MOONSHOT RESEARCH & DEVELOPMENT PROGRAM NEDO

Development of Highly Efficient Direct Air Capture (DAC) and Carbon Recycling Technologies

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Implementing organizations : Kanazawa University,
Research Institute of Innovative Technology for the Earth

R & D items

Item \ Fiscal year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Development of new solid sorbent materials for DAC (RITE)	Development of new materials			Optimization of synthetic process		Improving materials and synthetic process				
Development of effective systems for DAC (KU, RITE, Engineering company)	Development of DAC process (Indirect heating, rotary TSA)					Improving DAC system				
	Simulation for DAC			Simulation for pilot scale equipment		Optimization of DAC process by simulation				
DAC		Development of DAC system		Development of DAC system with small bench test		Improving DAC system				
Scale up DAC equipment（Engineering company）						Design of pilot-scale equipment	Fabrication of pilot-scale equipment		Pilot test	
Development of a high-efficient FT synthesis process (RITE)	Development of the water separation and hydrogen separation membranes			Durability test		Development of a high-efficient FT synthesis converting the recovered CO_2 to a liquid hydrocarbon fuel				
Design and fabrication of scale up equipment (Engineering company)	CO_2 conversion					Design and Fabrication of bench/small pilot equipment		Demonstration		
Evaluation of e-fuel and LCA for whole system (Automobile company)				Economically analysis of e-fuel		Evaluation of e-fuel with car engine			Life cycle assessment	

Final goal

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R & D items 1. "Development of high-efficiency CO_2 capture technology from the atmosphere"

・Several tons/d-scale of DAC will be demonstrated and establishing practical DAC technology enough for FT synthesis.
・Low energy/cost DAC system for countermeasure against global warming will be revealed.
（Target: Achieving high performance DAC system exceeding overseas）

R & D items 2. "Development of CO_2 conversion technology for carbon recycling into valuable resources"

・Develop a high-efficient FT synthesis converting the recovered CO_2 to a liquid hydrocarbon fuel.
・Control FT synthesis reaction by Extractor-Distributor all-in-one membrane reactor.
・Investigate a suitable process using the membrane reactor with pilot-scale tests.
（Target: Achieving 80% or more of conversion efficiency）

R & D items 3. "Practicality assessment as a liquid hydrocarbon fuel using LCA method"

・Final confirmation of the net CO_2 reduction amount produced by the whole of the DAC ＆ FT synthesis system by applying the Life Cycle Assessment.
・Evaluate the performance of synthesized liquid hydrocarbon fuel by user companies.
（Target: Identifying issues for practical use）

Realize carbon recycling society

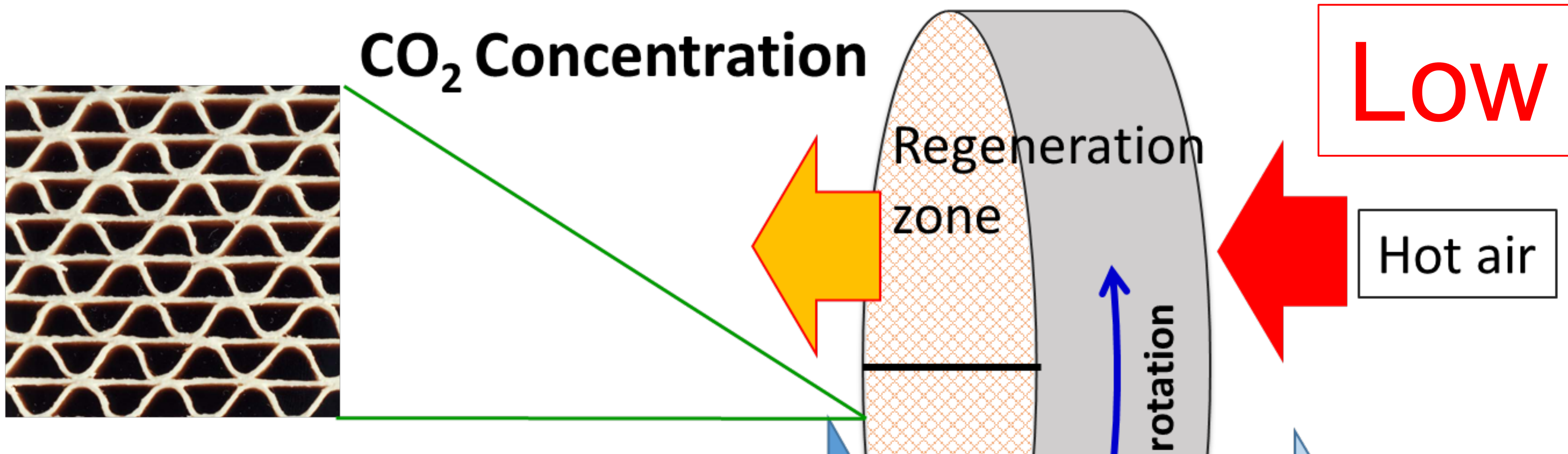
Points for Development of DAC

- **Effective use of Solar or Waste heat**
  1. **A low-temperature heat driven**
  2. **Reduction of excessive heat input**
     - ✓ **Larger CO_2absorption capacity／heat capacity**

       ***Minimize Heat losses during Temperature Swing operation**
     - ✓ **Heat recovery and recirculation in DAC**
- **Energy consumption of Blower**
  1. **Reduction of pressure drop at absorber**
  2. **Improvement of CO_2 recovery ratio**

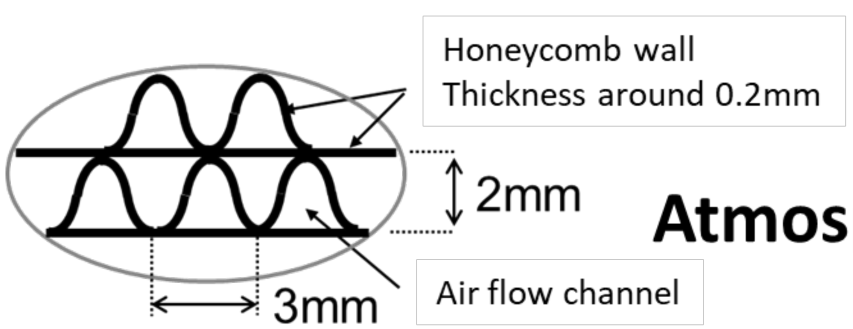
How can we break this trade-off relationship?

Honeycomb rotor or Indirect heating



Low pressure drop

How to supply required heat by small amount of hot air?

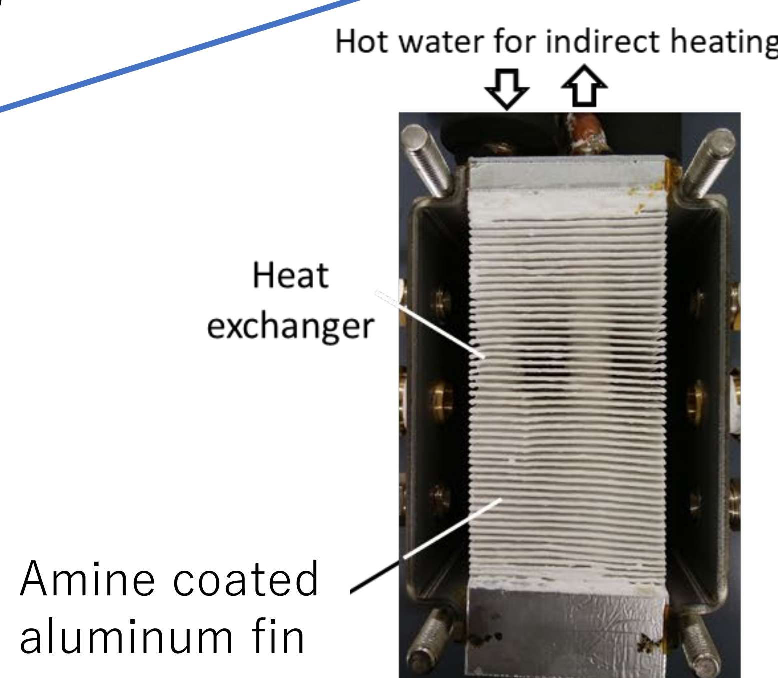


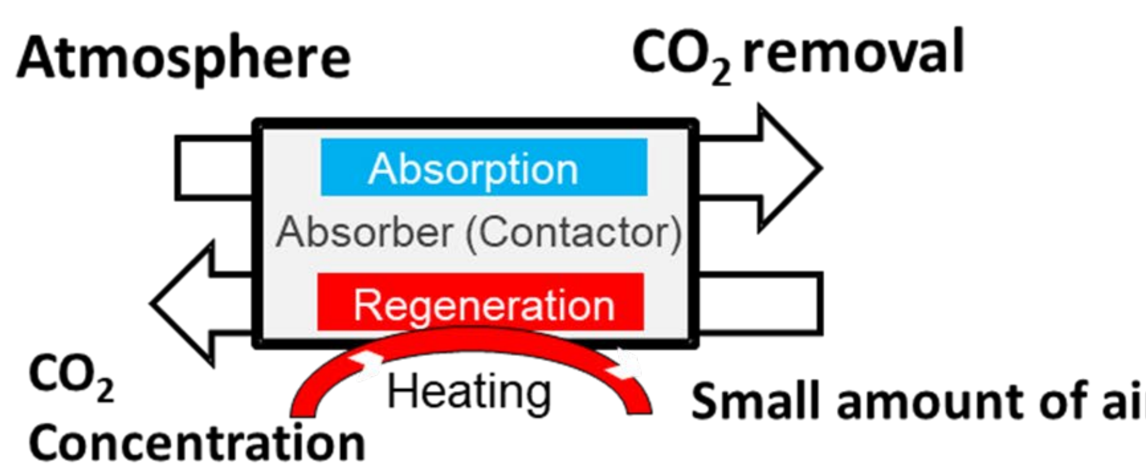
Amine impregnated honeycomb

and / or

Indirect Heating

Minimizing hot air supply amount results in a higher CO_2 concentration





Desorption behavior of CO_2

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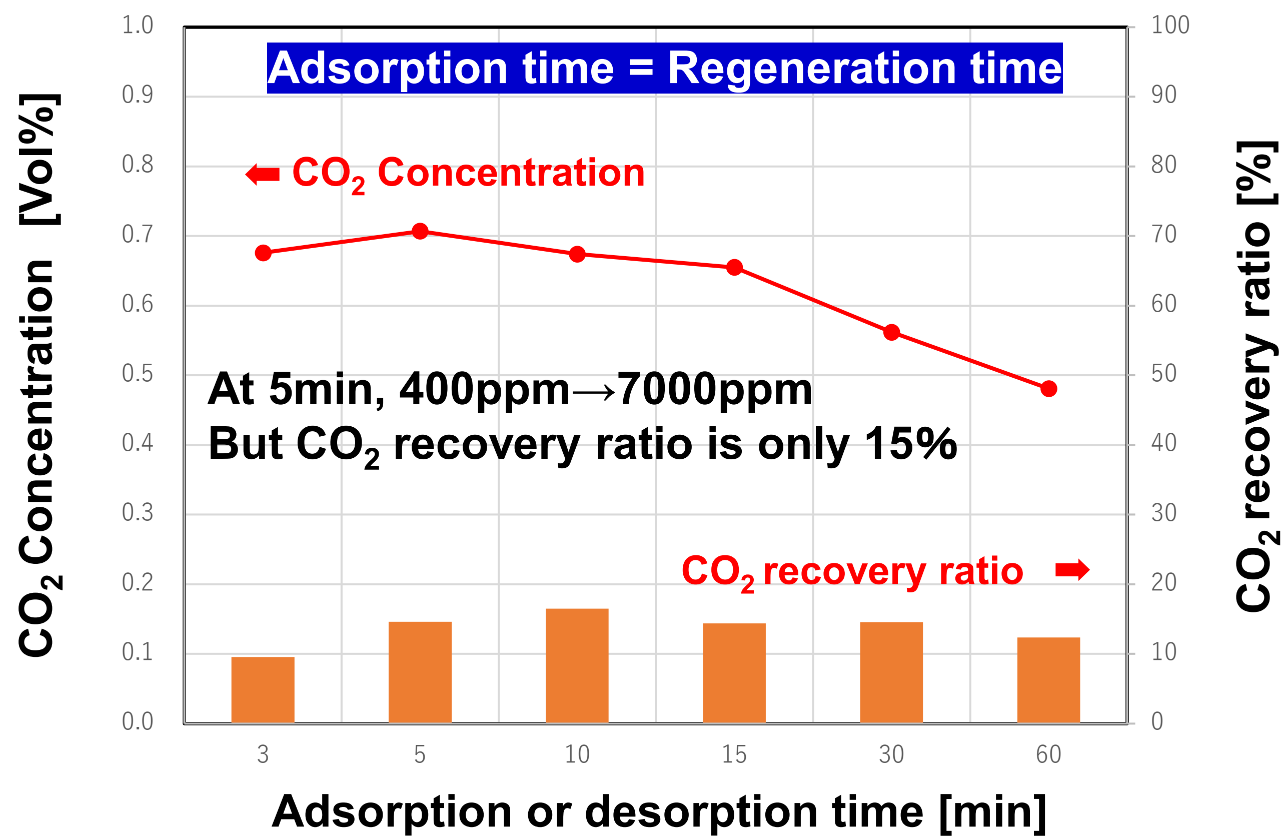
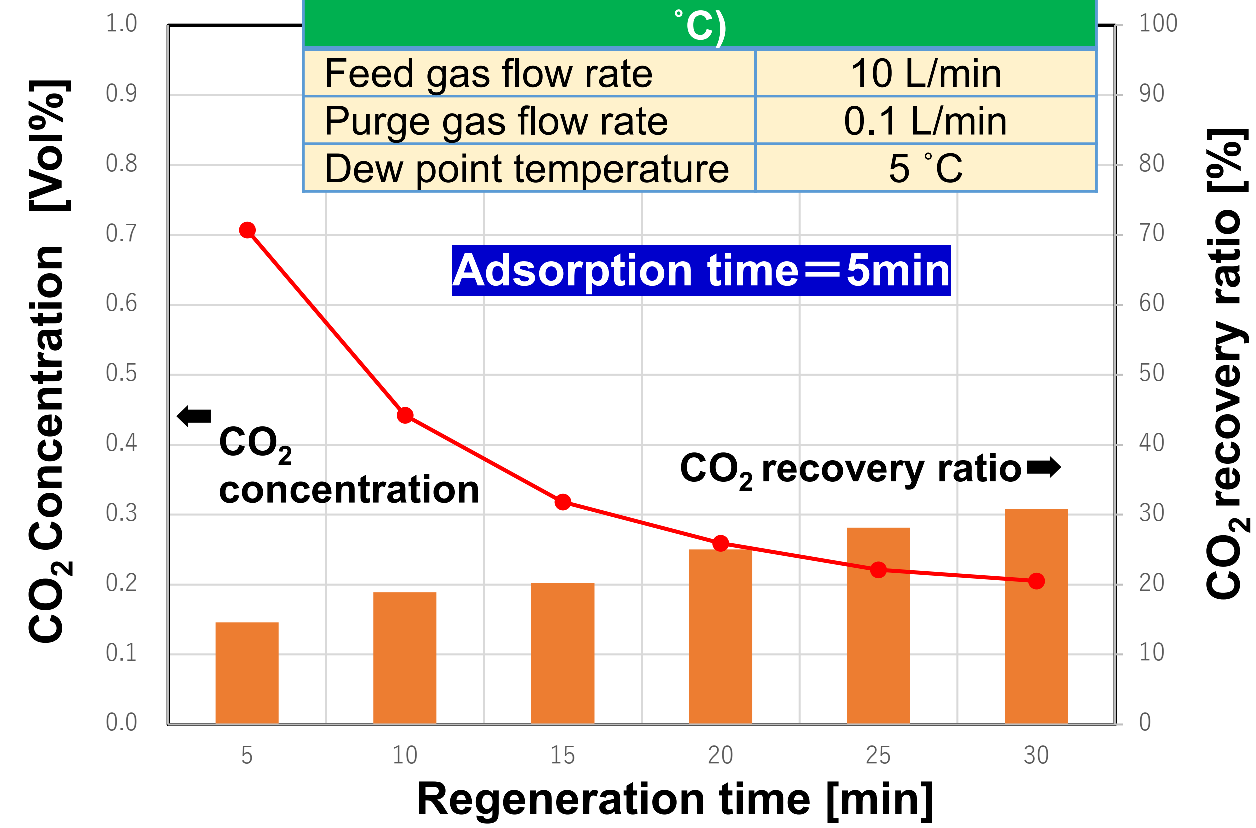
A simple absorption – desorption cycle

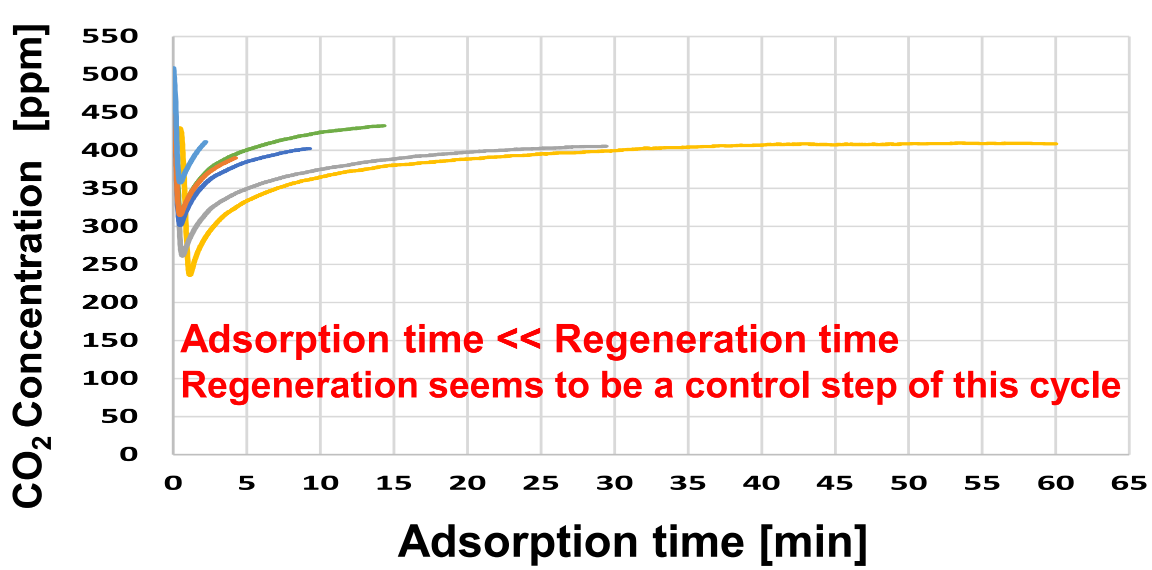
Indirect Heating

Space Velocity SV＝30s^{-1}

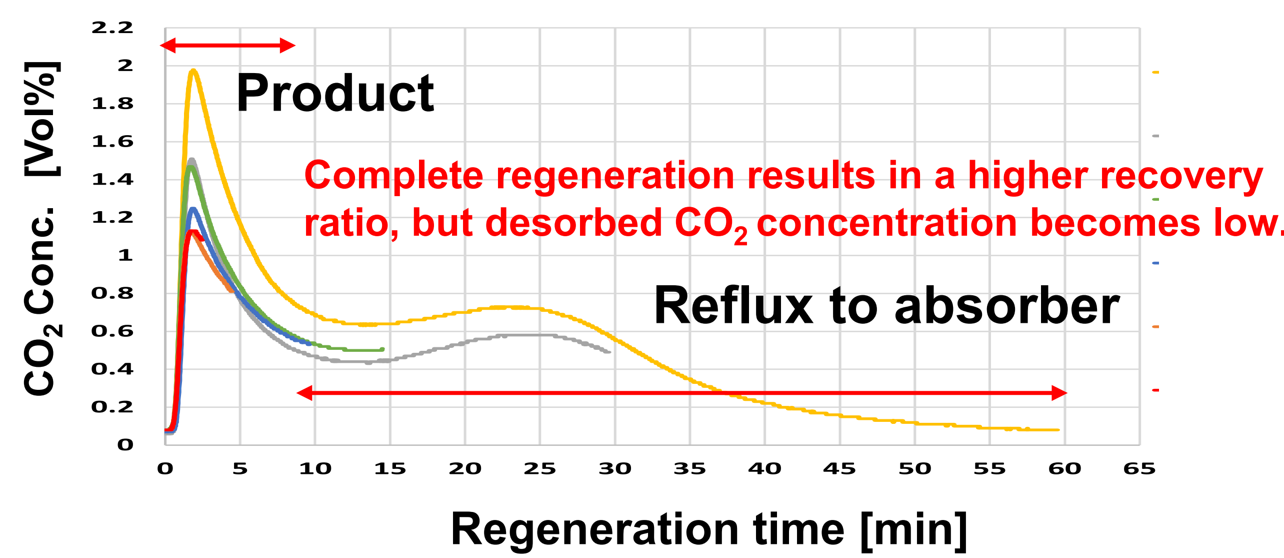


Adsorption (20 ˚C) ⇔ Desorption (60 ˚C)	
Feed gas flow rate	10 L/min
Purge gas flow rate	0.1 L/min
Dew point temperature	5 ˚C





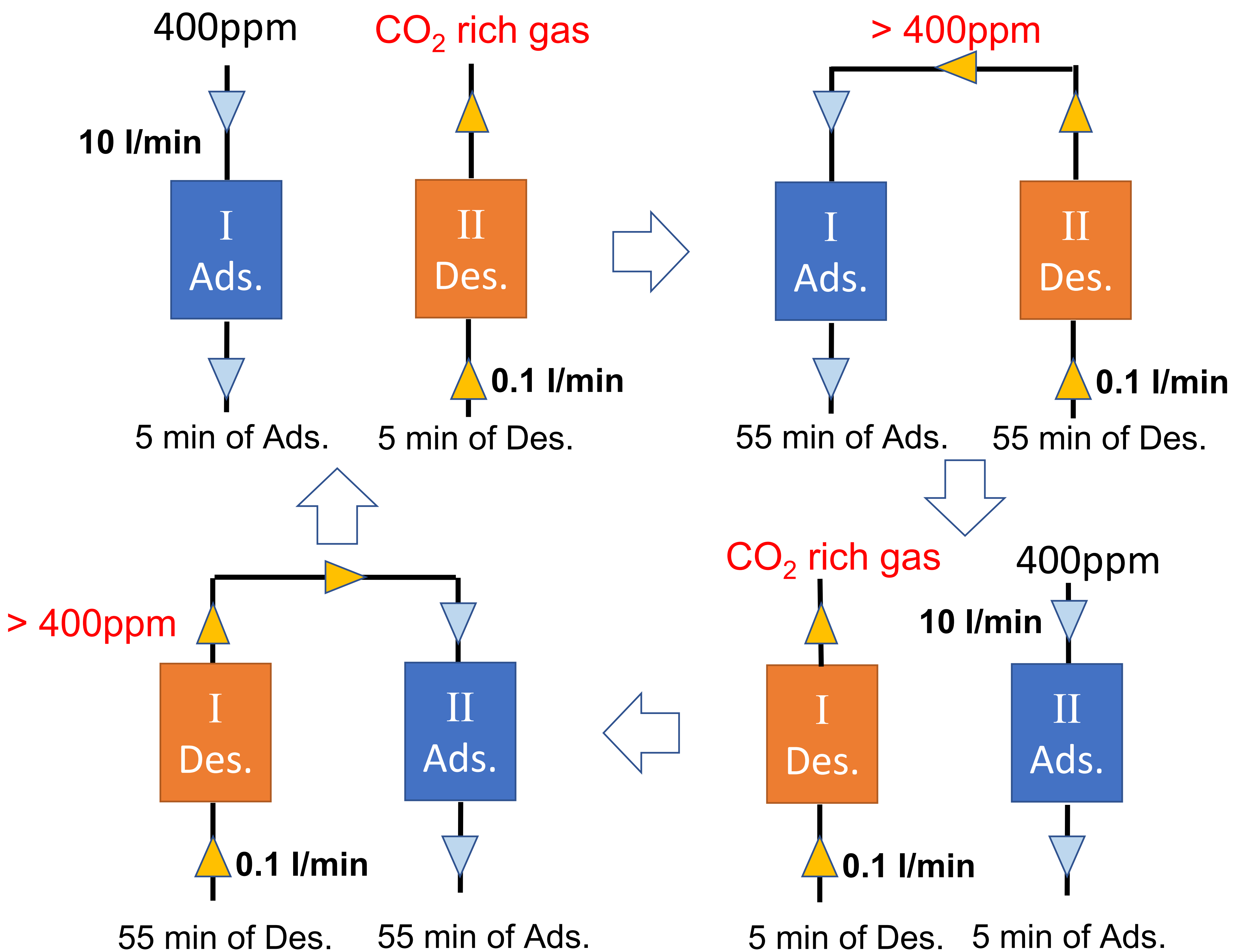
Time profile of adsorption outlet CO_2 concentration



Time profile of desorption outlet CO_2 concentration

An example of process configuration

Two adsorber



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