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Location-Specific Technoeconomic Evaluation of a Novel Amine Technology

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A novel amine capture technology for CO_2 emissions has been developed by Huaneng/Xi'an Thermal Power Research Institute. Lawrence Livermore National Laboratory (LLNL), on behalf of the U.S.-China Clean Energy Research Center, has evaluated the technology using location-specific economic parameters to reflect power generation loss from a coal-fired power generation plant due to amine regeneration, the necessary utility constraints and investment, and the constraints of the location.

The conceptual design used for cost estimates consists of a pre-absorption cooler (cooling by injection of water directly into the flue gas was not feasible because of 100% flue gas humidity post-flue gas desulfurizer), an absorber with a spray stage to minimize evaporative amine losses; an economizing heat exchanger and trim heaters and coolers: a stripper with a reboiler and condenser to recover absorbed CO_2; a five-stage CO_2 compression train with intercooling and water removal; and an ion exchange process to control build-up of heat-stable salts by treating a bleed stream from the lean amine stream.

We conclude that Huaneng's novel amine composition, because of the use of hindered and tertiary amines, has a lower heat of regeneration and hence reduces the power generation penalty. Further, we assess that the hindered and tertiary amines are less susceptible to thermal and oxidative degradation, although they are still susceptible to degradation by reaction with CO_2. We estimate the reduced power generation penalty and reduced solvent degradation gives a modest but tangible cost advantage relative to 30% MEA.

Among the location-specific constraints we have identified are: limited ability to cool incoming flue gas by water injection because of high humidity; and poor soil conditions that would require extensive civil engineering prior to plant construction. These differences we assess will increase the cost of implementing an amine-based capture technology over costs based on assumed greenfield construction.

Keywords: Carbon capture, Process economics, Gas absorption, Amines, Technoeconomics, Carbon dioxide, Greenhouse gas