Research and Development Toward Saving Energy for Direct Air Capture With Available Cold Energy

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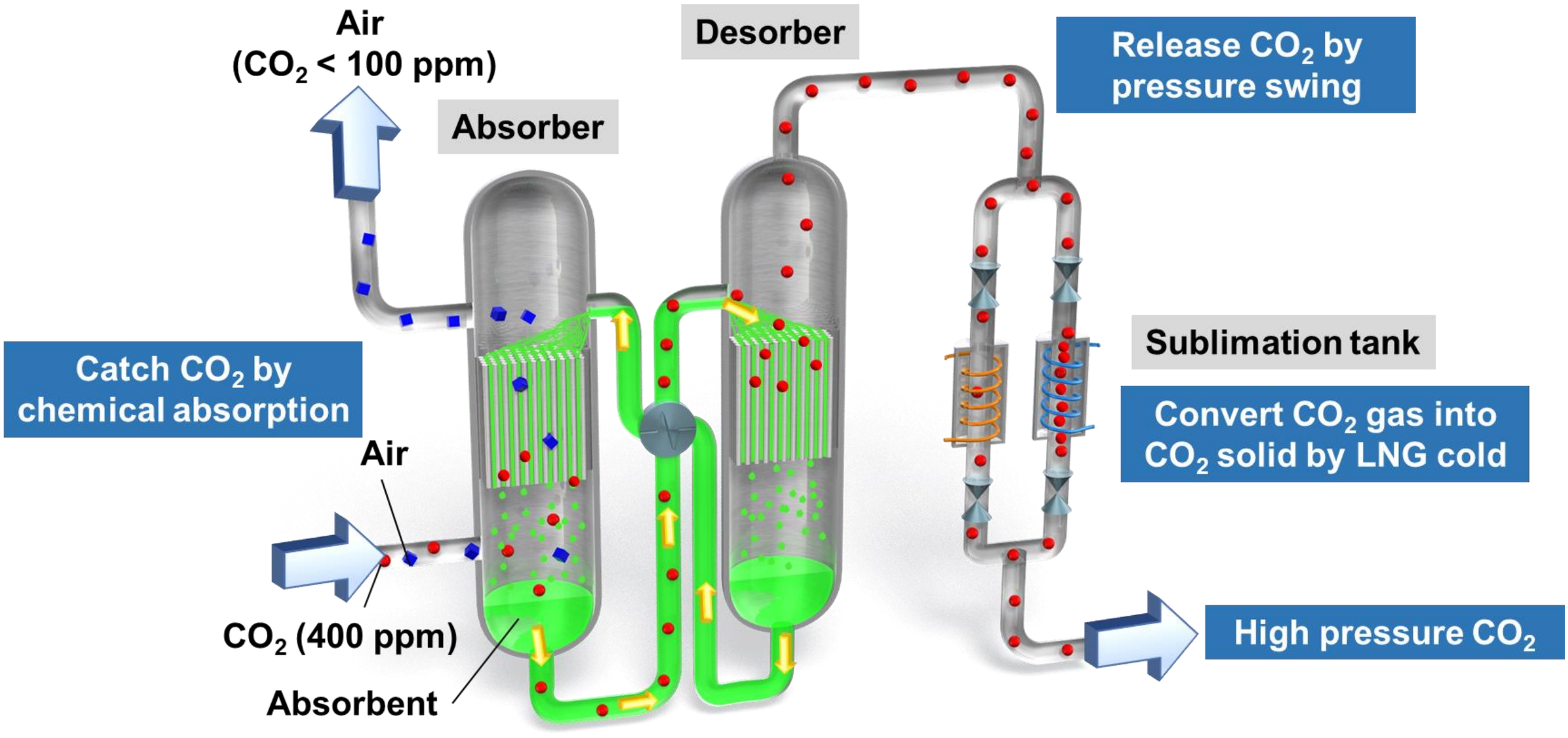
Implementing organizations : Nagoya University, Toho Gas Co., Ltd., Tokyo University of Science

Cryo-DAC - process -

- A pressure swing amine process driven by the cryogenic pumping with LNG cold



Cryo-DAC - our team -

- Use LNG cold for DAC

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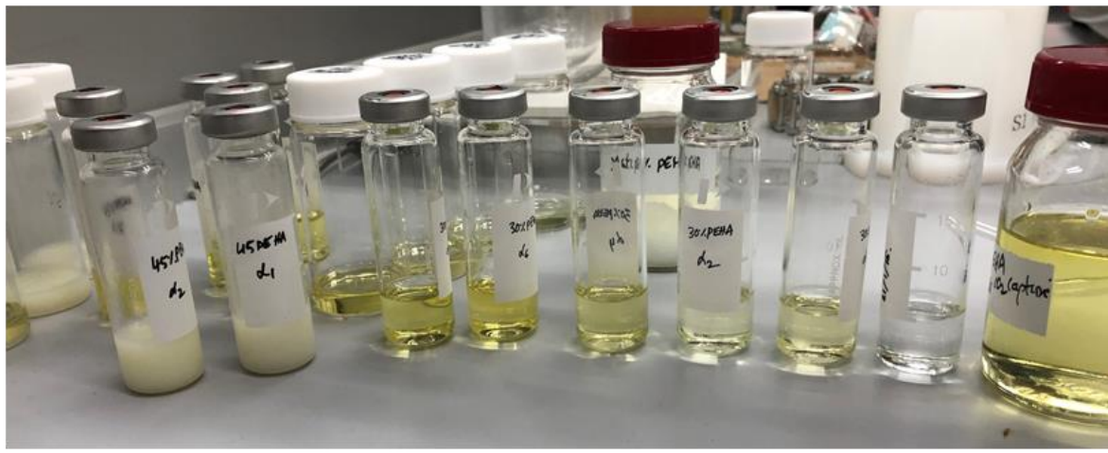
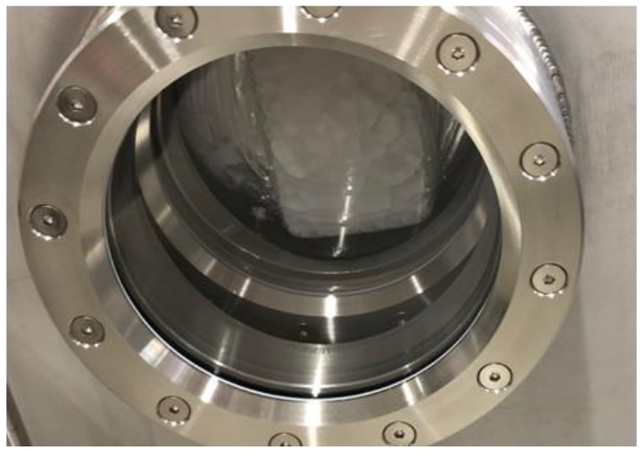
Process design	Commercialization	Materials	Optimization/monitoring	LCA

Cryo-DAC - advantages -

- Minimized thermal energy input
- Water in air can be accepted by amine



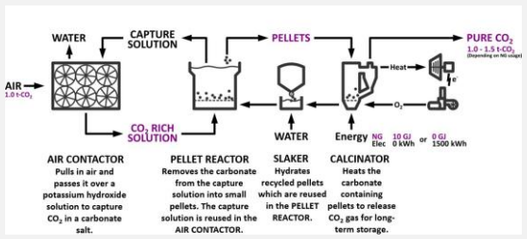
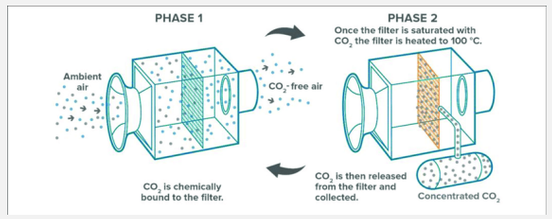
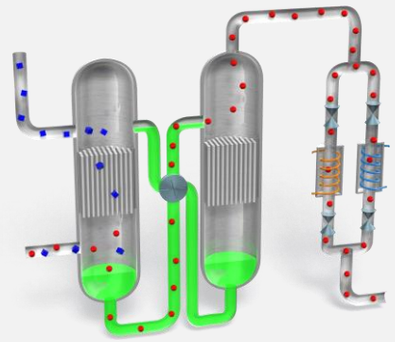
- High pressure and high purity CO_2 is output



No further compression and purification

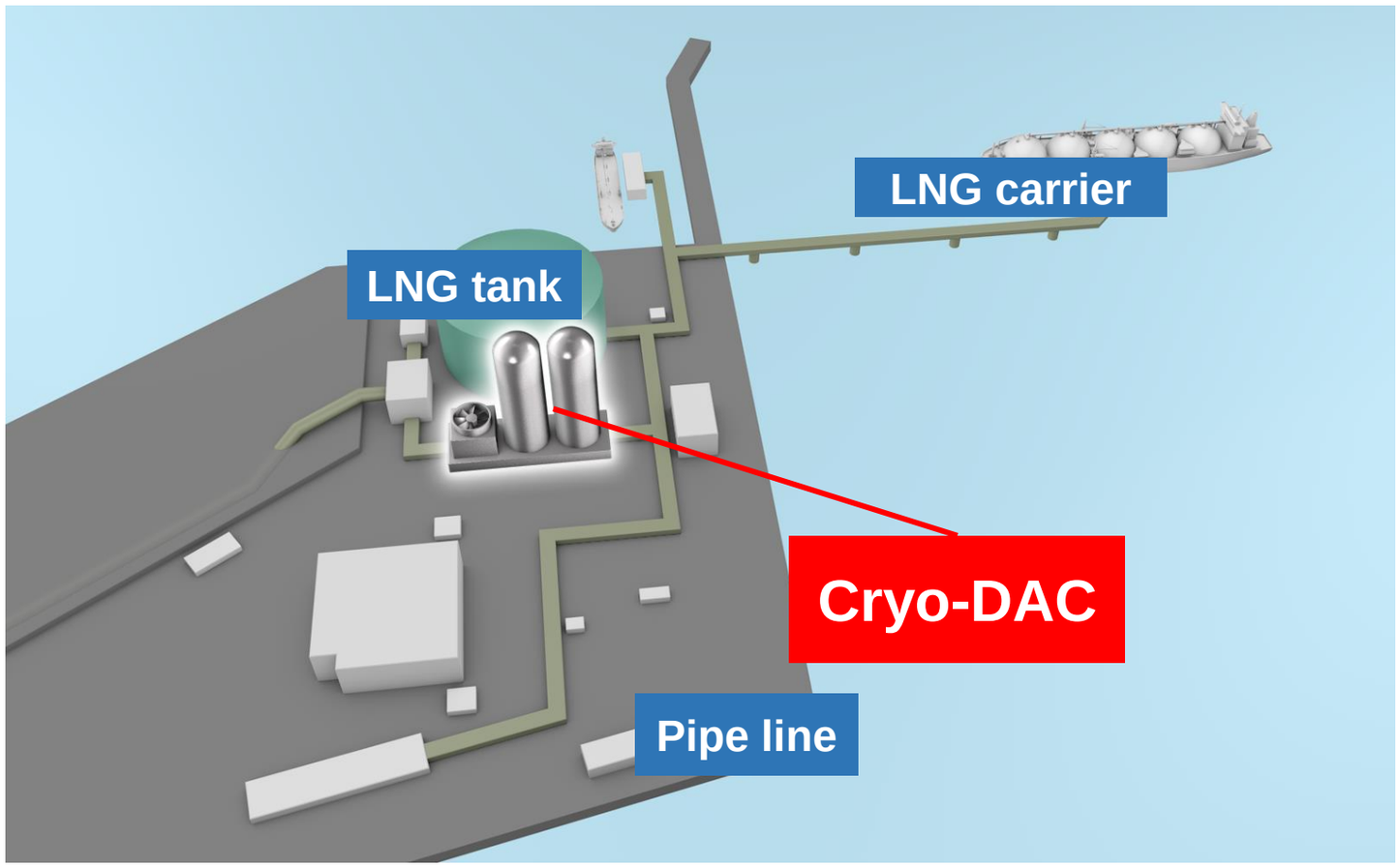
Cryo-DAC → Storage and Utilization

Other DACs vs Cryo-DAC

Developer	Carbon Engineering	Climeworks	Cryo-DAC
			
Principle	Aqueous alkali solution, T-swing	Solid absorbent, T-swing	Liquid absorbent, P-swing
Th Energy requirements, per captured CO_2 (relative)	100※	41※	40
Sorbents regeneration temperature, ℃	900※	80-120※	25

※McQueen, N.; Gomes, K. V.; McCormick, C.; Blumanthal, K.; Pisciotta, M.; Wilcox, J. A Review of Direct Air Capture (DAC): Scaling up Commercial Technologies and Innovating for the Future. *Prog. Energy* **2021**, *3* (3), 032001.

Cryo-DAC - perspective -



LNG imports share %(2020)

BP Statistical Review
of World Energy 2021 | 70th edition

Japan	21
China	19
South Korea	11
India	7
Taiwan	5
Total Europe	24

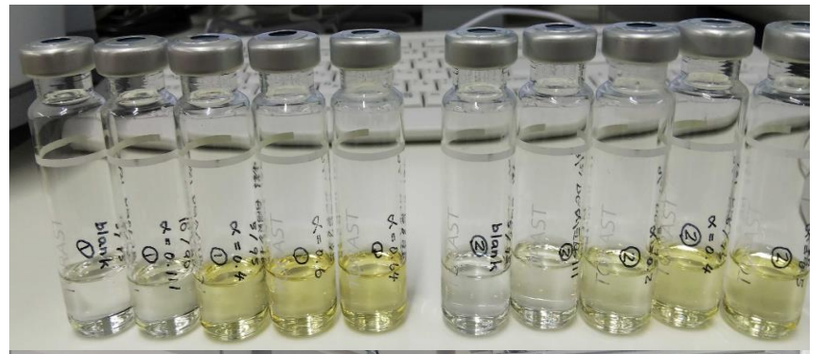
- **Cryo-DAC can be implemented to a city gas plant and capture CO_2 from the air and output high pressure or liquefied CO_2.**
- **Captured CO_2 can be geologically stored or converted to carbon neutral methane, etc.**

Cryo-DAC - study is going on -

- We found a good amine that absorbs CO_2 in air (~40 Pa) and release more than half of the absorbed CO_2 at 10 Pa that is the pressure of stripper as well as the dry ice sublimation pressure at -150°C.

- Process simulation based on the equilibrium properties of the amine indicates that the Cryo-DAC can be operated with much lower thermal energy input than the benchmark technologies.

- We are going to design and install a bench scale (~1 t-CO_2/y) and a pilot scale plant toward realization.



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