ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE

A Novel Biphasic Solvent for Post-Combustion CO_2 Capture

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PCCC4 Post Combustion Capture Conference

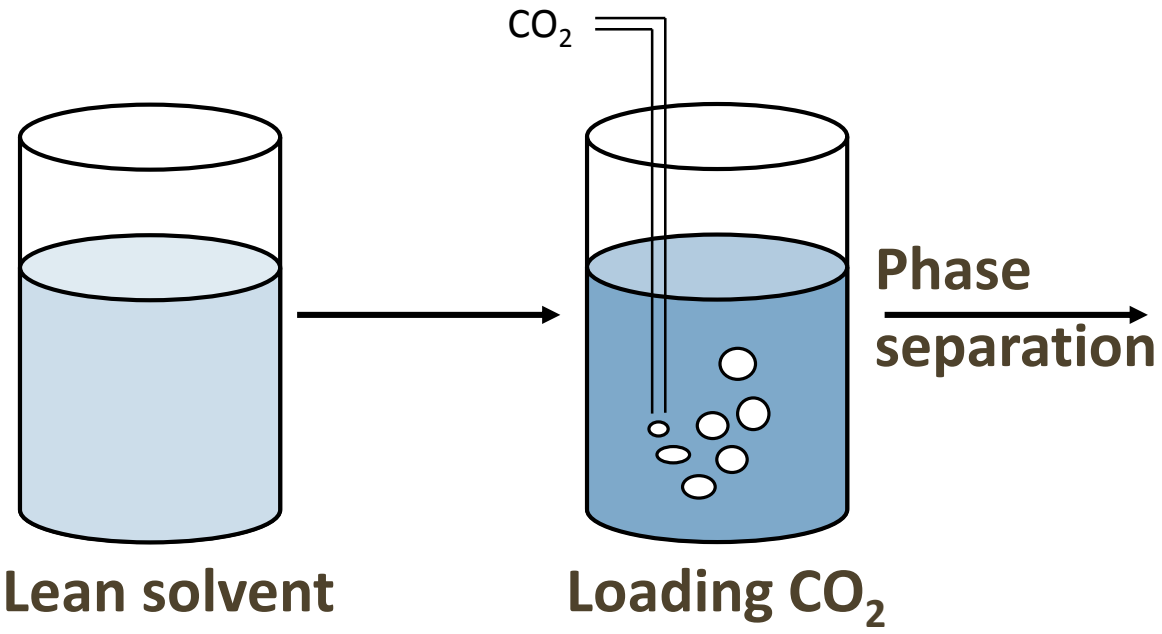
Outline

- **Background**
  - ✓ Biphasic amine scrubbing process
  - ✓ Criteria used for biphasic solvent selection
- **A novel biphasic solvent-BiCAP-1**
  - ✓ Solvent stability (thermal and oxidative)
  - ✓ CO_2 absorption performance
  - ✓ Heat duty for CO_2 stripping
- **Conclusions**

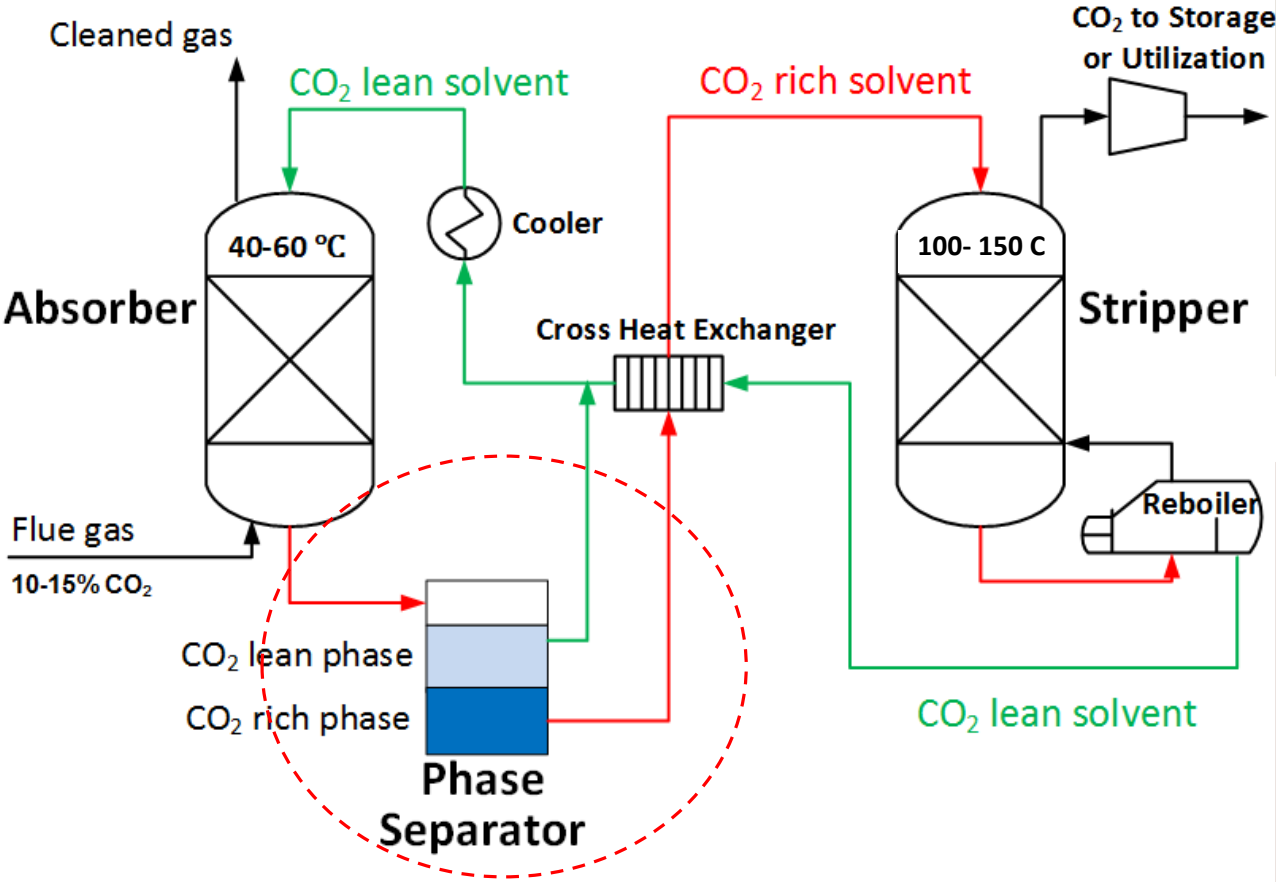
Background

Novel Biphasic Solvents

Fresh solvent in a single phase → Phase separation induced by CO_2 loading → Two-phase system w/ tunable phase vol.%



Biphasic CO_2 Absorption Process



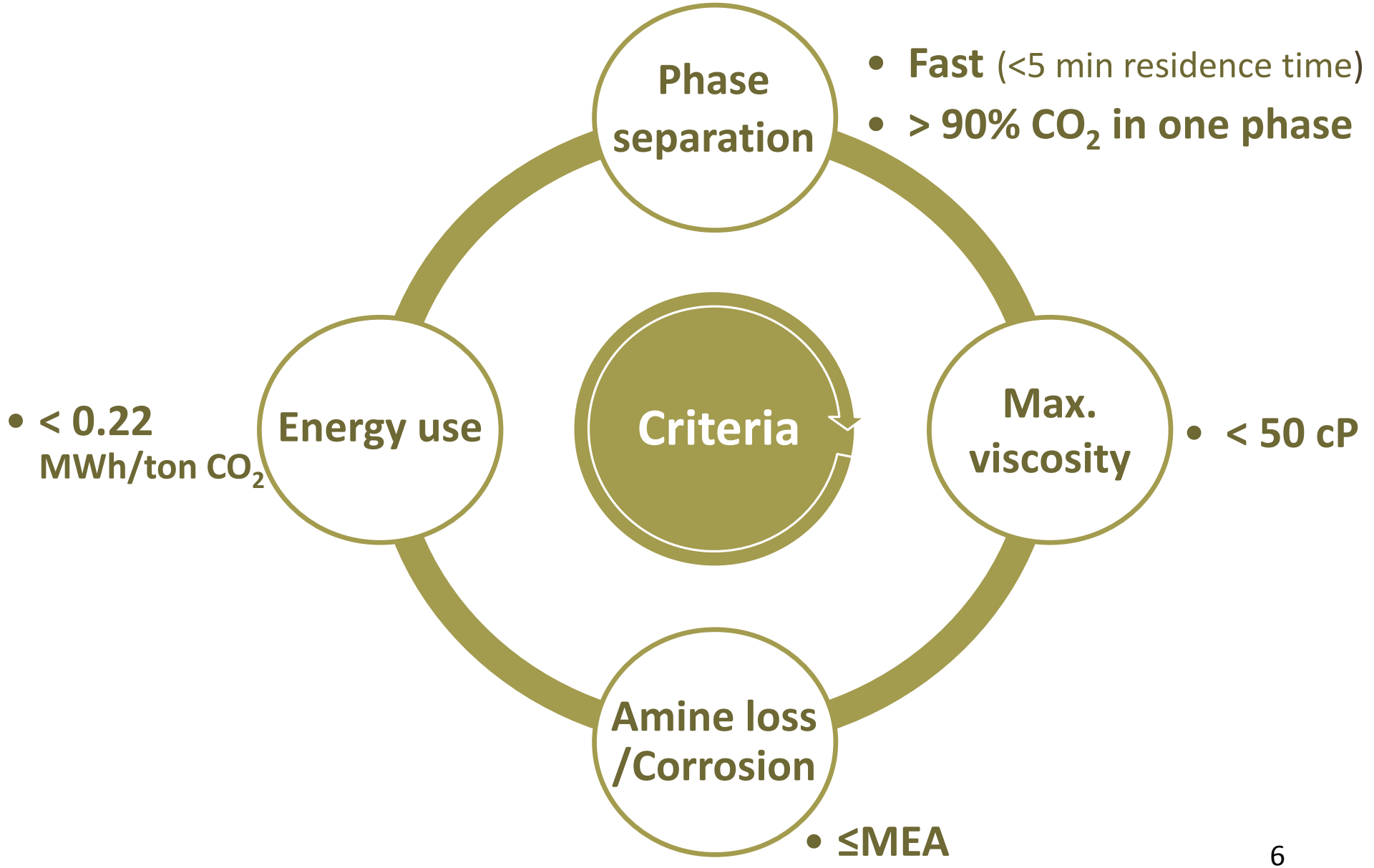
Main benefit:

Less sensible heat needed due to less solvent for regeneration

Main challenge:

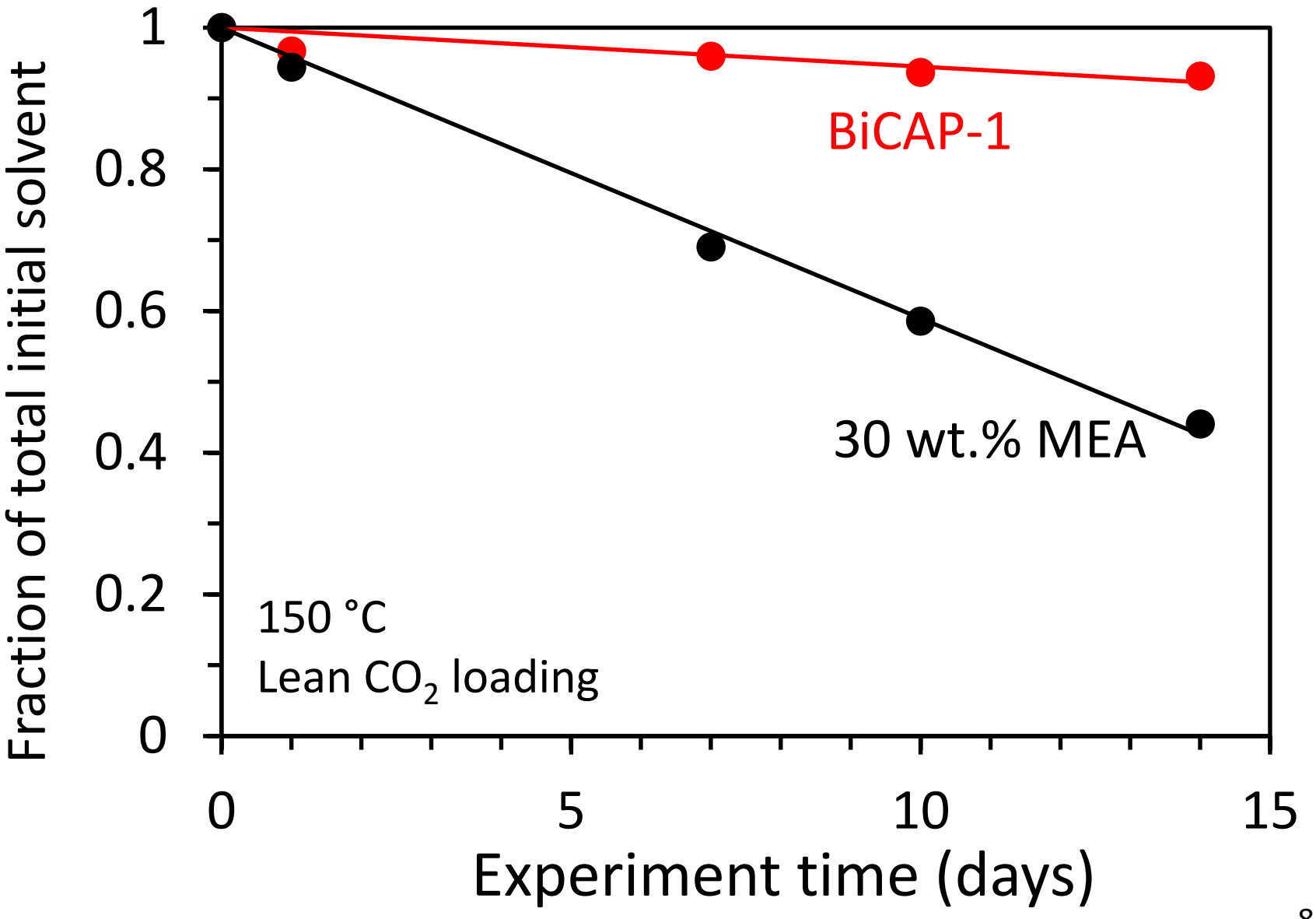
High viscosity of CO_2 rich phase, reducing mass and heat transfer rates

Multi-criteria used for solvent selection

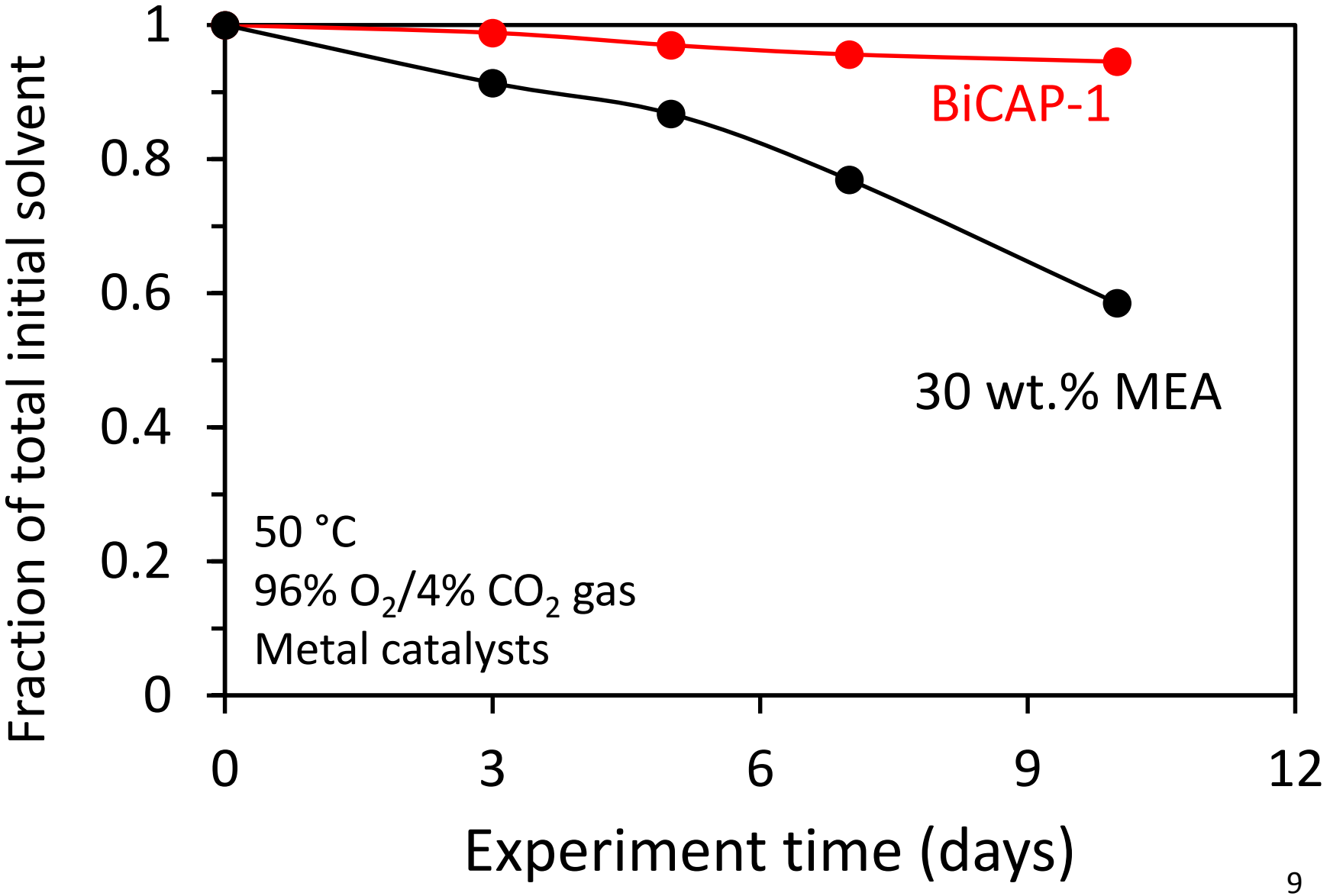


A novel biphasic solvent (BiCAP-1)

Stability of BiCAP-1: Thermal Degradation



Stability of BiCAP-1: Oxidative Degradation



Laboratory-column testing for CO_2 absorption

Specifications

Diameter: 4-inch

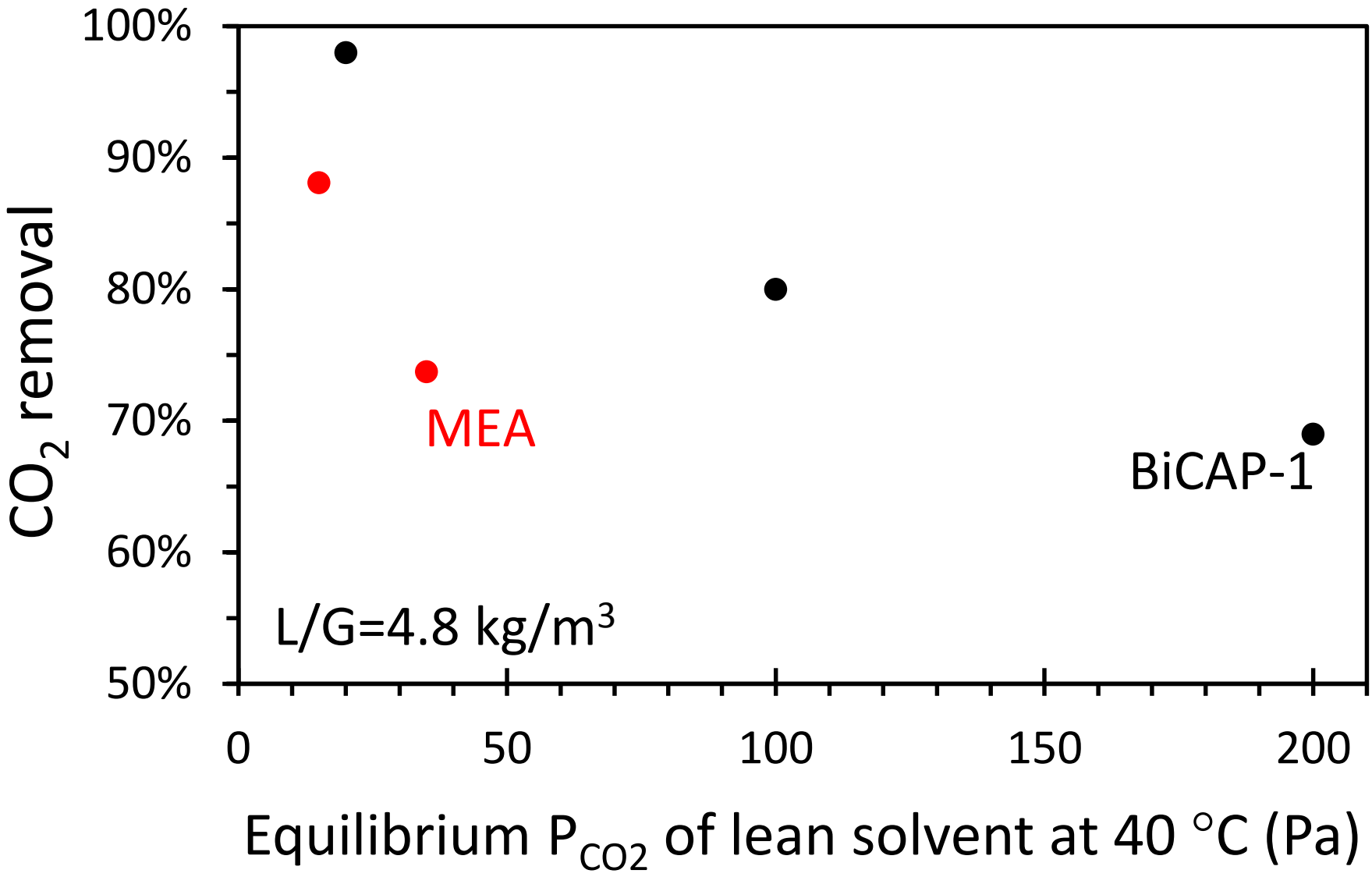
Height: 3× 7-ft structured packing

Gas flowrate: 250 L/min

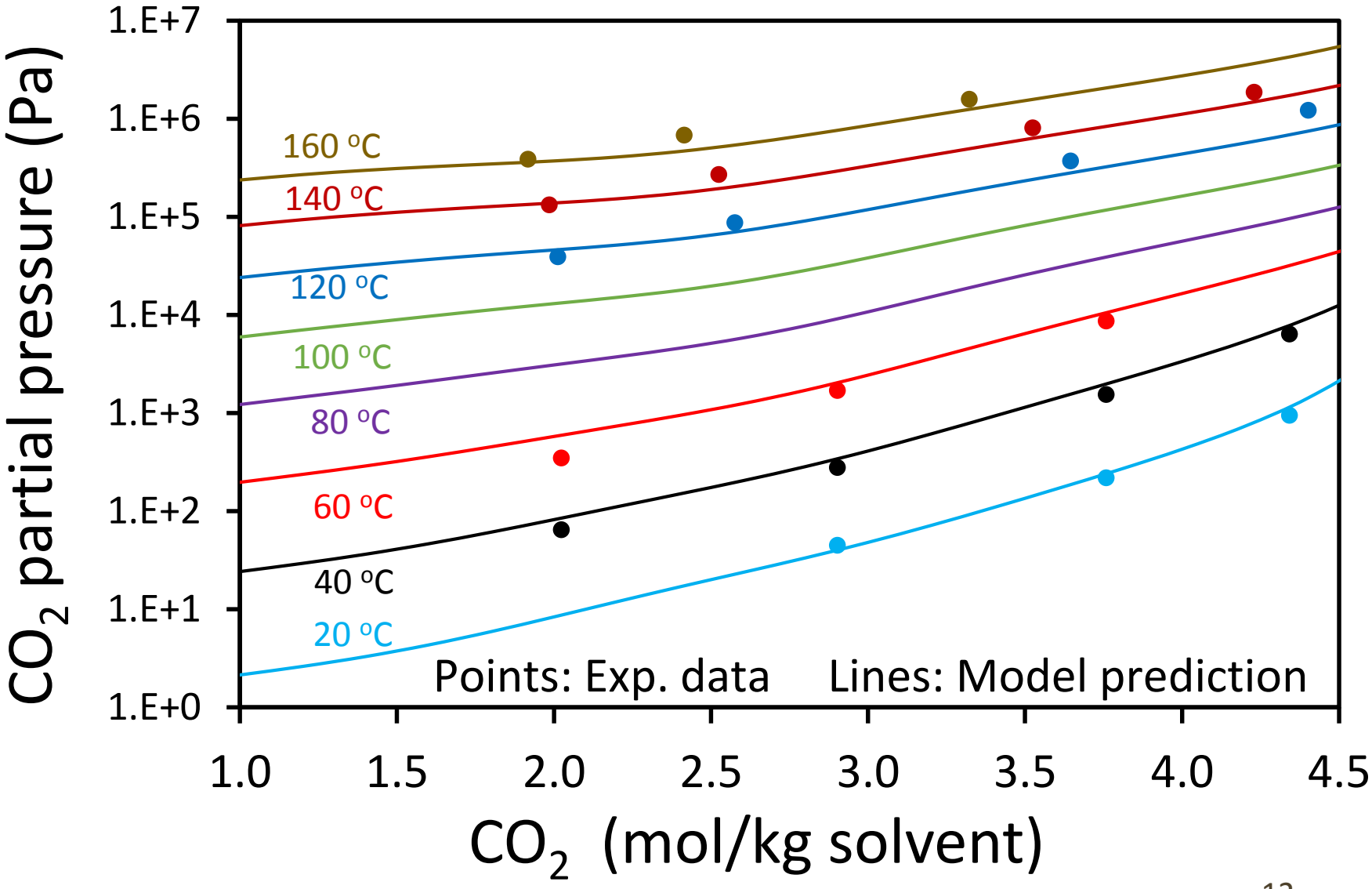
CO_2 concentration in gas: 14 vol%

Solvent flowrate: 0.9-1.5 kg/min

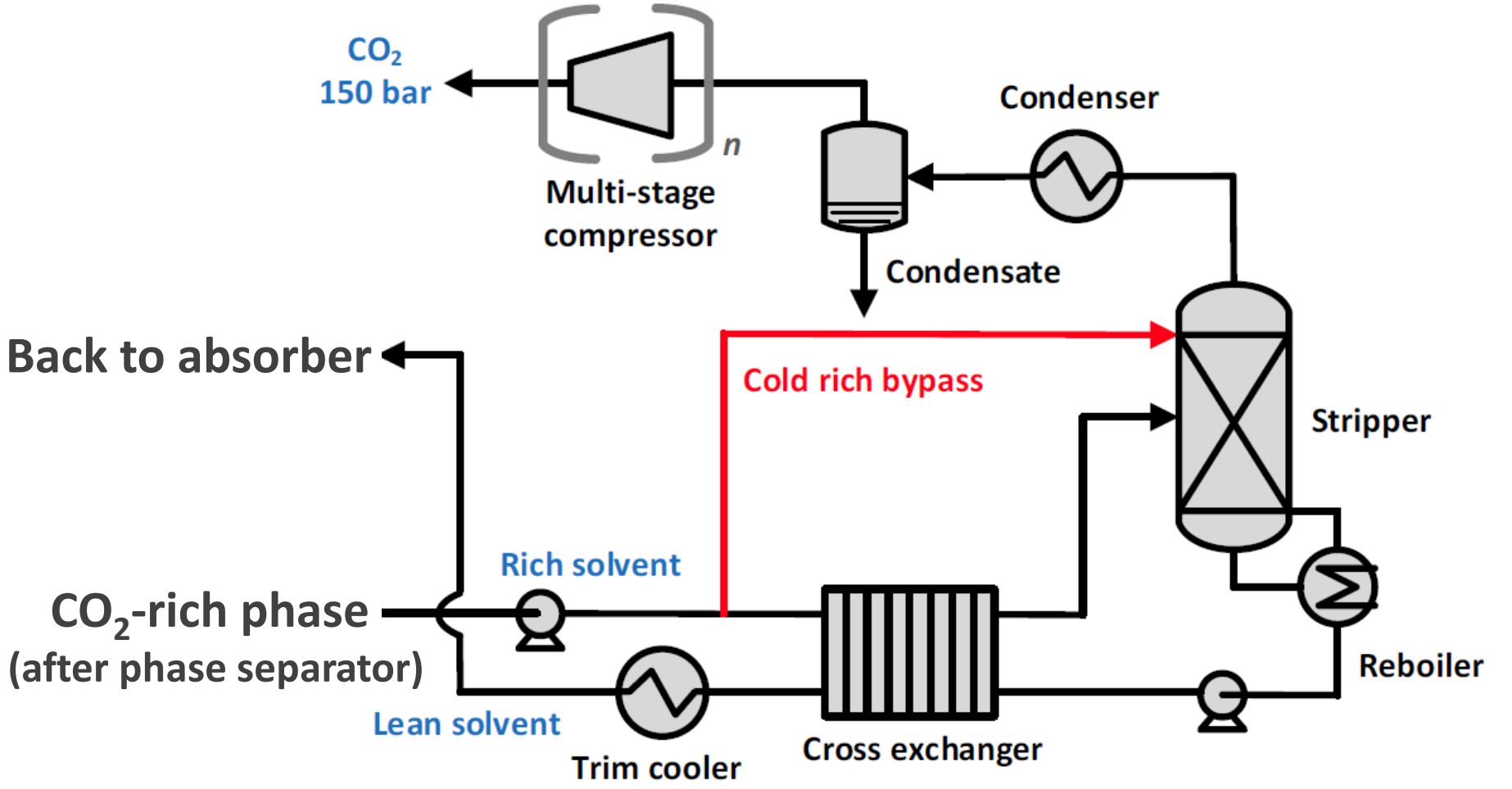
CO_2 removal of BiCAP-1 in column tests



Modeling of BiCAP-1 with Aspen plus



Simple stripper configuration without or with cold rich bypass



(Yu-Jeng Lin's Dissertation, 2016)

Comparison of Heat Duty with Other Processes

	MEA[1]	IFP-DMX[1]	BiCAP-1	
Status	Baseline	Mini-pilot	0.01 MWe, laboratory	
Q_{reb} (GJ/ton CO_2)	3.7	**2.5**	2.1	**2.0**
ΔT_{HX} (°C)	3	3	10	10
$T_{stripper}$ (°C)	~120	150	120	150
$P_{stripper}$ (bar)	~1.6	5.0	1.6	5.6

1: Raynal, Ludovic, et al. "Evaluation of the DMX Process for Industrial Pilot Demonstration–Methodology and Results." Energy Procedia 63 (2014): 6298-6309.

Conclusions

1. Stable with O_2 and at high temperature (up to 150 °C)
2. Acceptable viscosity (≤ 50 cP for CO_2 saturated solvent)
3. Heat duty 45% less than MEA and 20% less than IFP-DMX
4. Ready to test a bench-scale integrated system at next stage

Acknowledgements

U.S. Department of Energy / National Energy Technology Laboratory (DOE/NETL) through Cooperative Agreement No. DE-FE0026434

Comments & Questions?

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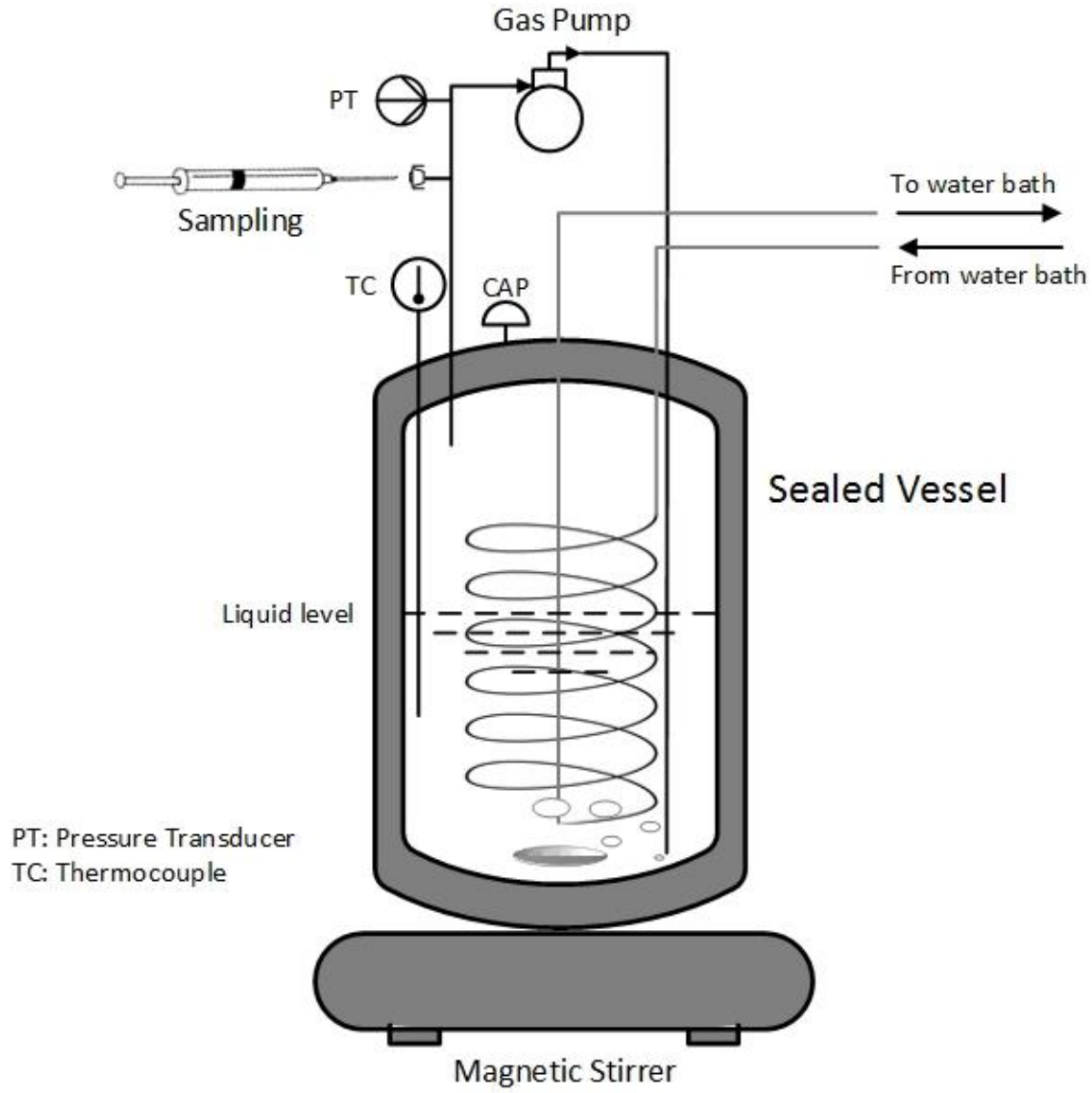
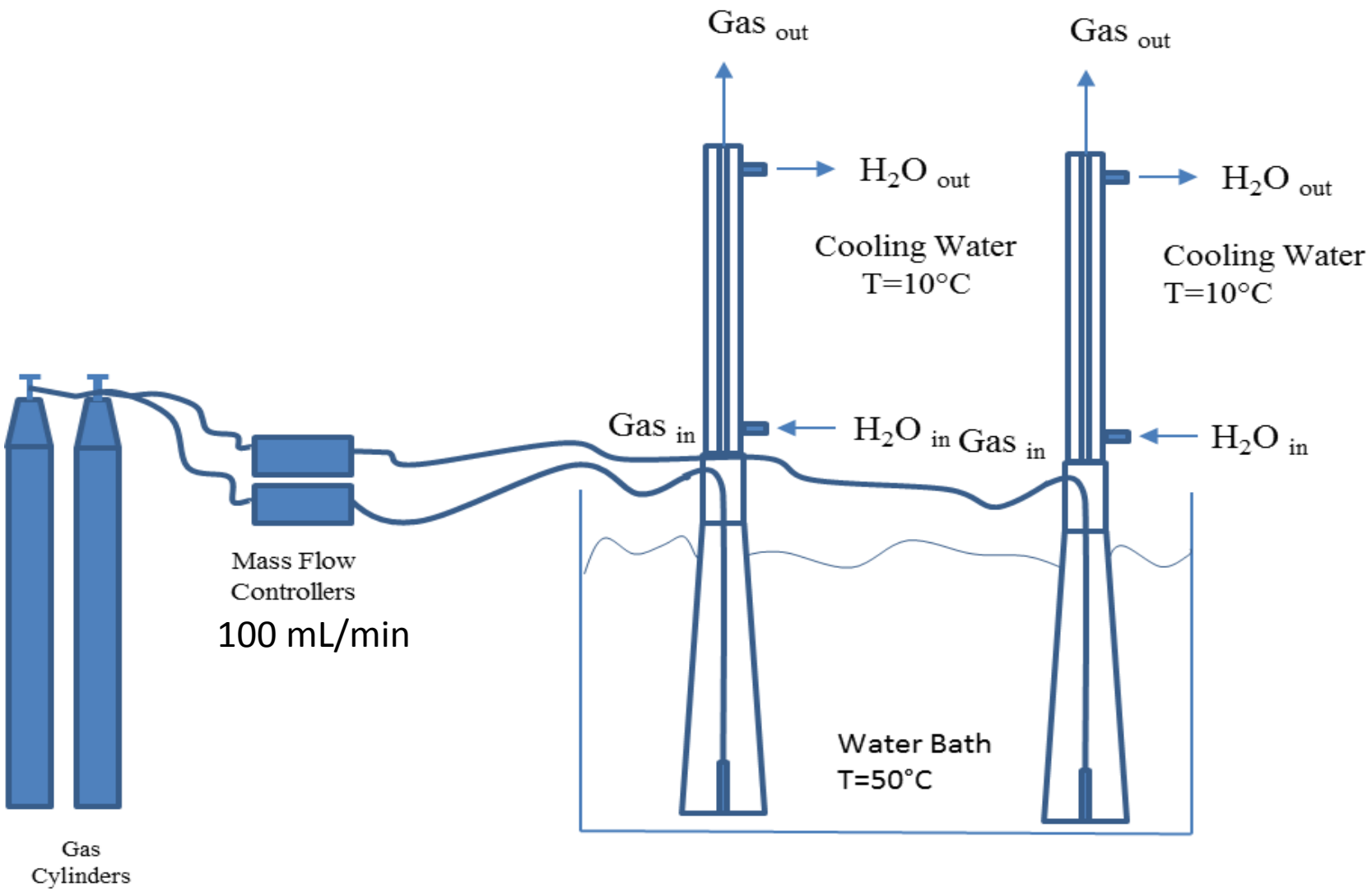
BACKUP

Low Temp. VLE apparatus



Oxidative degradation apparatus



Heat duty of BiCAP-1 Based Process