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Enhancing CO2 Capture Efficiency: Advanced Modifications of Solvent-Based Absorption Process—Pilot Plant Insights

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Since fossil fuels still dominate industry and electricity production, post-combustion carbon capture remains essential for decarbonizing these sectors. The most advanced technique for widespread application, particularly in hard-to-abate industries, is amine-based absorption. However, increasing energy efficiency is crucial for broader implementation. This study presents pilot-scale results from the Tauron Power Plant in Poland using a mobile CO2 capture unit (1 TPD). Two innovative process modifications—Split Flow (SF) and Heat Integrated Stripper (HIS)—were experimentally investigated; they achieved a 10% reduction in reboiler heat duty, reaching 2.82 MJ/kgCO2, along with a 36% decrease in overall heat losses and up to a 28% reduction in cross-flow heat exchanger duty. The analysis highlights both the advantages and challenges of these modifications. SF is easier to retrofit into existing plants, whereas the HIS requires more extensive modifications in the stripper section, thus making HIS more cost-effective for new installations. Moreover, as heat consumption constitutes the primary operational cost, even a moderate reduction in heat duty can lead to significant economic benefits. The HIS also offers substantial potential for thermal integration in industries with available waste heat streams. The pilot data underwent validation procedures to ensure reliability, which provides a robust foundation for process modeling, optimization, and scaling for industrial applications.

Metryczka

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