MIRACLES
SPECIALTIES FROM ALGAE

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CO_2 capture from atmosphere for microalgae cultivation

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Introduction

Flue gas and high purity CO_2 captured from point sources are generally considered as carbon provider in microalgae cultivation. However, they have some disadvantages such as restriction on location choice, high transportation cost and may contain contaminants and growth inhibitors like NOx, dust and SOx. Therefore, we aim at creating an innovative technology :
CO_2 direct capture from air for microalgae cultivation.

Advantages

- ✓ Higher flexibility on location choice
- ✓ Can be installed on unproductive lands
- ✓ Low concentration of inhibitor components
- ✓ Capture / Recycle CO_2 from distributed sources
- ✓ Contribute to stabilization of greenhouse gas level

Challenges

- ➢ Low CO_2 concentration (400ppm) in air
- ➢ Presence of H_2O (co-adsorption) and O_2 (degradation)
- ➢ To find a selective, stable sorbent

Experimental work

As ambient air normally contains much more (up to 100 times) water than CO_2, a selective sorbent is desirable as co-adsorption will most likely occur. For sorbent screening, a convenient method based on an TG-FTIR analysis system is developed and used to characterize potential sorbents for their water and CO_2 adsorption capacity when exposed to ambient air.

Principle: measure sample mass loss during heating in thermo gravimetric analyser (TGA) and analyse the composition of the evolved gases using FTIR.

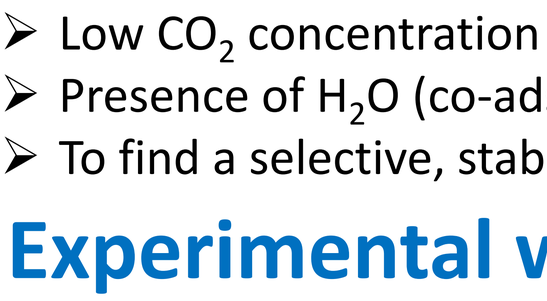
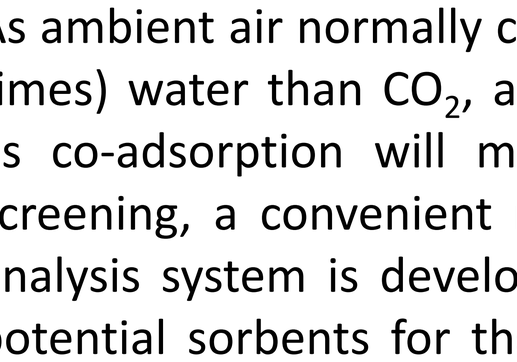


Figure 1a: TGA data total mass loss vs. time and temperature



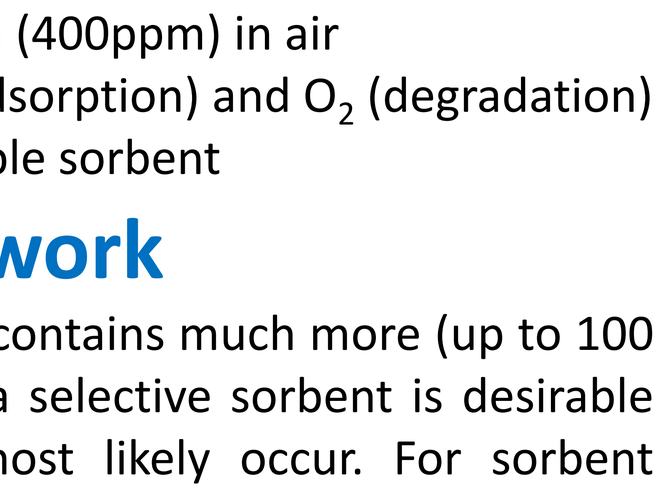


Figure 1b: FTIR spectra of CO_2 and H_2O

Figure 1c: hybrid techniques TG-FTIR facilities

Figure 1: The peaks of CO_2 and water are clearly separated. The maximum peak for CO_2 is at ν=2360 cm^{-1} and for H_2O at ν=1510 cm^{-1}. As the spectrum of CO_2 is easier to process, it is used for integration, the amount of H_2O adsorbed is subsequently determined by mass difference.

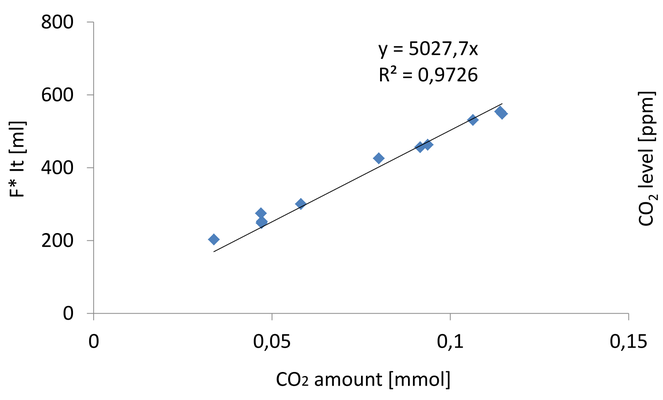


Figure 2a: pulse calibration at low amount of CO_2

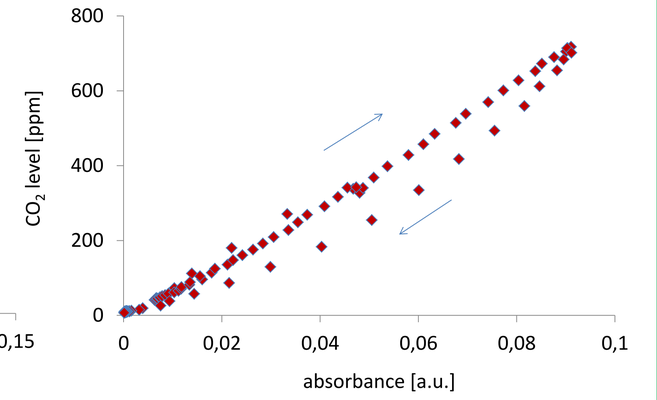


Figure 2b: testing proportionality between ppm CO_2 measured and FTIR absorbance during sample analysis

Figure 2 shows the results for both a pulse based calibration at low CO_2 concentration (100-800 ppm) and direct comparison with a CO_2 detector analyzing the TG-FTIR outlet gas. Both provide a clear basis for calibration.

Results

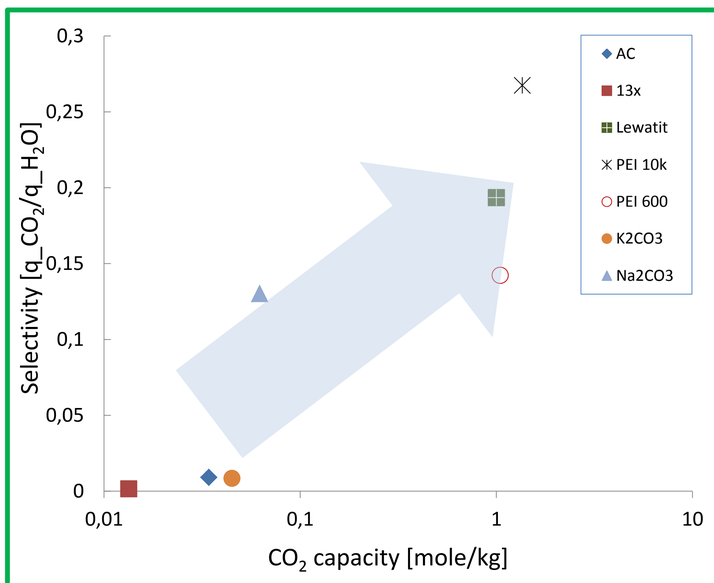


Figure 3a: screening sorbents for direct air capture at ambient (lab) conditions for 15h

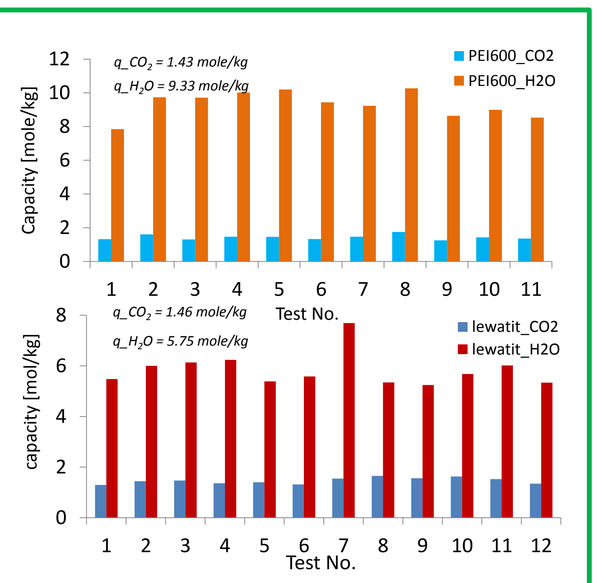


Figure 3b: reproducibility tests of PEI600 (above) and Lewatit (below) sorbents sample

Figure 3 shows supported amine sorbents having a high capacity and selectivity at ambient conditions, when compared to physi-sorbents and dry carbonate sorbents. Between PEI 600 and Lewatit, the capacity for CO_2 is almost the same, but the water co-adsorption of Lewatit is 40% smaller than for the PEI600 tested.

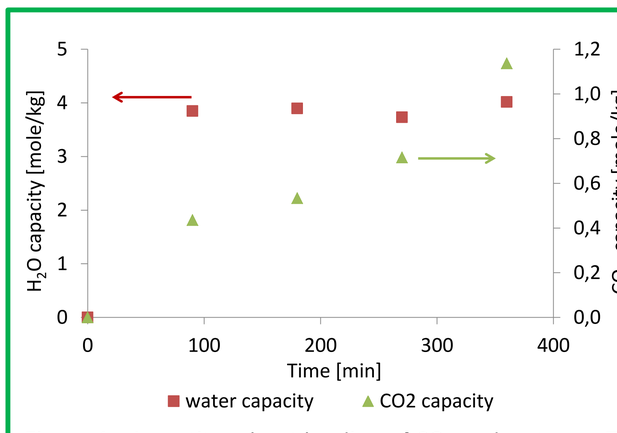


Figure 4a: Lewatit sorbent loading of CO_2 and water vs. Time

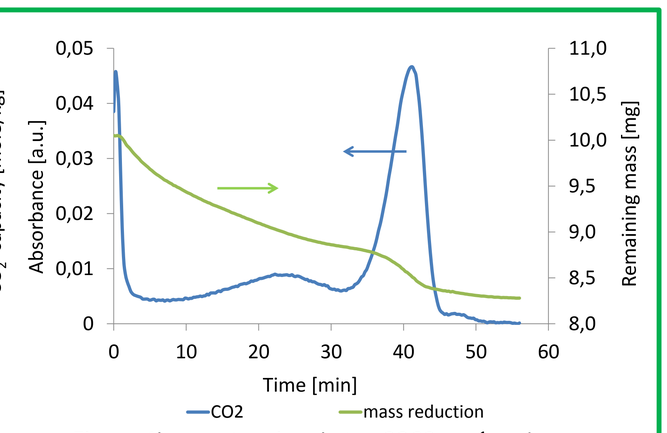


Figure 4b: spectra signal at ν=2360 cm^{-1} and mass reduction over time

Figure 4 illustrated that the saturation with water is much faster than for CO_2. This supports that water does not inhibit active sites for CO_2 sorption. In the desorption process, water releases at faster rate and lower temperature than CO_2. Work is ongoing in this area to seek for optimal strategy to recover water and CO_2 in separate temperature regions.

Acknowledgements

We acknowledge the financial support from the European Union's Seventh Framework Program under grant agreement No. 613588.