Aberthaw Carbon Capture Pilot Scale Demonstration

Dorian Matts  
Manager of Steam Raising,  
RWE Npower
“Politics is the Art of the Possible”

Otto von Bismarck,

11th August 1867
“Engineering is the Art of the Probable”

Dorian Matts,

13th March 2012
Risks

> H&S

> Regulatory including Planning, Consenting and Financial Remuneration

> Construction

> Performance of CC and its impact on power plant

> Counter-parties for CO2 transport & storage

> Operability & Reliability

> Longevity & maintainability

> By-product disposal
R&D Needs

> To underpin and help to optimise current technology which are to be demonstrated, and to support regulators and Government bodies (CCSA)

> Uncertainties surrounding scale-up
  - distribution of liquid across large columns for efficient performance
  - materials for column construction and packing
  - instrumentation and response – especially load-following
  - underpinning support for scale-up and maintenance issues

> Requires significant energy to separate CO2 from capture solvent
  - ongoing work to develop improved solvents
  - better efficiency through capture and power plant improvements

> Widely used under reducing conditions for oil refinery gases but both with oxygen and high temperature degradation products are an issue
  - high solvent loss rates and little understanding of mechanisms
  - little information on proprietary anti-oxidation additives, sensitivities to SO2 and NOX and environmental impact of reclaimers wastes
  - unit optimisation e.g. column length, intercoolers, vapour recompression, CO2 purity and capture rate
  - optimised energy consumption
  - solvent degradation and consumption rates
  - assessment of waste streams and their environmental impact
  - ability to model the process and assess its suitability for application at full scale
  - materials issues
### RWE Npower strategy

PCC Pilot Plant Projects on Amine-Based Processes. Preparing for Demonstration Projects

#### Didcot Test Rig → Aberthaw Pilot Plant → Future Demonstrator Project

<table>
<thead>
<tr>
<th>Date of commissioning</th>
<th>2008</th>
<th>2012</th>
<th>2016 ?</th>
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</thead>
<tbody>
<tr>
<td>Scale</td>
<td>1 tonne / day CO₂</td>
<td>50 tonne / day CO₂</td>
<td>Possible 4,000 tonne / day CO₂</td>
</tr>
<tr>
<td></td>
<td>0.07MWe</td>
<td>3MWe</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Generic</td>
<td>Cansolv.</td>
<td>To be decided</td>
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Didcot Combustion Test Facility: Amine Test Rig

<table>
<thead>
<tr>
<th>Technical parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; Commissioned in 2008</td>
</tr>
<tr>
<td>&gt; Amine circulation rate of 1 m³/h</td>
</tr>
<tr>
<td>&gt; Absorber: 300mm diameter, 6m absorption section, 8m overall height</td>
</tr>
<tr>
<td>&gt; Desorber: 300mm diameter, 6m desorption section, 8m overall height</td>
</tr>
<tr>
<td>&gt; Flue gas treated: approx 200 m³/h</td>
</tr>
<tr>
<td>&gt; Carbon dioxide removable: 1 tonne/day</td>
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</tbody>
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Amine Test Rig Schematic

COMBUSTION TEST FACILITY AMINE PROCESS

- Flue Gases from Combustor
- Treated Flue Gas
- Wash Water
- CO₂
- Lean Amine
- Rich Amine

Absorber
- From CTF Flue Gas
- FGD Package
- Booster Fan
- Rich Amine Pump

Desorber
- Water Wash Pump
- Water Wash Drum
- CO₂ Removed
- Condenser
- Water

Cross Exchanger
- Pressurised Hot Water
- Reboiler
- Amine Solution Tank

To Atmosphere
- Distilled/Demin Water
- Filter
- Lean Amine Pump

Amine Pump
R&D programmes

> 2 EU funded projects: Eco-Scrub and Cesar

- Eco-Scrub project: oxy-fuel combined with amine based CO2 capture
- Cesar: investigate performance of “film-trays” in absorber rather than random packing
Eco-scrub test work at Didcot Combustion Test Facility

Oxygen enriched firing

Post combustion capture of carbon dioxide using amine absorption
CESAR test equipment
Didcot lessons learned and areas for future investigation

> Lessons learned
  – How to achieve stable operation of post combustion capture process.
  – Identification of optimum operating conditions
  – Laboratory techniques for analysing key operating parameters

> Areas for further investigation
  – Benefit of heat integration / inter-stage cooling
  – Unknown effects of long term operation on coal fired power station
Aberthaw Carbon Capture Demonstrator
Project overview

> Demonstrate combined sulphur dioxide and carbon dioxide removal process

> Heat integration through Mechanical Vapour Recompression

> Technology provider Cansolv

> 2 year test programme
## Relative size of Aberthaw Demonstrator

<table>
<thead>
<tr>
<th></th>
<th>Staudinger</th>
<th>Didcot</th>
<th>Niederhausen</th>
<th>Aberthaw</th>
<th>Ferrybridge</th>
<th>Mountaineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.On</td>
<td>RWE NPower</td>
<td>RWE Power</td>
<td></td>
<td>RWE Npower</td>
<td>Scottish &amp; Southern / Vattenfall</td>
<td>American Electricity and Power</td>
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<tr>
<td>Treated gas volume (Nm³/hr)</td>
<td>150</td>
<td>200</td>
<td>1,500</td>
<td>10,000</td>
<td>20,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Technology provider</td>
<td>Siemens</td>
<td>Generic</td>
<td>BASF / Linde</td>
<td>Cansolv</td>
<td>Doosan Babcock</td>
<td>Alstom</td>
</tr>
<tr>
<td>Technology</td>
<td>Amino acid</td>
<td>Amine</td>
<td>Amine</td>
<td>Amine</td>
<td>Amine</td>
<td>Chilled Ammonia</td>
</tr>
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Cansolv Process
Cansolv Module Layout

- 6 Cansolv modules
  - SO₂ Absorber
  - SO₂ Stripper
  - CO₂ Absorber
  - CO₂ Stripper
  - Mechanical Vapour Recompression
    (heat integration)
  - Amine Purification Unit
    (to remove products of degradation)
R&D Test Programme

- Measure reboiler energy requirement
- Measure benefit of heat integration
- Measure benefit of inter-stage cooling in absorber
- Observe solvent degradation
- Obtain operational experience on coal fired power station
- Assess plant flexibility
Aberthaw CCD – current status

> Mechanically complete December 2011
> Currently in final stages of cold commissioning
> Operations team recruited and trained
> Initial operation April 2012
Thank you for your attention.