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Microalgae Production in Liquid Foam-Beds

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Background

Large-scale and cheap production systems are a necessity in order to exploit the huge potential of microalgae. Most techno-economic analyses up-to-date show that further progress is needed in order to achieve cost-effective and energy positive large scale microalgae cultivation for biofuels and bulk chemicals.

Objective

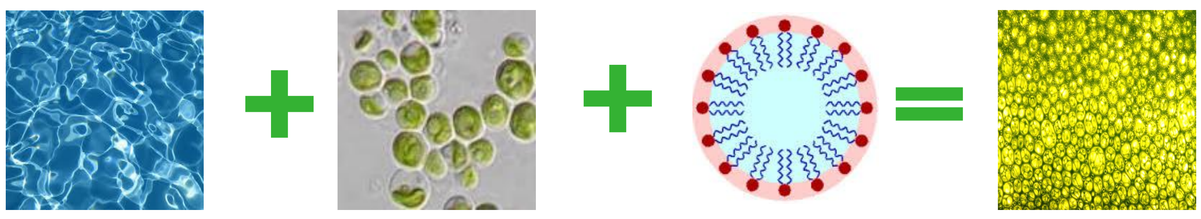
In order to make improvements towards the economic profitability of photobioreactor systems, a novel microalgae cultivation system is being developed. An innovative cultivation concept will be tested: growing microalgae in ~~a~~ liquid foams. The goal of this study therefore is to develop a liquid foam-bed photobioreactor that could enable economically feasible cultivation.

Advantages of foam-bed photobioreactors

- Big interfacial surface area
  - ➢ Increased mass transfer
  - ➢ increased CO_2 removal efficiency
- Increased residence time
  - ➢ Reduction in energy costs in aeration
- Reduced pressure drop
  - ➢ Reduced material requirement
- Short light path
  - ➢ Increased biomass density
  - ➢ Reduced harvesting and processing costs

Concept

The liquid foam of a photobioreactor is based on water to which apart from the microalgae cells, foam stabilizing agents are added.



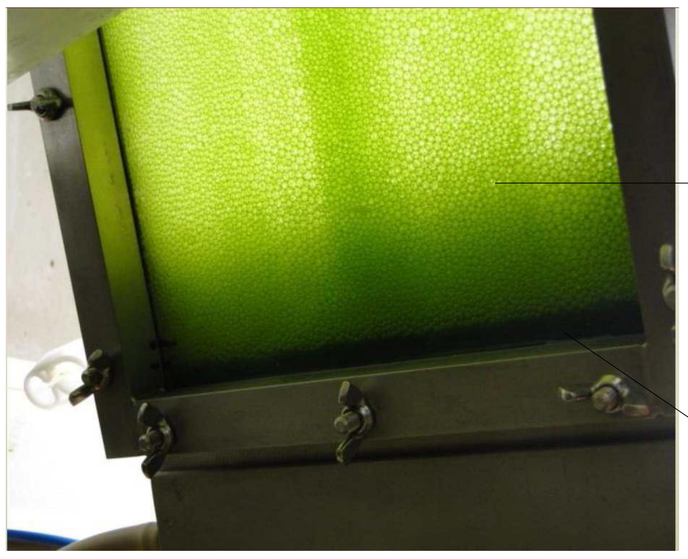


Figure 1. Close-up of the bottom of the lab-scale photobioreactor in which microalgae are grown in a liquid foam. The gas is distributed in the bottom in such a way that a finely dispersed and homogenous foam is created.

Methods

Flat panel photobioreactor
In order to create short light path

Foam breaking device
gaseous phase is separated from the liquid phase.

Alternatively, the foam is allowed to rise to that high levels that the liquid films drain by itself and the foam breaks up spontaneously.

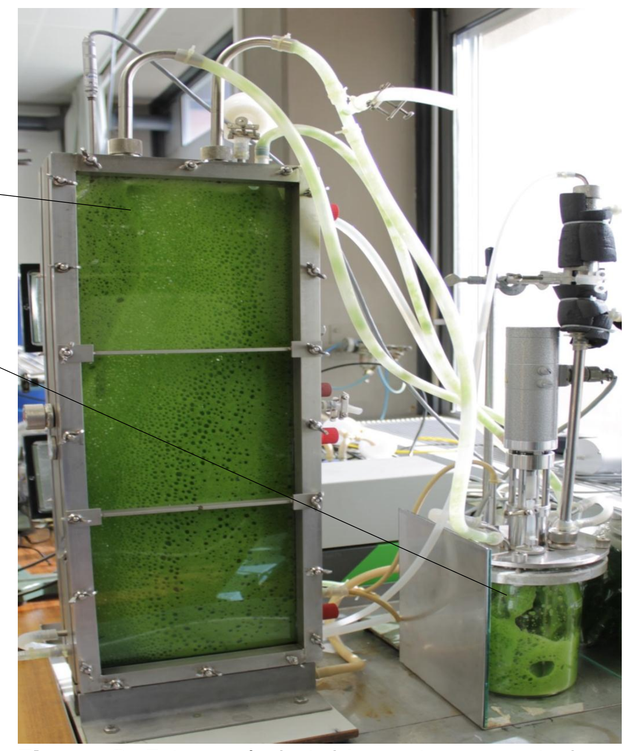


Figure 2. Fat panel photobioreactor operated as liquid foam bed photobioreactor with a mechanical foam breaker.

Preliminary growth results

Microalgae...

- Is dragged up with the uprising foam
- Withstands the physical process of foam break-up
- Grow within the liquid films of the foams (0.11 h^{-1} average μ, max. dry weight concentration 8-10 g L^{-1})

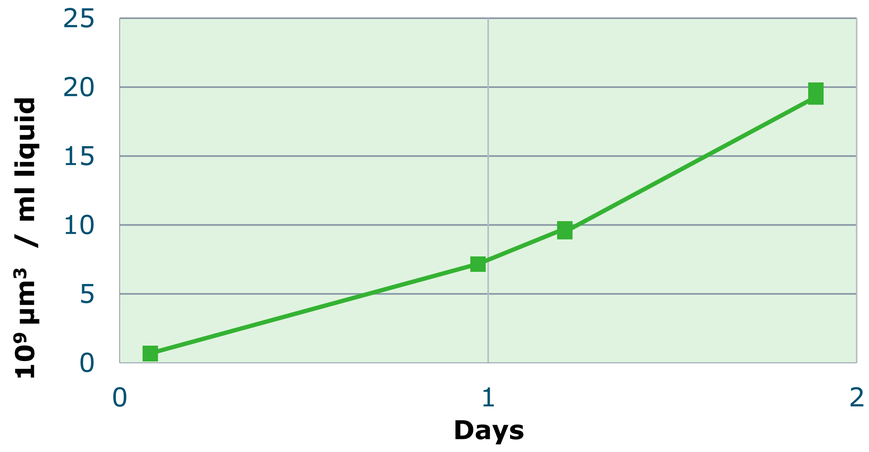


Figure 4. Increase in biomass concentration in the foam-bed reactor during a growth experiment, with the microalgae *Chlorella sorokiniana,* BSA as foam stabilising agent and 350 µmol/m^2/s light intensity.

Future objectives

Development of outdoor foam-bed photobioreactors with high microalgae productivity

Main challenges

Selection of suitable foam stabilising agents

Development of optimal...
- Foam formation
- Foam break up methods

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