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Alternative Fuels for Transport and Heating: Biodiesel

This summary is based on notes taken at the meeting. Ric kindly filled in for Paul Martin at the last minute so there are no slides.

Ric was a member of the Melbourne Biodiesel Club (which became an ATA special interest group) and has a long history of running biodiesel in his car. He has been a member of ATA for two years, but confessed this was his first meeting! He explained that Paul Martin is the expert in biodiesel manufacture –from individual to major commercial production. Ric's experience is mainly as a consumer and he will go into the chemistry, economics and politics – this should help people considering home brewing of biodiesel.

The politics of biodiesel

The fundamental problem is that there is not enough vegetable oil in the world to provide enough for transport fuel. Displacing arable land from food production would make it an unviable alternative to oil. There are other options, such as algal oil produced from algae in bio reactors, but this is still in development - the jury is still out on it.

By 'bio fuels' people usually mean ethanol, but it also means biodiesel, which is completely different. There are real problems with the 'energy equation' of ethanol based on the amount of energy used in its production and what it is produced from, usually corn. Provided biodiesel is produced from waste vegetable oil or animal fats, it has a good energy equation. It only becomes a problem when people start to use virgin palm oil as the feedstock, destroying tropical forests to produce fuel which will in turn return a lot of carbon to the atmosphere. So long as you're using waste vegetable oil or animal fats from food production that would otherwise be composted or put in land fill then biodiesel provides another use for the product.

Biodiesel in Melbourne

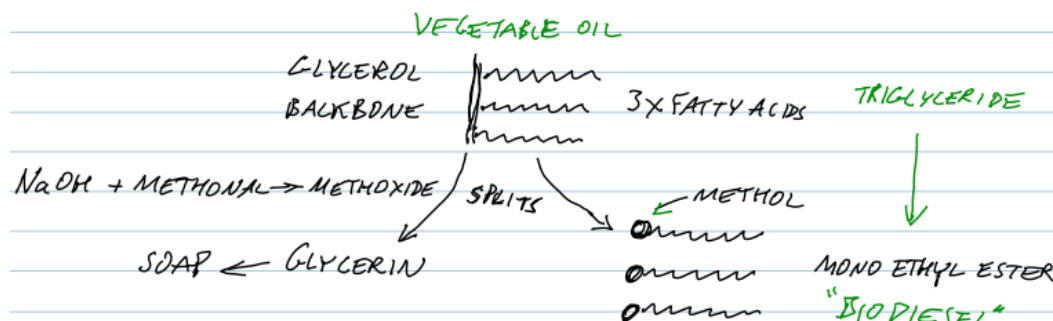
Ric uses biodiesel made from 50% waste vegetable oil from Melbourne restaurants and 50% chicken fat from a poultry processing plant in Thomastown made by Fina Biofuels Thomastown. It complies with Australian Standards and is far easier than making it yourself! There used to be a supplier in Prahran and will hopefully be more in the future but things have been static for a few years.

Truck fleets only start to switch to biodiesel when the diesel price goes above ~\$1.40. When it's around \$1.10-15 as at present, they won't bother making the trip or taking a risk with their warrantees. They're not interested in carbon reduction - biodiesel now is mainly used by individuals who are more interested in the environmental impact and less interested in the cost.

The current price is ~\$1.05/L, but is actually worth more. The government should be doing more to encourage the use of biodiesel made from waste and not associated with forest reduction (mostly in Indonesia or Malaysia). Most biodiesel from that source ends up in Europe where it is more popular and used in diesel blends. In Australia, petroleum diesel can contain up to 10% biodiesel before it has to be disclosed. It is useful for its high lubricity so companies don't need to add sulphur or other additives. The actual percentage used in Australian diesel is unclear, but there's a lot of biodiesel being produced and a lot of that doesn't go through retail outlets.

The chemistry of biodiesel

The original diesel engine was actually developed by Rudolf Diesel¹ to run on vegetable oil. This is composed of a glycerol backbone with three fatty acid chains coming off it. Glycerol doesn't burn cleanly and leads to a build up of carbon deposits in the engine. To make combustion more efficient, you convert the glycerol into glycerin and split off the fatty acids. Methyl alcohol is added to these free fatty acids so you go from a triglyceride to mono ethyl ester. This is a much better oil that burns more completely. Glycerin is a biodegradable byproduct that can be used in the manufacture of soap.



Making biodiesel at home

This is quite a simple reaction that can be done at home, but there are some safety issues involved. To drive the reaction you need quite a strong alcohol. Most use methanol which is cheap and easy to access, although quite dangerous and generally "not a nice chemical to have around". It's toxic to the nerves and can be absorbed through the skin or breathed in. It is also highly flammable [nervous titter in audience]. More worrisome is you need a strong base to drive the reaction so sodium hydroxide is combined with the methanol to form a *methoxide*. Methoxide is a highly caustic liquid that instantly burns the skin - and you won't feel it as it kills the nerve endings immediately [more nervous titter in audience]. You need thick aprons, safety goggles, rubber gloves and good ventilation.

Just the right amount of methoxide must be added to the oil so that all the triglycerides are converted to esters. In waste oil, however, there are some additional fatty acids from burning of the oil so it may be acidic. To work out exactly how much methoxide is required to convert the triglycerides *and* free fatty acids, you first need to do a titration. This is done by adding a pH indicator to a sample, e.g. phenol red, or use litmus paper, etc. You then add a known quantity of base (NaOH) until a colour change indicates that the free fatty acids are mopped up. You then plug this quantity into an equation to calculate how much extra methoxide is required to add to deal with the acidity of the feedstock. Making this quantity of methoxide is the dangerous part, but it's actually easy to do once you're shown how.

The reaction vessel could be an old water heater with a tap in the bottom to draw off the glycerin while holding back the biodiesel. The remaining biodiesel is taken out, washed and dried ready for use. It's not difficult from a chemistry point of view, but there are OH&S issues with the use of chemicals. You tend to use a lot of rags and need to be aware that these can spontaneously combust if left in a pile. There have been many shed fires from this. You would also not want pets or children around. A special licence would be required if producing over certain quantities of chemicals. You just have to be disciplined, plan carefully and watch others. Always do it in the presence of others, especially when starting.

The biggest problem in producing is obtaining sufficient waste vegetable oils. Ten years ago, restaurants would pay to have waste oil removed, now you have to pay them around 40- 45 cents. It goes into three markets: biodiesel, to India where glycerin is extracted and made into soap; and to farmers to increase the calorific content of animal food, particularly during the drought.

Use of biodiesel in cars

There's a lot of politics about whether its good or bad for engines. Ric has always got his biodiesel for his 2004 Citroen C5 from others. The first time he used it he was very apprehensive, but he has had absolutely no trouble. Check whether your car is compatible at the Biofuels Forum². Certainly bad fuel, whether petroleum or bio based diesel will ruin your engine. A bad batch of Mobil diesel about a year

¹ Rudolf Desiel <http://inventors.about.com/library/inventors/bldiesel.htm>

² Biofuels forum <http://www.biofuelsforum.com>

ago resulted in trucks not making it out of the petrol station. Millions of litres had to be withdrawn causing shortages and forcing the price up. In Ric's experience, there have been no issues with the two local biodiesel retailers. He hasn't heard of a diesel car that won't run biodiesel happily. Engines run quieter and there's clear evidence that gases emitted are far less toxic or detrimental to health due to its fundamentally different nature. Biodiesel is biodegradable and can be composted. It can be used as a solvent or a lubricant and washes off with mild soap. People used to say it would damage paint, but would only be from a bad batch where the methoxide was left in it – it's a paintstripper! Its fine so long as the methoxide and methanol are removed and it's pH neutral. There's even a YouTube video of Daryl Hannah drinking it³ but he wouldn't go that far!

Questions

- If making home brew biodiesel, you would not come under commercial regulations so long as you're producing for yourself and not selling or making it available to others. There may be a problem with volume of chemicals. The club was considering involving everyone in the manufacture to get around this. Talks with CERES about setting up a demo plant started, but the money didn't come through. The club instead became a special interest group of ATA.
- Biodiesel should last six months in storage without concerns. There's a possibility that something (e.g. a fungus) may grow in it if stored for extended periods but Ric has had no experience with long-term storage of biodiesel. If left open it will also absorb moisture, although this would only reduce its efficiency.
- Car manufacturers have very negative attitudes –more so in Australia. In Europe, Citroen allow up to 30%, blends in their warranties, but not in Australia. It is difficult to find a mechanic who will support you and not jump to the conclusion that biodiesel is the problem.
- Some new engines have a particulate capture device in the exhaust that reaches very high temperatures. There is an allegation that biodiesel may cause problems and signal faults.
- There are no problems with the fuel system side and no conversion is necessary, however, everyone running diesel, whether commercial or home brew biodiesel should add another filter in the low pressure fuel line before the manufacturer's filter, just in case you do get a bad batch. It's a lot cheaper to replace a generic one for \$6 rather than the Citroen one for \$600. Ric has only had to replace his cheap add-on filter once in two years and has had no problems with the fuel system, or any other aspect of running the car on 100% biodiesel for nearly 50,000kms.
- One user had problems starting in winter and lower power when switching to biodiesel in Tasmania. Batches varied depending on whether animal or vegetable fat was used - long fatty acid chains in animal fat gel more readily in cold temperatures. Thomastown biodiesel is guaranteed to -5°C and Ric has had no trouble even in snow.
- You can mix biodiesel and petroleum diesel in any amount in your tank. There is about 5% less energy in biodiesel. You can also get alpine diesel in Australian alpine regions during Winter – mixed with biodiesel, your fuel is less likely to gel.
- Plenty of ventilation is necessary when home brewing!
- Production of algae-based fuel could be the way in which biodiesel becomes a more acceptable product, but the problem is getting the volume and working out the extraction process. At this stage it is still experimental
- Other sources of fuel are possible, but waste oil is most readily accessible. Most involved are interested in recycling and renewable energy rather than making a living out of it.
- A number of commercial plants started up but have closed or moved on. Apparently there wasn't a market for them in Australia. Public floats didn't work. They were too early and perhaps received mixed messages from Government.
- Comparing biodiesel with hydrogen? Biodiesel is a lot easier to produce and easier to contain. Hydrogen is out there in the future.

It's an interesting hobby. If you want to run your diesel on a renewable fuel and live close to Thomastown then it's easy. Just put in the extra fuel filter and check the particulate filter first.

Summary by Paul Fritze pafritze@gmail.com twitter.com/pafritze

³ Daryl Hannah drinking biodiesel <http://video.google.com/videoplay?docid=7523728152167754607>