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Optimization of Process Cooling for Post-Combustion Carbon Capture

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Abstract

Implementation of post-combustion carbon capture is an essential technology to decarbonize industrial emissions. Amine based carbon capture solutions are the current benchmark for effective and efficient post-combustion carbon capture industry wide, with conventional commercial plants globally utilizing amine-based solvents. One of the most significant cost drivers of employing carbon capture is the necessity to cool the flue gas from stack temperatures (~180°C) down to temperatures that are tolerable and optimal for the absorption solvent. This highlights the need for a cost-effective flue gas cooling design. Additionally, much of the heat released when absorbing CO2 must be countered so as not to dehydrate the aqueous absorption solvent. Both capital and operational costs are significantly influenced by the cooling medium available and how the cooling system is implemented. Achieving efficient capture and reducing the levelized cost of capture requires significant optimization of the cooling method and consider both the utility availability and climate. In addition, the overall plant performance of the carbon capture technology can be affected by seasonal variabilities related to the cooling system medium which can be optimized to achieve annual carbon capture targets without over investing in assets. This paper will present an evaluation of different cooling strategies, and how they can be optimized to reduce the levelized cost of capture.

Post combustion carbon on gas turbine exhaust will be evaluated to determine the optimum process cooling method in both a hot (California, USA) and cold (Alberta, Canada) climate. Different cooling utilities will be considered for both climates, along with a discussion to highlight the constraints, cost drivers and risks for each.

This study leverages Fluor's extensive experience with Econamine FG+ carbon capture technology and incorporates the impact of different cooling utilities scenarios using proven licensed technology designs. It is based on reference projects, historical market data, and process simulations using a rate-based model to incorporate unique factors such as seasonal ambient temperature variability on the results. Results generated for each case allow for a comparison of each cooling method's efficiency, capital and operational costs.

The study centres around a techno-economic evaluation of water cooling, air cooling, indirect air cooling (using a secondary medium), and evaporative cooling. Factors such as cooling availability, process temperature optimization, off-design cases, heat integration opportunities, and winterization requirements are considered. The results highlight the most cost-effective and efficient cooling methods for different types of locations and constraints. The findings offer improved capital and operational efficiency for post-combustion carbon capture, paving the way for more sustainable and cost-effective solutions.

Keywords: Techno-economic evaluation; procrss configuration comparison; rate based modeling; flexibie operation; gas-fired power plants; minimum 1 page, maximum 4 pages inclding diagrams and references.