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Effect of Heat Stable Salts on Performance of Aqueous Diglycolamine (DGA) Solution during Acid Gas Capture Process: Simulation-Based Study using ASPEN HYSYS

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Abstract

Removal of the acid gases from natural gas is commonly done via amine solution chemical absorption process in the acid gas removal units in the plants. The oxidation of amines poses a significant challenge, as it produces acidic oxidative products that can cause corrosion, foaming, amine depletion, and the formation of heat-stable salts (H_SS). In this work, the impact of heat stable amine salts on the acid gas, i.e., hydrogen sulfide (H_2S) and carbon dioxide (CO_2), separation from natural gas using 50 wt.% diglycolamine (DGA) was comprehensively examined through studying a number of key process parameters related to the performance of capturing process, product purity, and energy performance of the desorption process. The simulation-based study used a ASPEN HYSYS commercial process simulator to analyze the performance of the process in the presence of various acidic oxidative products, namely glycolic, oxalic, acetic, hydrochloric, formic, and phosphoric acids. The results revealed that acids resulted in increased solution pH due to DGA's buffering capacity, with variations linked to acid strength and dissociation behavior. This increase in pH reduced the availability of free DGA molecules, leading to generally a decreased absorption capacity for acidic gases. Weak acids like glycolic and oxalic acid improved CO_2 and H_2S capture, albeit with a slight increase in reboiler energy demand. Conversely, reboiler duty decreased for most acids, with reductions up to 14.26% observed due to the formation of HSSs and reduced amine regeneration requirements. However, this came with a trade-off where the sweet gas purity declined at the specified solvent flow rate used. This indicates that higher solvent flow rates will be required to achieve the desired sweet gas product purity, which, in turn, will lead to increased reboiler duties. The acids increased the required DGA makeup flowrate due to degradation and losses. These results demonstrate a complex interplay between acid type, system energy demands, and absorption performance, necessitating optimization for effective acid gas capturing process.

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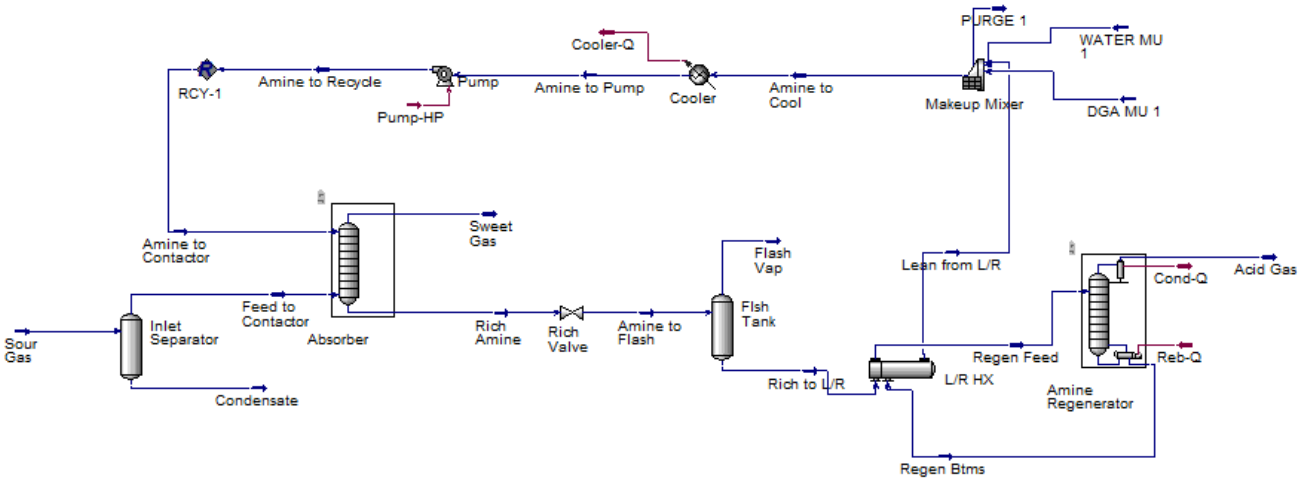

Figure 1. Acid Gas Removal Process Flow Diagram.

Keywords: Gas Sweetening;Process Simulation;Alkanolamine;ASPEN HYSYS;Acid Gases;Heat Stable Amine Salts.

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