methanol, oil-based fuels, town gas, synthesis gas, digestor gas, and land fill gas. The most common stationary fuel cell type is the Proton Exchange Membrane Fuel Cell (PEMFC), but Solid Oxide Fuel Cells (SOFC), Molten Carbonate Fuel Cells (MCFC), Alkaline Fuel Cells (AFC), and Phosphoric Acid Fuel Cells (PAFC) have also been used. The United States,

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 01, January-2022

Germany, and Japan have the greatest number of stationary fuel cell power stations.

HFC VS PETROLEUM ENERGY

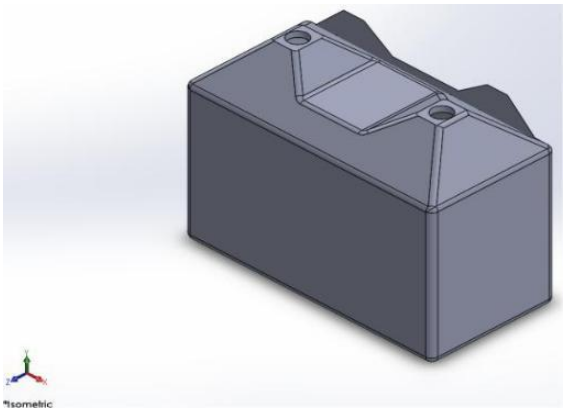
Hydrogen provides an edge over other petroleum products which are used to produce energy, due its zero-carbon emission, long term sustainability and reliability.Humans have been dependent on fossil fuel for too long now, it has shown impact on environment, as increased in flooding, rapid melting of polar ice caps, increased average temperature of planet and various other impacts.Hydrogen energy will be boon to humans in fighting the climate change and improve stability of earth. Many companies, investors, governments and environmentalists believe it is an energy source that could help end the reign of fossil fuels and slow the world's warming trajectory. Conventional combustion engines have an efficiency rate of 40-50% while HFC 's have more than 80%. Around one kg of hydrogen equals nearly five liters of petrol. You could drive for 500 km before needing to refill, making a hydrogen fuel cell car very similar in cost and range to a petrol vehicle. This range is much greater than most electric cars on the market.

ENVIORNMENT EFFECTS

A selling factor for any energy source lately is renewability. More individuals and businesses are investing in green resources for their homes or buildings. With hydrogen fuel cells, its composition drives renewability.Sustainability and renewability often go hand-in-hand. Sustainability refers to the length of endurance and prolonged environmental impact. Renewability suggests that the resource will continue to be available indefinitely.Hydrogen fuel cells can stand out, too. For instance, they can theoretically replace any battery, and many standard batteries have toxic substances in them that can harm the environment or water supply Fuel cell vehicles running on hydrogen produced from renewable resources virtually eliminates all GHG emissions compared to conventional fossil fuel powered vehicles, which in turn improves air quality and reduces pollution on planet earth. In long run, to combat climate change and improve survival rate of humans, it is essential to look for the alternative energy production methods like HF Cs and stop the use of fossil fuels before it's too late.

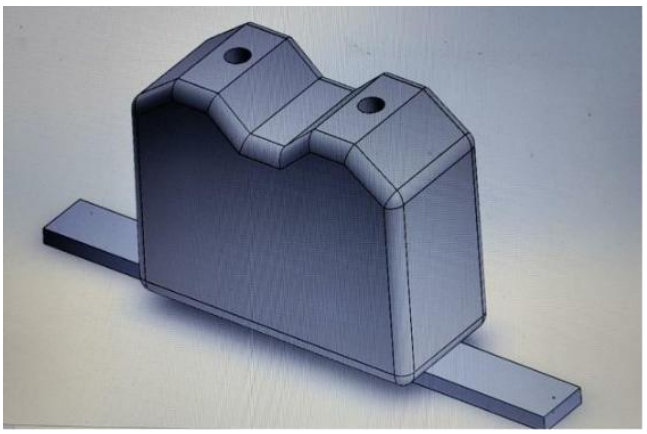
DESIGN

Before making any machine, that is very important step to design that machine and decide dimensions of the components and decide weight of the whole machine. For the modelling of our engraver machine we use SOLIDWORKS. Following are the images of that components which are we made in SOLIDWORKS.

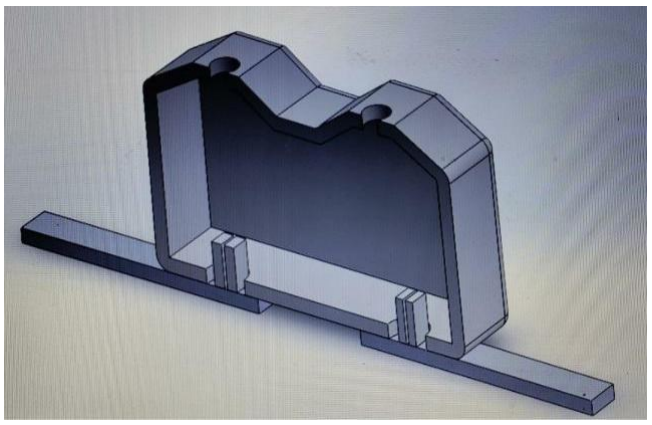


1. ISOMECTRIC VIEW

The above image shows the design of part 1 in isometric view of overall model. This part is used to perform electrolysis process to produce homemade hydrogen for further part of the project. The dimensions of the model are as follows 20*12*10 cm. The other two images depicts the side view and cross section of that part model.



2. SIDE VIEW



3. CROSS SECTIONAL VIEW

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 01, January-2022

CONCLUSION

Fuel cells are simple, environmentally clean, efficient, And low emission device. These factors in itself makes fuel cell to hold wide range of applications. There is thrust to find the way mankind can generate as much as electricity in an sustainable way. Fuel cells have real potential to qualify as technology From which electricity can be generated with harmless by products. As our demand for electrical power grows, it becomes increasingly urgent to find new ways of meeting it both responsibly and safely. In the past, the limiting factors of renewable energy have been the storage and transport of that energy. With the use of fuel cells and hydrogen technology, electrical power from renewable energy sources can Be delivered where and when required, cleanly, efficiently and sustainably.

REFERENCES

[1] Fuel Cell Environmental Impact | Connecticut Hydrogen-Fuel Cell Coalition (chfcc.org)
[2] THE HISTORY OF HYDROGEN | AltEnergyMag Fuel cell - Wikipedia
[3] 5 Fast Facts about Hydrogen and Fuel Cells | Department of Energy
[4] The new fuel to come from Saudi Arabia - BBC Future
[5] How efficient are hydrogen fuel cells? | Viessmann
[6] A Comprehensive Review of the Fuel Cells Technology and Hydrogen Economy - IEEE Conference Publication
[7] Fuel Cell Applications - an overview | ScienceDirect Topics.