

E-BOOK OF EXTENDED ABSTRACT

THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025



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THE 14th INTERNATIONAL
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DESIGN COMPETITION 2025

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HYBRID HYDROGEN POWER GENERATION

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ABSTRACT

Renewable energy systems, such as photovoltaic and wind power generations are playing an increasingly important role in energy production. These energy resources are utilized due to their abundance readily available zero cost. However, when used independently, they have some limitations which can be overcome by employing hybrid energy system. This system basically consists of a combination of multiple renewable energy resources. They provide efficient responses to voltage and frequency fluctuations, reduce harmonic distortion and system complexity, maintain low unit cost through a proper design. They also provide advanced fast response, optimization and control feasibility. Excessive consumption of fossil fuels has led to depletion of reserves and environmental crises. Therefore, turning to clean energy sources is essential. However, these energy sources are intermittent in nature and face challenges in meeting long-term energy demands. The energy cycle is composed of wind turbine, solar photovoltaic field (PV), an alkaline fuel cell (AFC), and an electrolyzer. The generated electricity powers the electrolyzer which decomposes water into oxygen and hydrogen gases. The goal of the introduced cycle is to generate electricity and hydrogen fuel efficiently.

Keyword: hybrid hydrogen, renewable energy

1. INTRODUCTION

In recent years, the use of renewable energy sources has increased due to increased energy demand and problems caused by the consumption of fossil fuels. Renewable energy sources are clean and accessible and greatly reduce environmental crises. Wind, and solar energy are more popular due to technological development and government encouragement. However, these energy sources are intermittent in nature and have problems meeting long-term energy demand. The option suggested by the researchers is to use hybrid energy system (HES), which can also be a combination of renewable and non-renewable sources.

Hybrid hydrogen power generation emerges as a promising solution, offering a pathway towards a sustainable and resilient energy future. This innovative approach integrates renewable energy sources, such as solar and wind power, with hydrogen production, storage, and utilization technologies. By harnessing the power of the sun and wind to produce hydrogen through electrolysis, this system effectively addresses the inherent intermittency of renewable energy sources. Hydrogen, with its high energy density and versatility, serves as an ideal energy carrier. It can be stored for extended periods, enabling the utilization of renewable energy even during periods of low generation. Furthermore, hydrogen can be utilized in various applications, including electricity generation through fuel cells, transportation, and industrial processes. This flexibility enhances energy security and provides a more reliable and sustainable energy supply.

Moreover, hybrid systems can be used as a standalone micro-grid or as a grid connection. The output of HES can be electricity, heat, cooling and hydrogen fuel. Through a comprehensive analysis of key components, including renewable energy sources, electrolyzers, hydrogen storage technologies, and fuel cells, this project seeks to understand the potential of hybrid hydrogen power generation to contribute to a sustainable energy future.

1.1 Objectives

The objectives of “Hybrid Hydrogen Power Generation” are as follows:

- i. To develop a Hybrid Hydrogen Power Generation System
- ii. To monitor and analyze the reactivity and efficiency of sodium in alkaline medium during hydrogen generation.
- iii. To optimize the energy output of hydrogen gas produced from the sodium-alkaline reaction.

1.2 Scope of Work

This scope of work provides a comprehensive outline of tasks and responsibility involved in the development of hybrid hydrogen power generation, ensuring that all aspects of the project are covered effectively. The scope of work as mentioned include:

- i. Create and design hybrid hydrogen by power generation.
- ii. Do some research and literature review the fundamentals of hydrogen power generation.
- iii. Prototype development and implementation.

2. METHODOLOGY

2.1 The expected project process can be summarized in terms of flow chart diagram shown below.

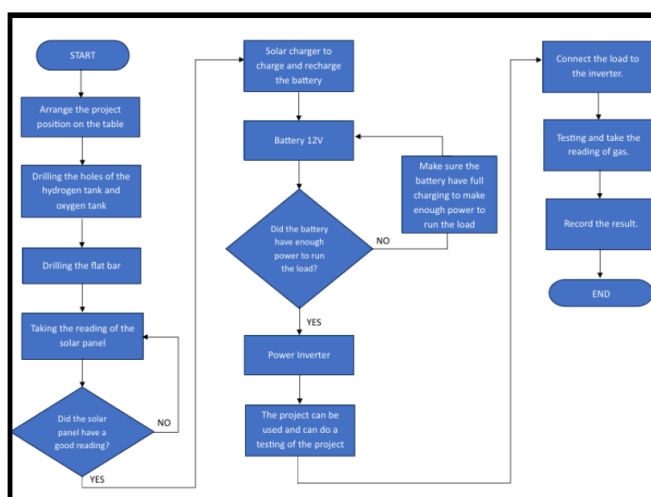


Figure 1 Process flow chart

2.2 Project block diagram.

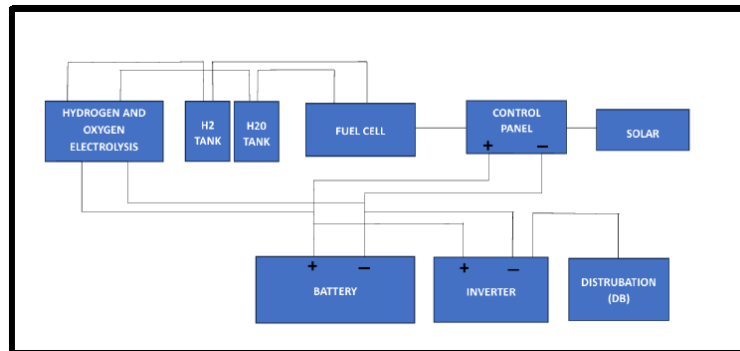


Figure 2 Project block diagram.

3. FINDINGS

3.1 Project prototype



Figure 3 Project prototype

3.2 Testing and Results

Table 1. Testing and Results for Hydrogen Production

No.	Material or Mixer	Reaction
1	Alkaline only	Almost No Reaction
2	Alkaline + Sodium (100g)	Start Bubbling, Warm Tank, Possible Internal Pressure rise
3	Alkaline + Sodium (200g)	Violent Bubbling, Tank Get Hot, Likely Pressure Buildup
4	Alkaline + Sodium (400g)	Very Violent, Large Gas Plume.

4. CONCLUSION

In conclusion, the hybrid hydrogen power generation system using an alkaline water battery combined with sodium has shown promising results in producing clean and efficient energy. The system works by using the reaction between sodium and water in an alkaline medium to generate hydrogen gas, which is then used in a fuel cell to produce electricity. This method offers a renewable and low-emission energy solution while also making use of abundant and low-cost materials. The combination enhances hydrogen production and energy storage, making the system suitable for off-grid power, emergency backup, or small-scale energy applications. Further testing and optimization are needed to improve the safety, control, and efficiency of the chemical reactions for larger and long-term use. Authors are expected to submit materials that have been carefully written and proofread.

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