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Negative emission by high CO_2 capture ratio of CO_2 capture plant

Hirofumi Kazuno[a], Takashi Nojo[a], Takashi Kamijo[b], Shimpei Kawasaki[b], Hiroshi Tanaka[c], Takuya Hirata[c] and Tatsuya Tsujiuchi[c]

a The Kansai Electric Power Co., Inc. b Mitsubishi Heavy Industries Engineering, Ltd. c Mitsubishi Heavy Industries, Ltd.

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1. Introduction

- The Kansai Electric Power Co., Inc. (Kansai EPCO) and Mitsubishi Heavy Industries, Ltd. (MHI) have developed the highly-efficient post-combustion CO_2 capture technology known as the KM CDR Process™ since 1990. After successfully delivering 13 commercial CO_2 Capture Plants across the world, Kansai EPCO and MHI continue to improve the KM CDR Process™.
- Achieving negative emission by higher CO_2 capture ratio is very important to help mitigate global warming. Negative emission is achieved when the CO_2 concentration of the treated gas released from the CO_2 capture plant is lower than the atmospheric CO_2 concentration of 400 ppm.
- This study examines the impact of capture ratio on the plant specifications and compares the Base case at 90% capture ratio and Negative emission case at 99% or higher with Gas Turbine (G/T) flue gas conditions by pilot verification testing and design study using MHI's proprietary simulator.

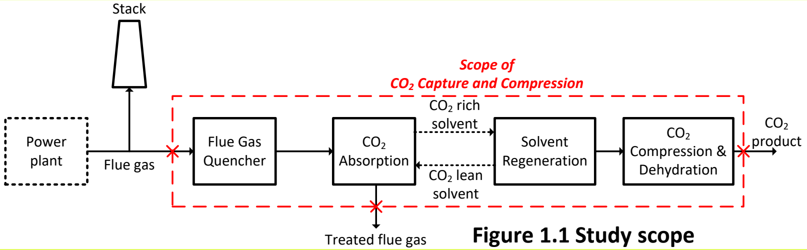

Figure 1.1 Study scope

2. Pilot Verification Testing

2.1 Test Conditions

Table 2.1 Test conditions at Kansai EPCO/MHI pilot plant

	KM CDR Process™
Capture ratio (%)	85 - 99.98
Flue gas rate (Nm^3/hr)	730 - 750
CO_2 concentration (mol%)	3.4
CO_2 capacity (tonne/day)	1.0 - 1.2
CO_2 product pressure (bar)	Without Compression
Absorption Packing Height	Constant

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2.2. Test Results

Negative emission (99% or higher capture ratio) under Gas Turbine (G/T) flue gas conditions

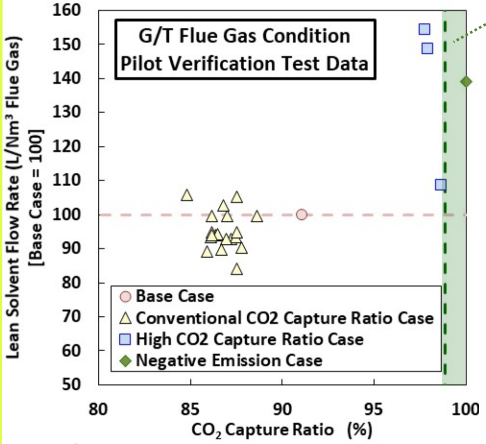

Figure 2.1 Lean solvent flow rate

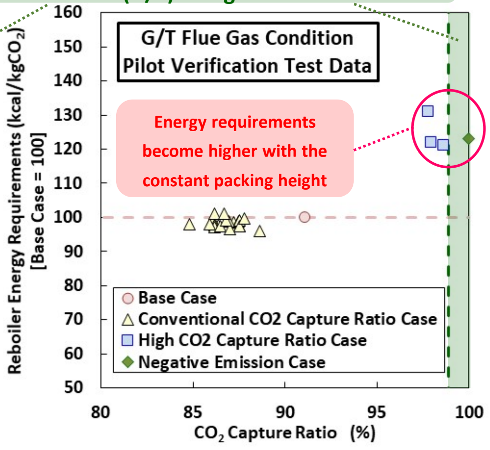

Figure 2.2 Reboiler energy requirements

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3. Design Study

3.1 Study Conditions

Table 3.1 Study Conditions

	Base case	Negative emission case
Capture ratio (%)	90	99.5
Flue gas rate (Nm^3/hr)	3,000,000	3,000,000
CO_2 concentration (mol%)	4.7	4.7
CO_2 capacity (tonne/day)	5,950	6,580
CO_2 product pressure (bar)	150	150
Relative absorption packing height (% as m)	100	100 - 150

3.2 Study Results

Table 3.2 Main design specifications and steam consumption
(Scale against base value: 100)

		Base case	Negative emission case	
			Case 1	Case 2 *1)
CO_2 capacity (tonne/day)		5,950	6,580	6,580
Flue Gas Quencher	Diameter	100	100	100
CO_2 absorber	Diameter	100	100	100
	Absorption packing H	100	100	150
Regenerator	Diameter	100	126	108
CAPEX (expected) per unit captured CO_2		100	Slightly Increase	Increase
Lean solvent rate per unit captured CO_2		100	162	94
Reboiler steam per unit captured CO_2		100	138	104
OPEX (expected) per unit captured CO_2		100	Increase	Slightly Increase

*1) Operating parameter adjustment case.

4. Conclusions

- **Negative emission by 99% higher CO_2 capture ratio using the KM CDR Process^{TM} was actually confirmed** in pilot verification tests with gas turbine (G/T) flue gas conditions.
- The increased steam consumption per unit captured CO_2 for Negative Emission case with 99.5% capture of CO_2 was significantly mitigated by increasing absorption packing height and operating parameter adjustment in the simulation.