Prince Sattam bin Abdulaziz University
College of Engineering
Mechanical Engineering Department

Design and Development of a Green Hydrogen Production System

Students: Faisal Mohammed Alsaif and Salman Atayah Almalki
Supervisor: Dr. Ibrahim B. Mansir

2nd Semester 1445 / 2023-2024 GP 2

ABSTRACT

The transition towards a sustainable energy future demands innovative approaches to hydrogen production, with green hydrogen emerging as a frontrunner. This project focuses on designing a green hydrogen production system which includes, electrolyzer module, green power unit, and water circulation system. Key to the project is the meticulous sizing of the power system to ensure optimal efficiency. Specifically, the electrolyzer is designed to operate at more than the capacity of 100 ml/min, meeting both current and future demands.

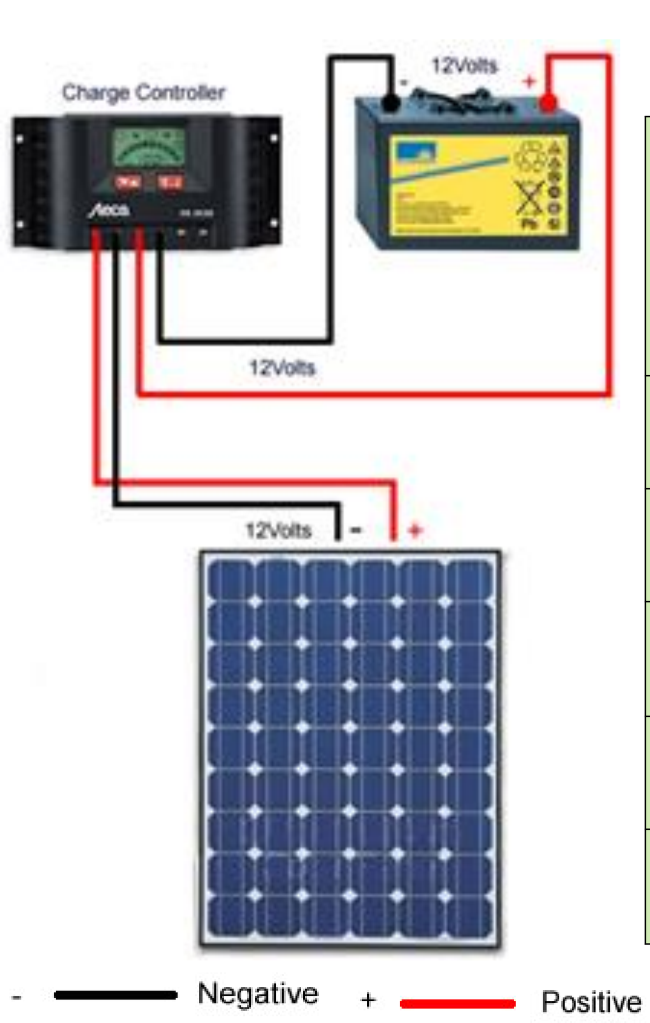
OBJECTIVES

- Design the green hydrogen production systems.
- Acquire the required components to develop the GHP system.
- Development of the green hydrogen production system.
- Conduct experiment to determine performance of the GHP prototype.

DESIGN CONSIDERATIONS

- Economic • Environmental • Ethical • Safety
- Technical • Sustainability • Political • Social

POWER UNIT SIZING

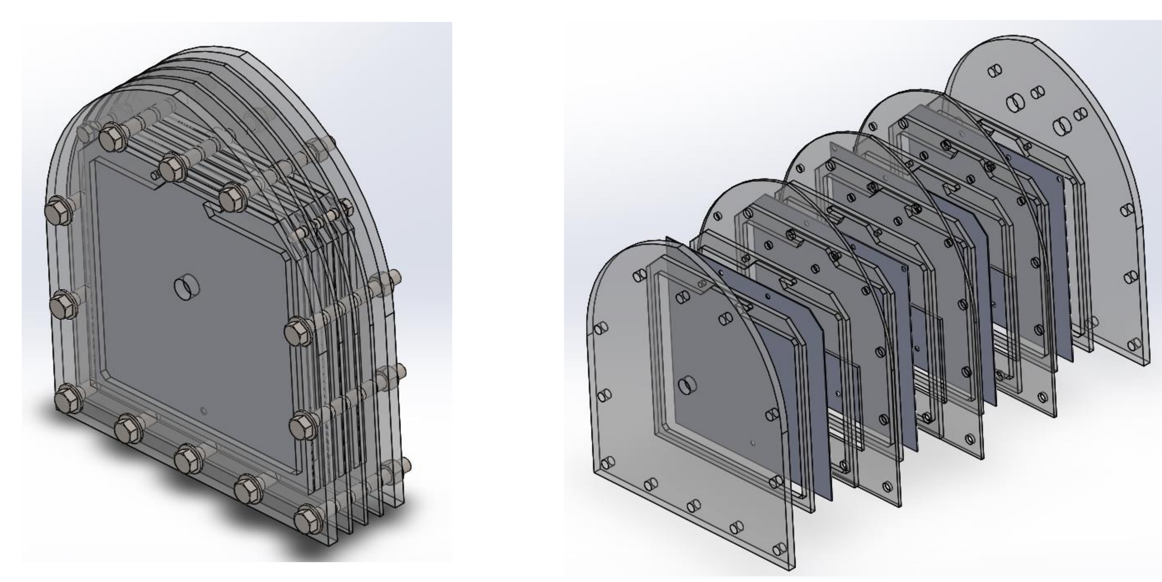


Total daily power consumption (Wh)	556.8
Perfect sun hours (h)	5
Batteries capacity (Ah)	60
Max. power of panel(W)	175
PV Capacity (W)	174
Number of solar panels	1

$$PV\ Capacity = \frac{TDPC}{PSH * DF * BE}$$

$$Number\ of\ solar\ PV\ panels = \frac{PV\ Capacity}{Max.power\ of\ panel}$$

DESIGN OF THE ELECTROLYZER



Hydrogen production f_{H_2}:

$$f_{H_2} = \frac{N * I}{z * F} * Mv * 60000$$

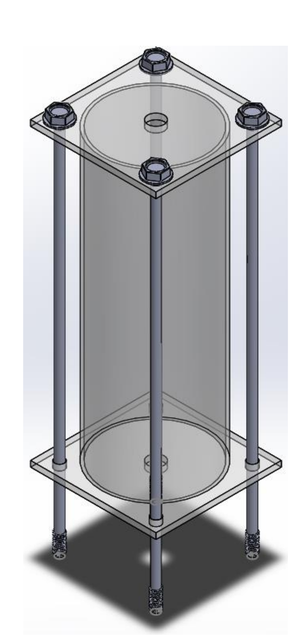
Number of cells, N	2	Faraday constant, F	96480C/mole
Current, I	10 A	Electrochemi-cal equivalent, z	2 mole/C
Molar volume, Mv	22.41 L/mol	f_{H_2}	139 mL/min

fH_2 produced > $100ml/min$

SPECIFICATIONS OF THE SYSTEM

Electrode materials	• Titanium Coated with 1µm platinum. • Stainless steel 316L • Nickel
Electrolyte	Sodium hydroxide (NaOH)
Sealing gasket material	Silicone Rubber
Base plates and Separators materials	Acrylic

WATER TANK



The volume of hydrogen:

$$V_{H_2} = m\, H_2/\rho\, H_2 = 13000mL/min$$

The volume of the water tank:

$$V_{H_2O} = \pi\, r^2\, h = 2.5L$$

CIRCULATION PUMP

$$H_{ML} = f\frac{L\,V^2}{D\,2g}$$

Pump max. flow rate (L/h)	240
Pump power consumption (W)	4.2
Pump max. head (m)	3
Major head losses (m) H_{ML}	2.4

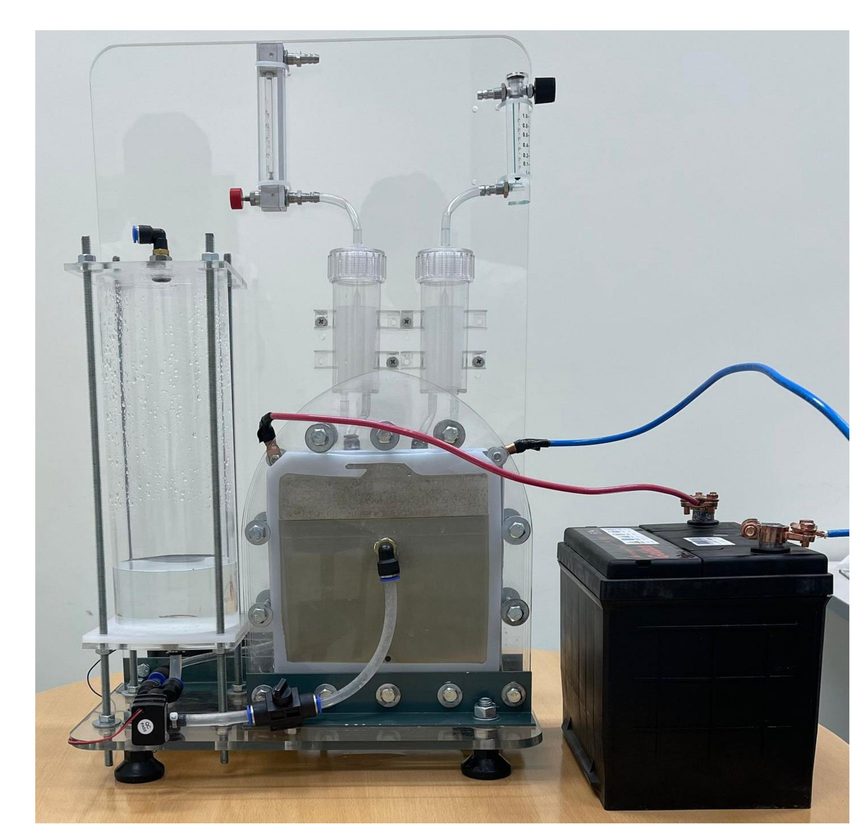
ELECTRODE MATERIALS

Titanium Coated with 1µm platinum

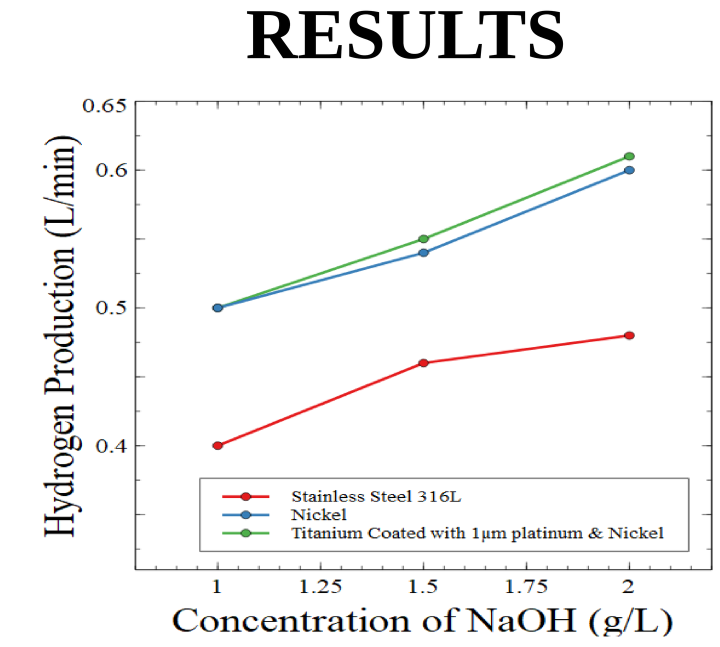
Stainless steel 316L

Nickel

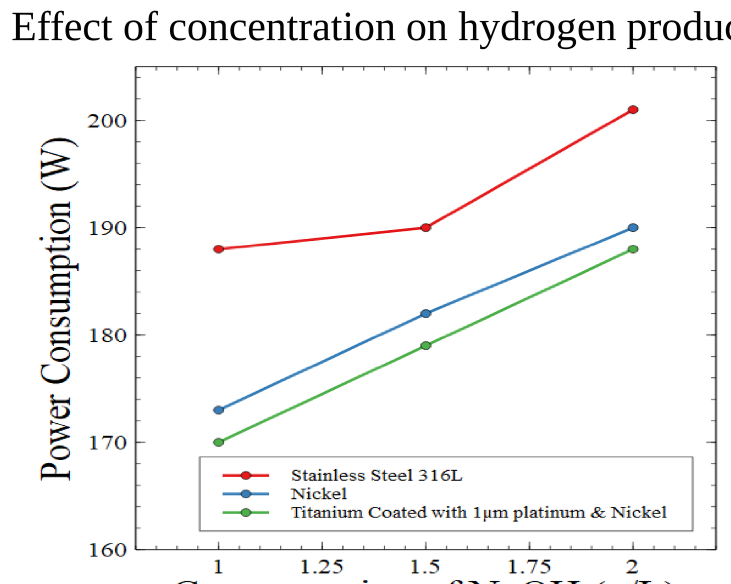
THE PROTOTYPE



RESULTS



Effect of concentration on hydrogen production



Effect of temperature on hydrogen production and power consumption

CONCLUSION

This project presents a design and development of green hydrogen production system it was found that hydrogen production is increased by the increase of the concentration of electrolyte as well as the water temperature.

DRAFT PUBLICATION

Faisal Alsaif, Salman Almalki, Ibrahim Mansir, Abdullah Alshehri. 'The effects of electrode material on green hydrogen production' Renewable energy 2024, (Under Preparation)