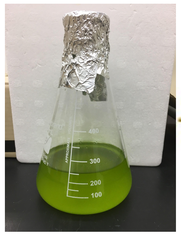
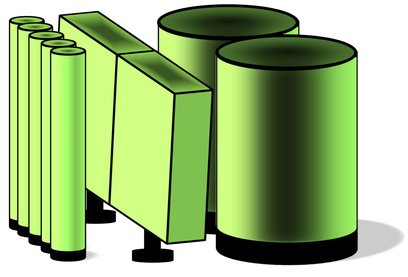
Microsensors to Quantify Light in Photosynthetic Bioreactors

Nyawira Nyota, Amanda Karam, Dr. Joel Ducoste



Introduction

- The extraction of lipids from microalgae to produce biomass could revolutionize the energy industry both economically and environmentally.
- The goal of this research is to optimize this process by developing a method for accurately measuring the amount of sunlight used by algae during the photosynthesis process.



Common Reactor Designs A) Tubular, B) Flat Plate Panel C) Annual Column

- Once this method is developed, it may be used to produce the most biomass at the lowest price by optimizing reactor design and operation.

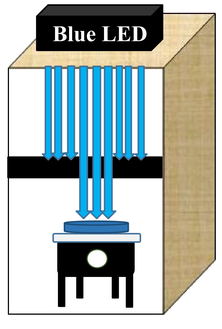
Background & Objectives

OBJECTIVE: Use microspheres that change in fluorescence when exposed to photosynthetically relevant light to mimic algae.

This is done by chemically attaching a special dye to microalgal-sized microspheres.

Methods

1) Expose small samples of microspheres to a collimated light beam for different light doses. Used spectrometer to measure the light and make sure it was centered and uniform.



Light Dosage **=** *Light Intensity* ***x*** *Time of Exposure*

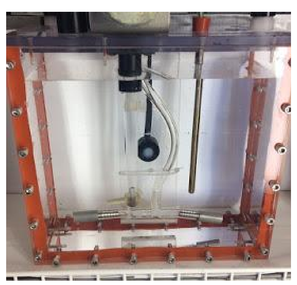
2) Measure the fluorescence of the microspheres using flow cytometry.

3) Use the data to relate the fluorescence to the dosage of light delivered and create a model to predict the light in a photobioreactor.

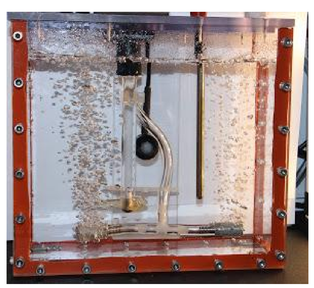
4) Test microsensors ability to predict light in a photobioreactor filled with 1) Water only, 2) Water with bubbling, 3) Water and algae.

→ Measure characteristic mixing time to determine sampling times.
→ Add beads, then expose to 0, 1, 2, and 4 min of light.
→ Use model created in step 3 to predict an avg.light.

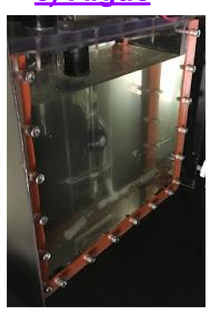
1) DI Water



2) Bubbling

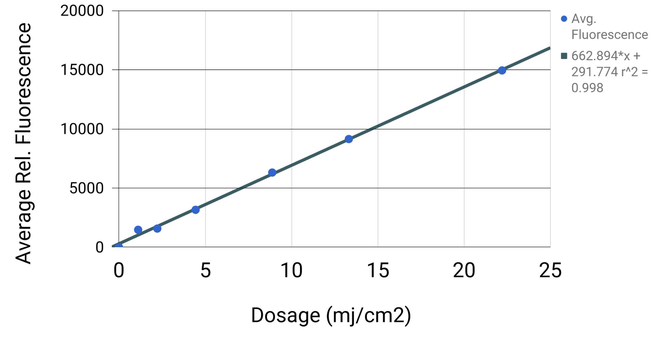


3) Algae



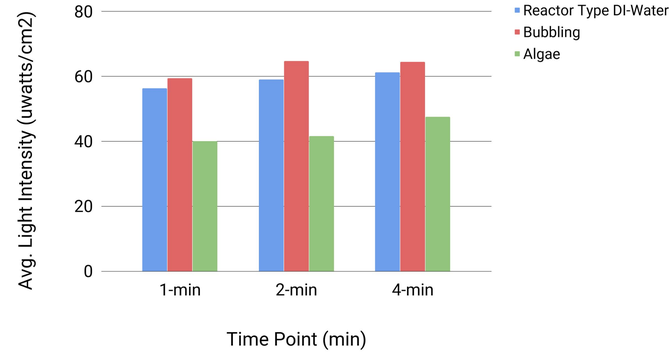
Preliminary Results

Standard curve: Dosage vs. Avg. Rel. Fluorescence



This graph shows light dosage vs average fluorescence for samples exposed to known, uniform light. Also known is stand curve generated that is used to predict light dosage .

Predicted Average Light Intensity in Reactors



The above graph shows how different reactor conditions impact the average light intensity experienced by a particle.

Summary

- The average fluorescence of particles increased linearly in dosage range tested.
- On average, the light intensity was 7% higher with bubbling and 27% lower with algae, as compared to just DI-water.
- More tests should be done in future to confirm these results.

Acknowledgements

1) National Science Foundation Emerging Frontiers in Research and Development
2) NCSU Summer Transition Program, Minority Summer Research Program and Dr. Javon Adams
3) NCSU Department of Civil, Construction, and Environmental Engineering