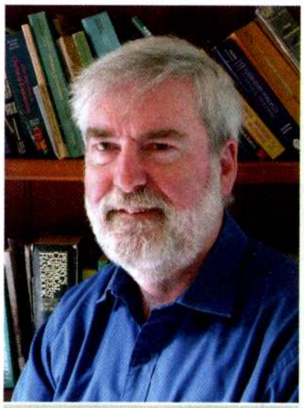
In search of a greener biodiesel

by Wayne Davies

PETROLEUM REPRESENTS OUR MOST concentrated and convenient form of energy, so much so that in just over 100 years we have used up about half of the best inventory on Earth, a concept known as Peak Oil. In addition, the burning of fossil fuels has raised atmospheric CO_2 levels which, together with other greenhouse gases (GHGs), are widely regarded as the cause of global warming.



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With the transport sector being a major user of liquid petroleum products, the search has been on for alternative fuels that are renewable and do not add to the carbon in the atmosphere. Diesel substitutes such as biodiesel made from organic renewable matter initially seemed like a good alternative fulfilling both requirements. However, recent studies have shown that there are some significant downsides to biodiesel depending on the type of crop and how it is grown.

The CSIRO's 2007 Life Cycle Assessment (LCA) compared petroleum diesel to biodiesel from various sources. Expressing GHG emission rates as CO_2 equivalents, petroleum diesel released about 840g CO_2 per km travelled. Canola or rapeseed biodiesel released about half of this, while palm oil from existing plantations came in at 180g and used cooking oil produced just over 100g.

But when emissions for new palm oil plantations were added, the figures were very different and biodiesel started to look a lot less green than originally thought. The figure for plantations on cleared rainforest was 8000g and on cleared peat swamp a whopping 18,000g per km travelled.

Another factor that needs to be taken into account is the use of fertilisers such as nitrogen, which crops need for high yield. Fixed nitrogen, which starts life as ammonia made from natural gas, is released as nitrous oxide, a GHG with 300 times the greenhouse potential of CO_2. The environmental lobby group Envirostat has claimed that GHG emissions from canola biodiesel are actually worse than those of petroleum diesel.

Overall, up to half of biodiesel's total GHG is said to be due to nitrous oxide associated with the crops used to make biodiesel.

GHG emissions aside, converting croplands from food production to fuel production has received trenchant criticism. Such alienation pushes up food prices, destroys old-growth forest, promotes soil erosion and destroys wildlife habitats. This plus the (until recently) rising costs of plantation oils, due to rising petroleum and fertiliser prices to which they are linked, has resulted in narrowing converter margins, which explains why many biodiesel companies have gone out of business globally.

Biodiesel from edible waste oils and fats gives the lowest GHG emissions because the debt has been paid already. However, the quantities of waste oils and fats available represent only a cupful compared to a barrel of petroleum, so biodiesel from waste edible oil will remain a niche market for smaller companies.

Byproducts made in larger volumes such as tall oil (or tallolja oil) from the Kraft Process may offer significantly greater opportunities.

A major problem with such oils and byproducts, however, is their high level of free fatty acid (FFA). Conversion to biodiesel cannot be done with conventional soluble catalysts because these turn instantly to soap. Existing methods that use sulfuric acid or potassium methoxide are slow and corrosive or expensive and dangerous.

The catalyst-free supercritical methanol process that converts both FFAs and triglycerides with equal ease has attracted great interest. However, it suffers from high running and capital costs owing to high methanol/oil ratios and plant that operates at 25,000kPa and 300°C. An informal costing based on my company's own supercritical biodiesel plant suggests no advantages over existing processes.

At present the most promising biomaterial to replace diesel from petroleum globally appears to be algae. They absorb CO_2 and convert it to over 50% lipids that are perfect for conversion to biodiesel. They are the highest yielders of biomass per unit area of any plant, and part of the crop is suitable for making ethanol as well.

The challenge then is to make fuel from algae in much the same way that petroleum was generated, but a lot faster. Algae can either be grown in farms consisting of concrete raceways covering hundreds of square kilometres, or in photo-bioreactors with large transparent surfaces. However, the capital and running costs for continuous pumping of water around the concrete raceways or for the transparent surfaces is known to be enormous and currently commercially prohibitive

A possible alternative that would be cheaper and therefore more likely to be commercially viable are farms where algae would be grown in artificial lakes filled with seawater using floating harvesters instead of continuous pumping.

Unfortunately for biofuels, however, the sharp drop in the petroleum price lately has been ruinous for new initiatives. If they cannot compete on price then their GHG credentials are irrelevant. Eventually petroleum prices will rise again. In the meantime the search for alternative transport fuels remains an urgent task. ■

Dr Wayne Davies is the director of his own company SN2, a chemical engineering consultancy that works in alternative fuels such as biodiesel, cryogenics and plant design (www.sn2.com.au).