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Shall I install LEDs for my PhotoBioReactor (PBR)?

Being a wide-ranging and flexible output light source technology, LEDs come in many shapes, forms, wavelengths, output characteristics, and efficiencies. Exactly HOW they are driven in large part determines the resulting output, and in the end, the process results. So, the general idea of "going LED" is, in itself, often not a panacea when seeking an alternative "drop-in" replacement for other types of light sources. It is essential to understand that there is a huge range of characteristics across the LED offerings, so one must carefully discriminate among them in order to not end up with a poor "solution" that becomes an eventual disappointment.

Where the use of LEDs can (and do) shine, however, is where one wants to specifically match the action spectra of some particular species' ideal PUR; in essence, delivering only the desirable wavelengths and thereby eliminating those that are extrinsic to (and inputting excess energy into) the PS II process. In short, only the microalgae-absorbable light is generated and delivered to the PBR, thus increasing the electro-optic "wall plug" efficiency. Additionally, this can also open up some other areas for additional efficiency improvement, such as device quantum efficiency, PBR energy balance (e.g., temperature control), better irradiance-targeting and spatial distribution of PPF, and for some applications, dramatically improved growth yield by means of temporal management[(see endnotes)] of photosynthetic photon flux delivery.

For those electricity-driven applications where the absolute maximum possible energy efficiency is essential, LED (or other forms of Electro-Luminescent Devices, ELDs) technology could be an essential solution. However, there are many applications that are economically less-challenged, so the additional work and Capital Expenditure of going to LEDs is considered unwarranted.

As a prime example, right now the astaxanthin production industry enjoys a high demand for the limited supply of product that is at a very expensive price point in the market, so conventional CW light sources are viewed as both simple and sufficient for their Cost of Goods Sold. However, if supplies increase over the demand, thereby increasing demand for better process energy efficiency per yield, then ELDs become a prime candidate in the solution toolbox. In fact, working both ends of the efficiency equation (energy input and growth/production rate) becomes vitally important.

The first step in answering the question of "LED viability" as a PBR light source is to perform a top-down and bottom-up analysis that considers the particulars of the:

1. Application
2. Market(s)
3. Process requirements
4. Producer's COGS sensitivity, CapEx resources, and long-range goals

With this understanding in hand, the potential for an appropriate ELD (or other light source) solution can be vetted, and only then can an informed and intelligent decision can be reached.

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