Reducing Regeneration Energy and Capital Costs in an Advanced PCCC System

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Overview

1. Background
2. Reduction in Regeneration Energy
3. Oxidative Degradation and Solvent Emissions
4. Corrosion Studies
5. Final Thoughts
6. Acknowledgements

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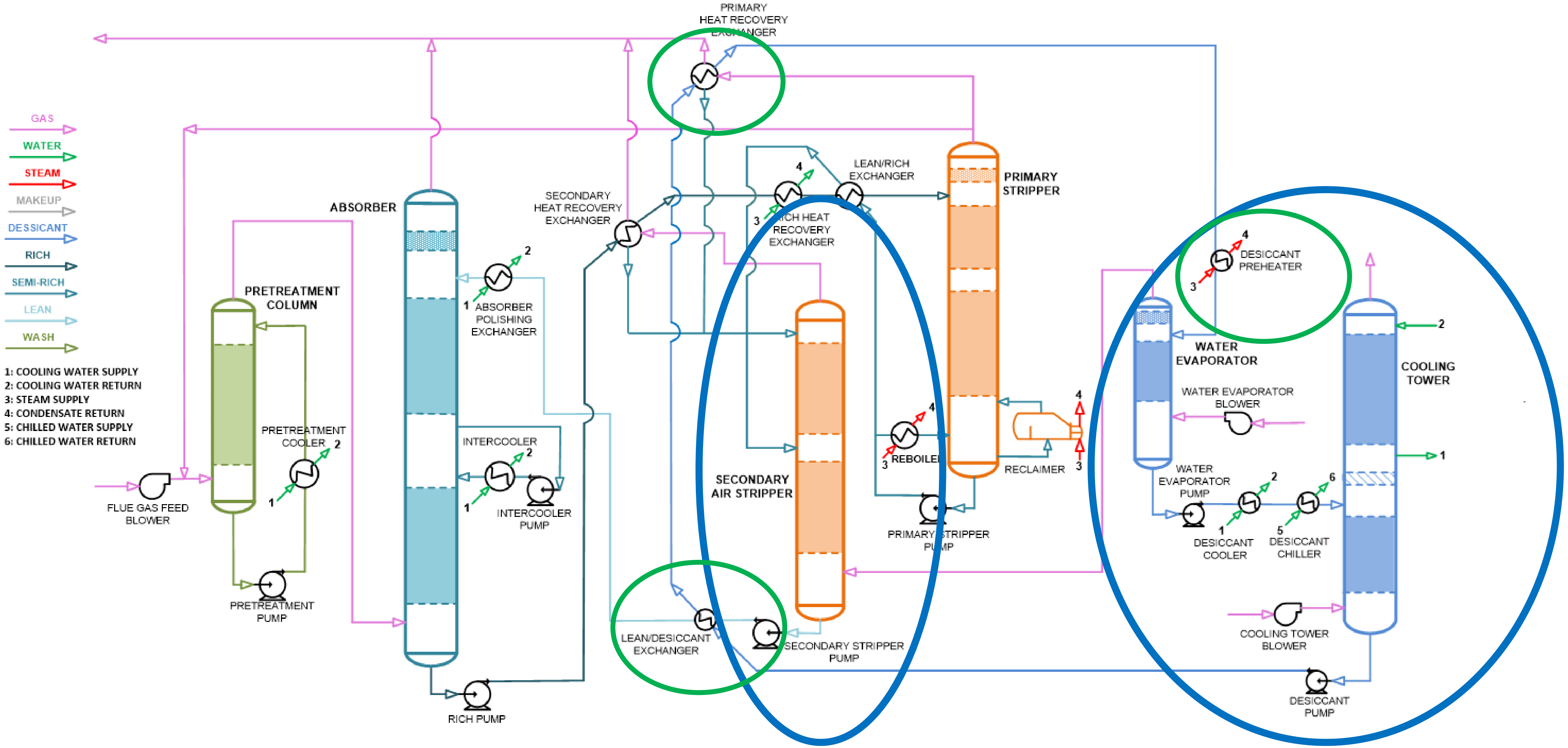
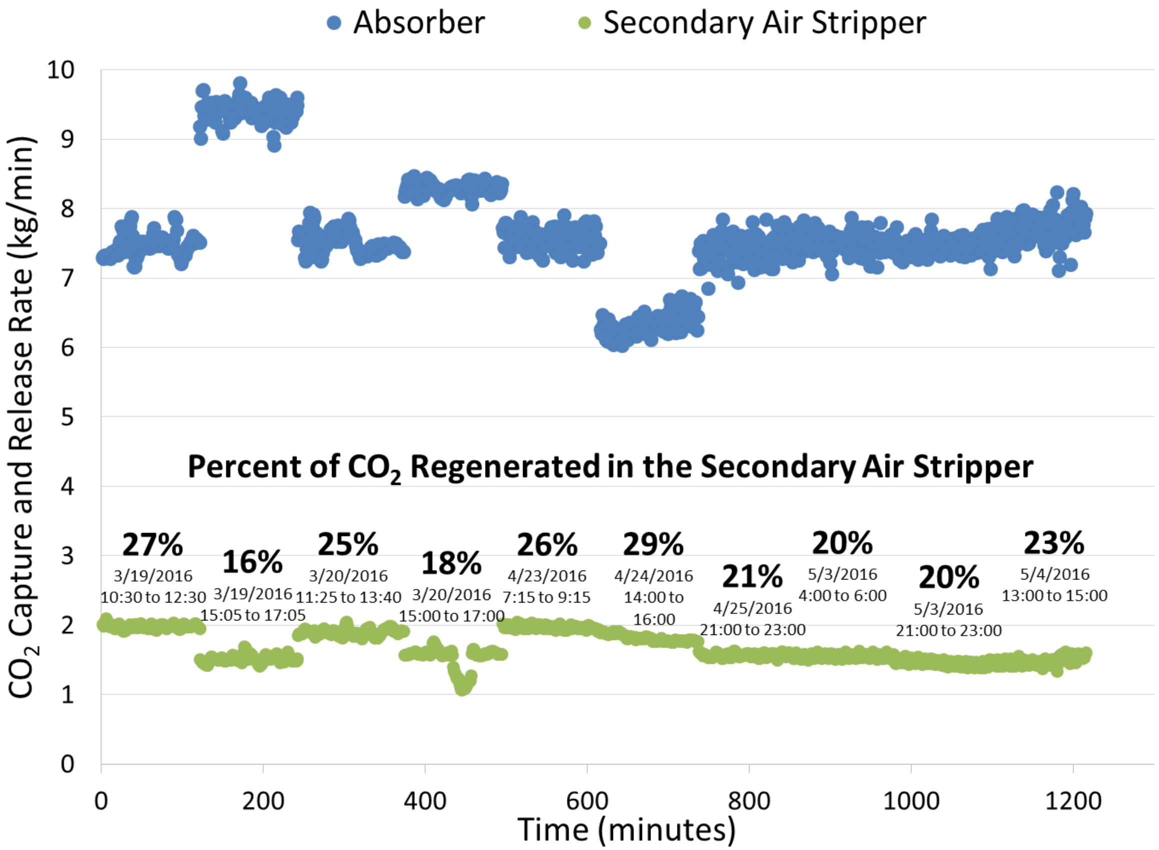
UKy-CAER CCS Project Overview

- 0.7 MWe (1300 ACFM) advanced post-combustion small pilot CO_2 capture
- Catch and release program
- Designed as a modular configuration
- Testing at Kentucky Utilities E.W. Brown Generating Station, Harrodsburg, KY, approximately 30 miles from UKy-CAER
- Includes several UKy-CAER developed technologies
- Three solvent testing campaigns (MEA baseline, advanced H3-1, and CAER-B3)

Process Flow Diagram

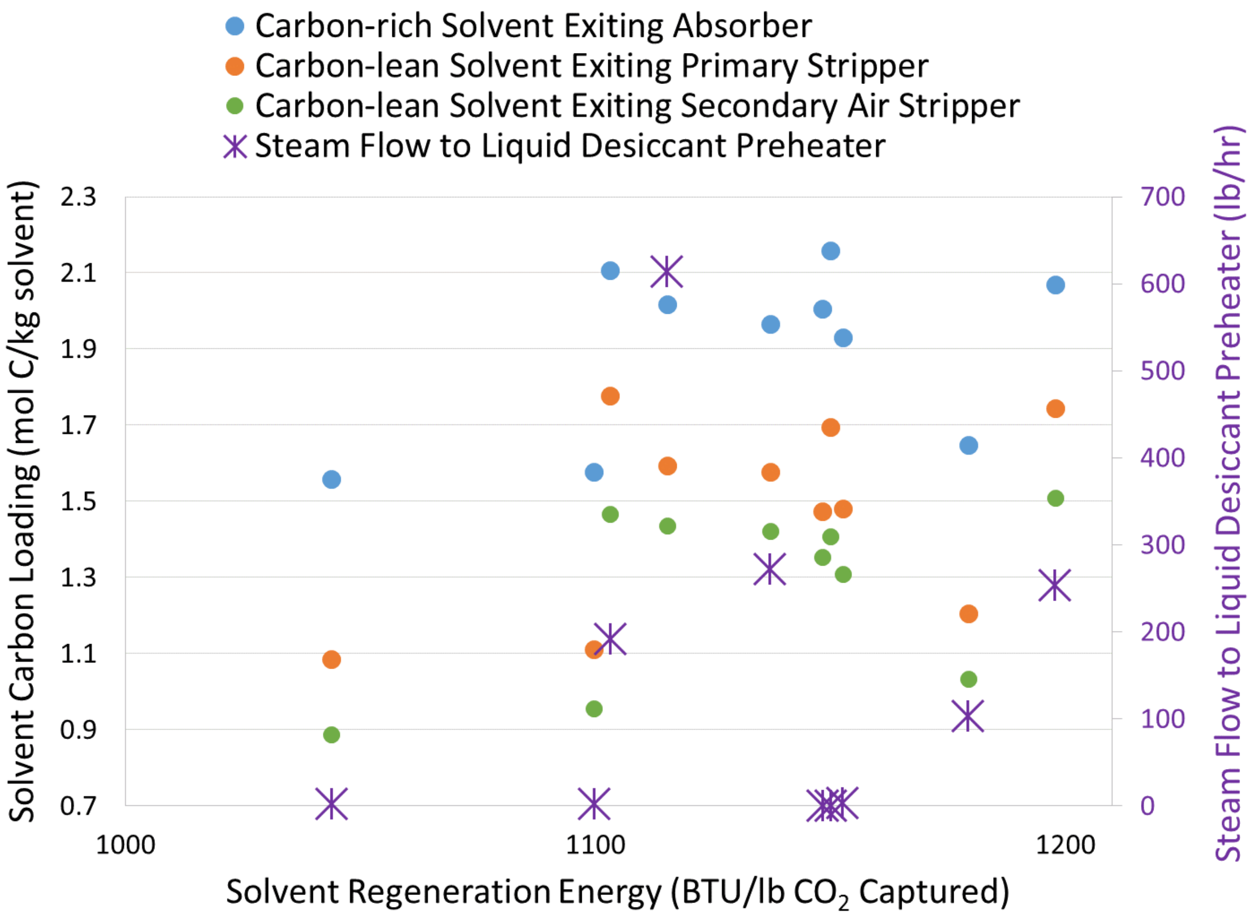


Heat Integration: CO_2 Released in Secondary Air Stripper



The secondary stripper is effective in removing >15% of the CO_2 absorbed.

Heat Integration: Solvent Carbon Loadings



No additional heat recovery required in the desiccant preheater for effective stripping CO_2 stripping.

Regeneration Energy: Summary

Experimental Results Compared to TEA

UKy-CAER process reduces the energy consumption

Energy Consumption	
DOE Reference Case 10	1540 BTU/lb-CO_2
UKy-CAER CCS process MEA case, according to TEA	1340 BTU/lb-CO_2
UKy-CAER CCS process MEA case, experimental long term	**~1350 BTU/lb-CO_2**
UKy-CAER CCS process H3-1 case, according to TEA	937 BTU/lb-CO_2
UKy-CAER CCS process H3-1 case, experimental campaign	**~1000 BTU/lb-CO_2**

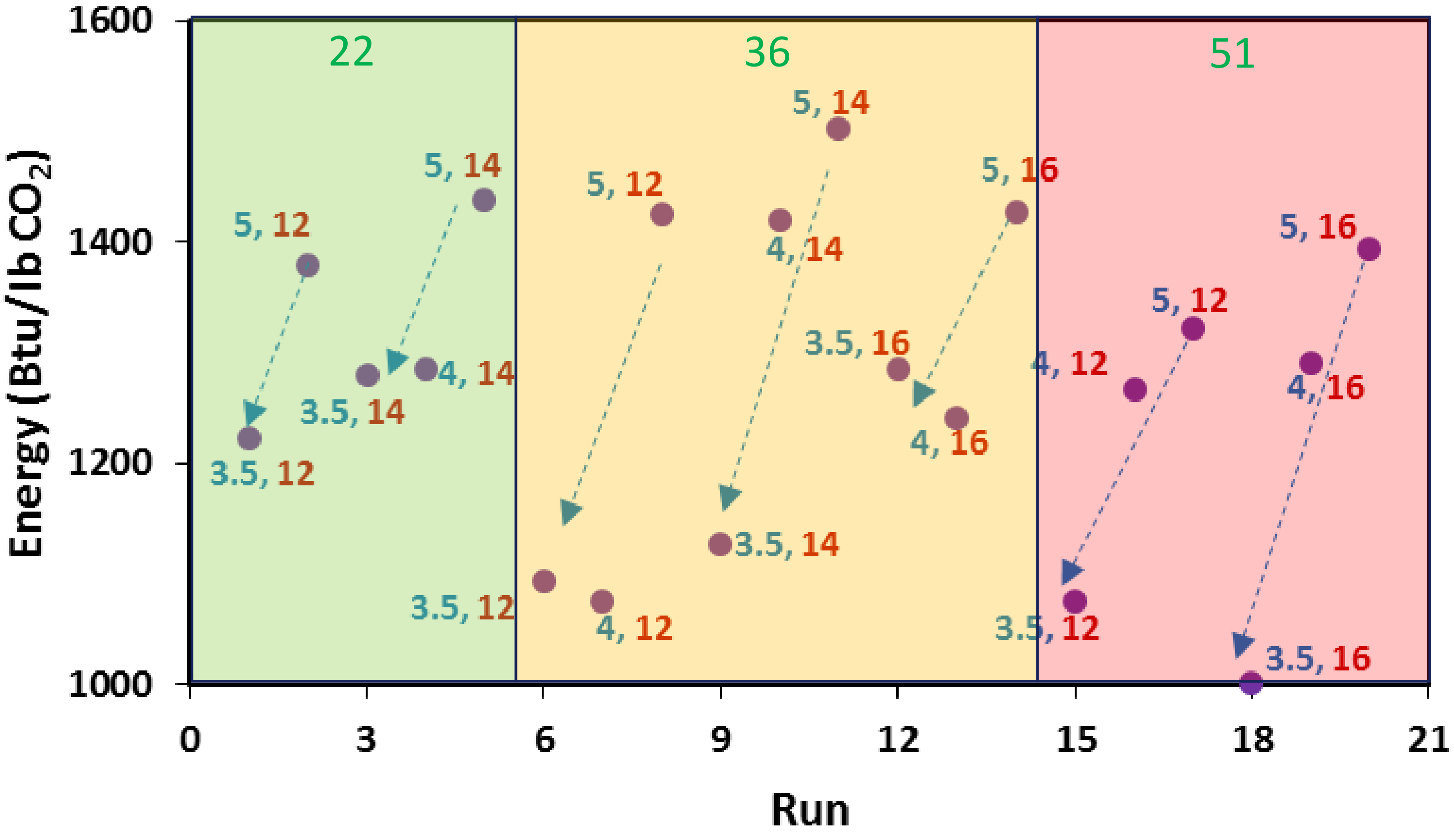
MEA Campaign Results

All Conditions during MEA Campaign

L/G, blue

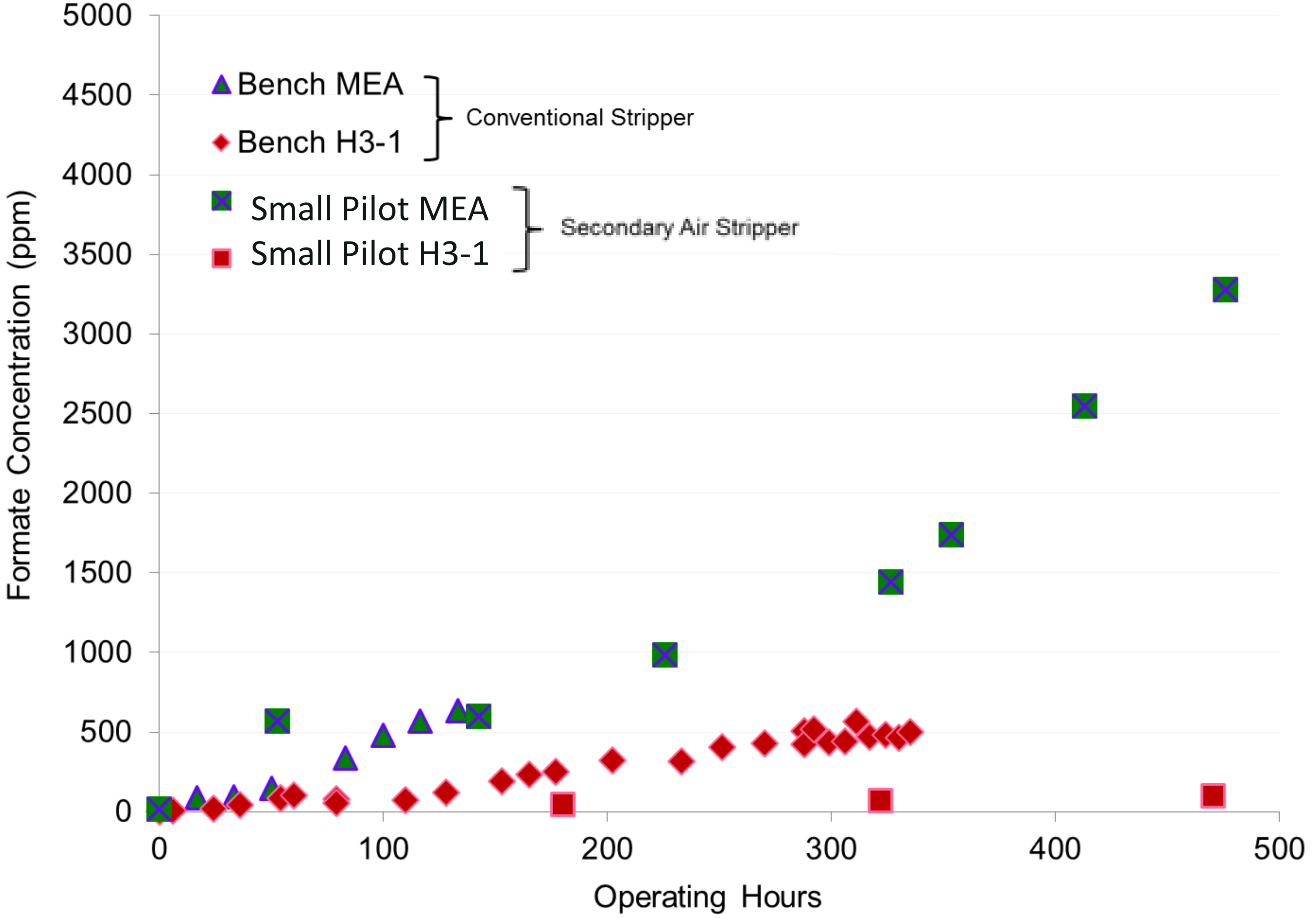
Inlet CO_2 Concentration (%) , red

Primary Stripper Pressure (psia), green



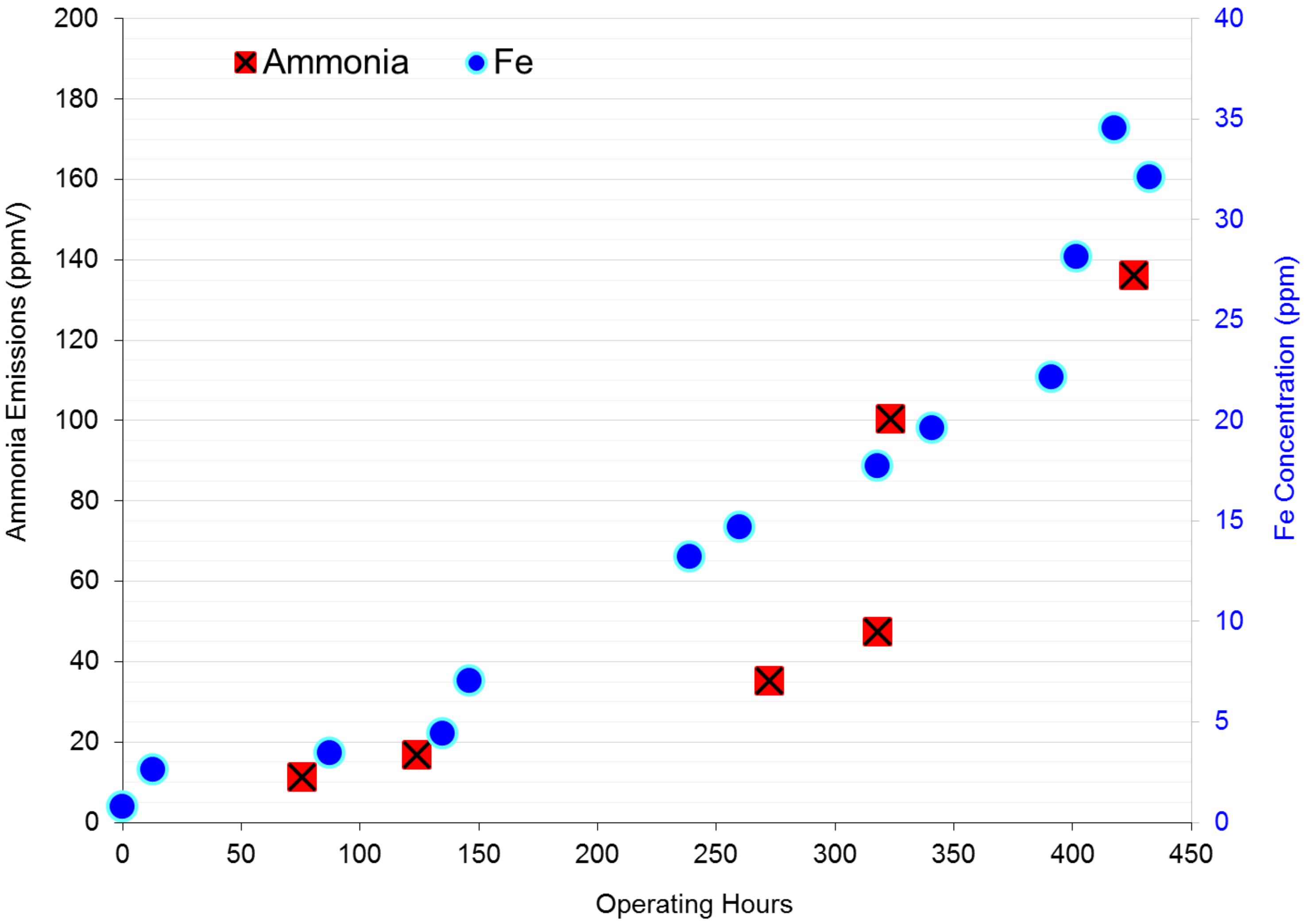
Secondary Stripper Impact on Degradation

Similar oxidative degradation rates (formate) with conventional stripper and secondary air stripper from two separate solvent testing campaigns



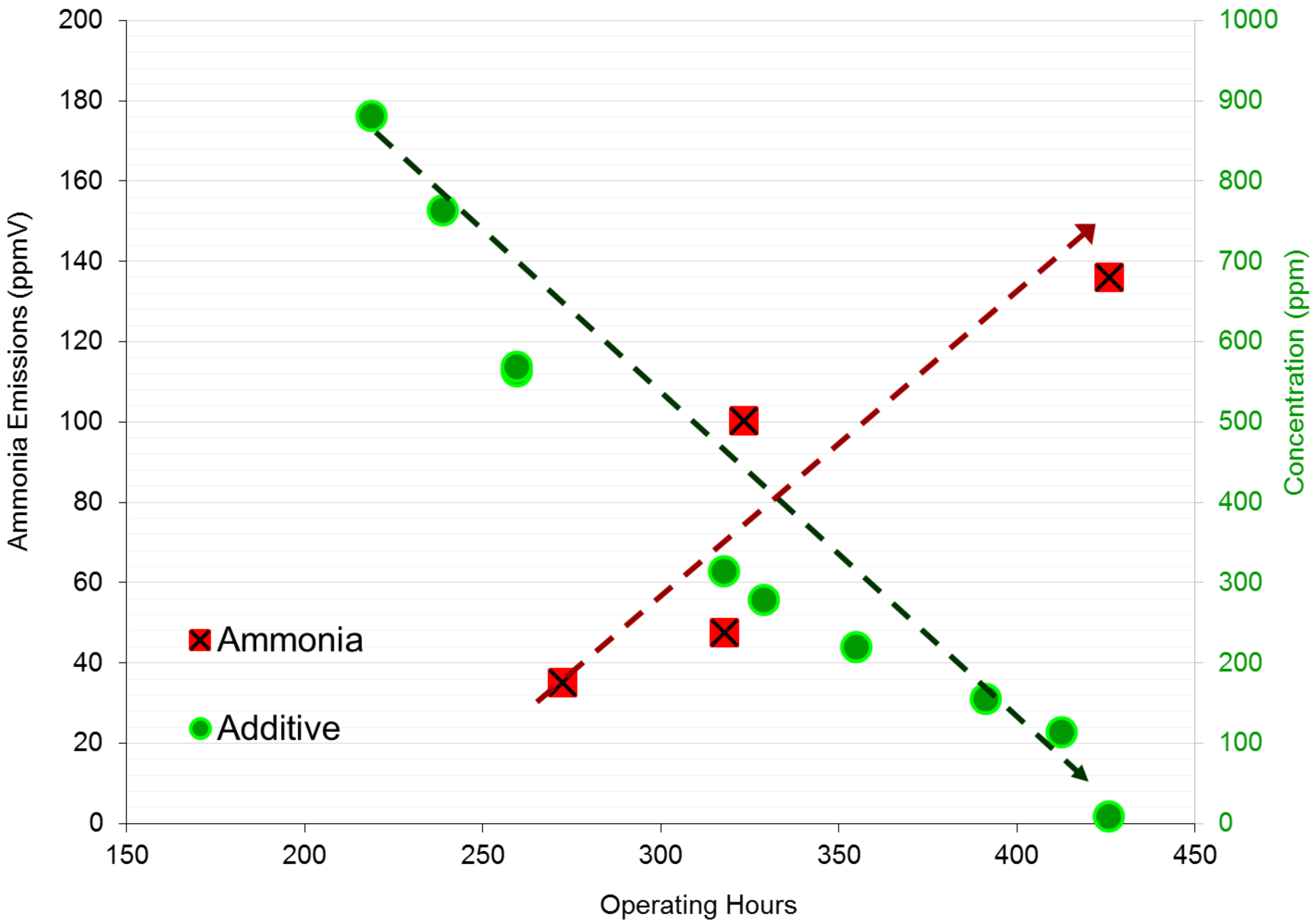
Ammonia Emissions vs Fe

Positive correlation between NH_3 emission and higher Fe in the solvent.



Ammonia Emissions vs Multi-Functional Additive

General increase in NH_3 emission with lower additive concentration in the solvent



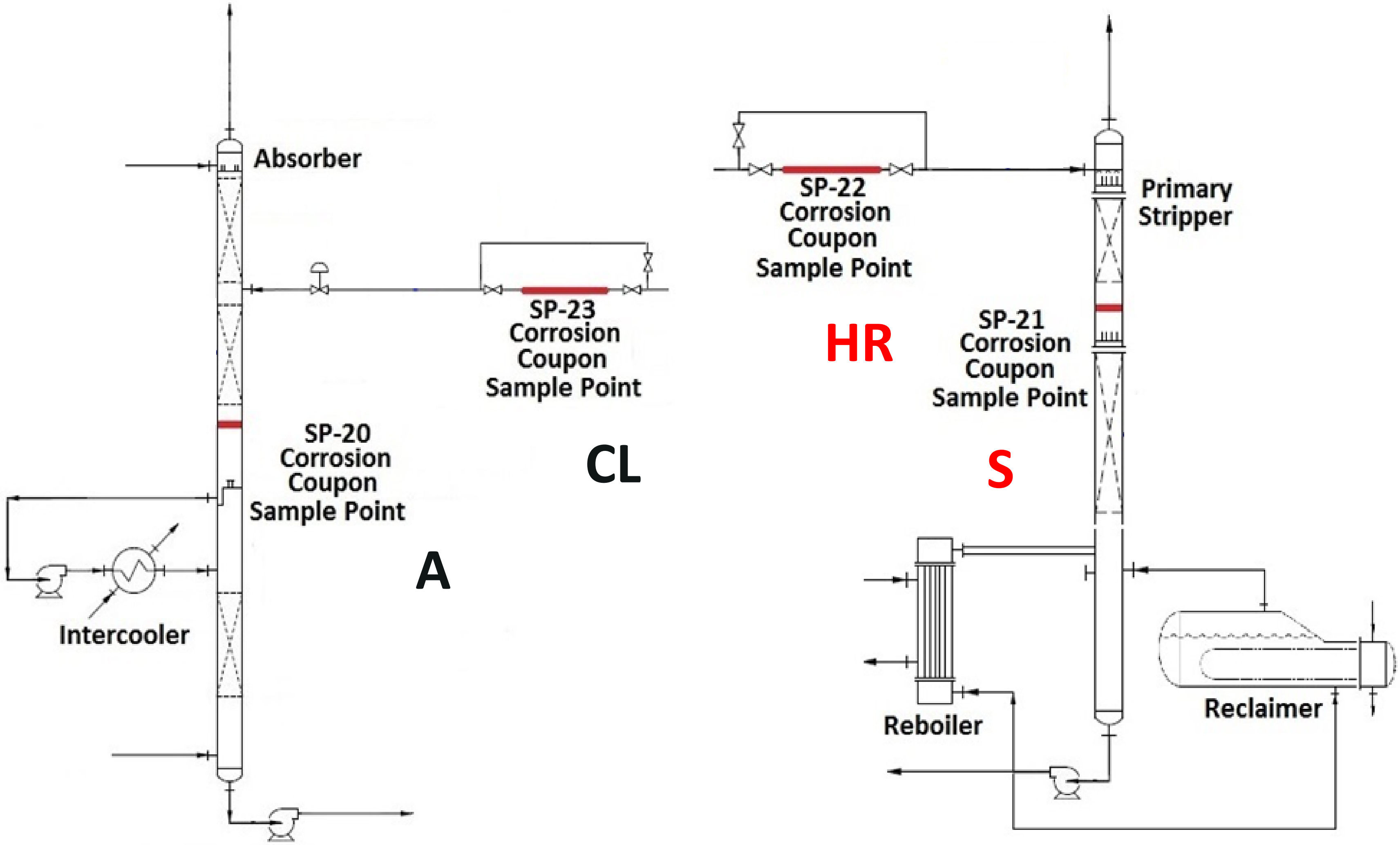
Corrosion Studies

- Carbon steel is widely used in CCS applications.
- Is there any beneficial corrosion inhibition impact from anti-oxidation additives?
  - Is there a dual-use additive to reduce oxidative degradation and corrosion to reduce initial and long-term CAPEX?

YES

Corrosion Sampling Locations

A = absorber
HR = hot-rich
CL = cold-lean
S = stripper

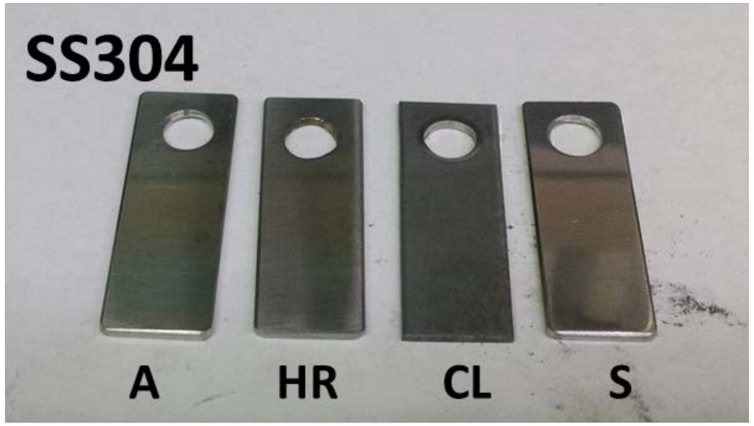


Corrosion Studies: MEA Baseline

A = absorber
HR = hot-rich
CL = cold-lean
S = stripper

A106 carbon steel (CS) held up well during the MEA campaign in the absorber and cold-lean return piping.

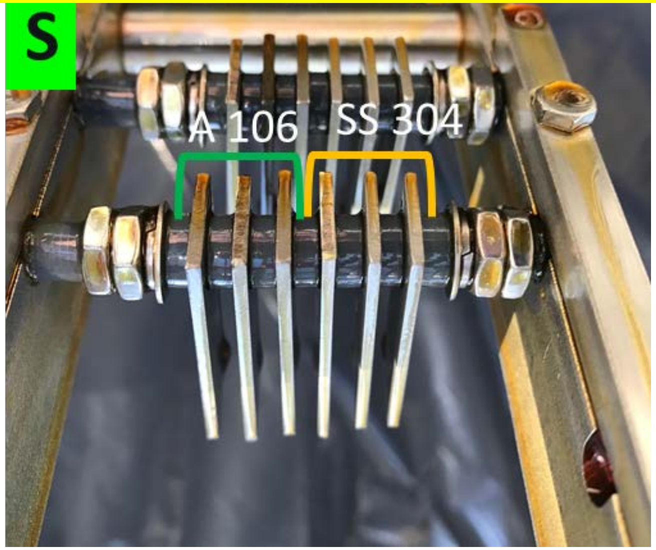
Focus directed to making CS last longer in the hot-rich piping and stripper.

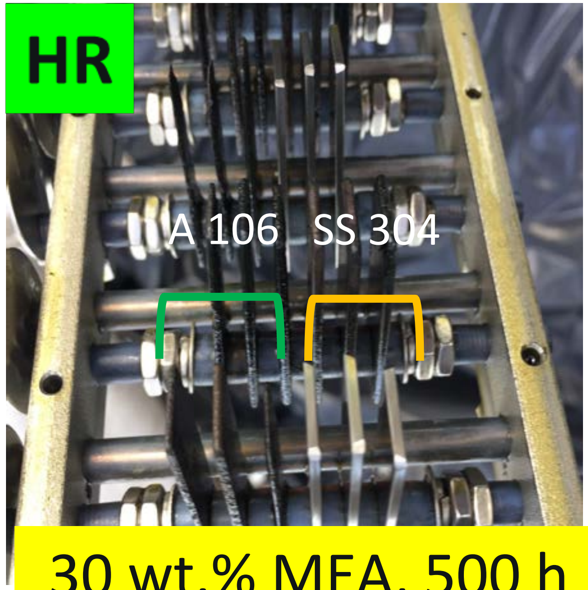


After approximately 430 run hours

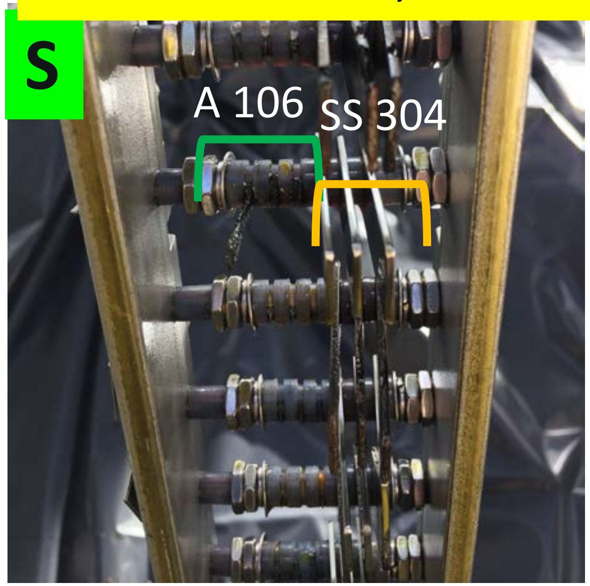
Corrosion Samples

CAER-B3 + Additive, 500 h

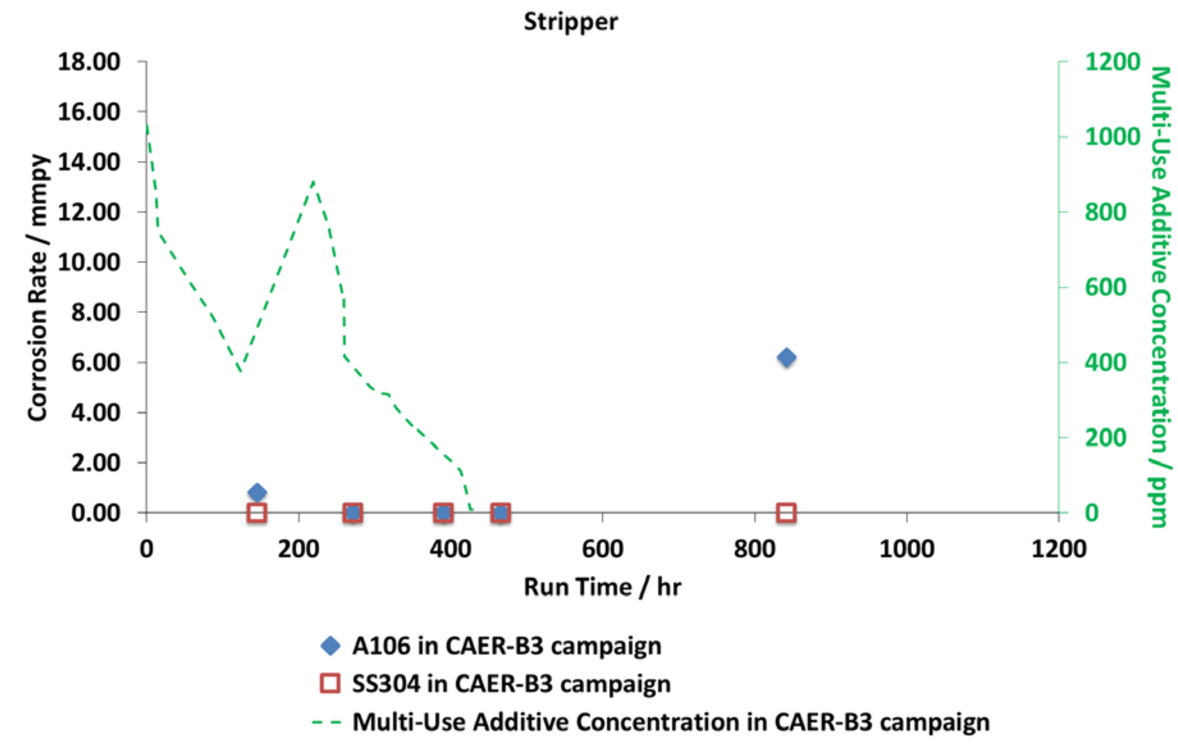


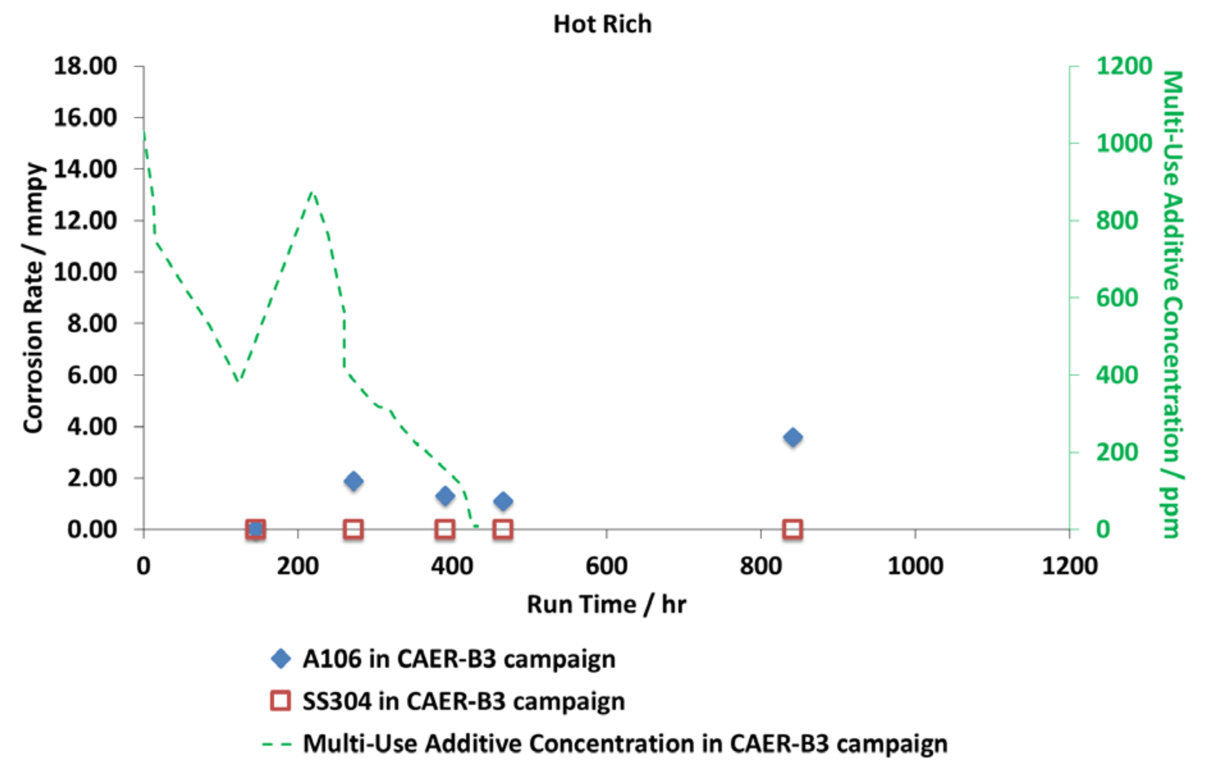


30 wt.% MEA, 500 h



Corrosion Rate Based on Total Run Time





Temperature range in the stripper:185–266 °F

Temperature range in the hot rich piping:185–230 °F

Final Thoughts:

- The UKy-CAER process demonstrates a pathway that leads closer to the DOE's goal of 90% capture with no more than a 35% increase in the cost of electricity.
- The UKy-CAER process demonstrates the benefits of heat integration and two-stage stripping
- UKy-CAER's use of a multi-use additive can potentially reduce CAPEX due to corrosion and potentially reduce OPEX related to solvent degradation

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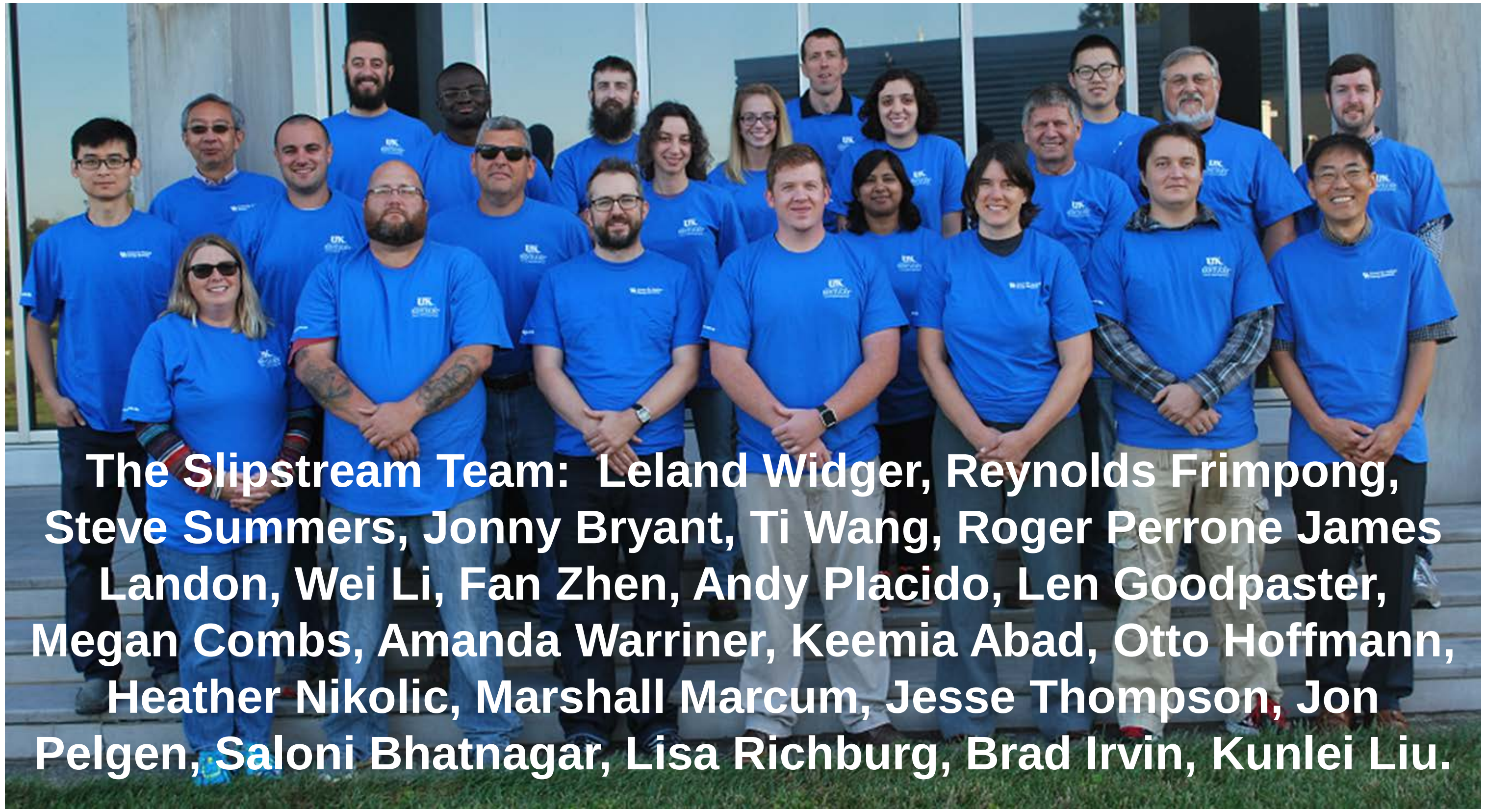

Thank you!

0.7 MWe Pilot Scale CO_2 Capture Project

KU E.W. Brown Generating Station

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