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Design of a Plant to Produce 100,000 MTPY of Green Hydrogen from Brine

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Abstract : Saudi Arabia is host to a state-owned oil and gas corporation, known as Saudi ARAMCO, that is responsible for the highest emissions of carbon dioxide (CO_2) due to the heavy reliance on fossil fuels as an energy source for various sectors such as transportation, aerospace, manufacturing, and residential use. Unfortunately, the detrimental consequences of CO_2 emissions include escalating temperatures in the Middle East region, posing significant obstacles in terms of food security and water scarcity for the Kingdom of Saudi Arabia. As part of the Saudi Vision 2030 initiative, which aims to reduce the country's reliance on fossil fuels by 50 %, this study focuses on designing a plant that will produce approximately 100,000 metric tons per year (MTPY) of green hydrogen (H_2) using brine as the primary feedstock. The proposed facility incorporates a double electrolytic technology that first separates brine or sodium chloride (NaCl) into sodium hydroxide, hydrogen gas, and chlorine gas. The sodium hydroxide is then used as an electrolyte in the splitting of water molecules through the supply of electrical energy in a second-stage electrolyser to produce green hydrogen. The study encompasses a comprehensive analysis of process descriptions and flow diagrams, as well as materials and energy balances. It also includes equipment design and specification, cost analysis, and considerations for safety and environmental impact. The design capitalizes on the abundant brine supply, a byproduct of the world's largest desalination plant located in Al Jubail, Saudi Arabia. Additionally, the design incorporates the use of available renewable energy sources, such as solar and wind power, to power the proposed plant. This approach not only helps reduce carbon emissions but also aligns with Saudi Arabia's energy transition policy. Furthermore, it supports the United Nations Sustainable Development Goals on Sustainable Cities and Communities (Goal 11) and Climate Action (Goal 13), benefiting not only Saudi Arabia but also other countries in the Middle East.

Keywords : plant design, electrolysis, brine, sodium hydroxide, chlorine gas, green hydrogen
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