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Production of Hydrogen from Solar System

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ABSTRACT

The pursuit of sustainable and environmentally friendly energy sources has resulted in notable progress in the realm of renewable energy technologies. One avenue showing promise is the utilization of solar energy systems to produce hydrogen, commonly referred to as solar hydrogen production. The following abstract offers a succinct overview of the fundamental concepts, techniques, and implications associated with harnessing solar energy for the generation of hydrogen. Solar hydrogen production entails the conversion of sunlight into hydrogen gas utilizing various methods, including photoelectrochemical cells, photovoltaic-electrolysis systems, and solar thermochemical processes. These techniques leverage solar energy to divide water molecules (H2O) into hydrogen (H2) and oxygen (O2), providing an environmentally sustainable means of generating hydrogen fuel.

Keywords: Solar Energy, Renewable energy technology**,** Hydrogen production, Water splitting

INTRODUCTION

The emergence of hydrogen production from solar systems has become a promising avenue for achieving a more sustainable and environmentally friendly energy future. Hydrogen, often referred to as the "fuel of the future," has the potential to revolutionize our energy landscape by providing a clean, versatile, and efficient source of power. Solar-based hydrogen production is situated at the intersection of two pivotal elements: the abundance of solar energy and the demand for cleaner energy alternatives. The necessity to transition away from fossil fuels, due to their adverse environmental impacts and finite availability, has sparked a growing interest in renewable energy sources. Solar energy, in particular, has gained prominence as an abundant and virtually limitless resource. By harnessing the power of the sun, we have the opportunity to generate clean energy on a scale that can meet our ever-increasing energy demands, while simultaneously reducing greenhouse gas emissions and mitigating climate change.

RESEARCH APPROACH

The paper focuses on the technical analysis of hydrogen production systems using water electrolysis and solar energy as the energy source. The study presents a case study of a hydrogen production and storage plant in Cluj-Napoca, Romania, with a daily capacity of 100 kg.

The authors analyse four different technical solutions for the plant and consider three scenarios for the efficiency of the sub-systems. The conclusion of the study suggests that hybridizing the solar hydrogen production system by using both electrical and thermal energy can maximize the conversion of solar radiation into chemical energy in the form of hydrogen.

METHODOLOGY:

The hydrogen production and storage plant using solar energy. The stages involved in the selection process include assessing the efficiency of the photovoltaic system with concentrated radiation, evaluating sub-system capacities, determining the necessary land area, and selecting the technical solution.

The authors developed a mathematical model based on data from relevant literature to calculate the efficiency of the photovoltaic system and the global efficiency of solar radiation conversion into chemical energy in the form of hydrogen.

The total energy demand for increasing water temperature and the total electrical energy demand for water splitting were also assessed using specific formulas.

The paper also discusses the assessment of the total yearly energy demand, the calculation of the total area of photovoltaic panels, and the determination of the necessary land area for the hydrogen production system.The selection of the technical solution was done using the ordinal single criterion method for ranking.

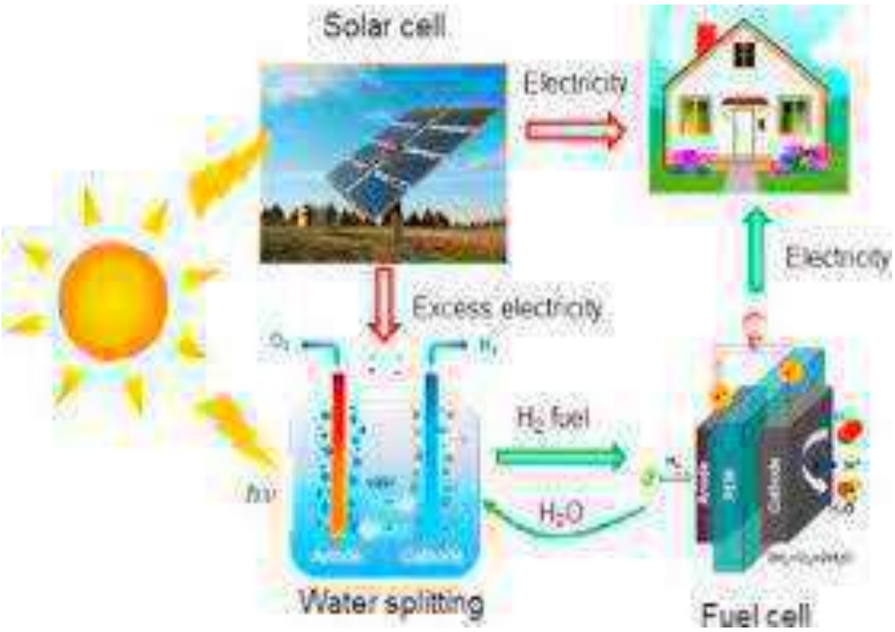

Fig 1: electrical energy demand for water splitting diagram

It primarily focuses on providing a review of solar energy usage for hydrogen production, discussing topics such as electrolysis, photovoltaic research focus areas, and photoelectrochemical hydrogen production.

It also presents maps showing the yearly sum of horizontal global irradiation of solar energy sources within Europe, Slovakia, and Hungary.

The paper mentions recent accomplishments in the electrolysis area, including hydrogen production in a planar electrolysis stack, development of new electrolysis system designs, and low-cost alkaline and PEM electrolysis systems for high-pressure operation.

However, it does not provide detailed information on the specific experimental or analytical methods used in these accomplishments.

RESULTS

The paper presents a case study of a hydrogen production and storage plant in Cluj-Napoca, Romania, with a daily capacity of 100 kg, using water electrolysis and solar energy as the energy source.

Four different technical solutions were analysed for the plant, and three scenarios were considered for the efficiency of the sub-systems.

The study concludes that hybridizing the solar hydrogen production system by using both electrical and thermal energy can maximize the conversion of solar radiation into chemical energy in the form of hydrogen.

The efficiency of the photovoltaic system using concentrated radiation was found to increase over time due to the improvement in technical performance of the equipment.

The global efficiency of solar radiation conversion into chemical energy in the form of hydrogen was also found to increase over time due to the improvement in technical performance of the equipment.

The total yearly energy demand for the hydrogen production system was calculated, taking into account the working temperature of the electrolyser.

The necessary land area for the photovoltaic panels was determined based on the required energy yield of the panels.

CONCLUSION

Hydrogen, a clean, versatile, and energy-dense fuel, has emerged as a promising alternative to fossil fuels in the pursuit of a sustainable energy future. Solar energy, abundant and renewable, offers a compelling source for generating this versatile fuel. The production of hydrogen from solar energy involves two primary methods: electrolysis and direct solar water splitting. Electrolysis, the established method, utilizes electricity generated from photovoltaic (PV) cells or other renewable sources to split water molecules into hydrogen and oxygen. Direct solar water splitting, a more advanced approach, directly converts sunlight into hydrogen and oxygen using semiconductor materials.

Despite the challenges of cost and efficiency, hydrogen production from solar energy holds immense promise for a sustainable energy future. As research and development continue, the cost and efficiency of solar-powered hydrogen production are projected to improve, making hydrogen a more competitive and attractive option for various applications, including transportation, power generation, and industrial processes.

The transition to a hydrogen-based economy, powered by solar energy, is a step towards a cleaner, more sustainable world. Here are some key takeaways from the discussion of hydrogen production from solar energy:

Sustainability: Solar energy is a renewable and abundant source, ensuring a sustainable supply of hydrogen without depleting fossil fuels.

Environmental Friendliness: Solar-powered hydrogen production is a clean process, producing no harmful emissions or pollutants, unlike traditional fossil fuel-based methods.

Versatility: Hydrogen can be used for various applications, including transportation, power generation, and industrial processes, offering a versatile energy carrier.

Energy Storage Potential: Hydrogen can be stored for extended periods, providing a flexible energy storage solution for intermittent renewable energy sources like solar and wind.

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