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
UKy-CAER CCS Project Overview

- 0.7 MWe (1300 ACFM) advanced post-combustion small pilot CO₂ 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)
Heat Integration: CO$_2$ Released in Secondary Air Stripper

The secondary stripper is effective in removing >15% of the CO$_2$ absorbed.
No additional heat recovery required in the desiccant preheater for effective stripping CO₂ stripping.
### Regeneration Energy: Summary

**Experimental Results Compared to TEA**

UKy-CAER process reduces the energy consumption

<table>
<thead>
<tr>
<th>Energy Consumption</th>
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<tbody>
<tr>
<td>DOE Reference Case 10</td>
<td>1540 BTU/lb-CO₂</td>
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<tr>
<td>UKy-CAER CCS process MEA case, according to TEA</td>
<td>1340 BTU/lb-CO₂</td>
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<tr>
<td><strong>UKy-CAER CCS process MEA case, experimental long term</strong></td>
<td>~1350 BTU/lb-CO₂</td>
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<tr>
<td>UKy-CAER CCS process H3-1 case, according to TEA</td>
<td>937 BTU/lb-CO₂</td>
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<tr>
<td><strong>UKy-CAER CCS process H3-1 case, experimental campaign</strong></td>
<td>~1000 BTU/lb-CO₂</td>
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MEA Campaign Results

L/G, blue
Inlet CO₂ Concentration (%), red
Primary Stripper Pressure (psia), green

CMTC-17 Houston, Texas July 17-20, 2017
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

CMTC-17 Houston, Texas
July 17-20, 2017
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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