CO_2-Philic Block Copolymers with Intrinsic Microporosity for Post-combustion CO_2 Capture (SC0020730)

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Objectives of DOE STTR Project

Objective 1: Optimize TFC membrane for CO_2 permeance ≥4,500 GPU and CO_2/N_2 selectivity ≥40 at 35-60°C

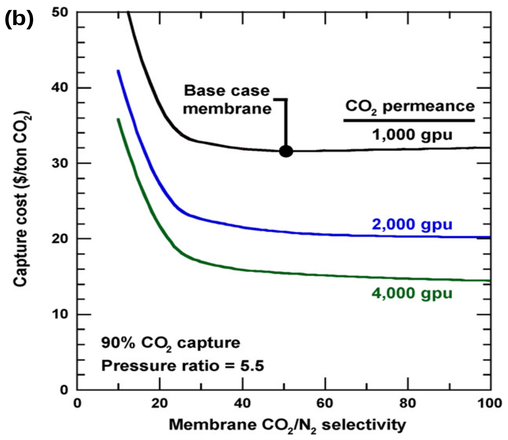
Objective 2: Scale-up TFC membrane fabrication

Objective 3: Validate resistance to contaminants

Objective 4: Fabricate small modules and validate in-process tests

Objective 5: Define the best process and refine TEA

Defining Membrane Properties for CO_2/N_2 Separation



Target: CO_2 permeance of 4500 GPU and CO_2/N_2 selectivity of ≥40 at operating conditions

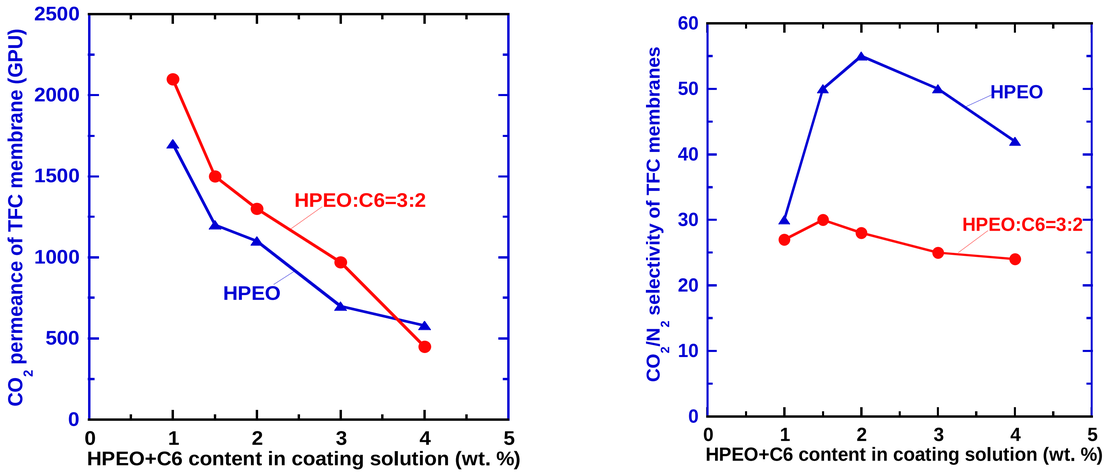
Merkel, et al., Pilot testing of a membrane system for post-combustion CO_2 capture (DE-FE0005795), Membrane Technology and Research, Inc., final report to DOE NETL, 2015.

Our Approach: Fabricate TFC Membrane Based on Poly(ethylene oxide) and Crown Ether

Three steps:

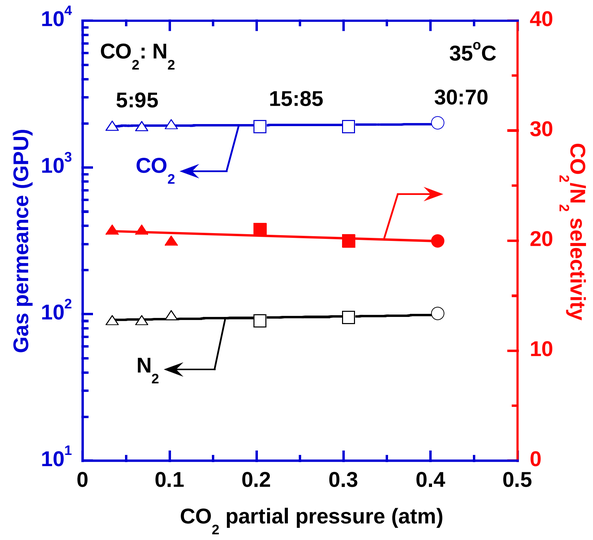
1. Synthesize high molecular weight poly(ethylene oxide);
2. Optimize the gutter layer to increase gas permeance of the membrane;
3. Add Crown ether (C6) into the selective layer to further increase gas permeance

Pure-gas Separation Performance of HPEO(C6) TFC Membranes

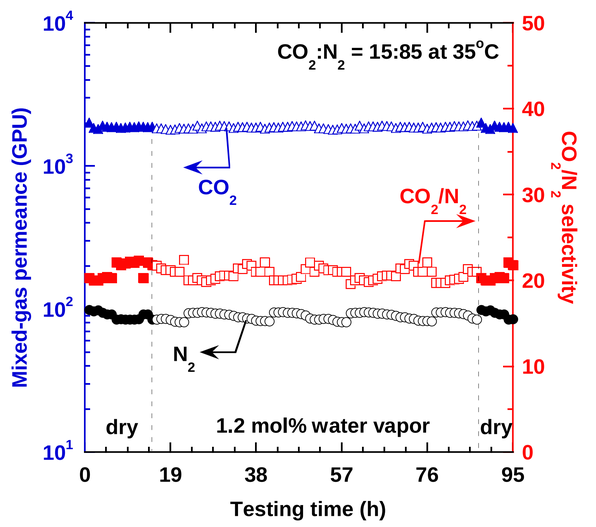


Adding 40wt% C6 into the selective layer increases gas permeance and slightly decreases selectivity.

Mixed-gas Separation Performance of HPEO(C6) TFC Membranes

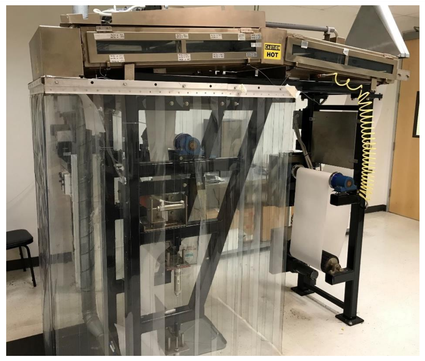


Absence of CO_2 plasticization.



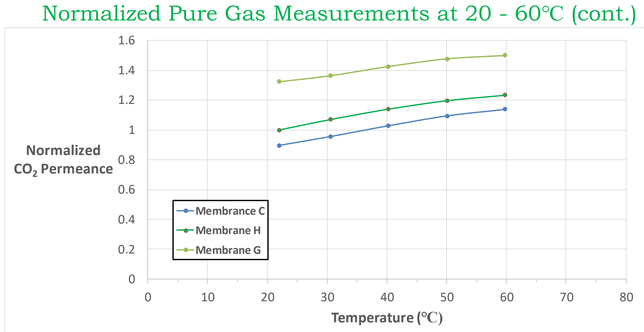
Stable and superior CO_2/N_2 separation in simulated flue gas conditions.

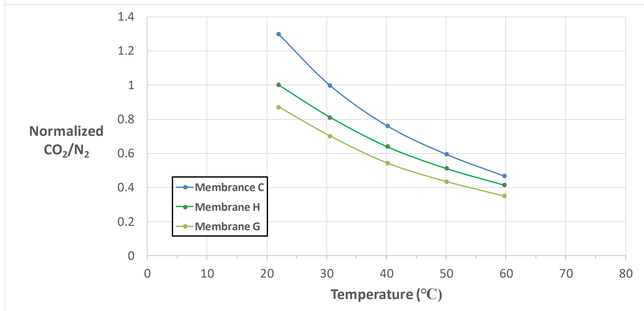
Scale-up the Fabrication of TFC Membranes



- MTR leads TFC membrane scale-up activities;
- Research-scale (12-inch width) roll-to-roll coating equipment has been used.

Normalized Pure Gas Measurements at 20 - 60°C (cont.)





Process Development and Economic Analysis

- **550MW SCPC plant**
- **Process:**
  - 2-Stg Cascade + Cryo
  - MTR air refluxed 3-Stg + Cryo
  - Capture efficiency: 91.5%
- **Membrane properties:**
  - CO_2 perm: 3500-4500 GPU
  - CO_2/N_2 selectivity: 35-40
- **50 mil Power; $50/m^2$**

	Mem 1 - Low End		Mem 2 - High End	
	W/o Cryo	W/- Cryo	W/o Cryo	W/- Cryo
Overall Capture eff	91.5%	91.5%	91.5%	91.5%
Prod CO2 Conc.	85.5%	100.0%	87.0%	100.0%
Power Used (MW)	59.5	109.0	58.5	108.0
CO2 Capture Cost ($/ton)	**21.2**	**29.5**	**20.1**	**28.5**

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