New Energy Efficient Processes and Newly Developed Absorbents for Flue Gas CO₂ Capture

Koji Kadono
The Kansai Electric Power Co., Inc.

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Outline

- Introduction and Background
- CO$_2$ recovery pilot plant (Nanko Power Station)
- Process Improvements
- Development of new absorbents
- Commercial CO$_2$ capture plants
- Summary
Kansai Electric Power Company (KEPCO) and Mitsubishi Heavy Industries, Ltd. (MHI) have been working together since 1990 and have developed an advanced CO₂ capture chemical absorption process – KM CDR Process™.
**CO₂ recovery pilot plant (Nanko Power Station)**

- **Location:** Nanko Power Station, Osaka, Japan
- **Capacity:** 2 metric ton/day
- **Feed Gas:** Natural Gas Boiler
- **Initial Start-up:** April 1991
- Installed at an operating thermal power plant
- Operating for 20 years (longest operation in the world)
- All process are demonstrated

**Please come and visit!**
**Process Improvement -1**

- **Energy saving process : Stripper -**

Utilization of Lean solvent & Steam condensate heat
Addition of several Heat exchangers & Pumps

<table>
<thead>
<tr>
<th>Test Process at Nanko Pilot Plant</th>
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<tbody>
<tr>
<td>Conventional Process</td>
<td>Close</td>
<td>Open</td>
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<tr>
<td>Improved Process</td>
<td>Open</td>
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Process Improvement -2

- **New Energy Efficient Process**: Increased CO$_2$ loading of rich amine -

The Process was confirmed through modification of the Nanko CO$_2$ capture pilot plant in 2009.
- Increased CO$_2$ loading of rich amine by reducing the absorber temperature
- Reduced absorbent heat loss by decreasing absorbent recirculation rate
- Reduced CO$_2$ reflux cooler heat loss by lowering the temperature at the top of the stripper

**Process Optimization**

- **New Energy Efficient Process**: Increased CO$_2$ loading of rich amine -

The Process equipment was further optimized and confirmed at the Nanko CO$_2$ capture pilot plant in 2010.
# Development of new absorbents

- **Nanko CO₂ capture pilot plant test results of newly developed absorbents**

<table>
<thead>
<tr>
<th>Test absorbents</th>
<th>Test condition</th>
<th>Test results</th>
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<tbody>
<tr>
<td></td>
<td>CO₂ concentration at plant inlet(%)</td>
<td>System configuration</td>
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<tr>
<td>KS-1™</td>
<td>10</td>
<td>①</td>
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<td>①②</td>
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<tr>
<td>New absorbent 1 (yet to be officially named)</td>
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<tr>
<td>New absorbent 2 (yet to be officially named)</td>
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Remarks) ① : Process Improvement-1  
② : Process Improvement-2  
③ : Process Optimization

The characteristics of this new absorbent, regarding corrosiveness and volatility, were confirmed through a series of recent laboratory tests.
United Arab Emirates

Client: Ruwais Fertilizer Industries (FERTIL)
CO₂ source: Natural gas boiler & steam reformer
Start up: December 2009
Capacity: 400 tpd
Product: Urea production
Process: Improved KM-CDR Process™
Solvent: KS-1™

Status: Highest Performing commercial CO₂ Capture Plant
Summary (1)

1. The Kansai Electric Power (KEPCO) has developed energy efficient chemical absorbents and economical processes which aim to reduce the cost of CO$_2$ capture, in collaboration with Mitsubishi Heavy Industries (MHI).

2. This work has been ongoing since 1990, using several Japan based R&D facilities and a pilot plant, located at Nanko Power Station in Osaka (Japan), to verify improvements.

3. Ten (10) commercial CO$_2$ capture plants (capacity up to 450 tpd), using KS-1™ solvent, have been contracted worldwide (8 operational & 2 under construction).
4. Process Improvement -1,-2 with process optimization and new solvents were developed and tested at Nanko pilot plant last year. CO₂ recovery and regeneration energy results:

- KS-1™ solvent: 563kcal/kg CO₂ (= 2.36MJ/kg CO₂)
- A ‘new’ solvent: 551kcal/kg CO₂ (= 2.31MJ/kg CO₂)

5. Improvements will be applied to all commercial CO₂ capture plants and for coal fired flue gas applications, designed and delivered by MHI.
Thank you
Any questions?