Photobioreactor

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Introduction

- A photobioreactor is a bioreactor that utilizes a light source to cultivate phototrophic microorganisms.
- These organisms use photosynthesis to generate biomass from light and carbon dioxide and include plants, mosses, macroalgae, microalgae, cyanobacteria and purple bacteria.
- Within the artificial environment of a photobioreactor, specific conditions are carefully controlled for respective species. Thus, a photobioreactor allows much higher growth rates and purity levels than anywhere in natural or habitats similar to nature

Open systems

- The first approach for the controlled production of phototrophic organisms was and still is a natural open pond or artificial raceway pond.
- Therein, the culture suspension, which contains all necessary nutrients and carbon dioxide, is pumped around in a cycle, being directly illuminated from sunlight via the liquid's surface.
- This construction principle is the simplest way of production for phototrophic organisms.
- But due to their depth (up to 0.3 m) and the related reduced average light supply, open systems only reach limited areal productivity rates.

Closed systems

- Since the 1950s several approaches have been conducted to develop closed systems, which theoretically provide higher cell densities of phototrophic organisms and therefore a lower demand of water to be pumped than open systems. In addition, closed construction avoids system-related water losses and the risk of contamination through landing water birds or dust is minimized.
- All modern photobioreactors have tried to balance between a thin layer of culture suspension, optimized light application, low pumping energy consumption, capital expenditure and microbial purity.

Redesigned laboratory fermenter

- The simplest approach is the redesign of the well-known glass fermenters, which are state of the art in many biotechnological research and production facilities worldwide.
- The moss reactor for example shows a standard glass vessel, which is externally supplied with light. The existing head nozzles are used for sensor installation and for gas exchange.
- This type is quite common in laboratory scale, but it has never been established in bigger scale, due to its limited vessel size.

Tubular Photobioreactors

- Made from glass or plastic tubes, this photobioreactor type has succeeded within production scale. The tubes are oriented horizontally or vertically and are supplied from a central utilities installation with pump, sensors, nutrients and CO_2.
- Tubular photobioreactors are established worldwide from laboratory up to production scale, e.g. for the production of the carotenoid Astaxanthine from the green algaeHaematococcus pluvialis or for the production of food supplement from the green algae Chlorella vulgaris.
- These photobioreactors take advantage from the high purity levels and their efficient outputs.

Christmas tree Photobioreactor

- An alternative approach is shown by a photobioreactor, which is built in a tapered geometry and which carries a helically attached, translucent double hose circuit system.
- The result is a layout similar to a Christmas tree.

Plate Photobioreactor

- Another development approach can be seen with the construction based on plastic or glass plates.
- Plates with different technical design are mounted to form a small layer of culture suspension, which provides an optimized light supply.
- In addition, the simpler construction compared to tubular reactors allows the use of less expensive plastic materials.

Horizontal photobioreactor

- This photobioreactor type consists of a plate-shaped basic geometry with peaks and valleys arranged in regular distance.
- This geometry causes the distribution of incident light over a larger surface which corresponds to a dilution effect.
- The mixing is accomplished by a rotary pump, which causes a cylindrical rotation of the culture broth. In contrast to vertical designs, horizontal reactors contain only thin layers of media with a correspondingly low hydrodynamic pressure.
- This has a positive impact on the necessary energy input and reduces material costs at the same time

Thankyou