The Use of Modulated Light to Enhance Oil Production from Algae in an Underground Environment

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Abstract: The production of bio-fuel from algae is one of the few remaining potential sustainable resources that continue to show considerable potential for fuel production (the others include cellulosic ethanol, sugar cane ethanol, and biodiesel from jatropha and the oil palm). However the need for large areas for production and the low areal yield make the costs of surface structures prohibitive to the commercial development of algae as a biodiesel source of sufficient size to have a significant impact on the international need for liquid fuel.

Through the use of abandoned portions of existing mines a productive volume is created that has no impact on the controversies over “food or fuel” and which has the additional benefit of the existing third dimension in the mine which allows an increase in areal yield of as much as 60-fold. This space has already been created, and has the advantage of remaining at a constant, and optimal growing, temperature all year with minimal cost. The presence of existing infrastructure, including walls, means that construction costs are also minimized.

The darkness of the mine can be overcome by transmitting in light, and distributing it throughout the bioreactor using an array of LEDs. While there is some loss in conversion, there is also an advantage, since it has been shown that by modulating light (flashing it on and off) the yield of algae can be increased an additional eight-fold. In this way the additional cost of providing that light can be overcome, particularly since, with the use of suitable LEDs the light can be distributed only in the wavelengths (450 - 650 nm) that is the range most productively used by the algae.

The process has the advantage of capturing carbon dioxide, and reusing it, rather than immediately discharging it into the atmosphere, if the algae are fed with power plant flue gases (which are often conveniently located near mining operations).

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