Microalgae - Successful Transition from Lab to Pond: Testing Performance in Climate Simulated Cultures

Pacific Northwest NATIONAL LABORATORY

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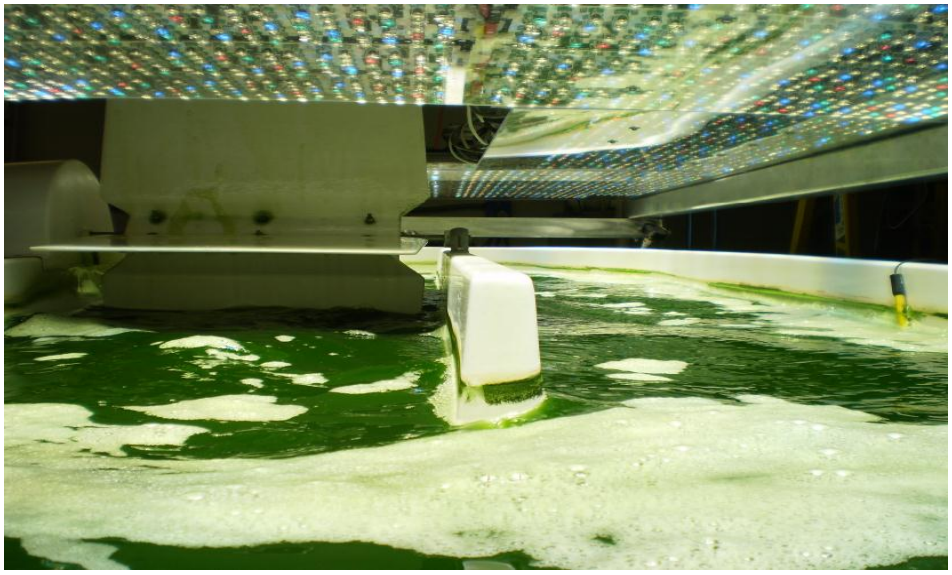

The Challenge: Predicting Industrial-Scale Performance of Novel Strains

Improving the economics of microalgal biofuels production requires the identification of novel microalgae strains with superior biomass and lipid productivities. Both academia and industry have launched campaigns to search for promising strains, either by prospecting or by genetic manipulation. While initial screening in photobioreactors is appropriate for eliminating poor candidates, **it is virtually impossible to predict a novel strain's performance in outdoor ponds using laboratory data**. Selecting the best strain for outdoor cultivation and subsequent commercialization requires answers to critical questions such as:

- What is the maximum achievable biomass and lipid productivity of this strain in outdoor ponds (i.e., under optimal temperature and light conditions)?
- How is the strain's performance affected by pond water temperature and temperature fluctuations due to diurnal heating and cooling?
- How do seasonal changes in lighting intensity and duration affect the biomass and lipid productivity of the strain?
- How would this strain perform in outdoor ponds at different geographic locations and in different seasons? Can performance be optimized by matching a strain to a suitable climate or by selecting different strains for winter and summer cultivation?

The Solution: A New, State-of-the-Art Microalgae Cultivation Facility

PNNL has designed and built **LED-lighted and temperature-controlled indoor raceway ponds** to enable the cultivation of microalgae strains under climate-simulated conditions which reproduce the light and water temperature fluctuations encountered in outdoor ponds at any

geographic location in the world. Meteorological data in conjunction with PNNL's pond water temperature model are used to control lighting and temperature variations to simulate the environment of outdoor ponds at any selected site. Furthermore, PNNL has designed and built a **thermal gradient incubator** that enables the determination of maximum specific growth rate and lipid content/composition as a function of temperature.

The state-of-the-art PNNL raceway ponds have the following capabilities:

- The fiberglass raceway ponds have a working volume of 800 L and a variable culture depth up to 26 cm.
- Access to clean seawater and groundwater allows for cultivation of both marine and fresh water strains.
- The light intensity can be increased from 0 to 2700 µmoles/m^2-sec to simulate diurnal sunlight intensity fluctuations at any geographic location of choice.
- The LED lights simulate the full spectrum of sunlight. If desired, the spectrum can be adjusted to simulate sunrises, sunsets, cloudy sky, or any other conditions.
- The pond water temperature can either be kept constant (10°C-40°C) or can be increased and decreased to simulate diurnal water temperature fluctuations in outdoor ponds.
- The culture pH is feed-back controlled via intermittent CO_2 sparging.
- Biomass can be harvested with a continuous centrifuge.

The Benefits: Accelerated Transition to Large-Scale Pond Culturing

Employing PNNL's LED-lighted and temperature-controlled raceway ponds translates into the following benefits and advantages, enabling you to:

- Obtain fast, cost-effective and reliable results regarding the performance of promising strains in raceway ponds, either under optimal conditions, climate-simulated conditions, or any other light and temperature conditions of choice.
- Compare the performance of several promising strains (e.g., wild-type versus engineered) under exactly the same pond operating conditions. Select the best strain for large-scale outdoor pond cultivation.
- Choose the optimal geographic location (climate) for the envisioned large-scale outdoor cultivation system based on the performance of promising strains under climate-simulated conditions (i.e., find the best match between strain & location).
- Avoid problems associated with risky pilot-scale outdoor pond culturing such as time delays, capital and operating expenses, sub-optimal geographic locations, inclement weather, invasive species, etc.

About Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory, located in southeastern Washington State, is a U.S. Department of Energy Office of Science laboratory that solves complex problems in energy, national security and the environment, and advances scientific frontiers in the chemical, biological, materials, environmental and computational sciences. The Laboratory employs 4,000 staff members, has a $760 million annual budget, and has been managed by Ohio-based Battelle since 1965.

For more information on microalgae strain testing or potential research collaborations, please contact:

Michael Huesemann, Ph.D., MBA
1529 West Sequim Bay Road
Sequim, WA 98382
360-681-3618
michael.huesemann@pnnl.gov