IEAGHG Information Paper 2018-IP29; 2018 NETL CO_2 Capture Technology Project Review Meeting: Advances in Hybrid Technologies

Hybrids technologies were also present during the 2018 NETL CO_2 capture technology project review meeting. As highlight, all the hybrid technologies were the combination of a membrane-based system with another CO_2 capture technology. Then, typical low-medium capture rates showed by membrane-based technologies will be higher by the addition of another carbon capture technology.

Although hybrid technologies are expected to sum up the advantages of each carbon capture technologies, the main conclusion was that hybrid systems are complex, meaning that they are not a simple combination of two technologies. In addition to the individual challenges of each technology, the combination can have a higher carbon footprint a more complex and longer retrofit/ installation. Costs might not compensate the higher capture rate obtained with an hybrid system, and the technology readiness level is still low compared to the individual technologies.

A summary of the projects presented is included in the table on the next page.

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Project Title	Duration	Coordinator	Info	Website
Lab-scale development of a hybrid capture system with advanced membrane, solvent system, and process integration	01/10/2015 – 30/09/2018	Liquid Ion Solutions, LLC	The hybrid technology is a two-stage CO_2 capture system combining a membrane separation process and an absorption/stripping process with heat integration between the absorption column and stripping column through a heat pump cycle. The project team has not been able to scale-up the production of materials through the dialysis technique and concluded that this route is not an option.	FE0026464
Bench-scale development for hybrid membrane-absorption CO2 capture	01/10/2013 – 30/09/2018	Membrane Technology and Research, Inc. (MTR)	The system will combine Polaris™ membranes (high-permeance, low pressure-drop, plate-and-frame modules), the piperazine (PZ)- based solvent, and advanced high-temperature and high-pressure regeneration (high thermal stability, rapid CO_2 absorption rate, and low oxidative degradation). A process simulation model will be developed for the hybrid process (series and parallel configurations). Series configuration shows OPEX savings due to removal requirements for the capture unit, while the parallel shows CAPEX savings, perhaps the separation seems lower based on the project results. Tests have been performed under a range of operating conditions for both series and parallel designs. These test results are being studied to determine the optimal mode of operation. Results show that the minimum O_2 concentration in the fluegas limits the CO_2 concentration and PZ needs to be over stripoed (not beneficial for partial capture rates). UTA examined various PZ blends for further screening of new mixtures. Potential candidates were selected (IPAE, BMEA, 1.2,DM-IMI, 2PDE, 2E-IMI, 2E-4M-IMI) and two absorber configurations were studied. The process performed well with fluegas with 20%CO_2, where energy requirement was independent on the inlet CO_2. The absorber model reproduced better the process at low CO_2 contents. The cost is similar to the 5M AFS capture system.	FE0013118
Pilot test of a nanoporous, super hydrophobic membrane contactor process for post-combustion carbon dioxide capture	01/10/2013 – 30/06/2019	Gas Technology Institute (GTI)	The process is designed in a way that CO_2-containing flue gas passes through one side of the PEEK HFC, while an advanced CO_2-selective solvent flows on the other side. The CO_2 permeates through the hollow fiber contactor pores and is chemically absorbed into the solvent. The CO_2 rich solvent is regenerated in a second PEEK HFC module. Pilot-scale testing will be conducted with commercial size 8-inch diameter modules on 0.5 MWe of coal-derived flue gas at the National Carbon Capture Center (NCCC). A 90% of capture can be obtained in one stage and is not affected by other contaminants. Preliminary TEA shows a cost reduction of 12 % compared to the DOE Reference case 12.	FE0012829
Membrane-sorbent hybrid system for post-combustion CO_2 capture	15/08/2018-14/08/2021	TDA Research, Inc.	This hybrid system will be scaled up to 1MWe. The system consists in a polymeric membrane (MTR) and a low temperature physical adsorbent (TDA). The early proof of concept demonstration in an SBIR proved the feasibility of such system. The approach is based on two membranes in series to remove 50% of the CO_2 in the coal-fired fluegas, avoiding the vacuum needed to achieve high CO_2 removal and allows the boiler to regenerate a high CO_2 gluegas. The challenges in the project are the existence of oxygen in the fluegas , the high pressure drop in the secondary membrane and the need to pressurize the fluegas to 2-3 atm for reasonable performance in the secondary membrane. TDA's sorbent (mesoporous carbon modified with surface functional groups) removes the remaining CO_2 from the membrane effluent by strong physical adsorption, achieving a 90% capture rate. The energy required for the solid regeneration is low because the CO_2 is not bonded (heat of CO_2 adsorption is 4-5kcal/mol). Lab and field tests have been carried out (20-40 kg/day CO_2). Preliminary results suggest lower energy consumption in this hybrid system compared to the traditional MEA-based process.	-