Solvents

No Escape for CO$_2$
BASF’s Development Program for Post Combustion Capture

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BASF well positioned to take on the challenges of carbon capture

- More than 40 years of experience in removing CO$_2$ from synthetic and natural gas streams

- Extensive R&D facilities for the development of gas treating technologies and new chemical compounds

- One of the world’s leading suppliers of amines with broadest product portfolio

- Comprehensive knowledge to scale up processes from lab scale to full industrial production
Major contributing cost factors

**Capture Plant**
- Equipment size
- Process configuration
- Material of construction
- Power plant integration

**Solvent**
- Energy requirement
- Capacity
- Kinetics
- Stability
# Objectives of BASF’s development program

<table>
<thead>
<tr>
<th>Solvent</th>
<th>MEA (30%)</th>
<th>NoEscape</th>
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</thead>
<tbody>
<tr>
<td>Power plant</td>
<td>12-14%</td>
<td>&lt;&lt; 10 %</td>
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<tr>
<td>efficiency loss</td>
<td></td>
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<tr>
<td>CAPEX</td>
<td>100 %</td>
<td>80 %</td>
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<td>Product losses</td>
<td>1.6 – 3.0 kg/t(\text{CO}_2)</td>
<td>&lt;&lt; 0.4 kg/t(\text{CO}_2)</td>
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## Selection criteria for solvent of choice

- Physical, chemical and toxicological properties
- Energy efficiency
- Mass transfer of carbon dioxide and kinetics
- Solvent losses and solvent stability
- Compatibility with construction material
- Large scale production
The long road to success

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

May 6th 2009, Andreas Northemann, BASF SE, Ludwigshafen, Germany
Summary of screening phase
capacity, energy, kinetic

‘Double stirred’
contactor cell
Solvent stability towards Oxygen

‘Stress’ tests using air

The graph shows the content of solvent over time for tested solvents and MEA. The solvents' content decreases with time, indicating their instability towards oxygen. The graph highlights the different rates at which the tested solvents and MEA degrade under stress conditions.
Verification in mini plant

Mini plant at BASF

![Mini plant at BASF](image)

![Graph showing specific energy demand vs. circulation rate with MEA optimum highlighted](graph)

May 6th 2009, Andreas Northemann, BASF SE, Ludwigshafen, Germany
Meticulous search and comprehensive testing ultimately paid off

A handful of solvents identified which have potential to meet the objectives of the development program

Most promising candidates subject to pilot testing using slip stream starting July 2009 (part of co-operation with RWE and Linde)

Results expected early 2010 to confirm mini plant data and to gain in-depth understanding for future scale up