World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:18, No:04, 2024

Co-Gasification Process for Green and Blue Hydrogen Production: Innovative Process Development, Economic Analysis, and Exergy Assessment

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Abstract : A co-gasification process, which involves the utilization of both biomass and plastic waste, has been developed to enable the production of blue and green hydrogen. To support this endeavor, an Aspen Plus simulation model has been meticulously created, and sustainability analysis is being conducted, focusing on economic viability, energy efficiency, advanced exergy considerations, and exergoeconomics evaluations. In terms of economic analysis, the process has demonstrated strong economic sustainability, as evidenced by an internal rate of return (IRR) of 8% at a process efficiency level of 70%. At present, the process has the potential to generate approximately 1100 kWh of electric power, with any excess electricity, beyond meeting the process requirements, capable of being harnessed for green hydrogen production via an alkaline electrolysis cell (AEC). This surplus electricity translates to a potential daily hydrogen production of around 200 kg. The exergy analysis of the model highlights that the gasifier component exhibits the lowest exergy efficiency, resulting in the highest energy losses, amounting to approximately 40%. Additionally, advanced exergy analysis findings pinpoint the gasifier as the primary source of exergy destruction, totaling around 9000 kW, with associated exergoeconomics costs amounting to 6500 $/h. Consequently, improving the gasifier's performance is a critical focal point for enhancing the overall sustainability of the process, encompassing energy, exergy, and economic considerations.

Keywords : blue hydrogen, green hydrogen, co-gasification, waste valorization, exergy analysis
Conference Title : ICSREE 2024 : International Conference on Sustainable and Renewable Energy Engineering
Conference Location : Boston, United States
Conference Dates : April 22-23, 2024

Open Science Index, Energy and Environmental Engineering Vol:18, No:04, 2024 publications.waset.org/abstracts/173926.pdf