CO₂ concentration from air for microalgae cultivation

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**Introduction**

CO₂ capture direct from air (DAC) is an enabling technology for sustainable algae cultivation, making it independent of (fossil based) CO₂ sources as flue gases.

Sorbent-based CO₂ capture:
- no solvent evaporation
- low specific heat
- fast sorption kinetics
- higher CO₂ capacity?
- Stability?

Production of ...
1. CO₂ enriched air (open PBRs)
2. Pure CO₂ (closed PBRs)

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**Sorbent Selection**

Ideal sorbents for DAC: 1) High CO₂ capacity
2) High selectivity of CO₂ over H₂O

**Principle:**
- measure sample mass loss during heating in TGA and analyze composition of evolved gases using FTIR.

**Sample size:** ± 10 mg
- **Analysis time:** 30 min.

![Sorbent Selection Diagram]

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**Sorbent Characterization (1): Stability**

To evaluate sorbent stability under different (desorption) conditions

**Continuous treatment:**

**Cyclic operation:**

![Sorbent Stability Diagram]

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**Evaluation**

- Air purge: 1 bar; T[K] = 333; 1% CO₂ in product gas
- Desorption method:
  - Continuous sorbent in/out
  - T regeneration: 60°C
  - 1% CO₂ in product gas

![Evaluation Diagram]

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**Acknowledgements**

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**Pilot plant for CO₂ enriched air production**

![Pilot Plant Diagram]

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**... and much more work on...**

- sorbent CO₂ capacities, sorption kinetics, water co-adsorption, sorbent circulation and fluidization, optimization of regeneration conditions, process evaluation, resulting in:

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**Figure 1:** screening sorbents for direct air capture at ambient (lab) conditions for 15h

**Figure 2:** reproducibility tests of PEI600 (above) and Lewatit IER (below)

**Figure 3:** Sorbent stability in air, CO₂, N₂ and H₂O at elevated temperature.

**Figure 4:** Comparison of cyclic treatment and continuous treatment in air at 120 °C.

**Figure 5:** OpEx cost breakdown, based on energy needs and sorbent costs. No heat integration was included

**Figure 6:** CO₂ concentration at the outlet of desorber and desorption temperature