See how two men came together to begin a project aimed at producing biofuels from algae and how they ended up building a whole town

Second exit to biofuels

The glowing green tanks on the second floor of the Goshen College Science Hall in Indiana, US look like something from a sci-fi movie.

This is a fitting description however as the three clear plastic photobioreactors (PBR) have been designed with the future of biofuel production in mind. Each tank, which has large florescent lights strapped on the outside to encourage photosynthesis, are alive with 700 litres of green algae-filled water.

Ladies and gentlemen – welcome to AlgaeTown.

Photobioreactors: the blue tank contains nutrient only and the green tank has healthy live algae growth

Intriguing proposition

The project was conceptualised four years ago by Dave Slagel, the CEO of engineering and manufacturing company Formco, and Stan Grove, professor emeritus of biology at Goshen College. The project's end goal is to find an efficient way to produce and harvest algae to be used in biofuels production.

When Slagel, himself a Goshen College graduate, began looking for a team of biologists to test his design for an algae growth tank, Grove answered his call.

'When we started this, we wanted to build a simple system which could be operated by hand, with minimal technology, anywhere in the world,' says Slagel.

Grove had not worked on algae production before but the idea of solving growth and harvest problems intrigued him, so Formco provided the initial photobioreactor and the college provided space, equipment and student assistants. Two assistants helped get the project up and running and now over a dozen contribute to AlgaeTown's on-going research.

Sourcing feedstock

'We believe we are on a different track with this project,' believes Slagel. 'The team is working with buoyant-lift PBRs but Stan and his students began looking for local algal strains to fill them about a year before their installation in 2011.'

The algae strain that currently fills the tanks has been named LC and was found at a local lake. Slagel explains LC became the feedstock of choice due to its large size and clumping properties.

'From the beginning we have viewed efficient growth and effective harvest as equal parts of the same problem,' he adds. 'We hoped the clumping LCs would simplify the harvest.'

The AlgaeTown team primarily focuses on the challenge of effectively growing and harvesting algae to meet consumer demands through energy positive systems. Energy or space intensive methods, such as centrifuging or evaporating, are currently used to glean algae from its watery habitat.

The team admits the clumping tendency of LC may not appear in spirulina or oil-producing algae however. But, as the US Department of Energy currently considers all concentrated algae as having biomass value, one student suggested: 'Couldn't we just modify the cells to produce more oil as well?'

The process

LCs at Goshen College are grown in 82cm diameter transparent plastic tanks with an active bell attached to a tall, hollow centre column. The bell is elevated and dropped by a simple aero lift system that alternately captures and releases system sparging air. This system uses ~20 watts to run four tanks.

On hand: a sample of dried algae that was grown in the Goshen College lab

The team is working with three methods of concentration and extraction: a 10 micron woven sleeve, a density specific plate system and folded mesh packets.

The 10 micron mesh sleeve is positioned in a plastic cylinder frame in the centre column of the PBR bell. The bottom of the mesh is positioned above a one-way valve, allowing water and algae to flow into the mesh as the bell lowers into the water. As the bell rises up, water runs out of the mesh and down the sides of the centre column, forced outside of the inner mesh due to the valve. The algae is then trapped in the mesh.

'This method yielded a harvest of four times the tank concentration,' explains Grove. 'While this was a fantastic start, the method only worked for so long. The mesh would get plugged, possibly due to constricted water flow and natural secretions from the algae. Attempts to reverse the flow direction, and increase the concentration, have been partially successful.'

The mesh method revealed the centre column as a great location to collect algae and Grove reveals that discovery has lead to a number of variations of the original concept.

'The best result so far has been a harvest that was 30 times the concentration of the grow solution,' he enthuses. 'All harvest attempts with this PBR have been localised efforts to isolate and remove a concentrated packet of algae encouraging growth to continue. Typically less than 2 of the total 700 litre volume are removed. Our goal is to match harvest with growth and stabilise grow concentration.'

Another collection attempt uses a separation disc less dense than settled LC, but denser than the grow solution to harvest from the bottom of the tank. LCs settle underneath the plate and are periodically siphoned up a small tube.

Grove says this method seems logical and is based on an early discovery that LCs are self-concentrating and, once clumped, will eventually reach a settled concentration of 70%. To date this attempt has yielded mixed results.

'The early trials of the plate seemed to cause algal cultures to die prematurely with stagnation and shading at the bottom possibly to blame. To increase mixing, we've tried a number of things including adding density-specific plastic chips,' he adds.

'LC became the feedstock of choice due to its large size and clumping properties'

The AlgaeTown team has also found that by adding weight to the top of the bell's column, stronger currents are formed to help reduce stagnation. This has allowed a revisit to the bottom-plate collection method with more success.

As the functionality of collection has grown more concrete, the programme has found itself moving away from the initial so-called exploratory Freeform Science to a need for more standardised research.

'Our current thought is, given the resources, we will modify the PBR to minimise the effects of wind and weather to set up outside. We'd like to move out into the sun by next spring if possible,' says Slagel. 'We are in communication with the college about possible outdoor sites to evaluate production in natural light.'

Acquiring more support

The AlgaeTown team feels it needs more support to complete its research however. Formco and Goshen College have funded the project to date, but it launched a fundraising campaign this autumn in an attempt to build publicity and funds for the programme.

'This project gives students a chance to go beyond the classroom and experience the real-world applications of solving energy needs using biomass,' says Slagel. 'Senior business students have also joined the effort this year to bring a commercial perspective to the science side of AlgaeTown.'

'The idea that we're a collaboration between science and industry gives our students quite a different interdisciplinary opportunity in our classes,' adds Grove. 'There are few chances for this to happen in most of our classes.'

As well as applying for grants, the project as a whole is currently aiming to raise $18,700 (€13,800) via RocketHub, an online portal which offers projects a way of building support and raising money online via a large number of people donating small amounts of money. All funds raised will go towards additional equipment supplies and student work-study allocation. ●

For more information:
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