The Results from PCC Pilot Plant with New Amine Solvent, Process and Packing

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IHI Corporation
Chemical Engineering Dep.
Product Development Center
Today’s Contents

1. Introduction
2. Advanced Solvent
3. Advanced Packing
4. Advanced Process
5. Summary
**CO₂ capture method for coal fired power plant**

**Oxy-fuel Combustion**

- Coal
- N₂
- Air
- O₂
- Oxygen production unit
- Flue gas recirculation
- Boiler
- Flue gas treatment
- CO₂, H₂O, O₂
- Non-condensable gas

**Calide Oxy-fuel Project 30 MWe (Demonstration project)**

- N₂, H₂O, O₂

**Post-combustion**

- Coal
- Air
- Oxygen production unit
- Flue gas treatment
- Precise treatment
- CO₂ separation
- CO₂ storage
- Compression/cooling

**20 ton-CO₂/day Pilot Plant**

- Pre-combustion (Gasification)
- N₂
- Air
- O₂
- Oxygen production unit
- Gasification
- Flue gas treatment
- Shift reactor
- CO₂, H₂
- Use of H₂ (for power generation)
- CO₂ separation
- CO₂ storage
- Compression/cooling
Development Items

- High efficiency heat recovery
- High CO₂ loading of rich amine

Advanced Process

Pilot Plant →Demonstration/Commercial Plants

- High CO₂ cyclic capacity
- Low reaction heat
- High desorption performance

Advanced Solvent

Advanced Packing System

- High absorption performance
- Low gas pressure drop
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IHI’s Pilot Plant

20 ton-CO₂/d Pilot Plant located at IHI's Aioi Works in Japan

Absorber

Stripper

Pre-Treatment Tower

Specifications

<table>
<thead>
<tr>
<th>Source Gas</th>
<th>Flue Gas of Coal-Fired Boiler or PG Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captured CO₂</td>
<td>20 ton-CO₂/d</td>
</tr>
<tr>
<td>CO₂ Capture Ratio</td>
<td>90 %</td>
</tr>
<tr>
<td>Flue Gas Flow Rate</td>
<td>MAX 4000 m³_N/h-wet</td>
</tr>
<tr>
<td>CO₂ Concentration (Inlet)</td>
<td>14-15 %-dry</td>
</tr>
<tr>
<td>Solvent Flow Rate</td>
<td>MAX 24 m³/h</td>
</tr>
<tr>
<td>Steam Flow Rate</td>
<td>MAX 2500 kg/h</td>
</tr>
</tbody>
</table>
Pilot Plant Process (conventional process)

Absorber
- I.D. 850 mm
- 5 m x 3 sections
- Structured packing
  250 m²/m³ (conventional)

Stripper
- I.D. 700 mm
- 5 m x 2 sections
- Structured packing
  250 m²/m³ (conventional)

Possible to evaluate in different packing height

Superficial gas velocity ≅ 2.0 m/s

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Results of Advanced solvent

- The absorption rate of Solvent A is the highest in lab test.

![Fig. Lab-test results](image1)

![Fig. Pilot plant results](image2)

- The regeneration energy of Solvent A has been achieved 20% lower than of MEA(30wt%).

CO₂ Capture ratio = 90%
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Advanced packing

Absorber
- I.D. 850 mm
- 5 m×3 sections
- Structured packing

Stripper
- I.D. 700 mm
- 5 m×2 sections
- Structured packing

Replaced the bottom conventional packing (5 m) with IHI advanced one
Results of advanced packing by Pilot Plant

- Regeneration energy with 5m IHI advanced packing is as same as 10m conventional packing.

- Whole pressure drop of IHI packing was lower at the same absorption performance (regeneration energy).

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Heat efficiency was improved and possible to make higher rich amine CO₂ loading. Latent heat of evaporation can mainly be reduced.
## Results of 50 kg-CO$_2$/d Bench-scale test

<table>
<thead>
<tr>
<th>Solvent</th>
<th>MEA</th>
<th>Solvent A</th>
<th>Solvent B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption Rate</td>
<td>○</td>
<td>◎</td>
<td>△</td>
</tr>
<tr>
<td>Desorption Ratio</td>
<td>×</td>
<td>△</td>
<td>○</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regeneration Energy (Bench-scale test results)</th>
<th>Conventional Process</th>
<th>IHI Advanced Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>× (3.8 GJ/t-CO$_2$)</td>
<td>No Data (2.7 GJ/t-CO$_2$)</td>
</tr>
<tr>
<td></td>
<td>△ (2.9 GJ/t-CO$_2$)</td>
<td>△ (2.9 GJ/t-CO$_2$)</td>
</tr>
<tr>
<td></td>
<td>△ (2.9 GJ/t-CO$_2$)</td>
<td>○ (2.5 GJ/t-CO$_2$)</td>
</tr>
</tbody>
</table>

Solvent with high desorption performance is suited to IHI advanced process.
Results of advanced process by Pilot Plant

- 3% energy saving was achieved by advanced packing only, and when advanced process was further added, energy saving improved 4% more.
- It expects that the regeneration energy of Solvent B is 37% energy saving.
Summary

- Absorption performance of IHI advanced packing was twice as much as that of conventional one.

- Advanced process can reduce the regeneration energy. Especially high desorption performance solvent was suit to this process, we plan to evaluate this year.
Thank you for your attention!

IHI

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