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Simulation and optimization of CO_2 capture from flue gas by ammonia scrubbing

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Public Summary

The reduction of CO_2 emissions in flue gas of fossil fuel-fired power plants, especially coal-fired power plants, is essential to mitigate climate change. However, the energy penalty of CO_2 capture is so large that the current research priority is to find new solvents that may lower the penalty.

This study simulated an ammonia absorption system and integrated it with mother plant steam cycle. The factors that affected absorption, regeneration and CO_2 compression were analyzed, respectively. The steam cycle of the power plant was simulated and the effects of the steam extraction on electricity output were studied. Finally, the capture system was integrated with the steam cycle and the reduction in the efficiency of the power plant caused by CO_2 capture was researched.

The ways that various parameters affect absorption and regeneration were studied via the simulation of the absorber and stripper. The optimum values of temperature, ammonia concentration and CO_2 concentration in the solvent can be determined by their influences on the flow rate of solvent, ammonia losses and water losses. The steam cycle model of a 300MW power plant was set up and the relationship between extraction of steam and temperature of feed water with the load of power plant was found. The comparison of simulated data with real data validates the model. The integration of the CO_2 capture system with the steam cycle shows the cost of CO_2 capture: the output of the power plant reduces because steam is extracted to heat the reboiler and electricity is needed to compress flue gas and CO_2 and to increase the pressure of solvent. CO_2 concentration in solvent and the pressure of stripper are the two key factors in determining the reduction in the mother plant output. The reduction in the efficiency of the power plant could be minimised if the optimum concentration and pressure are chosen. Furthermore, the extraction point of the steam decides the flow rate of steam extracted and the power output of the mother plant. The rest of this document is project confidential