

PROJECT FACTS

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POWER GENERATION & UTILITY FUELS

Development of Membrane/Solvent Hybrid Separation Process for Post-combustion CO₂ Capture in Existing Coal-Fired Power Plants

Due to global warming related to massive CO₂ emissions, there is a common consensus that greenhouse gases such as CO₂ have to be captured and sequestered prior to being vented into the atmosphere. The membrane separation technique holds promise as a major improvement over the currently available methods for CO₂ removal in some specific applications such as pre-combustion IGCC, and NGCC post-combustion, because of its inherent advantages such as chemical-free, compact volume, operationally simple, and energy-saving. Individual membrane separation processes in general cannot offer high separation efficiency in the isolation of various CO₂-containing gas streams, mainly associated with an unsatisfied selectivity for CO₂ molecules or a relatively low permeability, or both of them. The overall goal of this project is to find out an efficient and feasible solution to overcome the above barrier.

Relative to the conventional CO₂ scrubbing process, the proposed membrane-based hybrid process will provide compact design of the stripper section with significantly less energy consumption. This membrane device will be installed prior to the stripper or absorbent solvent regenerator. The membrane media will preferentially permeate a majority of the water component in the solution and reject a major portion of the carbonate/bicarbonate species in the solution. This will have the effect of concentrating the carbon loading before entering the stripper for regeneration. Afterwards, the ammonia solution collected on the permeate side of the membrane is recycled to the scrubber for additional CO₂ capture.

The objectives of this study are to:

- (1) Develop a solvent-based post-combustion CO₂ absorbent/membrane hybrid process by integrating a highly selective membrane for dehydration and concentration.
- (2) Screen, fabricate and reproduce a class of selective membranes for our purpose, and then evaluate their separation performances in terms of CO₂ capture efficiency.
- (3) Optimize the system integration and membrane separation technique in order to intensify and simplify the operational units.
- (4) Calculate the energy penalty and the total cost savings with respect to the scenario involving only the absorption solvent.