Characterizing CO_2 Utilization Rates Across Different Cyanobacteria Strains under Varying Light Intensities by a Novel Mass Balance Approach

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Methods

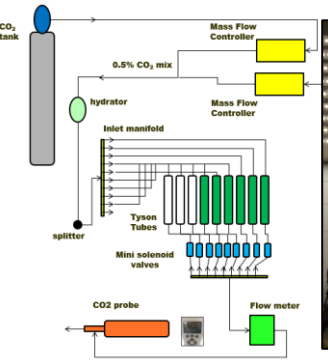


Figure 1: Simplified overview of the CO_2 sampling system.

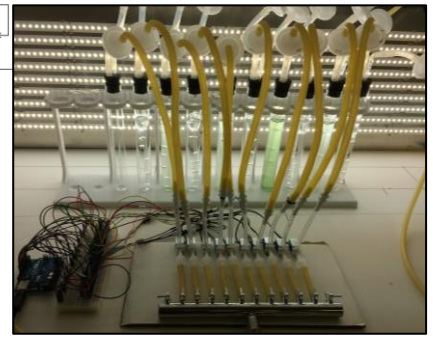


Figure 2: Actual photo of system set up for experiment

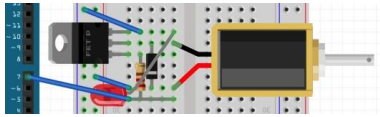


Figure 3: Digital breadboard demonstration of the *n=1* Arduino system, where the Arduino is located on the left of the image and the solenoid on the right.

Conclusion and Future Ambitions

In its current state, this auto sampling system has been saving researchers weeks of time reading CO_2 probes. Unfortunately, the complete extent of light titrations was not completed in this time span and is still ongoing. However, this compact, consistent, and cost-efficient system is highly applicable to the cyanobacteria research being conducted here at ASU and around the world and has the potential for use in other research involving simple dynamic gas systems.

Abstract

Cyanobacteria and its complex photosynthetic systems have been a prime target for synthetic biologists and their molecular engineering tools for the last couple of decades. However, characterizing meaningful CO_2 removal performance has always been a struggle within the field. Measuring these changes in gas concentration within a dynamic system can be accomplished with a simple automated Arduino-powered system. The system employs solenoids in parallel and can be applied for *n* number of outlet streams, all are connected to one large manifold which feeds to a CO_2 concentration probe. The development of such a system allows for high fidelity growth experiments between different strains of cyanobacteria. These experiments provide continuous data collection over the entire life cycle of each individual culture and aim to quantify the differences in total CO_2 fixation between strains and overall growth. In the future, the system can be modified to fit other simple dynamic gas systems, as well as testing similar gas production capabilities within other organisms.

Introduction

Cyanobacteria is a photosynthetic organism and therefore utilizes water, CO_2, and sunlight to produce sugar and oxygen. Growing up cultures and measuring different properties such as OD730 and CO_2 concentrations is one technique researchers use to gain insight into whether their molecular engineering has been successful. In addition to changes within the bacteria, factors such as light intensity, temperature, and initial CO_2 concentration all play a large role in optimizing both CO_2 sequestration efforts and biofuel production. The development of an automated CO_2 concentration measurement system within cyanobacteria research provides researchers with the ability to produce full growth cycle CO_2 measurements.

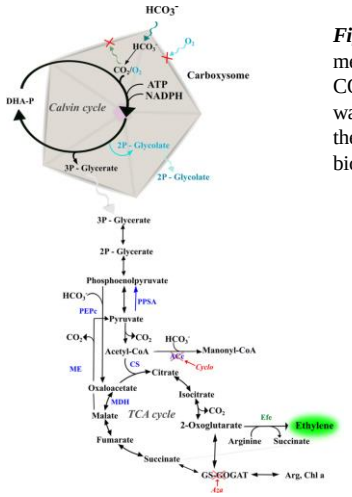
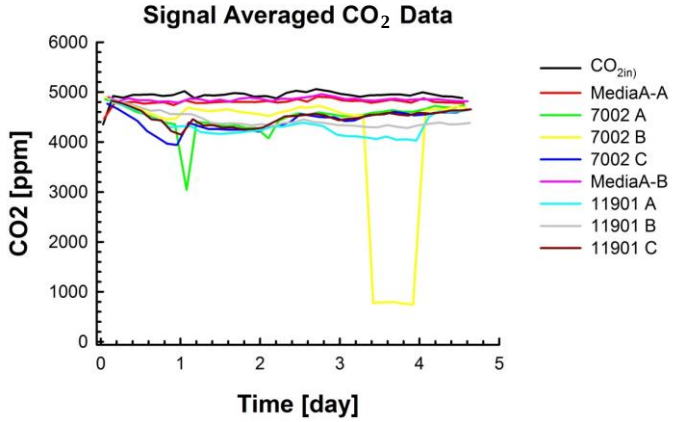
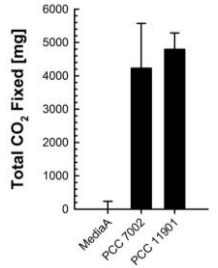


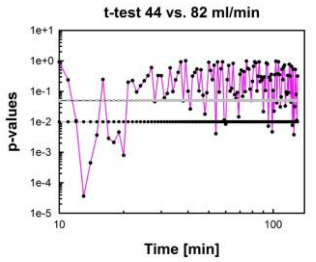
Figure 4: Main caron fixation metabolism in cyanobacteria. CO_2 will quickly react with water to form bicarbonate and then is imported via one of the bicarbonate transporters.

Results



Figures 5, 6 & 7: Figure 5 illustrates raw unprocessed CO_2 data PCC 6803 (unicellular, freshwater cyanobacteria, model microorganism for the study of photosynthesis) and PCC 11901 (shorter doubling time, high light intensity growth, high biomass production) Figure 4 takes this data along with subsequent flow readings to estimate the total amount of CO_2 fixed over the entire growth period. Figure 7 conducts a t-test on equilibrium response time in the system.





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