

# CO<sub>2</sub> Capture and Fixation Technology Utilizing a Seabed Ground Improvement System

## CO<sub>2</sub> Fixation Technology Using the Cement Deep Mixing Method

Large-scale marine construction using work vessels faces the challenge of reducing CO<sub>2</sub> emissions from onboard generators. To address this, a technology using a compact CO<sub>2</sub> capture system installable on work vessels is being developed.<sup>1)</sup>

The compact CO<sub>2</sub> capture system, "ReCO<sub>2</sub> STATION®," is housed in two 20-foot containers and can capture approximately 400 kg of CO<sub>2</sub> per day. The aim is to achieve practical deployment of CO<sub>2</sub> capture on work vessels using this system.

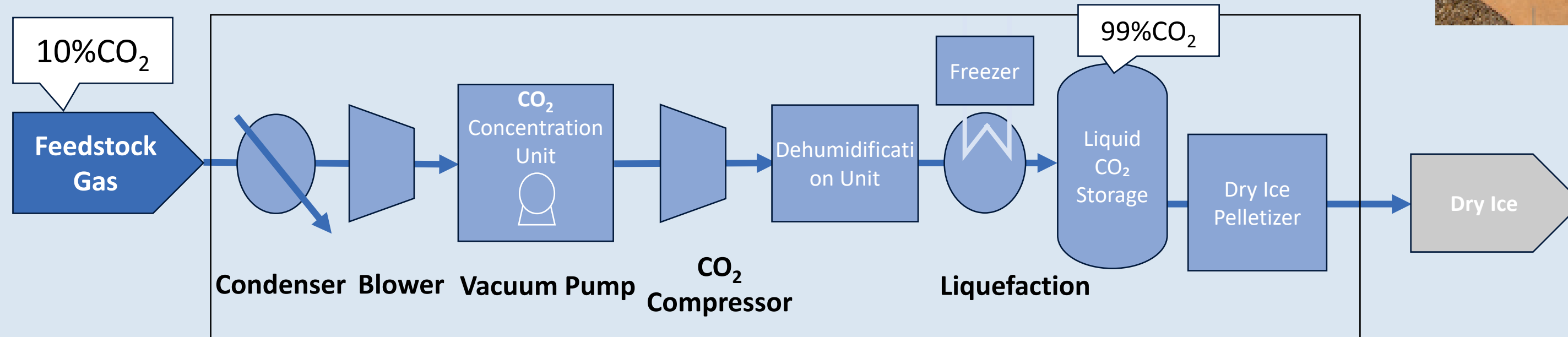
### Development of CO<sub>2</sub> Capture Technology

#### ● Compact CO<sub>2</sub> Capture System "ReCO<sub>2</sub> STATION®"

The compact CO<sub>2</sub> capture system "ReCO<sub>2</sub> STATION®," developed by Air Water Inc., draws in exhaust gas as feedstock through a condenser unit. CO<sub>2</sub> is then concentrated using a vacuum pump, followed by compression and dehumidification, and finally liquefied and stored as liquid CO<sub>2</sub> using a refrigeration system. It can also be formed into dry ice when necessary. Assuming a CO<sub>2</sub> concentration of 10% in the exhaust gas, the system is designed to recover approximately 16 kg/h of liquefied CO<sub>2</sub>.

Toyo Construction Co., Ltd. is jointly developing CO<sub>2</sub> capture technology for work vessels in collaboration with Air Water Inc.<sup>2)</sup>

#### ■ CO<sub>2</sub> Capture Mechanism of the Compact CO<sub>2</sub> Capture System "ReCO<sub>2</sub> STATION®"



#### ■ Demonstration Test Using the Compact CO<sub>2</sub> Capture System "ReCO<sub>2</sub> STATION®" (Tier 3 Emission Gas)



#### ■ Produced Dry Ice



#### ■ Demonstration Test Using the Compact CO<sub>2</sub> Capture System "ReCO<sub>2</sub> STATION®" (Tier 2 Emission Gas)



#### ● Demonstration Test of CO<sub>2</sub> Capture from Exhaust Gas

Demonstration experiments were conducted using Stage 2 and Stage 3 emission-regulated diesel generators to develop practical CO<sub>2</sub> capture from exhaust gas emitted by power generators on work vessels.

#### ● Experimental Method

CO<sub>2</sub> concentration in exhaust gas was measured under varying generator loads, along with CO<sub>2</sub> recovery amount corresponding to the CO<sub>2</sub> concentration.

#### ● CO<sub>2</sub> Concentration in Generator Exhaust Gas

CO<sub>2</sub> concentration increased proportionally with generator load. It was 4.0% at 35% load and 8.2% at 95% load. Third-stage emission-controlled generators showed CO<sub>2</sub> concentrations approximately 2% higher than second-stage units.

#### ● Relationship Between CO<sub>2</sub> Concentration and Recovery Amount

As CO<sub>2</sub> concentration in the exhaust gas increased, the production of liquefied CO<sub>2</sub> also increased almost proportionally. These results indicate that higher generator loads lead to higher CO<sub>2</sub> recovery rates per unit time.

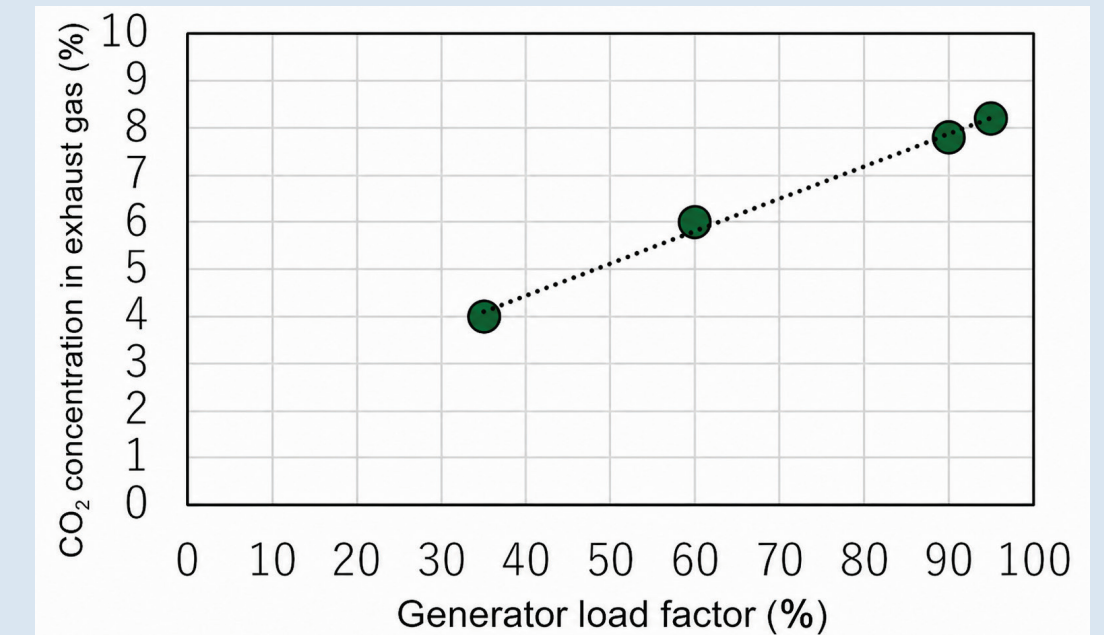
#### ● Exhaust Gas Composition and Generator Load

Exhaust gas contained CO<sub>2</sub>, PM, CO, SO<sub>2</sub>, NO<sub>2</sub>, NO, H<sub>2</sub>, and O<sub>2</sub>. Experimental results showed that higher generator load factors increased NO concentration, while CO, NO<sub>2</sub>, and O<sub>2</sub> concentrations decreased. No correlation was observed between SO<sub>2</sub> concentration and generator load factor.

1) Mae Hara, KaneKo, Kai Gawa, Oh De, Yama Zaki: "CO<sub>2</sub> Capture from Actual Exhaust Gas Using a Compact CO<sub>2</sub> Capture System," Proceedings of the 79th Annual Meeting of the Japan Society of Civil Engineers, VI-173, 2024.

2) <https://www.toyo-const.co.jp/topics/technicalnews-18047>

#### ■ CO<sub>2</sub> Concentration in Exhaust Gas



#### ■ Generator Load Ratio and Exhaust Gas Composition

Item	Unit	Constant load		Variable load		Constant load			
		35	60	60-90	60-90	90	95	98	
Generator load factor	%	35	60	60-90	60-90	90	95	98	
Exhaust gas composition	CO <sub>2</sub>	mol%	4.5	6.1	6.0-7.8	6.0-7.8	8.2	8.9	9.2
	CO	molppm	210-240	140-160	110-140	110-150	100-120	150-170	180-200
	SO <sub>2</sub>	molppm	0-2	0-5	0	0	0-14	0	0
	NO <sub>2</sub>	molppm	44-47	17-24	6-8.5	5-16	5	5	5
	NO	molppm	250-270	400-430	440-650	420-640	620-680	690-740	770
	H <sub>2</sub>	molppm	0-20	0-20	0-15	2-12	0-14	1-16	7-20
	O <sub>2</sub>	mol%	14.2	11.9	9.4-11.9	9.4-12.0	-	8	7.4