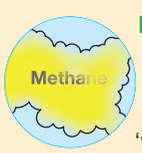
Fuel

Considered a great opportunity for tackling climate change fleet-wide, others label biofuels a maintenance nightmare. One thing's for sure, says John Challen, they are here to stay

Talk to a cross-section of transport engineers who have first-hand experience of biofuels and the response will probably not be a glowing endorsement of this alternative to fossil fuels. Corroded fuel injectors, issues surrounding storage and shelf life, and questions about the validity of warranties on biofuel-fed engines and ancillaries are just some of the gripes.

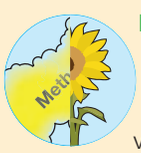
But the outlook for the future is not all bad, despite the obvious drawbacks and teething problems encountered. There's the reduced CO_2 emissions, a positive step that can also provide positive financial effects. What's more, there is currently more research and development than ever

Alternative biofuels



Biogas

Biogas is a gaseous fuel that mostly consists of methane. It has high energy efficiency 'well-to-wheel', and low CO_2 and particulate emissions. It can be produced locally, but the energy efficiency, compared to diesel, is only 20% and current production is low.

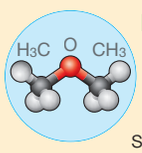


Biogas and biodiesel

Biogas and biodiesel can be combined in combustion, using separate on-board vehicle tanks and fuel injection. A smaller amount of biodiesel or synthetic diesel can be used to keep the compression combustion in a diesel engine.

Biodiesel

Biodiesel is made by trans-esterification (the ester to alcohol process) of vegetable oils, usually harvested from rape seed or sunflowers to produce FAME (fatty acid methyl ether) or RME (rape methyl ester). Now regarded as first generation biodiesel, it can be blended with conventional mineral diesel, but the resulting energy efficiency, in terms of 'well-to-wheel' processes, is low. It also risks increased NOx emissions, is hygroscopic (so absorbs water) and supports bacterial growth. The transport industry now recognises that the potential for large-scale production of biodiesel is limited, not least because of the damaging impact on food production and prices.



Dimethyl ether (DME)

DME is a gas produced by gasification of biomass, although using a relatively simple and inexpensive process. It is also easy to handle and distribute, being maintained in liquid form under low pressure (5bar). Experience suggests that relatively modest modifications are required to convert existing diesel engines to run on DME. Volvo uses a low-pressure (300 bar) common-rail fuel system and replaces conventional rubber or neoprene seals with a Teflon-like material, because the fuel is corrosive. Since the fuel can be produced from biomass, such as black liquor from the pulp industry, DME can be made CO_2 neutral and EU sources estimate that, by

intentions

into the fuels and their performance, as the industry works to reassure operators and technicians alike, while helping to reduce any mechanical damage that might occur.

Shell Global Solutions is one organisation trying to find such breakthroughs, as Dr Keith Reading, project leader of its commercial diesel fuel programme, reveals. "Methods of producing standard diesel fuel have developed hugely in the last few decades and these changes have made newer technologies possible," he says. "Years ago, when diesel used to wax up in the winter, you'd see drivers with bonfires under their tanks trying to warm up the fuel. Today, there are additives that prevent the wax from forming 'plates' and instead force production of stick-shape wax [platelets] under very cold conditions, which do not block filters or cause the same problems."

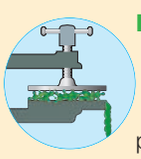
Age of the alternative fuel

With the threat of dwindling fuel reserves, coupled with these developments in diesel fuel, it was inevitable that alternatives – 'bio' versions – would appear. "We all want to reduce our CO_2 contribution and to become less reliant on imports, and our view is that a low percentage of biofuel can be used to help achieve this goal. There are two types of biofuel: fatty acid methyl ester [FAME], for diesel, and ethanol for gasoline, both of which can have a positive effect, if they are handled properly," says Reading.

"Biodiesel is much more viscous than diesel fuel, so it needs to be split – providing a by-product of glycerine, using methanol as part of the process," he elaborates. "That is dangerous, so it's a specialist process. However, it also needs to be blended very carefully and there is the potential problem of water being carried through and enabling microbial growth, which then digests the fuel and causes the deposits that can sometimes block filters and injectors."

This last point may sound familiar to many readers, with personal experience, and it is one of the points highlighted in 'Your Shout' from January 2010's Transport Engineer (page 40). But Reading cites further developments and the use of the whole plant, rather than just the seed, in second-generation biofuels, as a way forward.

2030, it could replace 50% of diesel oil currently used for heavy road transport – certainly in the Nordic countries – although Volvo talks more realistically of 20%.



Hydrogen

Hydrogen gas must be compressed to 350–700bar for use in vehicles. It is produced by reforming hydrocarbons using heat and steam, gasification of heavy hydrocarbons or biomass and electrolysis of water. The combustion or electrochemical reaction (fuel cell) is emission-free, but the 'well-to-wheel' energy efficiency is low, delivery and storage are expensive, and current production is limited. At 700bar, the energy content is only about 22% that of diesel.

Methanol/ethanol

Methanol and ethanol are both alcohols. The former is again produced by the gasification of biomass, while most ethanol is produced by fermentation of sugar and other crops. They can be blended into gasoline and are available today. Ethanol has a low energy efficiency 'well-to-wheel', compared to biomass conversion of methanol, and also has a low boiling point and about 55% energy by volume, compared with diesel. Meanwhile, methanol has high energy efficiency 'well-to-wheel' and low global warming potential (GWP), and is also low cost. Its downsides, however, are that it is toxic and corrosive, and has about 45% of the energy efficiency of diesel.

Synthetic diesel

Synthetic diesel is a mix of manufactured hydrocarbons, produced by gasification of biomass in a BTL (biomass to liquid) process. Again, it can be blended with diesel (in any percentage), and is then compatible with existing diesel engines, where its zero sulphur content is attractive. There are several sources, but while 'well-to-wheel' energy efficiency is better than that of FAME and RME biodiesel, it is still lower than for other synthesis gas products. Also, production to date is very limited.

Transport Engineer wishes to thank Volvo for its help in this evaluation of the current best alternative fuel options.

Big British breakthroughs for biofuels

Despite a chequered history, biofuels are being used for more than just solutions to the UK's transport needs. Once seen as the solution for climate change, biofuels have since come under attack, because of the use of fertile land to grow biofuel crops. Now British teams are developing biofuels that really could help save the planet.

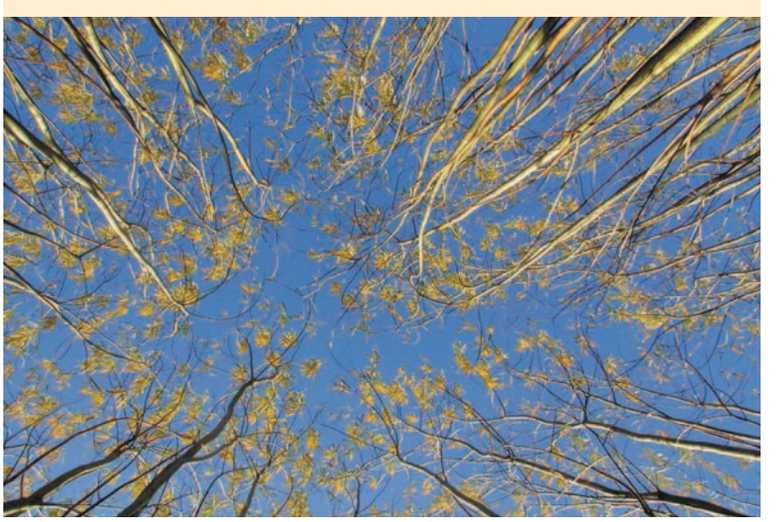
The British Biotechnology and Biological Sciences Research Council (BBSRC) is administering the largest ever UK public investment in bio-energy research. "The Sustainable Bio Energy Centre is a virtual centre of six teams, led from five different universities and institutes, working on different aspects of the problem," explains Alf Game (pictured), science manager and deputy director of research, innovation and skills at the BBSRC.

"It's not like a pipeline, where each of the teams feeds into the next; what we have are exemplars, models or patterns to be copied, of what can be done at different stages of the pipeline," he adds. Game's job has been to lead the construction of the centre.

The first generation of biofuels was relatively easy to produce, he says. Plants produce their own concentrated stores of energy in seeds or tubers, and biofuels simply tapped into those, taking oils from seeds and ethanol from the sugars in tubers. Now, however, scientists are looking at the entire plant as a source of biofuel.

"The next generation will either use by-products, like wheat straw, or [fuel] will be grown where it won't compete with food," advises Game. "And that doesn't have to be on land; one of the most promising sources is algae."

He also comments on energy efficiency from 'well-to-wheel'. "It doesn't make sense to transport wood around the country to huge refineries, so processing will have to be done near the source," agrees Game. "Biofuels won't totally replace petrochemicals, but they could make a difference." His view: 10–20% of Britain's fuel needs could be grown in Britain, adding a further level of efficiency.



So all biofuels are clearly not the same, then, but they can all have the same lasting effects on storage tanks – algae and bacteria creeping in. "We have encountered a number of operators that have experienced problems with fuel storage, namely contamination," agrees Kevin Bond, chairman of transport and logistics training supplier M2 Training. Part of his M2 group is Fuel Management Solutions, set up partly to deal with the fallout from biofuels and the effect they were having on operators' hardware.

Bond says that what many individuals describe is due to diesel bug (microbiological organisms that grow between the water and the fuel), a problem that has been known, but contained, for years – until the age of biodiesel. "The combination of water, a dark place and variations in temperature results in the tank becoming like an incubator," says Bond. "What we're finding is that algae and bacteria are growing at an increasingly rapid rate as the biofuel mix [with conventional diesel] increases, causing filter blockages, increasing acidity of the fuel [leading to excessive seal wear] and problems with the ignition systems."

Frequent cleaning

With government targets for the biodiesel mix rising by 0.5% a year (it currently stands at 3%), contamination will only increase, says Bond, who believes that the authorities' own benchmark leaves a lot to be desired. "The latest client we have dealt with – a major logistics operator – had a two-year-old, 35,000-litre tank, with bacteria and algae growth covering the whole of its interior, despite turnover of 18,000 litres a week," he elaborates. "It was heavily contaminated, but still fell well within the requirements of British standards for fuel manufacture, which requires no more than 200ppm of water in the mix. When we took samples at the beginning of our treatment, it was 110ppm."

Shell's Reading suggests a cautious approach to the 3%, 4% and 5% mix, not least because viscosity can be lost within the diesel specification envelope for injection equipment. He's heard of transport operators in Spain that use vegetable oil after starting with diesel and then finish off on diesel to flush through deposits. "That's a very local solution," he says. "You also see some operators running on untreated vegetable oil, but those will leave horrible deposits."

As Bond confirms, there is no chance of eradicating the contamination, but it is treatable. What is required, he says, is a fresh approach to storage, with regular cleaning and treatment. "This requirement will grow as the percentage of biological mix increases and the contamination gets worse," he predicts. "Major transport operators storing fuel have got to put in place a frequent cleaning regime for their fuel and also look at how they dispose of the waste, because it is typically hazardous." TE