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Transformational Molecular Layer Deposition Tailor-made Size-Sieving Sorbents for Post- combustion CO₂ Capture

DOE Award No.: DE-FE0031730

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2019 Carbon Capture, Utilization, Storage, and Oil and Gas Technologies
Integrated Review Meeting
August 29, 2019

Project Overview

- **Performance period**: Oct. 1, 2019 – Sep. 30, 2022
- **Funding**: \$3,000,000 from DOE; \$759,206 cost share
- **Objectives**:

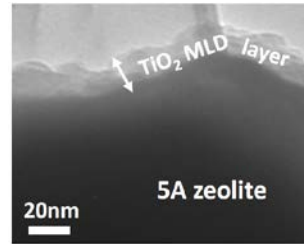
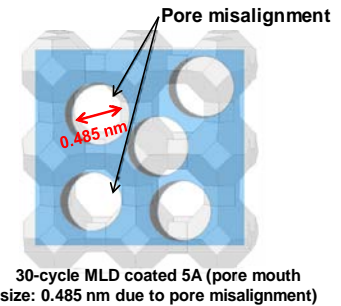
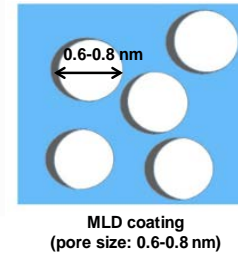
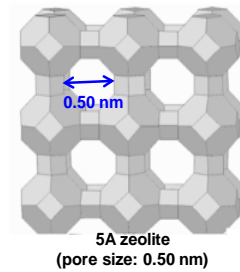
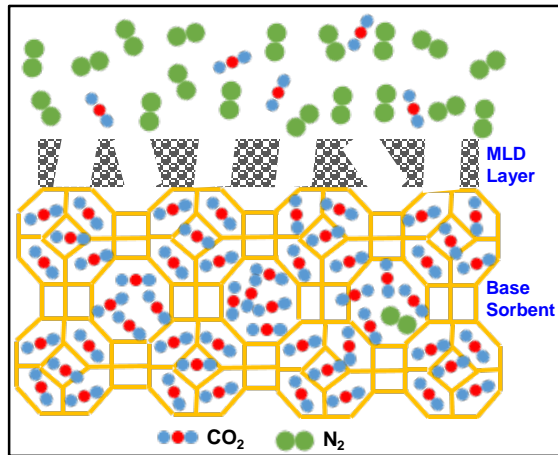
Develop a transformational (T) molecular layer deposition (MLD) tailor-made size-sieving sorbent (S) integrated with a tailored PSA cycle schedule (designated as MLD-T-S/PSA process) that can be installed in new or retrofitted into existing pulverized coal (PC) power plants for CO₂ capture with a cost of electricity at least 30% lower than a supercritical PC with CO₂ capture, or approximately \$30 per tonne of CO₂ captured, and with it being ready for demonstration by 2030.

- **Project participants**:



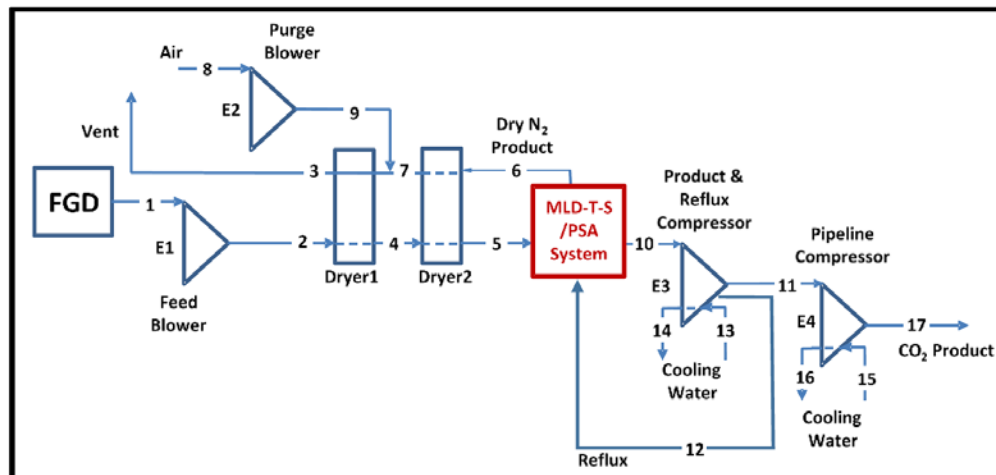
Technology background

MLD-T-S for molecular sieving



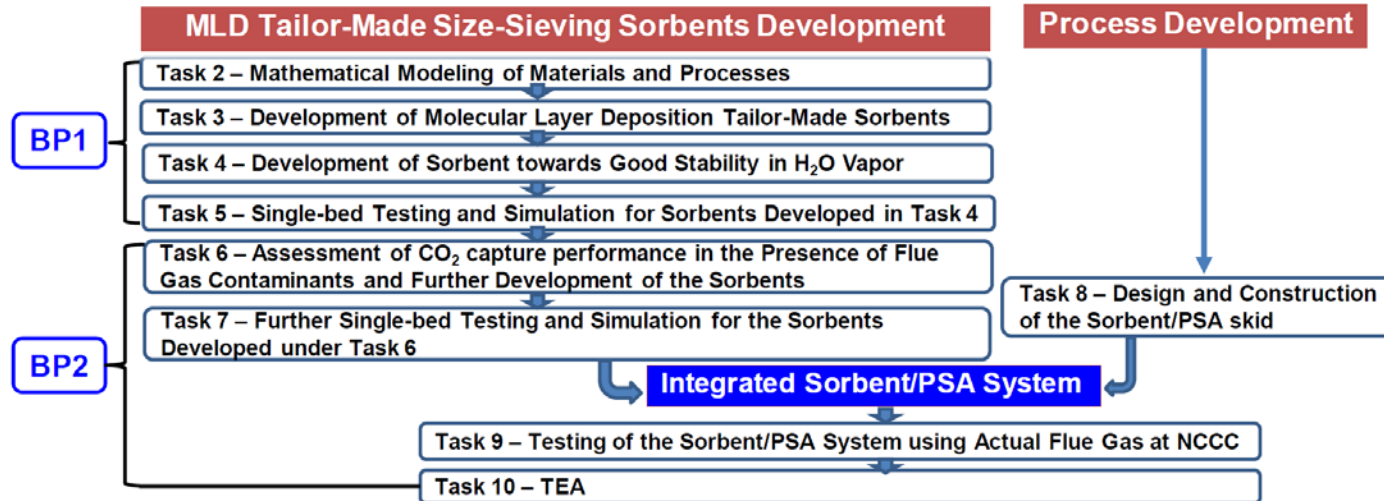
Adsorbents	Adsorption capacity (mmol/g)		CO ₂ /N ₂ ideal selectivity
	CO ₂	N ₂	
5A zeolite	1.0	0.15	35
5A-MLD-250-2h	0.97	0.036	130
5A-MLD-250-4h	0.55	0.028	98
5A-MLD-250-8h	1.0	0.11	46

USC's unique PSA process flow sheet from FGD through CO₂ compression



Technical Approach/Project Scope

Experimental design and work plan



Key milestones and success criteria

BP1: Achieve performance targets for the MLD tailored-made sorbents and achieve baseline PSA

Success criteria: i) MLD tailor-made sorbent showed CO₂/N₂ selectivity ≥ 130 with simulated flue gas containing water; the measured heat of adsorption for CO₂ is < 35 kJ/mol;

ii) 1-Bed PSA testing with MLD T-S and follow-on DAPS simulation validated that the required beds can be reduced to ≤ 48 for a 550 MWe (net) power plant.

BP2: Achieve 95% CO₂ purity and 90% CO₂ recovery with the MLD-T-S/PSA skid for actual flue gases at National Carbon Capture Center (NCCC) and validate DOE cost goal.

Success criteria: i) Sorbent/PSA skid testing at NCCC using flue gas complete, 70-90% CO₂ removal rate achieved, 95% CO₂ purity validated, and sorbent shows good stability during a 200-h continuous testing;

ii) Final TEA report issued. DOE cost goal (cost of electricity 30% less than baseline CO₂ capture approach Case B12B, or approximately \$30 per tonne of CO₂ captured) validated.