Economist.com PRINT EDITION
SCIENCE AND TECHNOLOGY

Biofuels from algae

Craig's twist

Jul 15th 2009
From Economist.com

Algae inch ahead in the race to produce the next generation of biofuels

Eyevine

And for my next trick

WHEN BP branded itself as "Beyond Petroleum", and the fashionable colour among oil companies was green, Exxon Mobil stood aloof from the rush to embrace alternative sources of energy. Indeed Rex Tillerson, the firm's chief executive, once humorously referred to biofuels as "moonshine". Now, when some of the enthusiasts are having second thoughts and scaling back on alternatives, Exxon seems to be going the opposite way yet again. On July 14th the oil giant said it would put $300m into what is probably the biggest effort so far to create a new generation of biofuels—with a further $300m to come if things go well.

The beneficiary of this largesse is Synthetic Genomics, a firm based in San Diego that is the commercial vehicle of Craig Venter (pictured above). Dr Venter may be familiar to readers as the former head of Celera Genomics, which ran a privately financed version of the human genome project during the late 1990s, and before that as the leader of the team which produced the first genetic sequence of a living organism (a bacterium called *Haemophilus influenzae*). In this case, though, the money will be thrown at neither people nor bacteria, but algae.

At the moment, most biofuels are either ethanol, usually made from sugarcane or maize, or biodiesel, made from plant oils. But many people hope that will no longer be true in ten years' time. By then, the expectation is, biofuels will chemically resemble the stuff that pours out of existing oil refineries—ie, hydrocarbons. The question is, how do you get there from here?

Dr Venter thinks he knows the answer. He proposes the industrial-scale culturing (biomanufacturing, as he describes it, rather than farming) of single-celled algae that have been genetically engineered to turn out fuel-ready hydrocarbons. He is by no means the only person to be working on the idea of turning algae into biofuels, but he has one or two particular ideas about how to do it. The most important of these is to get the algae to secrete their products into the culture medium in which they are being raised. Many algae make oil, which they store as a foodstuff against an uncertain future. But they do not squirt it out of their bodies. That would be pointless.

Other firms are working on ways to break up the cells of oil-rich algae to get at the oil. Dr Venter, however, has succeeded in engineering a secretion pathway from another organism into experimental algae. These algae now release their oil, which floats to the surface of the culture vessel. That is why he refers to the process as biomanufacturing. It is not farming, he reckons, because the algae themselves are never harvested (though it may be necessary to cull them if they become too abundant).

The next trick, which Exxon's money will help pay for, is to tweak the biochemical pathway that makes the algal oil (which is known, technically, as a triglyceride, and has oxygen atoms in it as well as carbon and hydrogen) so that the oxygen-containing parts of the molecules are snipped off and a pure hydrocarbon is left. After that, it will be a question of looking through the thousands of species of algae around to see which would make the best "platform" for the new technology. The ideal species will be able to stand up to intense illumination (more light means faster photosynthesis) and heat (for the high levels of sunlight required will also warm things up). It will also need to be resistant to viruses, which will otherwise be a big threat to such a concentrated population of identical organisms. And if no suitable species exists, then Synthetic Genomics's researchers will take the desirable characteristics from several and create what is, in effect, a new one.

The other raw material for photosynthesis, carbon dioxide, will be supplied as the exhaust from industrial plants such as power stations, oil refineries and natural-gas processors. That this will be captured before it can get into the atmosphere and promote climate change will be a bonus. The process will not be truly carbon-neutral (for that, the CO_2 would have to come out of the atmosphere, and if the algae could use only the limited amount of the gas in natural air, they would not grow fast enough) but each carbon atom will have been made to do double duty in a fuel before it finally escapes. The result, if all goes well, will be a mixture of hydrocarbons that can be fed into the stage of the oil-refining process just before petrol and diesel emerge from the stills, and at a price that competes with the equivalent chemical mixture produced by traditional methods.

Dr Venter reckons that even with existing technology, it should be possible to turn out ten times more fuel per hectare than can be garnered from maize. That is not a completely fair comparison, of course, as growing algae is far more capital intensive, and requires the plants to be force-fed with CO_2. But it can be done on land that is unsuitable for agriculture, as long as a source of CO_2 is available.

In the end, that might be the limiting factor, for not all power stations, oil refineries and so on are suitably located for biomanufacturing of this sort. That said, if the process really can be made to work, CO_2 would go from being a polluting waste product to a valuable raw material, and it might even become worthwhile building systems to capture it and pipelines to ship it around. That really would be ironic.