RESEARCH

Now, energy from single celled algae

A pathbreaking study conducted by scientists from the Centre for Ecological Sciences, IISc, Bangalore, proposes that diatoms, which are single celled algae, could provide us with an unlimited source of energy, in fact, precious oil, points out Sharath Ahuja

The recent soaring and crashing of oil prices and diminishing world oil reserves, coupled with greenhouse gas emissions and the threat of climate change, have generated considerable interest in using algae as alternative and renewable feedstock for energy production. Also, in the face of increasing CO2 emissions from conventional energy (gasoline), and the anticipated scarcity of crude oil, a worldwide effort is underway for cost-effective renewable alternative energy sources.

Harvesting oil from diatoms

In a pathbreaking review article to be published in the international journal Industrial and Engineering Chemistry Research, scientists from the Centre for Ecological Sciences (CES), Indian Institute of Science (IISc), Bangalore, led by T V Ramachandra (also with the Centre for Sustainable Technology, CST, IISc), in collaboration with Richard Gordon, Department of Radiology, University of Manitoba, Canada, have proposed that diatoms, which are single celled algae with silica shells, could provide us with an unlimited source of energy, in fact, precious oil.

Gordon and Ramachandra feel that “despite approximately 170 years of research on the relationship between diatoms and crude oil, we still know very little about the oil inside diatoms itself. The primary producers within phytoplankton in terms of net productions and contributors to sedimentary organic matter are the diatoms. Therefore, living diatoms may also point the way to a sustainable source of oil.”

The scientists use a simple line of reasoning: (a) geologists claim that much crude oil comes from diatoms; (b) diatoms do indeed make oil; (c) agriculturists claim that diatoms could make 10-200 times as much oil per hectare as oil seeds; and (d) therefore, sustainable energy could be made from diatoms.

The scientists, “propose ways of harvesting oil from diatoms, using biochemical engineering and also a new solar panel approach that utilises genomically modifiable aspects of diatom biology, offering the prospect of “milking” diatoms for sustainable energy by altering them to actively secrete oil products”.

Gordon and Ramachandra say, “Based on the photosynthetic efficiency and the growth potential of algae, theoretical calculations suggest that an annual oil production of greater than 30000 litres (or approximately 200 barrels) of algal oil per hectare of land may be achievable in mass culture of oleaginous algae, which is 100-200 times greater than that of soybeans. “The per unit area yield of oil from algae is estimated to be between 5,000 and 20,000 gallons per acre (56,000 to 2,25,000 litres per hectare) per year, which is 7-31 times greater than the next best crop, palm oil,” they add.

Diatoms, unlike other oil crops, grow extremely rapidly, and some can double their biomass within 5 h to 24 h. Even “in the wild”, doubling times can be 2-10 days, which includes photosynthesis and photorespiration periods.

Diatoms have been regarded as C3 photosynthesisers, and their photosynthetic efficiency is enhanced by concentrating CO2 around Rubisco, diminishing photorespiration. It is estimated that diatoms are responsible for up to 20 per cent of global CO2 fixation.

Clearly, if diatoms could be used to make gasoline, then we could continue using our gasoline-based motor vehicles without a major change in technology or our way of life. The private automobile becomes a sustainable proposition. We could continue to use the combustion engine, which would then remain a major competitor to other propulsion technologies. It sounds like an easy resolution to the current situation, a way to “have our cake and eat it too”. Thus, in this regard, diatoms are worthy of serious consideration.

Diatom solar panel

The milking of algae has been done by solvent extraction methods that do not kill the cells, but in which they are otherwise passive. Gordon and Ramachandra propose altering cells so that they actively secrete their oil droplets. Unlike ordinary solar panels that produce electricity, a diatom solar panel would produce oil for us; therefore, in designing it, we would have to solve various optical and mass transport problems. The scientists say, “we pose this here as an engineering and genomics challenge, rather than presuming to give a complete solution”.

Role in oil production

Diatoms may have a major role to play in the coming years, with regard to mass production of oil. This entails appropriate cultivation and extraction of oil, using advanced technologies that mimic the natural process while cutting down the time period involved in oil formation.

According to Gordon and Ramachandra’s conclusions, geologists claim that much crude oil comes from diatoms, diatoms do indeed make oil, agriculturists claim that diatoms make 10 times as much oil per hectare as oil seeds, with theoretical estimates reaching 200 times, and, therefore, sustainable energy could be made from diatoms. We may be able to get diatoms to secrete their oil, perhaps even as gasoline, and therefore milk them.

With more than 2,00,000 species from which to choose, and all the combinatorics of nutrient and genome manipulation, finding or creating the “best” diatom for sustainable gasoline will be quite a task. Gordon and Ramachandra feel the quest for finding the “Holy Grail” in harvesting oil from diatoms has just begun.

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