Analysis of membrane-based processes for CO_2 capture from natural gas combined cycle power plants

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A variety of separation processes have been advanced as candidates for post-combustion removal of CO_2 from fossil-fired electricity generating units. Carbon capture and storage (CCS) processes based on selective gas separation membranes provide several practical advantages, including avoiding steam extraction from the electricity generating cycle. Several groups have proposed membrane-based flowsheets to balance trade-offs between permeability and selectivity.[1-4] In addition, combustion of natural gas in natural gas combined cycles (NGCC) plants have contributed a increasing portion of the electricity generated in the US as a result of the recent low price of natural gas and the relatively low cost to build NGCC systems. As more electricity is generated by burning natural gas, reducing CO_2 emissions may require the use of CCS technology on natural-gas derived flue gas streams. We have used process modeling to quantify the impacts that membrane-based CCS processes could have on NGCC plant output. These process models were used to compare different process flowsheets and to help determine the trade-offs between membrane properties (permeance and selectivity) and process variables such as membrane stage sizes and stream pressures. Numerical optimization techniques were used to minimize either the power used by the capture system or the projected cost of CO_2 capture under different process constraints.

References

1. Toy, L.; Kataria, A.; Gupta, R. P. *CO2 Capture Membrane Process for Power Plant Flue Gas*; Final Technical Report DE-NT0005313; RTI International: Research Triangle Park, NC, 2012; p. 76.
2. Bocciardo, D.; Ferrari, M.-C.; Brandani, S. *Energy Procedia* **2013**, *37*, 932.
3. Merkel, T. C.; Wei, X.; He, Z.; White, L. S.; Wijmans, J. G.; Baker, R. W. *Ind. Eng. Chem. Res.* **2013**, *52*, 1150.
4. Ramasubramanian, K.; Verweij, H.; Winston Ho, W. S. *Journal of Membrane Science* **2012**, *421–422*, 299.