CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
31232

Project Title
Tackling the Bottleneck of Algae Biofuel Production: The Dewatering Process

Abstract

Objectives/Goals
Producing biofuels from algae is an expensive and energy intensive process. The major bottleneck is the dewatering process. The separation step with centrifuges provides the best results, but consumes much energy. The amount of time and energy required depend on the settling rate of algae in the centrifuge, which in turn depends on density and size of algae cells. I characterized these factors for various algae types in order to predict algae types that require the least amount of energy for dewatering. I indirectly tested centrifugation settling velocities for three algae types: Chlamydomonas reinhardtii, Thalassiosina pseudonana, and Phormidium tenue, which I called algae A, B and C respectively.

Methods/Materials
I performed more than 40 tests, ten preliminary tests and 33 final tests. The algae solutions were run over varying periods of centrifugation, increasing in time from 30 seconds to 30 minutes in duration. I extracted samples each time from the top layer in the centrifuge vial and measured the concentration of the algae by the samples' optical absorbance using a spectrophotometer.

Results
According to my data, the concentration depletion of algae A was significantly more rapid than that of algae B, at a rate that was consistent with its larger cell diameter. The depletion rate for Algae C was the most rapid of the three, consistent with its larger size due to its longer filamentous shape.

Conclusions/Discussion
I learned that the settling velocity increases with the size of the cell. Because dewatering energy consumption increases with separation time, I concluded that dewatering Algae A will consume less energy than dewatering Algae B. Stoke's law for spherical objects does not apply to long filamentous objects such as Algae C and as such, it could not be used directly in this instance. However, the general result that larger particles having larger mass settle faster is consistent with my observation that Algae C separated at the fastest rate.

Because all algae types are denser than water, I conclude that algae strains that are richer in oil (lighter) would necessarily have density closer to that of water, making separation harder and more energy intensive. My project highlights the importance of measuring algae candidates' settling velocity to ensure that the extra energy that oil-rich algae produce is greater than the extra energy required for its dewatering.

Summary Statement
I indirectly tested the settling velocity for various algae types by measuring the optical density of the vial sample at the surface after centrifugation using a spectrophotometer.

Help Received
Thanks to Dr. Greg Mitchell for teaching me basic lab skills and Dr. Robert Pomeroy for allowing me to use his lab and equipment. Thanks also to my science teacher and my father for their guidance and support.