Background – Aerosol Formation

- Solvent-based scrubbers are leading technology for CO₂ capture from coal-fired power plants
  - Solvents such as MEA, MDEA and PIP are used to strip CO₂ from flue gas
  - Their high volatility results in emission to atmosphere
  - Emissions due to fine particles (aerosols) too small to be captured by existing counter-measures (water wash and de-misters)
- Aerosol formation occurs primarily from ultra-fine particulate via condensation of alkali and SO₃

Project Objectives and Methodology

- Objective:
  - Eliminate formation and improve capture of all aerosol types (particulate, alkali and acid) with >98% efficiency
  - Mitigate fouling of pre-heater during low load operation cycling
- Methodology:
  - Alkali Species – Prevent formation in boiler
  - SO₃ Species & Particulate Species – neutralize in boiler and improve performance of capture devices (ESP)

Phase I Experimental Setup

- Alkali-rich coal (0.5% Na) combusted in a 10 kW down-fired combustor
- An alkali sorbent added during coal combustion
- 3 sorbent levels investigated: Low, mid and high.
- Fine and Ultra-fine particulate collected using Dekati® Low Pressure Impactor (DLPI) and a EPA Southern Research Institute (SoRI) 5 stage cyclone.

<table>
<thead>
<tr>
<th>Cyclone Stage</th>
<th>Cut-Points (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.6</td>
</tr>
<tr>
<td>2</td>
<td>3.4</td>
</tr>
<tr>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>4</td>
<td>1.3</td>
</tr>
<tr>
<td>5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

13 Stage DLPI showing aerodynamic cut-points for each stage
Future work will focus on SO₃ and particulate control:

- SO₃ is also responsible for aerosol formation and fouling:
  - High SO₃ levels result in acid condensation in air pre-heater
  - Low operating temperatures due to low load cycling also result in acid condensation
  - SO₃ that doesn’t condense grows to form aerosols later in the particulate control devices

- Sodium (Na) levels in the ash showed shift to larger (> 1 micron) range; 75% drop in the sub-micron range compared to baseline.

- Sorbent reducing ultra-fine particulate and concentrating alkali to larger size bins.

Proposed Control Strategy for Aerosol Mitigation and Fouling due to Low Load Cycling

- Mitigate SO₃: by injecting sorbents to neutralize acidity
- Improve particulate capture operation to improve removal of particulates and neutralized acid
- Perform pilot testing to identify best sorbents for SO₃ capture
- Perform field testing to demonstrate particulate capture, alkali, and SO₃ mitigation

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