The preparative Artificial Light Photobioreactor Alpfors

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A fully aseptic and controlled photobioreactor is in its final stage of development in order to better handle the production of microalgae, even the most delicate, at preparative scale for biochemical analysis, activity assessment, and extraction-purification of valuable compounds. This new photobioreactor consists in tubular loops including a series of connected annular light chambers around central lamps. It will implement new features to cope with cell fragility and biofilm.

A small scale prototype with 50 L working volume was constructed in 2013 by Infors AG and tested in 2014 by Microphyt. The results proved satisfactory for the cultivation of the *Porphyridium purpureum,* a fragile and biofilm forming rhodophyte. No biofilm was observed and repeatability was stated. Typical culture results expressed in terms of dry weight concentration time course[1] were compared (Figure 1) to a theoretical model[2].

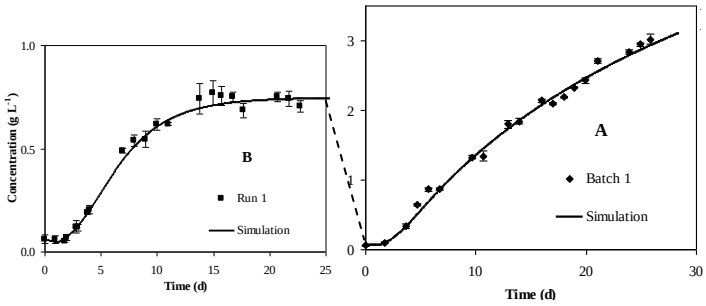
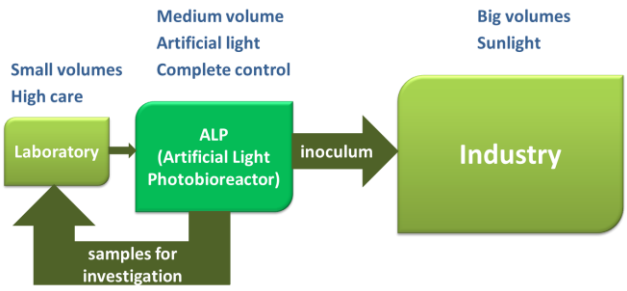


Figure 1: Batch (A) and continuous (B) concentration kinetics of *Porphyridium purpureum* cultures.

Minimum quantities of microalgae of the range 10 to 100 g DW are necessary for applied research investigation. Moreover, such quantities are also required to inoculate larger industrial facilities. The new artificial light photobioreactor Alpfors (Figure 2) is designed to cultivate microalgae in sufficient amount and in fully controlled process in order to fill the gap between research and commercial productions.



Various features will contribute to perform high yield of continuous monoseptic cultures of delicate species. Especially, a wiping system for keeping clean the optical wall of the inner lamp during the process and insure a complete illumination of the culture volume. The gas transfer is achieved by co-circulating both fluids in the loop counter or co-current. This bubbleless and low shear flow pattern induced by a soft pump proved respectful of the cell integrity[3]. Additional functions such as light intensity adjustment, cleaning in place, etc.. contribute to ease operating the equipment.

The achievement of the expected performance of the new photobioreactor with *Porphyridium purpureum* as compared to prototype was evaluated by means of theoretical simulation (Table I) in terms of volume productivity, concentration at steady state and daily production.

Table I: Compared performance of prototype and Alpfors as given by theoretical simulation.

	50 L Prototype	150 L Alpfors	Increase rate
Productivity ($gL^{-1}d^{-1}$)	0.2	0.3	1.9
Concentration (gL^{-1})	0.7	1.4	1.9
Production (gd^{-1})	16	50	3.1

Continuous production rate will be increased three fold. This simulation did not account for the improvements in hydrodynamics and gas transfer, which will result in additional increase.

Figure 2: Synthetic image of 150 L Alpfors.

Alpfors is the missing link between laboratory and industry for developing microalgae applications. It should be marketed during 2015.

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2. Muller-Feuga A., Le Guédes R., Pruvost J., 2003. Benefits and limitations of modeling for optimization of Porphyridium cruentum cultures in an annular photobioreactor. J. Biotechnology 103(2): 153-163
3. Muller-Feuga A., Lemar M., Vermel E., Pradelles R., Rimbaud L., Valiorgue P. Appraisal of a horizontal two-phase flow photobioreactor for industrial production of delicate microalgae species. J. Appl. Phycol. J Appl Phycol 24(3): 349-355