Quantification of Ancillary Environmental Benefits of Transformational Water-lean Solvent Technology

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INTRODUCTION

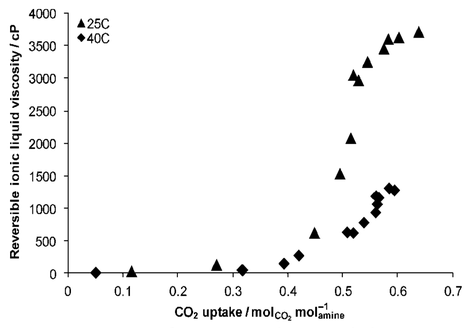
For conventional carbon capture applications, hazardous pollutants such as sulfur dioxide (SO_2) and nitrogen oxide (NO_x) need to be removed prior to capturing CO_2. The cost of implementing emission control technologies for SO_2 and NO_x is substantial and can be even more concerning for applications that require high removal efficiency. This ultimately leads to a significant impact on the overall economics of the carbon capture processes. One potential solution is to demonstrate transformational carbon capture technologies with significant ancillary environmental benefits. However, very little effort has been focused on the understanding and quantification of the co-benefit pollutant reductions.

ROCO'S WATER-LEAN SOLVENTS

Water-lean Solvents (vs. MEA)

- Lower regeneration energy
- Potential lower capture cost
- High viscosity (at high CO_2 loading)

ChemSusChem, 2014, 7: 299-307;
ACS Sustainable Chem. Eng. 2019, 7, 8, 7535–7542



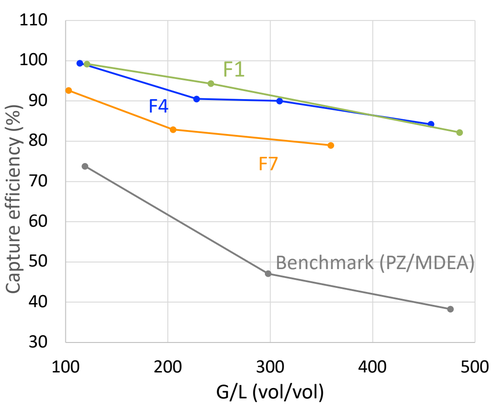
Viscosities of a water-lean silylamine

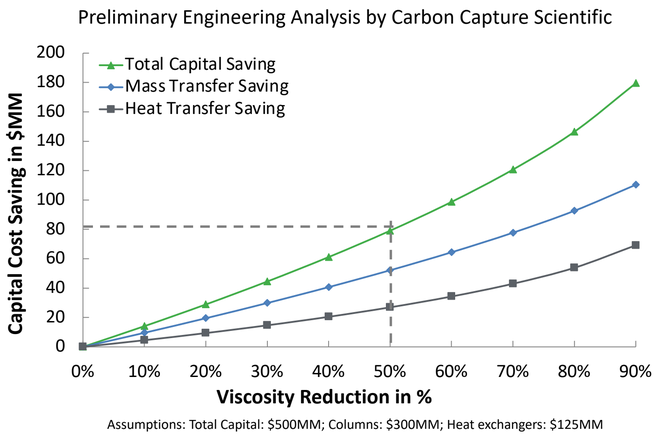
Viscosity-Reducing Additives

- Completed fundamental insights and rational design of molecular architecture and functionalities for targeted performance of additives to reduce viscosity.
- Proprietary viscosity-reducing additives that can reduce viscosities of various amine solvents by up to 50% upon CO_2 loading.

Acknowledgment: The viscosity-reducing additive work is funded by DOE/NETL under agreement DE-FE0031629

3rd Generation Water-lean Solvents





Assumptions: Total Capital: $500MM; Columns: $300MM; Heat exchangers: $125MM

Parametric study showed capture efficiency up to 99%; working capacity as high as 7.4 wt%, and viscosity of rich solvents below 6.5 cP at 40 °C

A 50% viscosity reduction results in a net **16%** (or $80 M) reduction in capital cost at 90% capture efficiency.

Acknowledgment: The water-lean solvent work is funded by DOE/NETL under agreement DE-SC0021827

PROJECT OVERVIEW

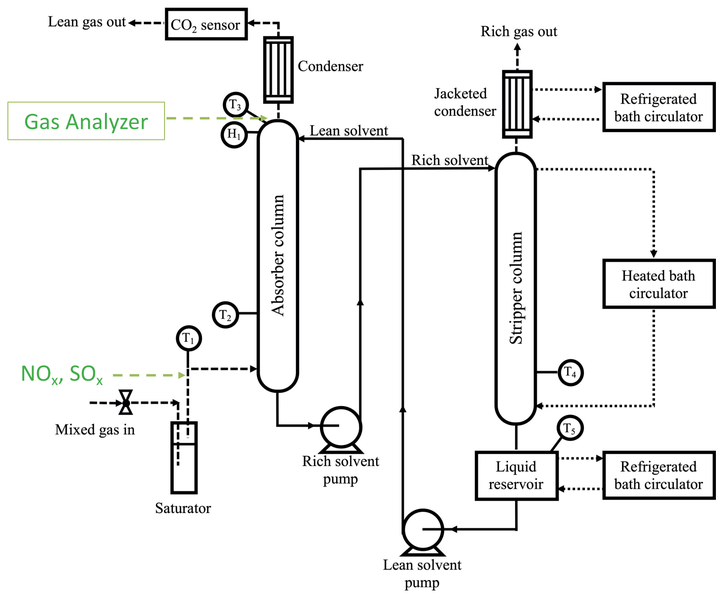
The project aims to perform a lab-scale study to understand and quantify the co-benefit pollutant (NO_x and SO_x) reductions and evaluate their impact on RoCo's water-lean solvents. Objectives for phase I include:

- Scale-up preparation of water-lean solvent candidates.
- Upgrade of a lab-scale capture system for the capability of testing NO_x and SO_x.
- Assessment of water-lean solvents in the lab-scale testing system with simulated exhaust containing NO_x and SO_x to quantify the reduction of these impurities.
- Evaluation of solvent properties (CO_2 uptake, viscosity) and stability during the test to understand the impact of impurities on the water-lean solvents.

PHASE I WORK PLAN

Lab-scale Column Upgrade

RoCo lab-scale testing unit

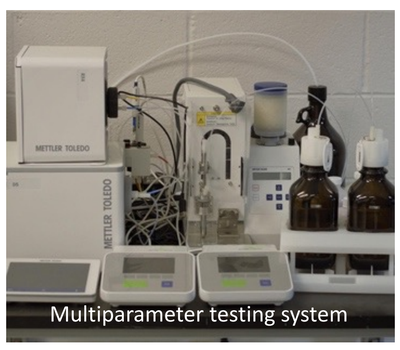


Lab-scale Testing of Water-lean Solvents

Process conditions for lab-scale capture system

Parameter	Value	Unit
Gas flow rate	1-11 ±0.1	SLPM
CO_2 in gas composition	4±0.5 (or 15±0.5)	vol%
NO_x and SO_x concentration	0-100	ppm
Solvent flow rate	5-30±1	mL/min
Absorber temperature	40±5	°C
Stripper temperature	90-120±5	°C
Stripper pressure	1	bar
Target capture efficiency	> 95	%

Gas chromatography



Multiparameter testing system

Viscometer

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