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Blue-Green Acres

Fighting factory CO_2 emissions with cyanobacteria

By Patrick DiJusto

What do you get when you put polluted water, fossil-fuel exhaust, sunlight and heat-loving green slime into a metal box? If the box belongs to David Bayless, you get pure oxygen, clean water and a potential means to remove greenhouse gases from the atmosphere.

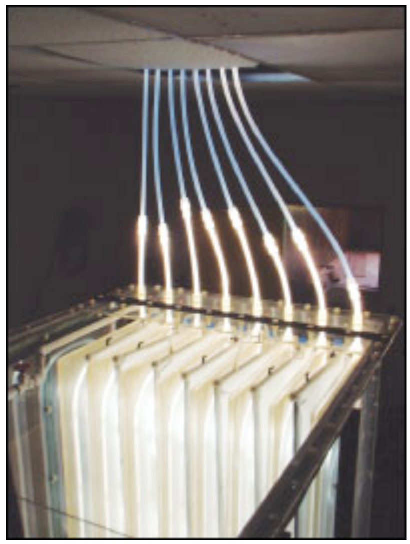

Image: SUNLIGHT DIRECT

GLOW PLATES, lit by the channeling of sunlight via fiber optics, provide a light source for algae, which would be placed on screens between the plates.

Bayless, director of Ohio University's Ohio Coal Research Center, thinks that the easiest way to eliminate the carbon dioxide given off by coal-burning power plants is nature's way, through photosynthesis. But industrial quantities of CO2 need industrial amounts of photosynthesis. So, with the help of a Department of Energy grant, Bayless came up with a scalable box packed with photosynthesizing cyanobacteria (blue-green algae).

In Bayless's bioreactor, algae grow on 60- by 120-centimeter membranes of woven fibers, which resemble window screens. Capillary action wicks water to the algae, and ducts bring in the hot flue gas. By spreading the cyanobacteria on membranes, "you get a lot of surface area for growth, but you don't need a lot of water," Bayless explains. The algae use the available CO2 and water to grow new algae, giving off oxygen and water vapor in the process. The organisms also absorb nitrogen oxide and sulfur dioxide, which contribute to acid rain.

Because the flue gas and water enter the bioreactor at a toasty 55 degrees Celsius, Bayless needed a hardy species of algae. "We were very much against genetic manipulation for this project, because we were going to be generating such very large quantities of algae," he remarks. To find the right bacterium, Bayless contacted Keith Cooksey, a microbiologist at Montana State University who had been researching bacteria found in the mineral hot springs of Yellowstone National Park. "We took some of

David's membrane screens and stuck them in a hot stream just outside of Yellowstone," Cooksey explains. "Whatever bacteria stuck to the membranes we knew was a good bet." The best candidate was a newly discovered iron-loving cyanobacterium, which he tentatively named Chroogloeocystis siderophila.

To spread a little sunshine inside the bioreactor, Bayless turned to the scientists at Oak Ridge National Laboratory. They had developed a system using parabolic mirrors to collect sunlight and channel it along plastic fiber-optic cable. Ordinarily used to provide office or factory lighting, the Oak Ridge system was modified to use "glow plates," slabs of acrylic plastic that emit sunlight directly onto the bioreactor's algae screens. "The bacteria use only about 10 percent of full-strength sunlight," says Oak Ridge's Duncan Earl. "This enables us to take one square meter of sunlight and spread it out over 10 square meters of glow plates."

One big problem is what to do with the huge quantities of algae the bioreactor produces; C. siderophila might constitute an invasive species if released outside of Yellowstone. "That's definitely one of the drawbacks," Bayless admits. Current plans call for automatically hosing off and collecting the excess algae, which might be used as fuel.

The idea of algal photosynthesis to fight pollution is not new. GreenFuel Technologies in Cambridge, Mass., has been testing 30 bioreactors on the roof of a gas-oil 21-megawatt power plant at the Massachusetts Institute of Technology. Its method also relies on natural sunlight, but with a twist: instead of moving the sunlight to the algae, GreenFuel rotates the algae in and out of the sunlight, a process called photomodulation, explains GreenFuel co-founder Isaac Berzin. Bayless likes his fiber-optic system better, however, because it has a smaller "footprint," needing only a tenth of the sunlight.

Right now Bayless has a prototype handling 140 cubic meters of flue gas per minute, equivalent to the exhaust from 50 cars or a three-megawatt power plant. If a test using a Tennessee Valley Authority power plant works, Bayless hopes to have a full-scale bioreactor, with 1.25 million square meters of algae screens handling the output of a 10-megawatt power plant, running by 2010.