A New Route to Hydrogen: Multiscale Conceptual Design of H_2S Thermal Splitting Process

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Hydrogen sulfide (H_2S) is a common pollutant in the process industry, due to its high toxicity and corrosive nature. This compound is typically removed during natural gas sweetening processes and as a residue of oil upgrading strategies (i.e. hydrofinishing). In natural gas, H_2S concentrations range from trace levels to significant percentages, its removal is typically performed via well known technologies such as amine washing or membrane systems. Currently, the Claus process is the industry standard for H_2S management, converting it into elemental sulfur and water through the oxidation of hydrogen sulfide. However, this approach does not exploit the hydrogen content present in H_2S. This study explores the integration of a thermal splitting unit for H_2S, aiming to recover hydrogen as a valuable product, according to the global endothermic reaction:

$$H_2S \rightarrow H_2 + 0.5\ S_2$$

A case study on a natural gas sweetening process implementing the Sulfidric Acid Thermal Splitting (SATS) unit has been conducted. Natural gas sweetening is performed using amine washing adopting a conventional tertiary amine (i.e. MDEA). The recovered H_2S is sent to thermal degradation to recover hydrogen, while the unreacted H_2S is recycled back to the amine washing section. The analysis includes an energy assessment of the integrated system and evaluates potential revenues from hydrogen recovery. This approach can be relevant for revamping existing facilities, offering an alternative to the conventional Claus process.

The proposed system comprises two main sections: the H_2S splitting reactor and the purification step for Hydrogen recovery. This work provides an initial feasibility assessment of introducing SATS technology, highlighting its potential for enhancing process efficiency and pollutant utilization. The analysis is performed using dedicated tools: the overall simulation is carried out in Aspen HYSYS v.11, while the modeling of the hydrogen recovery unit is conducted via DSmoke, a specialized suite for managing sulfur-containing compounds.

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