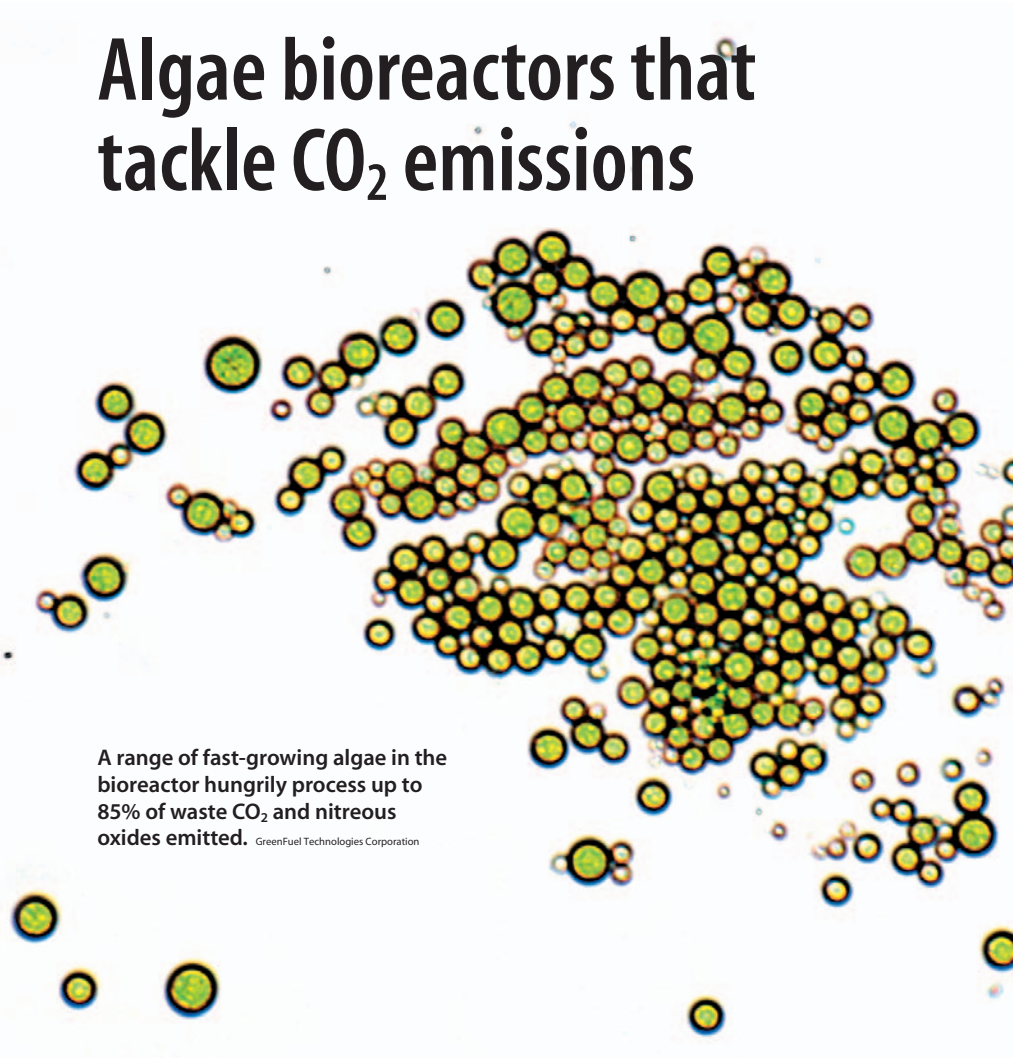
Algae bioreactors that tackle CO_2 emissions



A range of fast-growing algae in the bioreactor hungrily process up to 85% of waste CO_2 and nitreous oxides emitted. GreenFuel Technologies Corporation

An Australian company is assessing an innovative, natural system for reducing CO_2 emissions right at their source, before they hit the atmosphere. Using NASA inspired research, the technique utilises the carbon-fixing abilities of single-celled algae, cultured in specially designed bioreactors, to consume carbon dioxide and nitrogen oxide at their source.

Amid growing concern about the impacts of climate change, Melbourne-based company The Victor Smorgon Group (VSG) this year signed an exclusive licence agreement with the United States firm GreenFuel Technologies to distribute, install and operate patented algae bioreactors here in Australia. VSG Managing Director, Peter Edwards, is optimistic that it will prove an effective way to reduce greenhouse gas emissions at power stations and other industrial sites.

'From trials at the Massachusetts Institute of Technology in the United States, we have the advantage of knowing that the technology works,' Edwards told *Ecos*. 'We are now conducting, at our own plant in Melbourne, an on-site assessment, measuring levels of sunlight, temperature, land availability, flue gas composition and water quality for the bioreactors. We have also signed up with a power station in Victoria for some on-site assessments and the aim is to commercialise as early as next year.'

'The beauty of the GreenFuel bioreactor is that it can be retrofitted to existing smokestacks, such as those at coal-fired power stations, at relatively low cost and with minimal disruption,' says Edwards. 'The micro-algae lock up the carbon in their cells and these can be harvested from the bioreactors and their lipids, proteins and carbohydrates then converted into biodiesel, ethanol, methane or other useful products, using conventional methods.'

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How the system works

The bioreactors contain specially selected species of micro-algae, suspended in water and nutrients for optimal growth. Fresh, salt, artesian or recycled water can be used and poor quality water works well. A stream of gas is drawn from the smokestack by a blower and passed through the bioreactor where the algae, bathed in sunlight, consume the CO_2 component for photosynthesis. They can also break down nitrogen oxide pollutants. A portion of the media is drawn off and goes through a 'dewatering' process to concentrate the algae and finally yield a solid algal cake, suitable for oil extraction and other processing. Most of the water (98%) is returned to the bioreactor and the entire process has a low energy requirement.

Preliminary tests conducted in the United States by CK Environmental indicate that the algae achieve unprecedented growth rates, enhanced by the addition of CO_2, and are remarkably efficient at scrubbing greenhouse gases from emissions. Over seven days, the bioreactors reduced nitrogen oxide emissions by 85% and CO_2 emissions by 82% on sunny days. Reduction levels were about 50% for both gases on very cloudy days. Being dependent on sunlight for photosynthesis, the algae work a 12-hour day and knock off at night, although they absorb nitrogen oxides 24 hours a day.

'GreenFuel has been working on the bioreactor design for some six years and has streamlined the harvesting of algae, automated the flow controllers and gas uptake and come up with a very simple system that is even self-cleaning,' says Edwards. 'This robust simplicity is a great strength and, we think, gives it a technical edge over earlier bioreactors.'

In Australia, VSG, confident that the bioreactors will turn a profit in due course, plans to scale up the system once the on-site assessments are completed. The next

step is a mini-plant, then the scale of the operation can be increased by a factor of 10 at each step, from say a hectare to 10 to a hundred hectares and so on. A pilot plant in the United States indicated annual yields of about 5000–10 000 gallons of biofuel per acre.

Better than geosequestration?

GreenFuel argues that its process has several advantages over geosequestration, especially when the latter is not used for enhanced oil recovery (EOR). The company says non-EOR sequestration 'raises serious technical and legal issues, as well as requiring significant investment in pipelines, compressors, injection wells and monitoring equipment … [and] with EOR, the injected CO_2 often returns to the surface when the oil is recovered.'

In contrast, says the company, 'the GreenFuel process has a low parasitic power requirement, and does not require extraction steam, although it can beneficially use waste heat from the power plant.'

GreenFuel claims the proposed system

Solid algal cake, formed after GreenFuel's dewatering process, can be used to produce a range of valuable end products, including fuels, from the oils, proteins and carbohydrates in the algae. GreenFuel Technologies Corporation

results in a net gain in value-added products from the site in the form of valuable and clean products such as biodiesel and ethanol. Also, unlike CO_2 for EOR or sequestration, says GreenFuel, 'there are no limitations on the markets for biofuels, and no additional infrastructure requirements to integrate them into the existing transportation markets.'

Nonetheless, Edwards told *Ecos* he doesn't necessarily see geosequestration as a competitor. 'There are more CO_2 emissions in Australia than either system will be able to eliminate, so we see the GreenFuel–VSG emissions-to-biofuels process as complementary to sequestration. There's room for both.'

● **Steve Davidson**

More information:
GreenFuel Technologies Corporation claims to be the leading developer of algae bioreaction systems that recycle CO_2 from power and manufacturing plant flue gases – converting it to an on-site, continuous supply of biofuel. The company was founded in 2001 by Isaac Berzin and is headquartered in Cambridge, Massachusetts.

www.greenfuelonline.com
www.warren.usyd.edu.au/bulletin/NO47/ed47art4.htm

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