Optimized Post-Combustion Capture Technology for Power Plants

Georg Sieder (BASF), Torsten Stoffregen (Linde-KCA-Dresden)
Dresden; May 18, 2009
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III. BASF development of new solvents
IV. Pilot plant
V. Study for Demo and full scale plant
VI. Outlook
A PCC demonstration project must realize the full PCC-CCS chain

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<tbody>
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<td>Pilot Plant Niederaussem</td>
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<td>Design of the Demonstration Plant</td>
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<td>Demonstration Plant</td>
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- **Proof of concept**
- **Definition of scale-up factor**
- **Decision on the PCC technology**
- **Grant of approvals is prerequisite for final investment decision**
- **Detail Engineering, approval procedure**
- **Construct.**
- **Routing**
- **Screening**
- **Start CO₂ Injection**
Outstanding capability of all partners to reach the ambitious goals for PCC-technology:

- Efficiency losses: < 10 % points
- CO2 avoidance costs: < 30 €/t CO2

- **RWE Power**: operation of pilot plant and later demonstration plant / PCC integration
- **BASF**: development of a new advanced technology/solvent for PCC
- **Linde**: EPC for pilot plant and development of new solutions for full scale plant
Powerful Cooperation of
RWE Power/BASF/Linde

Solvent Development BASF
- Screening
- Miniplant performance tests

CO₂ Capture Pilot Plant
- Engineering, Procurement
- Construction
- Operation

Working Group “PCC-Demo”
- Optimization of the PCC concept
- Scale up for a full-scale plant
- Designing of the demo plant
Selection criteria for solvent of choice

- Physical, chemical and toxicological properties
- ‘cyclic capacity’ and thereof derived energy efficiency
- Mass transfer of carbon dioxide and kinetics
- Solvent losses and solvent stability
- Compatibility with construction material
- Large scale production
Product portfolio, databases

~ 400 Substances

Pre-selection: Molecular weight, Vapour pressure, Alkalinity, Safety data

~ 180

Screening: Phase equilibria, Reaction kinetics, Stability

10 - ??

Verification: Mini plant

2

Litmus test: Pilot plant

Discontinuous Synthetic gas

Continuous Synthetic gas

Continuous Slip stream
Results of screening phase

**Phase Equilibria**

**Kinetics**

**Losses/Stability**

- Cyclic capacity / Nm³/t MEA

- Absorption rate

- Losses/Stability

- Content of amine
Verification of laboratory results in mini plant

Mini plant at BASF

- Verification of the screening results
- Several options for an advanced solvent are identified.
Site Niederaussem

Coupled operation with progressive plant technologies at the site Niederaussem BoA1

Example: High-performance FGD: “REAplus” goal: < 10 mg/Nm³ SO₂ and < 2 mg/Nm³ dust and SO₃

<table>
<thead>
<tr>
<th>Location</th>
<th>FGD building, BoA1</th>
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<tbody>
<tr>
<td>Diameter scrubber</td>
<td>app. 1.8 m (GRP)</td>
</tr>
<tr>
<td>Height</td>
<td>app. 25 m</td>
</tr>
<tr>
<td>Flue gas volume flow</td>
<td>app. 30.000 Nm³/h</td>
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<tr>
<td>Optimization concept</td>
<td>Internals and multi-spray levels</td>
</tr>
<tr>
<td>Operation</td>
<td>automatic</td>
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<tr>
<td>Partners</td>
<td>RWE, AE&amp;E</td>
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REAplus technology for the reduction of OPEX / CAPEX of PCC
PCC Pilot Plant Niederaussem

- CO₂-capture rate 90 %
- app. 300 kg CO₂/h
- Height: app. 40 m
- Area: app. 15 m x 20 m
- Commissioning: Mid 2009
- Budget RWE Power: 9 Mio. €
- 40% funding by BMWi
PCC Pilot Plant Niederaussem - Basic process

**Flue gas cooling and SO₂-pre scrubbing**

**CO₂-capture**

**Solvent regeneration**

Flue gas cooling and SO₂-pre scrubbing

CO₂-capture

Solvent regeneration
## Pilot plant Niederaussem

### Technical facts

<table>
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<tr>
<th>Type</th>
<th>Pilot plant</th>
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<tr>
<td>lignite</td>
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<td><strong>Flue gas</strong></td>
<td>1552 Nm³/h</td>
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<tr>
<td><strong>Product</strong></td>
<td>159 Nm³/h CO₂; 7.2 t/d CO₂</td>
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<tr>
<td><strong>Source</strong></td>
<td>lignite-fired power plant</td>
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<td><strong>Start-up</strong></td>
<td>June 2009</td>
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<tr>
<td><strong>Design</strong></td>
<td>6 Skids, 2 Container</td>
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<tr>
<td><strong>Skid 1</strong></td>
<td>4 x 4 x 41 m; weight: 80 t</td>
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<tr>
<td><strong>Instrumentation</strong></td>
<td>240</td>
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<tr>
<td><strong>MOC</strong></td>
<td>tests at 15 different locations</td>
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PCC Pilot Plant Niederaussem
Erection Skids 1-6

Erection of skids from
March 4 -11, 2009
The tasks for the pilot plant as well as for the demonstration plant testing programme will be defined by the need to validate the feasibility and performance of a commercial full scale plant.

All essential capture process performance parameters as
—energy demand,
—CO$_2$ purity and emissions,
—long term stability of the solvent,
—the stability of constructional elements and materials
will be determined in the pilot plant testing programme.

On basis of a preliminary, realistic capture plant design the preparation of the engineering for the demonstration plant as well as for a full scale plant starts.

The results of the pilot plant testing programme are the basis for the definition of the validation concept in the demonstration plant scale.
Part of the partnership between RWE Power, BASF and Linde

Field of developments:
- energy consumption
- plant concept and layout
- train minimization
- utility consumption
- material of construction
- risk analysis
- equipment design for large capacities

Result:
- optimized concept for full scale plant - 2 trains with 550 MW_{el} each
- definition of next steps for demo plant
Next steps:

— start-up of pilot plant started on May 6, 2009
— start test with MEA as reference solvent from July 2009
— test with new advanced amine wash solvent end of 2009

Announcement:
International PCC Symposium
Duesseldorf/Neuss, July 30/31, 2009
Your Questions?

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