The Best Way to Produce Microalgae

Rethinking Algae Cultivation

Introduction

With all the different technologies available to produce microalgae, it can be hard to figure out which method best fits your needs when it comes to high-end algae cultivation. To help you make the right decision, we therefore made an overview of the different types of technologies and go into the pro's and cons of each technology to cultivate microalgae. Understanding the different technologies available to produce microalgae, and knowing the benefits and limitations of each technology, will provide clarity on what method and system will be most beneficial to get the outcome you need.

Microalgae are photosynthetic microorganisms that grow like plants using nutrients, water, CO_2, and sunlight. This feature gives them a huge advantage in the current scenario where the world needs to change its industrial production from linear to circular. The fixation of CO_2 and the ability to be cultivated without land are among their biggest advantages. **You can learn more about microalgae visiting this link to our website.**

We can explore these features to cultivate microalgae in controlled environments, which we call production systems. Many options are available, and we want to share this knowledge with you. There are two main categories: open and closed systems. The first have direct contact with air (open ponds, or tanks). The second have a barrier separating the culture from the environment around it (known as photobioreactors). We will tell you more about them further down.

Open ponds are the oldest technology. Cheap and reliable, yet prone to contaminations

The first historic record of microalgae consumption comes from ancient communities harvesting naturally occurring algae from shallow lakes or ponds. The sun-dried biomass would be consumed or stored. This principle gave the inspiration for the oldest technology in recent history: the open raceway ponds (ORP). They are open shallow basins usually not deeper than 2 m and with a wall in the centre of the oval shape. There, water containing algae and nutrients is kept in motion by a paddlewheel (sometimes sheltered from

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rain with transparent/semi-transparent coverage or placed in greenhouses). Benefits & drawbacks: The main benefit is the lower capital investment. Ponds can be built with cheap materials and their operation doesn't require a lot of energy. However, the volumetric productivities (unit of biomass per unit of volume, grams/litre) are much lower when compared to closed systems. The main drawback is surely the high risk of contamination, either by other species of algae or predatory planktonic microorganisms that kill algae (bacteria, fungi, protozoa's). One way to solve this is to place ponds inside closed environments, which will increase your capital investments and bring the question: why sheltering a pond when the whole cultivation can be in a closed environment?

Bubble columns are versatile and ideal inoculum producers

Bubble columns are simple systems to design, build, and operate. They are transparent cylinders often made of soft or hard polymers/plastics, or even glass; the material to use is up to the application you have in mind. The wider the cylinder, the lower is light penetration and the biomass productivity. The air bubbles are injected from the bottom and the culture gets mixed when the bubbles rise. This simplicity keeps operation cheap, and allows you to mix CO2 to air. Remember, algae love CO2 and will grow faster if it is given together with other nutrients. Benefits & drawbacks: Bubble columns are ideal to make inoculum, the starter cultures. They are versatile lab-scale systems but are difficult to scale up. There is a limit in the size that can be increased before it gets too expensive or not sustainable to bubble air to keep the algae moving (if ideally mixed, algae are healthier and more productive). Don't forget that some algae species are sensitive to mixing and their cultures could collapse if too much mixing is given. They are closed systems, but could share the lower productivities of the ponds.

Flat panels join simplicity with efficient, but deliver less biomass

From cylinders to cubes, very thin cubes. Flat panels are large in surface but have

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little volume (because they are wide and thin). This characteristic makes them more productive: no other system will deliver so much biomass/litre. The thin structure lets the light cross the reactor in a uniform way, causing the algae to multiply faster. Yet, this high concentration comes at the cost of having lower biomass yields overall. Benefits & drawbacks: Flat panels are more expensive to build since you need more materials. This is a decision you must make when planning your investments, as you might have higher investment/kg biomass than with other options. Scaling up remains a problem, as the laws of physics won't allow you to increase the size of the panels indefinitely. They are closed, and it means you can keep the culture healthy, inject CO_2 for a faster production, but the mixing remains done mostly with bubbling air.

Tubular photobioreactors require higher investments, but deliver quality and scalability

Tubular photobioreactors (PBR) are closed cultivation systems that allow more control than the options mentioned above. The tubes are made of transparent materials: plastic polymers need to be replaced eventually, while glass can be used for decades. The tubes are connected to each other through bends (elbows), giving a flexibility of design and the possibility of combining different loops of tubes into one operation (scalability at its best!). **Glass also allows you to sterilize your systems with harsher treatments, achieving higher purity and hygiene** Tubular systems are the only closed system allowing to cover larger areas, meaning you get more biomass per square metre. All of this while controlling the production parameters, avoiding contamination, and increasing your yields. Benefits & drawbacks: Although the advantages are high, one should keep in mind that tubular PBRs require higher capital investments (a decision to be balanced with the cost/benefit from the higher biomass produced). Automation can reduce the operational costs. But the main

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drawbacks of tubular PBR's are the intense energy consumption, accumulation of biofilm in the tubes (some algae cells can deposit on the tubes), and difficulty to clean. This limits the length of the tubes, reducing the culture volume and the overall yield. Until now that is.

Lgem developed their own tubular photobioreactors to solve current drawbacks

At Lgem, we used all this knowledge to design and build a a better tubular PBR (link product description/spec), solvingthe main disadvantages of regular tubular PBRs. Our patented technology consumes less energy because we use a combination of pumps and air compressors instead of only liquid pumps. The result is the possibility to build much longer tubes. The Wavywind® and Bubblebrush® technologies keep the culture in movement by pushing it through waves. **This reduces the formation of biofilm/biofouling and keeps cultures healthier for a longer period.**

Conclusion

Are you ready to rethink algae cultivation? Want to experience an in-depth discovery on how Lgem's technology can help you produce the high-end microalgae you desire? Call now to visit our AlgaeHUB®, where you can see our systems in action year-round, gving you valuable insight into how our systems can benefit your algae cultivation. If needed you can even validate and thus de-risk your business case using one of our PBR systems your business case in our AlgaeHub using one of our PBR

Need a risk assessment of your algae project?

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