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Optimization of MEA based post combustion CO_2 capture process: Flowsheeting and energetic integration

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Abstracts

The purpose of this works is to assess the impact of the different flowsheet modifications and power plant integration on the plant performance for post-combustion MEA absorption. The capture plant increases the cost of a new power plant by approximately 70% and the electricity price by 45%. Process flowsheet optimization on the amine capture plant do no significantly increase the specific power plant cost with CO_2 capture, the additional expenditure are compensated with the plant efficiency gains. The addition of a capture plant increases by approximately 1.4%pt the risk of forced outage factor and therefore decreases the whole power plant availability by the same value. The effects of the availability decreases due to the capture plant on CO_2 and electricity prices are negligible.

Keywords : absorption, integration, availability, electricity cost

1. Introduction

The main limitation of post-combustion CO2 capture technology is the high energy consumption leading to a power output loss of approximately 25% when coupled with CO2 compression. Studies to break this limitation follow two main paths: formulation of new solvents and optimization of the process flowsheet.
The purpose of this works is to assess the impact of the different flowsheet modifications and power plant integration on the plant performance.

2. Main hypothesis

CO_2 capture amine plant has been integrated in a gross electrical 1200 MWe supercritical coal-fired power plant; a process optimization study coupled with economical and availability analysis has been performed for each studied case and compared to a reference case: standard amine capture process with 30%wt MEA.

Figure 1 shows an example of investigated improved flow scheme:
process 1 with a stripper staged feed and an internal stripper compression train
process 2 with an improved economizer, a stripper overhead compression and a lean solvent vapour compression with an optimized heat recuperation

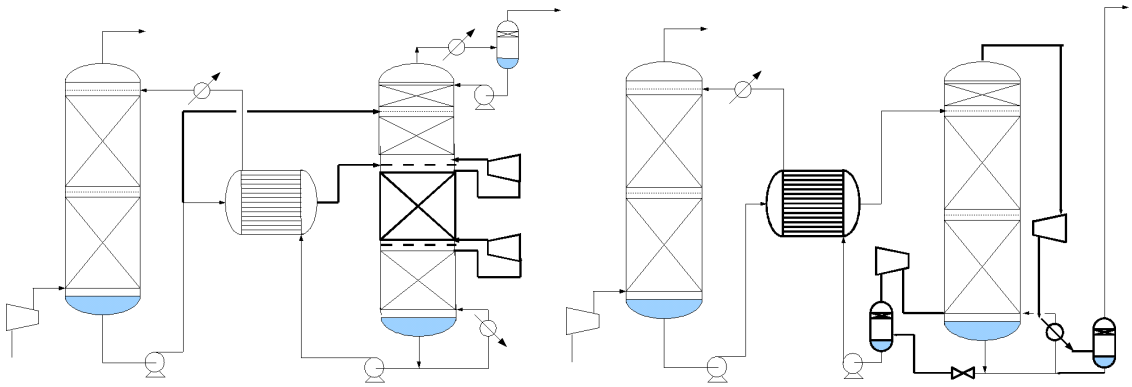

Figure 1: example of investigated flow scheme (right: process 1, left: process 2)

3. Results

The capture plant increases the cost of a new power plant by approximately 70% and the electricity price by 45%. Process flowsheet optimization on the amine capture plant do no significantly increase the specific power plant cost (from 0 to 2%) with CO_2 capture, the additional expenditure are compensated with the plant efficiency gains. The cost of electricity is, also, almost not affected by the flowsheet optimization (from -2.5 to +1.5 %). The best tested configuration allows a reduction of 10% of the cost of avoided CO_2. The addition of a capture plant increases by approximately 1.4%pt the risk of forced outage factor and therefore decreases the whole power plant availability by the same value.

The effects of the availability decreases due to the capture plant on CO_2 and electricity prices are negligible. This work shows that these modifications alone are not sufficient to enable an economically feasible carbon capture on coal fired power plant despites a loss of efficiency of approximately 10%pt. The goal of less than 5% pt efficiency losses induced by post combustion carbon capture need a combination of new solvent and optimized process or a totally new breakthrough process.