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Green ammonia small-scale production plant: simulation on the base of energetic aspects

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Generally speaking, the Haber-Bosch (HB) process for ammonia (NH3) production requires large-scale industrial equipment; however, a smaller and more cost-effective setup could improve accessibility to ammonia production. The transition to an electrically driven HB ammonia process will depend on the development of agile systems that align with geographically isolated and intermittent renewable energy sources. Such a flexible system could utilize renewable energy to produce ammonia for fertilizer and fuel applications, meet local electricity demands and generate hydrogen for energy storage. Motivated by these advancements, this work focuses on small-scale NH3 production plants. The proposed green ammonia system integrates a nitrogen membrane generator, a water alkaline electrolyzer stack, and an HB ammonia synthesis unit, designed for three different capacities: 1 MW, 5 MW, and 10 MW electrolyzers. The plants are analyzed through Aspen Plus simulations, being energetic aspects the main criteria for selecting the working conditions. The study examines the effects of pressure and temperature on electrolysis, nitrogen production, and ammonia synthesis, providing insights into energy efficiency, product purity and flow rates. Additionally, the results asses the impact of reactor number, providing valuable information for designing efficient small-scale green ammonia production systems. Figure 1 show the percentage of energy consumption as a function of reactor number and electrolyzer power in the HB process.

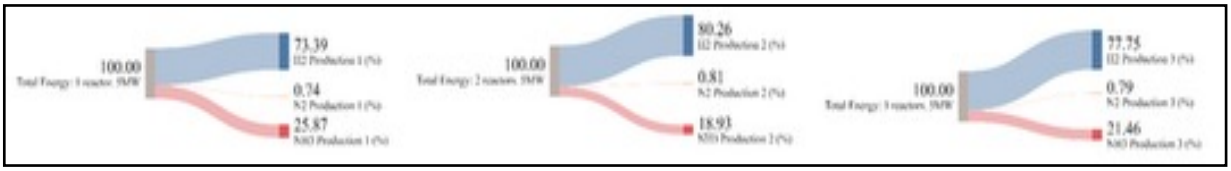

Figure 1. Energy consumption (%) for each process stage as a function of the number of reactors in a 5 MW plant.

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Biography:

I got the Bachelor degree in Chemistry (1989) by the University of Basque Country, master's degree (Mphil) by the University of Bath (United Kingdom) in 1992 and PhD in chemistry by the University of Cantabria in 1994 where I am at present. Currently, the objective of my research is modelling and simulation of chemical and environmental processes, systems, or industrial sub-systems and the development of methods for selecting operating conditions or configurations. This work leads to proposal for alternatives for improvement and optimization of processes, or (ii) intermediate solutions that enable improvements in the system or in the search of optimum conditions. The main areas of application of my work are: process design of water separation, simulation of operations and environmental optimization.