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Bio-Hydrogen: The Energy of The Future Produced from Agriculture Waste

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Introduction

There is an increased consensus around the world that concerted steps need to be taken to reduce global warming to less than 2 °C. India, on its 75th Independence Day, has launched the National Hydrogen Mission. Hydrogen is expected to play an important role in the effort to reach climate neutrality by 2050, as recognized by the 2020 Hydrogen Strategy**.** Yet, one of the main challenges facing the hydrogen sector is decarbonizing its production. Over 95% of hydrogen production capacity in 2023 will be derived from fossil fuels. Despite increasing global political support, green hydrogen constitutes less than 1 percent of the world's hydrogen production and usage, according to the September release of the *Global Hydrogen Review 2023* by the International Energy Agency (IEA). To align with the organization's Net Zero Emissions (NZE) scenario, green hydrogen capacity must grow more than 100 times by 2030. On January 4, 2023, the Indian Union Cabinet allocated a budget of ₹19,744 crore to the National Green Hydrogen Mission (NGHM) to possess the objective that India will become the global center for the production, utilization, and export of green hydrogen. India goal of attaining 50 GW of renewable energy capacity by 2030. India has 424 GW of power generation capacity, which includes around 180 GW from non-fossil fuel, as announced by Union Minister of Power and New and Renewable Energy Minister R.K. Singh. India has declared its goal to achieve net zero emissions by 2070. Hydrogen has a much higher calorific value (119.93 MJ kg^{-1}) as compared to gasoline (44.5 MJ kg^{-1}). Moreover, the burning of hydrogen produced fewer harmful emissions into the atmosphere. There are two methods of production of agricultural hydrogen: conventional and renewable energy. The conventional technique is costly, but it satisfies 95% of industry requirements for hydrogen and is utilized in the production of fertilizers. The second classification employs renewable energy sources like solar, wind, and biomass for hydrogen generation. Within this framework, hydrogen can be produced either through electrolysis or biomass-based processes involving thermo chemical or

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biological methods. The past decade has seen a notable surge in industrial interest in biogas reforming. This process transforms two major greenhouse gases in biogas (CH_4 and CO_2) into environmentally friendly chemicals, namely syngas or bio-hydrogen.

This is primarily because biogas, with methane as its main constituent, is the raw material for hydrogen production. Green hydrogen is made from agricultural waste and is known as biohydrogen. Biohydrogen, a type of green hydrogen derived or produced from biogases and biomass, can support the decarbonization of hydrogen production. In contrast to the other forms of hydrogen, biohydrogen can be zero or even carbon-negative if it is obtained from feedstocks such as waste and manure. In addition, depending on the biohydrogen technology, biohydrogen production can generate co-products such as pure biogenic carbon dioxide, digestate, or biochar. This process further supports the decarbonization of industries, contributes to the circular economy, and helps to permanently store carbon in the soil. Biohydrogen can be generated from domestically produced biogases. For instance, in rural areas where there could be a future need for biohydrogen, biohydrogen can be produced from raw biogas or biomethane to provide a local source of green energy. This also helps to reduce exposure to volatile natural gas prices. It is a developing field that offers potential for sustainable energy generation and waste management. The process of producing biohydrogen is obtained from agriculture crop waste residue, animal manure, and waste from the food industry. The conversion of the agriculture waste into biohydrogen production by anaerobic fermentation of it into a biogas plant, where microbial conversion breaks the organic matter into simpler compounds. Methane and hydrogen gas are produced in the digester, which is purified and then used. Another method of producing biohydrogen is the gasification of biomass. Gasification is the process of converting biomass into organic or fossil-based carbonaceous materials at high temperatures (>700°C), without combustion with a controlled amount of oxygen and/or steam into carbon monoxide, hydrogen, and carbon dioxide. As biomass gasification is a mature technology, feedstock costs and lessons learned from commercial demonstrations will determine its potential as a viable pathway for cost-competitive hydrogen production.

Benefits of Bio-Hydrogen from Agricultural Waste

The benefit of using bio-hydrogen is to save the environment from greenhouse gases**.** In addition to its environmental benefits, biohydrogen can be obtained at a lower production cost than other types of green hydrogen. Biohydrogen production costs today range from EUR

1.15 to EUR 9.65/kg H_2, while the production cost of green hydrogen from electrolysis fluctuates between EUR 2.51 and EUR 11.94/kg H_2. Green hydrogen can be used as a renewable energy storage medium. It allows the storage of extra renewable energy. It uses this stored energy during peak demand. Utilizing agricultural waste for bio-hydrogen production offers a sustainable solution for waste management, reducing greenhouse gas emissions from waste decomposition and minimizing the need for land filling or incineration. Bio-hydrogen production from agricultural waste is a carbon-neutral process. Plants seizure the carbon emitted during hydrogen combustion. Plants use it during their growth. This helps in reducing greenhouse gas emissions and opposing climate change. By producing hydrogen locally from agricultural waste, they can increase their energy security.

Application of biohydrogen in the agriculture sector

Green hydrogen as a replacement for fossil fuels in agriculture has the potential to replace traditional fertilizers in agriculture through the production of ammonia using renewable energy sources. Ammonia is a key ingredient in the production of fertilizers, and the current production process relies on natural gas, which is a fossil fuel and contributes to greenhouse emissions. Green hydrogen-powered farm machinery like tractors, harvesters, and irrigation systems requires a lot of energy to operate. Green hydrogen-powered farm machinery can significantly reduce greenhouse gas emissions while still delivering the power required carrying out essential farm tasks. It is also used for water management in desalination plants that convert saltwater into freshwater. It is also used in the industrial sector and in the transport sector.

Conclusion

The following conclusion of the following article is discussed above that hydrogen is one of the alternative sources of fuel obtained by a gasification process of biomass or obtained from the biogas plant is used as an energy source in future aspects. It is a clean energy sources which can be used in engine as a fuel and replace the non-conventional sources of energy.