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Abstract

Optimizing Carbon Capture Efficiency in Coal-Fired Power Plant Using Pinch Assessment Techniques for Clean and Sustainable Energy Production †

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Carbon capture and storage (CCS) technologies play a critical role in mitigating greenhouse gas emissions from coal-fired power plants, which is essential for achieving global climate goals. Pinch assessment techniques offer a systematic approach to optimizing carbon capture efficiency and energy utilization within these facilities. By integrating heat exchange networks and identifying optimal heat transfer points, a pinch analysis enables the reduction in energy consumption and the environmental impact associated with carbon capture processes. In the context of coal-fired power plants, achieving high-purity CO_2 capture is a key objective. The use of a 30% MEA solution, despite introducing an initial 17.6% energy premium, results in a significant 12.3% reduction in overall energy consumption. This translates to a substantial 50% decrease in energy requirements for carbon capture operations, along with an impressive 90% CO_2 capture efficiency. These findings underscore the potential of pinch assessment techniques to enhance the sustainability and cost-effectiveness of carbon capture technologies. Furthermore, the implementation of a pinch analysis offers a pathway towards achieving cleaner energy production and reducing environmental footprints. The systematic optimization of heat exchange networks not only leads to energy savings but also contributes to operational efficiency improvements within coal-fired power plants. By strategically matching hot and cold streams, the consumption of water and energy in carbon capture processes can be minimized, paving the way for greener and more sustainable power generation practices. In conclusion, the comprehensive application of pinch assessment techniques presents a promising opportunity for enhancing carbon capture efficiency and advancing clean energy technologies in coal-fired power plants.

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