Labfors 5 Lux LED Flat Panel Option

Luminostat mode batch cultivation of microalgae in a flat panel photobioreactor

Marco A. J. Siemerink[1], Maria Cuaresma[2], Rouke Bosma[2]

Introduction

Currently, only (stirred) vessel type bioreactors were available on the market. Recently, INFORS HT and Wageningen University and Research Centre (Bioprocesss Engineering) commercialized the first flat panel photobioreactor. Advantages of the flat panel over a stirred vessel type are i) shorter light path ii) light absorption can be easily quantified and iii) increased volumetric productivities. In addition, a versatile laboratory bioreactor was needed for research in which outdoor conditions could be simulated perfectly.

Specification Labfors 5 Lux (LED Flat Panel Option)

High-power LED lighting
- Warm white LEDs (4000 K colour)
- Energy efficient
- Supply of 2400 µmol m^{-2} s^{-1} (400-700 nm)
- Homogenous light (unidirectional)

Controllable light intensity from 0–100%
- Simulation of sunlight, outdoor conditions

Optical path length :2 cm
- High algal concentrations

Easy to program
- Implement new control strategies
- Mimicking outdoor conditions

Asymmetrical shape (round corners)
- No stagnant zones

Airlift system
- Gentle mixing
- Mixed in about 20 s

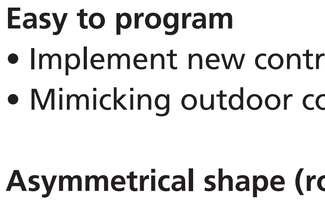
Working volume: 1.8 L

Sterilisable (121°C, 15 minutes)

Easy to dismantle (click system)

pH control by
- CO_2 addition
- Pumping acid/base

Experimental (luminostat) set-up

Organism	*Chlorella sorokiniana* CCAAP 211/8K
	fresh water microalgae
	fastest growing microalgal species
	doubling time: 2.6 hr (μ_{max} 0.27 h^{-1})
Parameters	**Set point**
Temperature	37°C
pH	6.7
PFD_{out}	30 µmol photons m^{-2} s^{-1}
Medium	M8-a

Experimental (luminostat) set-up (continued)

PFD_{out} should be kept constant (30 µmol $m^{-2}s^{-1}$; preferably at the compensation point)

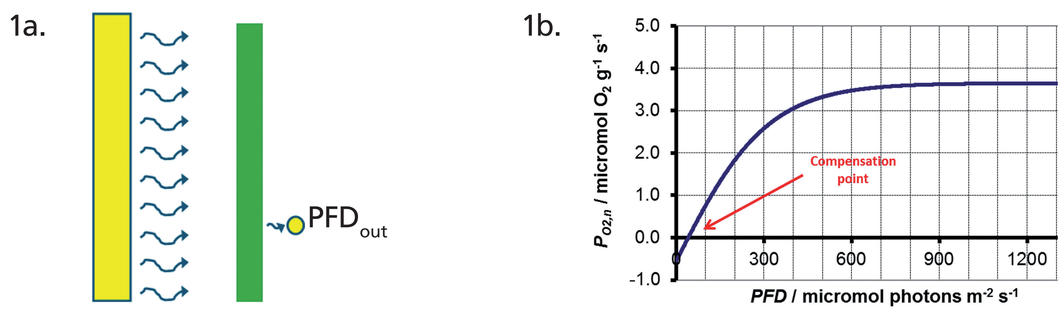


Figure 1a: Schematic view of Luminostat principle;
Figure 1b: Typical PI-curve which shows the gross rate of photosynthesis (i.e. oxygen evolution, pO_2) as a function of light intensity (PFD). Numbers are based on the photosynthetic capacity of the green microalgae *Chlorella sorokiniana*.

Results

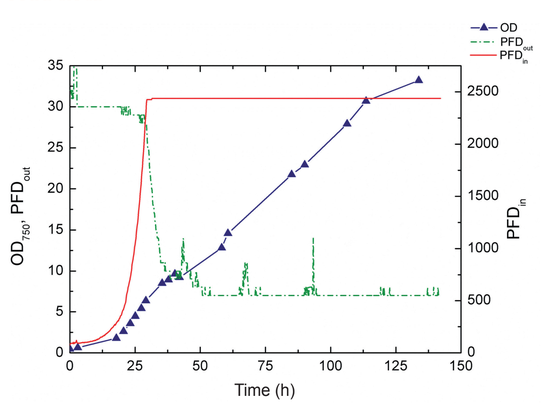


Figure 2
Biomass concentration evolution and luminostat conditions at aeration rate of 1.8 L min^{-1}. Optical density at 750 nm is represented by (▲, —), light input (PFDin, —) and light transmission (PFDout, ---) are represented by lines.

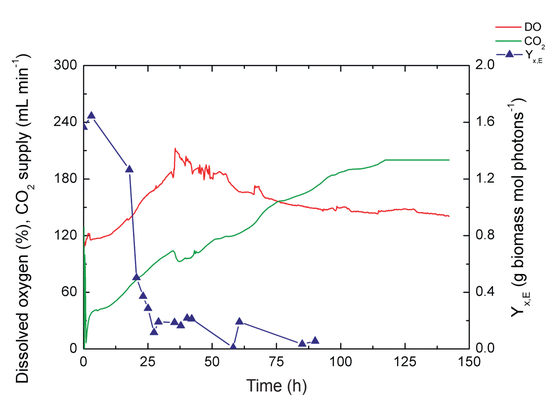


Figure 3
Dissolved oxygen concentration, photosynthetic efficiency under luminostat regime at aeration rate of 1.8 L min^{-1}). Dissolved oxygen (DO, —) and CO_2 supply (—) are shown as indicators of the algae growth. Cell efficiency is represented by the biomass yield on light energy ($Y_{x,E}$, ▲)

Conclusions

The luminostat control gives a fast increase in biomass while limiting overexposure to light and waste of light energy. The cells are exposed to a more constant light regime compared to traditional batch cultivation.

A high cell concentration was achieved at highest aeration rate **(11.34 g L^{-1})**. Oxygen accumulation under such conditions was the lowest, with a maximal value of about 200 %. The volumetric productivity was **2-fold** the productivity achieved at the lowest aeration rate (**3.4 and 1.69 g L^{-1} d^{-1}**, correspondingly)

The values of maximum quantum yield of PSII confirm that the luminostat regime prevented overexposure to light and consequent photo-inhibition.

The photobioreactor Labfors 5 Lux (LED Flat Panel Option) is ideal for research purposes with cyanobacteria and microalgae.

Reference
1 Infors Benelux, Fabriekstraat 38, 7005 AR Doetinchem, The Netherlands
2 AlgaePARC, Wageningen UR (University & Research centre), Nergana; Bornsesteeg 10 (building 112), 6721 NG Bennekom, The Netherlands
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