PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

POWER GENERATION & UTILITY FUELS

PARTICIPANTS

University of Kentucky
Center for Applied Energy Research
2540 Research Park Dr.
Lexington, KY 40511

SPONSORS

Advanced Research Projects Agency-Energy (U.S. Department of Energy (DOE))

PROJECT VALUE

$2 Million

CONTACT

Kunlei Liu
UK CAER
2540 Research Park Dr.
Lexington, KY 40511
Tel.: 859-257-0293
Fax: 859-257-0302
kunlei.liu@uky.edu
www.caer.uky.edu

A Solvent/Membrane Hybrid Post-combustion CO_2 Capture Process for Existing Coal-Fired Power Plants

Moving forward with post-combustion Carbon Dioxide (CO_2) capture technology will require significant advances in technology to reduce costs. The solvent/membrane process in this project will reduce costs for existing chemical solvent-based CO_2 capture methods by increasing the concentration of captured CO_2 in the solution sent to the solvent regenerator. This reduces energy demand by increasing the CO_2 stripping driving force. In addition, the catalytic process will further drive the reaction towards bicarbonate, reducing the heat of the reaction for regeneration.

This novel technology acts as an absorption solvent/catalytic membrane hybrid post-combustion CO_2 capture process for existing coal-fired power plants. The membrane is working as a catalytic separator, coupling nanofiltration separation and catalysis functions. The absorption solvent of interest includes aqueous ammonium and some typical alkyl amines (e.g., MEA solution). The membrane reactor selectively rejects water from the permeate and catalytically drives the reaction towards bicarbonate allowing a more concentrated and more easily regenerated solution to be sent to the stripper. Through implementation of the catalytic membrane reactor, the energy penalty for CO_2 capture is reduced greatly. The membrane unit can be conveniently integrated into an aqueous-based scrubbing system as a cross-over heat exchanger and installed between a scrubber and a stripper in the typical carbon-capture process for fossil fuel-fired power plants. The technology developed in this project, if successful, could potentially ensure the realization of the DOE's target of less than 35% increase in the cost of energy service, while capturing at least 90% of the CO_2.

The objectives of this study are to:

(1) Develop a catalytic solvent-based post-combustion CO_2 membrane separation hybrid process.
(2) Develop ceramic support extrusion technology exhibiting high permeate flux capability while maintaining suitable membrane growth.
(3) Develop a hollow fiber extrusion and testing capability incorporating the catalytic membrane separation function.
(4) Optimize the developed system, while constructing and integrating it into the CAER's 0.1 MW_{th} pilot CO_2 scrubber/stripper unit.
(5) Test the membrane separation unit at the pilot scale including testing with coal flue gas from the CAER's flue gas generator.