Optimization of CO_2-compression and purification units for CCS power plants

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Abstract:

From a global point of view, fossil fired power plants are responsible for a major part of anthropogenic carbon dioxide emissions. In order to limit the effect of global warming by 2K until 2050 different measures have to been taken. Carbon capture and storage technology (CCS) is an important approach within the efforts to limit global CO_2 concentration in the atmosphere. Within CCS three major technologies are established: Pre-combustion capture, where the carbon is removed from the fuel before combustion; oxy-fuel technology, where high CO_2 concentrations in the flue gas are generated by combustion with nearly pure oxygen; post-combustion capture, where the carbon dioxide is separated from the flue gas behind the conventional power plant process. Each separation technology delivers a carbon dioxide rich gas stream with a characteristic composition. In all separation cases the carbon dioxide rich gas stream has to be compressed, purified, transported and stored or reused. In order to ensure a secure pipeline transportation and storage, different requirements regarding CO_2 rich gas composition have to be fulfilled.

Within the proposed paper three types of carbon dioxide compression and purification units (CO2CPU) are presented and compared to a conventional multi-stage CO_2 compression unit without purification. All three types of CO2CPU are based on phase separation technique and are modeled in AspenPlus®. The first two types are equipped with flash columns and the third one includes a distillation column. All three types require a dehydration station for water removal.

For each technology the impact of main design parameters on performance features such as power requirement, cooling duty, separation efficiency and CO_2-purity are analyzed, including variations in CCS-technology, fuel quality, plant loads and mixing parameters.

The goals are first to point out the main differences resulting from upstream composition, the requirements for downstream composition and CO2CPU technology and second to optimize the design of each CO2CPU with respect to the above mentioned parameters.

Keywords: CCS, CO_2 compression, CO_2 purification, CO_2 quality

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