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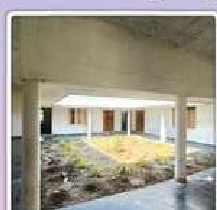
Government Degree College
Mandapeta-533308

విశాలమైన క్రీడా ప్రాంగణం మరియు కోనసీమ
జిల్లాలోనే ఏకైక అతిపెద్ద ఇండోర్ స్టేడియం


విశాలమైన తరగతి గదులు మరియు ప్రయోగశాలలు

అత్యాధునిక గ్రంథాలయం (ఎ.సి.)




కళాశాల ప్రాంగణం

ఇండోర్ స్టేడియం

క్రికెట్ గ్రౌండ్


జిమ్, చెస్ ఆటల్లో పాల్గొన్న కళాశాల విద్యార్థులు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కబడ్డీ ఆటల్లో పాల్గొన్న కళాశాల విద్యార్థులు

స్టేట్ లెవెల్ టెన్నికాయిట్ ఈవెంట్ & క్యాంప్ ఫైర్

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Stability of Molten Carbonate Fuel Cell Electrolyte Prototype: A Simulation Study of V-I Characteristics

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Abstract
Hydrogen (H_2) technologies are increasingly attractive for reducing carbon emissions in global energy systems, despite occasional periods of high expectations and low satisfaction in view of substantial improvements in efficiency and cost. A summary of the tested methods from literature for producing H_2 is provided in this study. Advances in studies of Molten Carbonate Fuel Cells (MCFCs) enable enhancements in achievement, resilience, cost effectiveness, plus surmounting constraints. This simulation study investigates the impact of voltage and current on the efficiency and durability of MCFCs, revealing that time enhances V, I, and power production by considering two electrolytes, Nafion, Zirconia. Nafion electrolyte is found to be the most effective electrolyte for MCFC based on the simulation results.
Keywords: MCFC, Voltage, Current, Power, Nafion, Zerconium, Electrolyte.

1. Introduction

Hydrogen (H_2) fuel cells (FC) offer an environmentally friendly alternative to internal combustion engines, generating temperature and power through electrochemical interactions of H_2 and O_2 [1-2]. With a 40-50% resource transfer rate, they can be used with various fuel types and are essential for housing, vehicles, and environmental preservation [3-4]. MCFCs are being researched for a variety of uses within fossil fuels as well as genuine gas-fired electricity plants [5]. Non-precious metallic substances can act as triggers for such elevated temperatures in fuel cells that utilize a melting carbon dioxide mix of salts within ceramics Li-Al oxide matrices [6]. At an effectiveness of almost 60%, MCFCs provide important price savings across phosphoric acid fuel cells [7]. High-energy fuels can be converted to H_2 without the need for an outside reformist, along transforming is less expensive [8]. The molten carbonate fuel cell's functioning theory, which illustrates the anode along with cathode processes whenever hydrogen is utilized as feed and additionally, MCFCs provide effectiveness rates of about 50%, and this can reach 80% if excellent waste energy is recycled. H_2 extremely energetic material that is capable of being used to generate valuable output as a fuel [9]. Hydrogen is an extremely plentiful substance throughout our solar system but could potentially being utilized to be power [10]. An electrochemical system called a fuel cell generates electrical power by reacting hydrogen with oxygen [11] fuel is used as an intake by fuel cell devices. They do not require recharging and they can be easily replenished whenever needed. Several essential elements are required to manufacture hydrogen fuel [12].
MCFC is an apparatus that powers an energy cell using hydrogen fuel is called a molten carbonate fuel cell. It generates positive and negative poles using an electrolyte, a carbonate salt solution and water. The anode receives the hydrogen, and the cathode receives oxygen, carbon dioxide, and electricity. After that, an outside circuit is used to compel the ions into

circulation, producing an electric charge. The schematic diagram is presented in Fig. 1. The effectiveness of hydrogen and its production capacity is reviewed from the literature and are presented in Table 1 and 2. The deviations of hydrogen fuel cell under various operating conditions have been noted down and presented in Fig. 2 and 3.

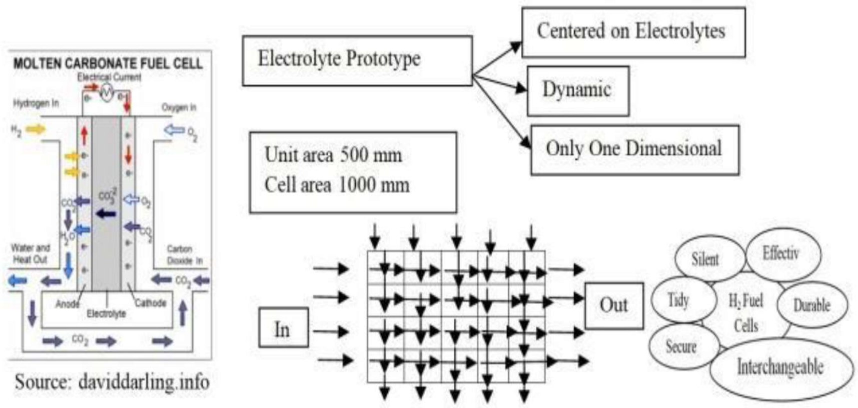

Fig 1 Working and Simulation of MCFC

Table 1. Summary on H_2 Process Effectiveness

Process Name	Effectiveness (%)
Steam reforming	65-70
Electrolysis	65
Photo process	10-15
Radiolysis	1

Table 2. Summary on H_2 Production Capacity

Process Name	Avg.Capacity (MW)
Steam reforming	750
Gasification (Coal)	490
Gasification (Biomass)	176
Electrolysis	75.5

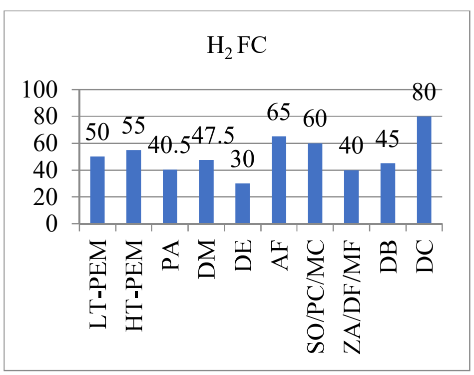

Fig 2. Deviations of Avg. E. E (%)

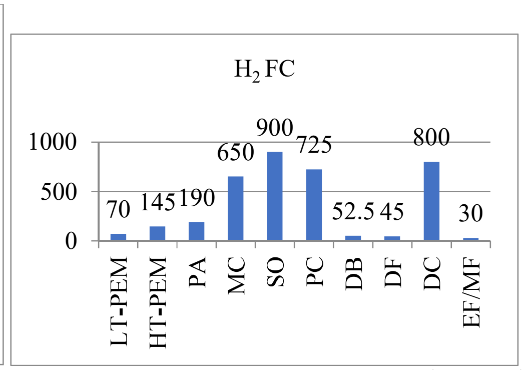

Fig 3. Deviations of Avg. O.T (Deg. C)

LT- Low Temperature; HT- High Temperature PA-Phosphoric; DM- Direct Methanol; DE- Direct Ethanol; A- Alkaline; F- Fuel; SO- Solid Oxide; PC- Proton Ceramic; MC – Molten Carbon; Zn – Zinc Air; DB – Direct Borohydride; DC- Direct Carbon; PEM – Proton Exchange; E.E-Electrical efficiency; O.T-Operating temperature.

2. Methodology

A prototype or model is created considering MCFC as grid as shown in Fig. 1, using MatLab simulation to examine the functionality of MCFC and its VI characteristics assuming that the fuel cell functions in stable settings with a perfectly balanced gas combo, panels acting as perfect conductors, a rapid water-gas transfer response, plus stable inertial operation via very little pressure fall. Two electrolytes namely, Nafion, Zirconia are used in simulation. Fuel cell performance correlates negatively to current flow. This analysis ignores fluctuations in gas makeup and considers continuous component MCFC electrolytes. The architecture of MCFCs incorporates both cross-gas circulation directions and the chemical reactions are presented here.

$$\text{anode}: \quad H_2 + CO_3^{2-} \rightarrow H_2O + CO_2 + 2e^-$$

$$\text{cathode}: \quad CO_2 + 1/2O_2 + 2e^- \rightarrow CO_3^{2-}$$

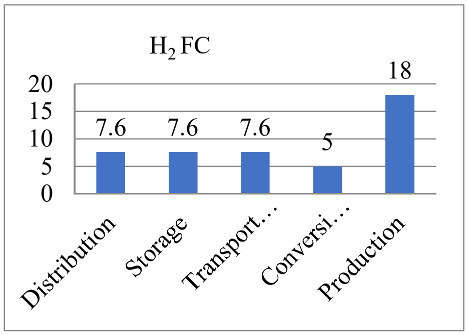

Fig 4. Energy Loss Distribution

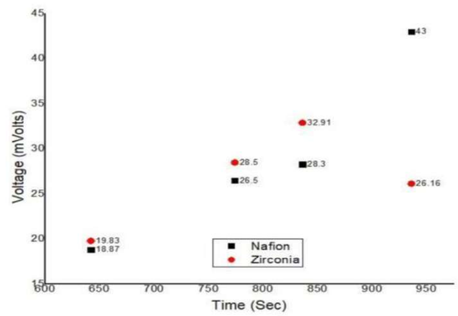

Fig 5. V Vs T

3. Results

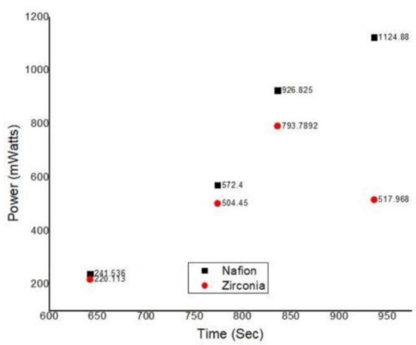

Fig 6. P Vs T

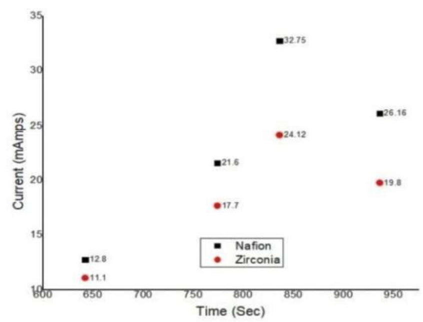

Fig 7. T Vs A

Two electrolytes are considered in this simulation and the characteristics of voltage, power and current with respect to time period are plotted. It is observed from Fig. 5, when the time period increases, the voltage for both the electrolytes is increased. The highest voltage for the Nafion electrolyte found to be 43 mvolts against 936 sec. It is observed from Fig. 6, the power for both electrolytes is increased when time period increases and the highest power found to be 1124.88 mwatts against 936 sec for Nafion electrolyte. Further, it is observed from Fig. 7, the current increases for both electrolytes when time period is increased and the highest current for Nafion electrolyte found to be 32.75 mamps against 836 sec. Based on the simulation results, MCFC may be utilized extensively in automobiles, electricity and production of ammonium etc but further research in this direction is recommended.

4. Conclusion

In terms of voltage, current, and power characteristics, Nafion electrolyte demonstrates superior performance compared to Zirconia electrolyte. As our demand for electricity continues to rise, finding innovative, secure, and reliable methods to meet this need becomes increasingly crucial. Previously, challenges such as the shipping and storage of clean energy limited our options. However, with advancements in fuel cells and hydrogen generation, we can now provide fresh, efficient, and sustainable energy from renewable sources whenever needed.

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