CO_2 concentration from air for microalgae cultivation

Algae Biorefineries for Europe

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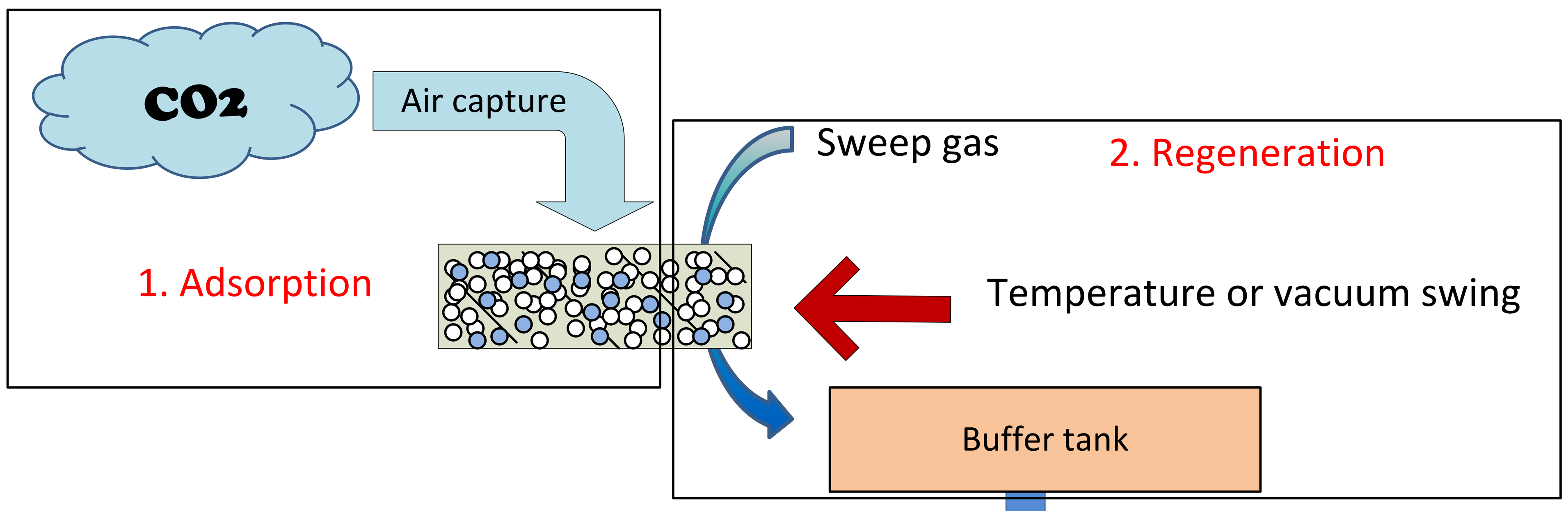
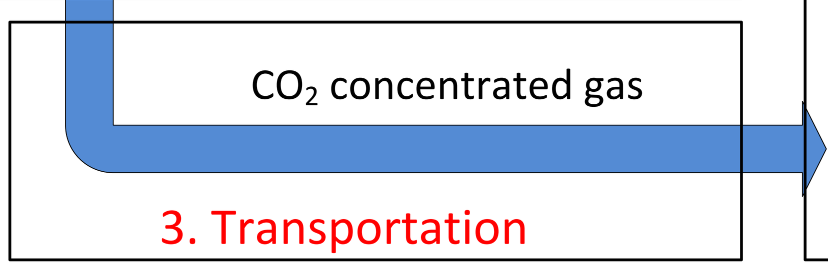
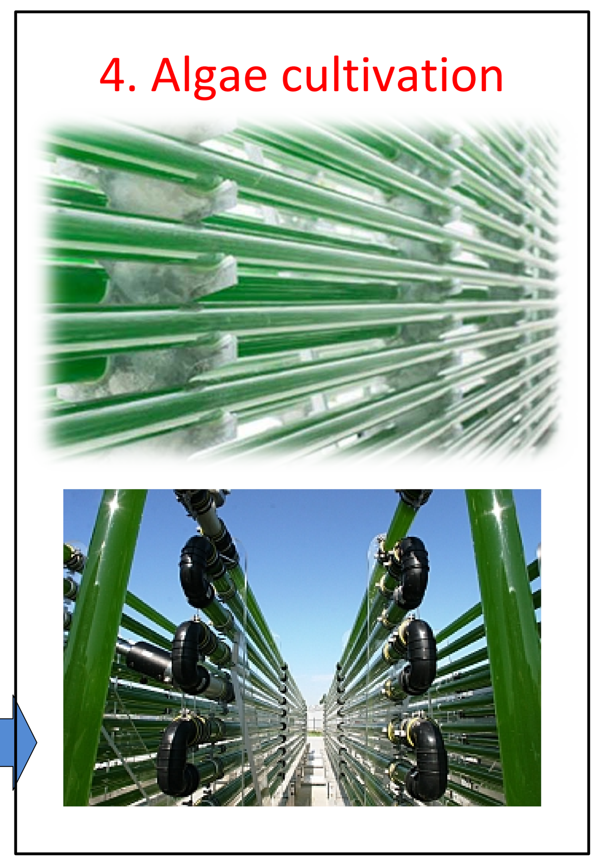
Introduction







CO_2 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 CO_2 capture:

- ✓ no solvent evaporation
- ✓ low specific heat
- ✓ fast sorption kinetics
- ✓ higher CO_2 capacity?
- ✓ Stability?

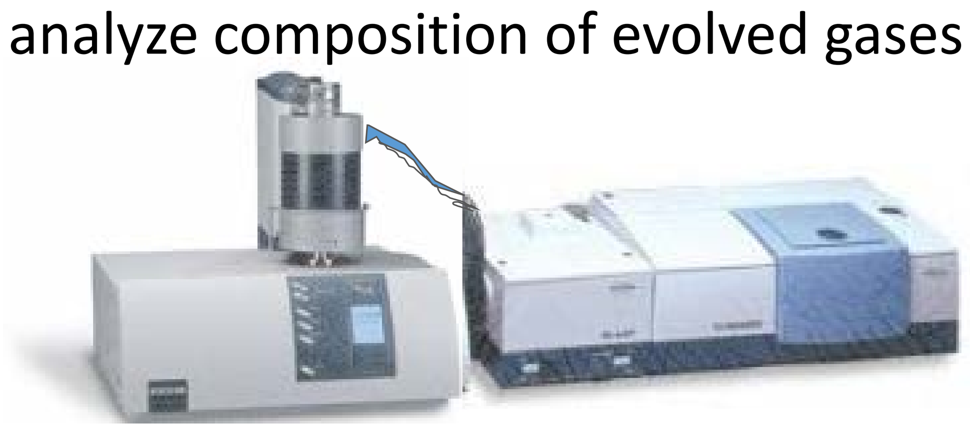
Production of …

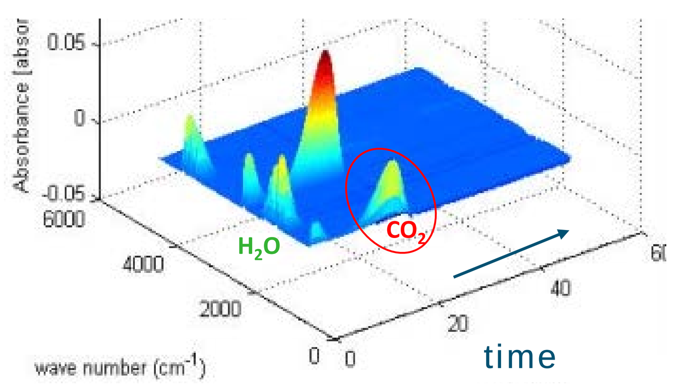
(1) CO_2 enriched air (open PBRs)
(2) Pure CO_2 (closed PBRs)

Sorbent Selection

Ideal sorbents for DAC: 1) High CO_2 capacity
2) High selectivity of CO_2 over H_2O

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.

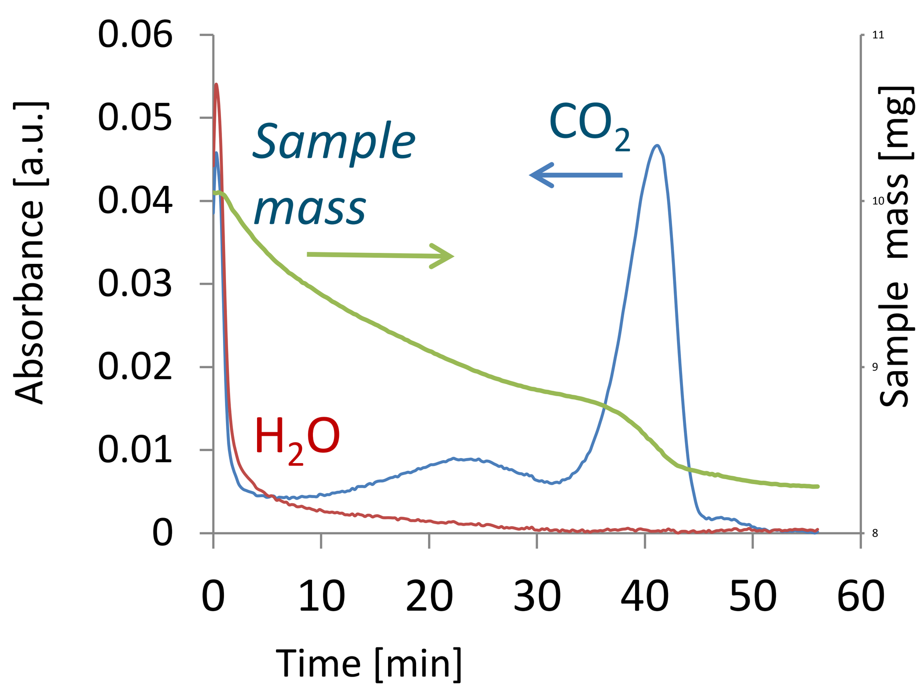


Figure 1: screening sorbents for direct air capture at ambient (lab) conditions for 15h

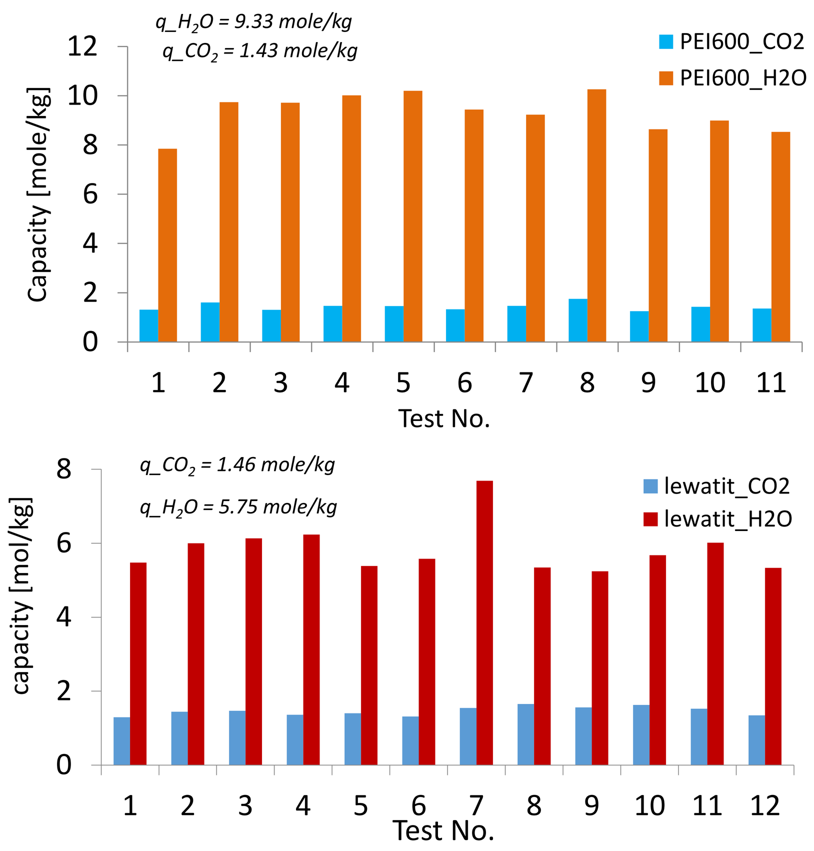
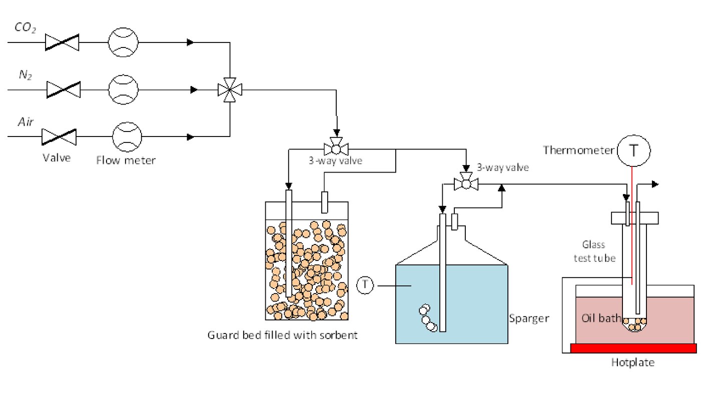


Figure 2: reproducibility tests of PEI600 (above) and Lewatit IER (below)

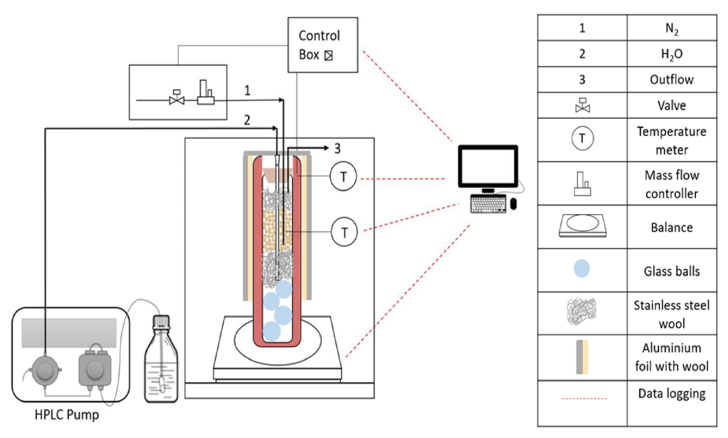
Sorbent Characterization (1): Stability

To evaluate sorbent stability under diff. (desorption) conditions

Continuous treatment:



Cyclic operation :



Stability in air, CO_2, N_2 and H_2O at elevated temperature

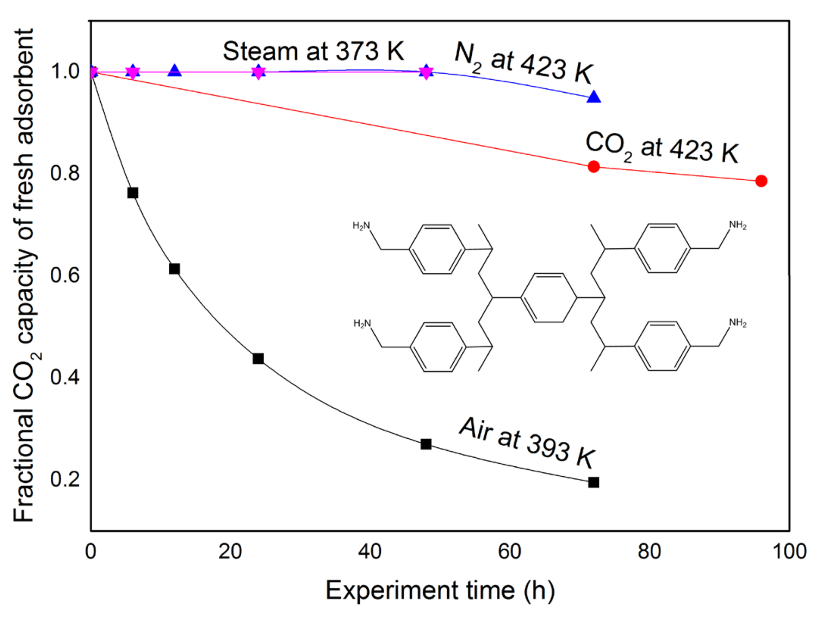


Figure 3: Sorbent stability in in air, CO_2, N_2 and H_2O at elevated temperature.

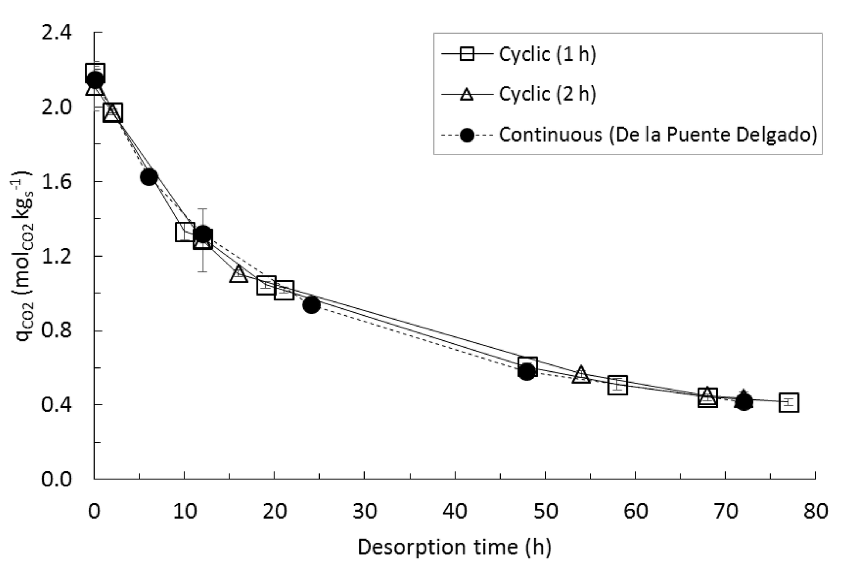
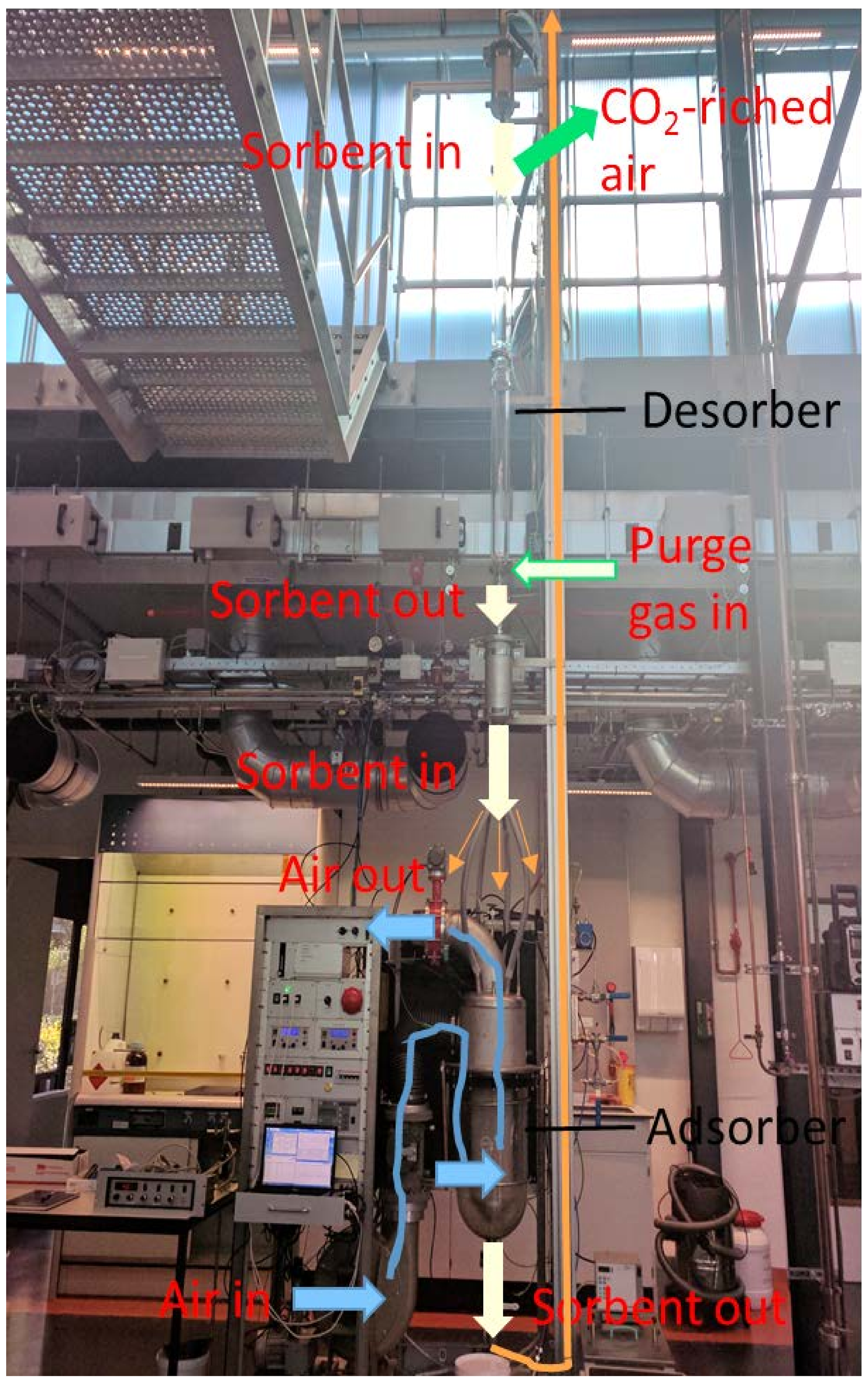


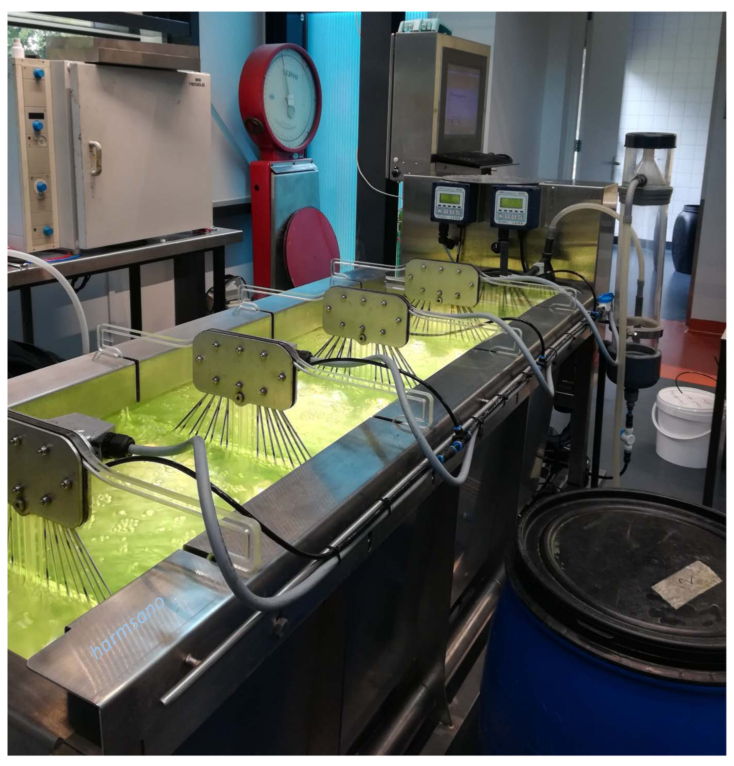
Figure 4. Comparison of cyclic treatment and continuous treatment in air at 120 °C.

… and much more work on…

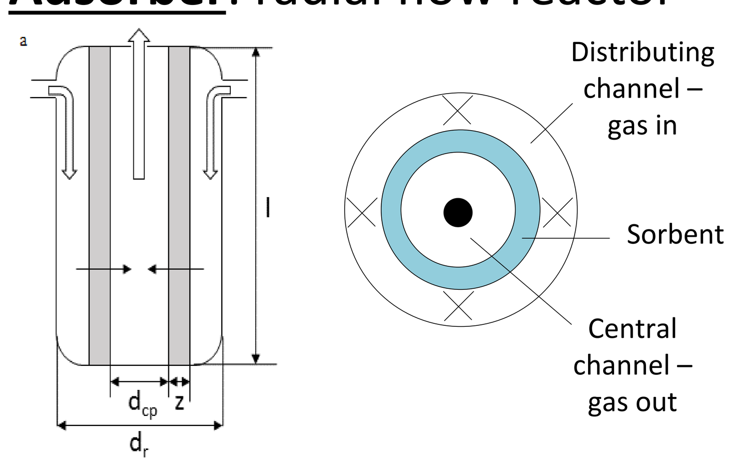
sorbent CO_2 capacities, sorption kinetics, water co-adsorption, sorbent circulation and –fluidization, optimization of regeneration conditions, process evaluation, … … **resulting in** :

Pilot plant for CO_2 enriched air production





Adsorber: radial flow reactor



Desorber: moving fluid bed

Desorption method:

- ✓ Continuous sorbent in/out
- ✓ T regeneration: 60°C
- ✓ 1% CO_2 in product gas

Evaluation

Air purge; 1 bar; T[K] = 333 ;

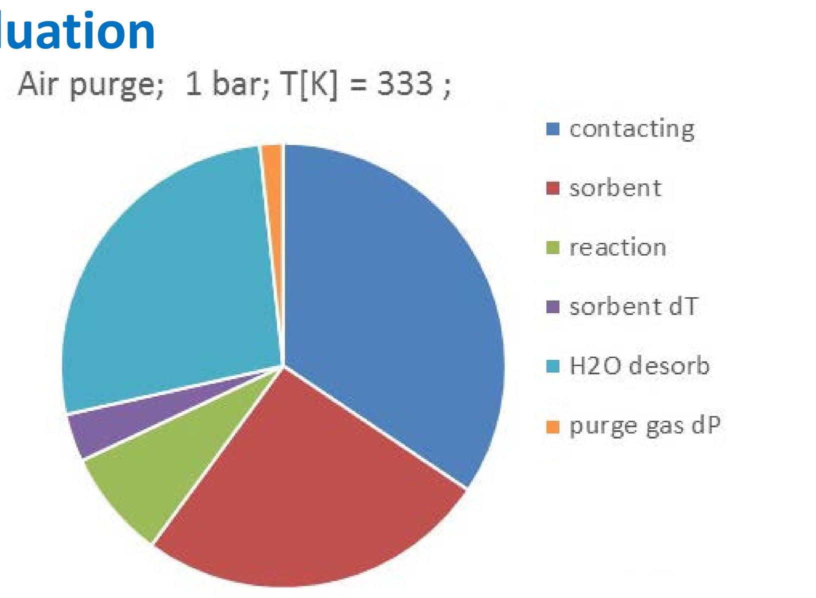


Figure 5: OpEx cost breakdown, based on energy needs and sorbent costs. No heat integration was included

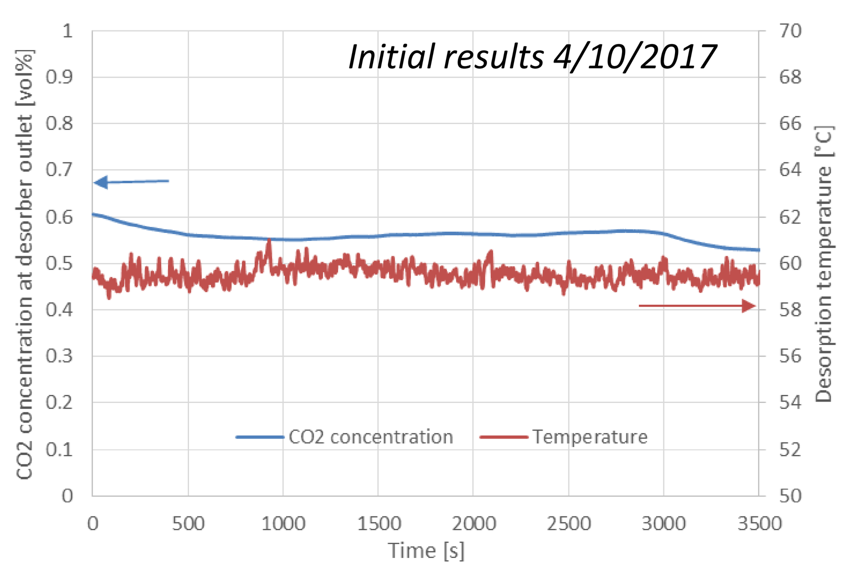


Figure 6: CO_2 concentration at the outlet of desorber and desorption temperature

Acknowledgements

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