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

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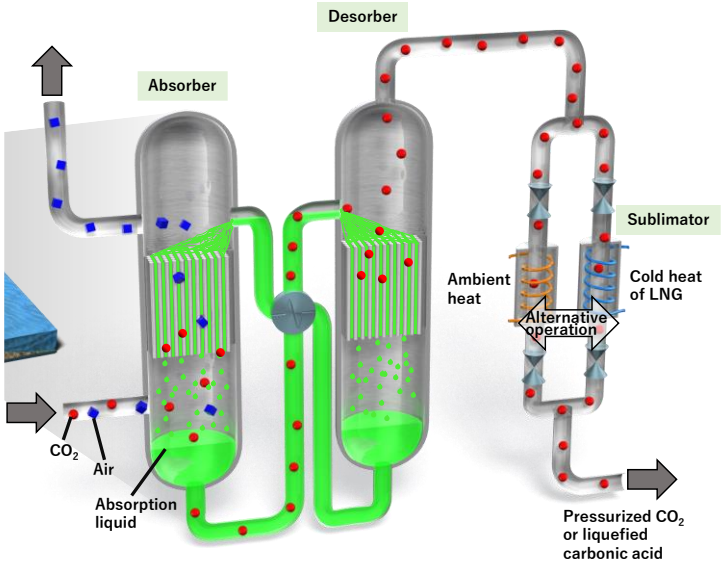
Summary

We are going to develop a new technology that significantly improves the efficiency of Direct Air Capture (DAC) by utilizing unused cold heat from liquefied natural gas (LNG). A series of processes that recover CO_2 as dry ice are proposed and demonstrated. The underlying principle includes that heat generated by CO_2 sublimation is absorbed by the heat of vaporization of LNG.

In the absorption tower, the alkaline solution absorbs CO_2 in the atmosphere and subsequently flows into to the regeneration tower. Sublimation tanks equipped with heat exchangers using LNG as a cooling medium are installed downstream, where CO_2 can be collected as dry ice. Due to the CO_2 sublimation in a closed system, the pressure of the regeneration tower can be reduced, and CO_2 is released from the absorption liquid. The feature is that CO_2 is recovered from the absorbent not by heating but by vacuum induced by cooling and CO_2 sublimation. As a consequence, both absorption and regeneration can be operated near the environmental temperature, and the input of thermal energy can be minimized. If the dry ice is heated in a closed tank, we can generate a fluid such as high-pressure CO_2 or liquid CO_2, that can be directly delivered to the subsequent CO_2 storage (CCS) and utilization process (CCU).

[Main R & D contents]
〇Designs of absorber, regenerator, and sublimation tank.(Nagoya University)
〇Development of new absorbents that can drive the pressure swing DAC process.(Nagoya University)
〇Selection of steel grade for sublimation tank (Tokyo University of Science)
〇Development of sublimation tank soundness monitoring technology (Toho Gas)
〇Design of mounting system on LNG terminal, development of energy-saving technology and evaluation of economic efficiency and environmental friendliness (Toho Gas)
〇Development of Cryo-DAC commercial facility and extraction of social implementation issues (All)



Targets by 2030

FY2022: Development of a new absorbent to drive the process.
Development of equipment materials and soundness diagnostic sensors that can be used in a temperature range of - 196℃ to room temperature and a pressure range of 10 Pa to 4 MPa.

FY2024: Development of a bench scale facility (~ 1t-CO_2 / year) and implement continuous operation.

FY2029: Conceptual design of the commercial plant and propose social implementation scenarios.

Implementation

Nagoya University, Toho Gas Co., Ltd., Tokyo University of Science