

Bad fuel – and some other problems

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This is not a complete review of issues by any means, so don't treat it that way. Modern common rail diesels for example are complex computer controlled machines, with numerous feed back loops to ensure clean efficient fuel burn. Biodiesel has a Cetane number far superior to fossil diesel, for example, and this can apparently confuse these sophisticated control systems.

I know plenty of people who make biodiesel badly - and definitely this will cause problems. Most problems can be resolved easily. Some of the problems are.

BACTERIA

It is true that biodiesel will kill off the bacteria that grows in fossil diesel - this comes through as a whitish slimy substance. It usually blocks up the fuel filter and then the engine stops - it happens over a day or two - a rather rapid loss of power over 2 days and then the engine stops. Put in a new fuel filter (about \$50) and away you go. If the engine stops abruptly with no warning it's likely to be a different problem.

For new users of biodiesel especially where water may have got into the fossil fuel in the tank then this bacteria problem will need attention. So boats and tropical environments in older vehicles are where the bacteria is likely to build up over time.

The solution is put a \$5 in line cheap fuel filter before the main fuel filter - throw these away when they block and replace. After about the 4th filter most of the slime will be gone from the system. Biodiesel will prevent further bacteria build up.

BAD FUEL

Made from a high melting point oil - tallo, palm, coconut - oil too viscous on a cold day. Pump works too hard (you can here it rattling as it tries to shift the viscous biodiesel). Can break the fuel pump shaft or excessive wear on the pump.

In tropics should not be a problem but might be on cold days for palm biodiesel (freezes at about 5 °C)

Fuel not filtered well enough - golden rule for all diesel - every time you move it to another container or vehicle filter it - I filter at 5 microns for the 1999 Hilux ute - conventional aspirated engine (2 years and no problems yet) and 1 micron for the 2.0 TDi Golf which has common rail turbo engine (4 months and I'll let you know after a year – a potentially expensive experiment). Always filter the fuel. Small particles can block the injectors and \$2000 later you can have your car on the road again. The filter in the petrol station bowser is usually about 10 microns. In your car it is usually about 5 to 10 microns I think.

Fuel has other materials in it - glycerine, un or incompletely reacted oil, methanol, water, phosphor lipids (usually lecathin).

Glycerine - Take 2 liters of the biodiesel put it in a clear bottle - juice bottle and leave it sit on the shelf for a month or two.

The glycerine in any will sink to the bottom as a dark layer - really there should be none - but a very small amount < 0,1 % (thats about 2 ml in 2 litres) should not be of too much concern - I would have less than this in my biodiesel. If you make biodiesel leave it for a few months to allow the last drops of glycerine to settle out – long but cheap process.

Water - take a mug full of the biodiesel - heat it in the microwave. If it boils after about 2.5 min then that's the residual water boiling out of the hot biodiesel. Eventually you could make the biodiesel boil as well so the idea is to get the water to boil at 100 °C and not the biodiesel so don't heat it for like 5 min.

Leave it to cool for 10 min and repeat this cycle but less time on the microwave for the second go as the biodiesel is already hot - just until it boils. After about 5 cycles maybe more it should stop boiling as all the water will have been driven out. Well if you find it works like this - that is it boils - then there is too much water in the biodiesel. There should be no water in the biodiesel - at some level (not sure but probably < 0.1%) it will not make much difference to the engine above this the engine will lose power run rough and seriously sound sick. I understand water in diesel for a period will erode injectors - not good

Unreacted oil - not sure really how this affects the engine - a lot of people run their cars on straight cooking oil but I'm not suggesting you do this. Can easily test for this. Take a 300 ml measuring cylinder (or thereabouts). Add 290 ml methanol add 10 ml of biodiesel. Mix the two by shaking the cylinder - don't get the methanol on your skin. Let it sit for 10 min (just 10 min) and if there is a layer on the bottom it is unreacted oil. The bottom layer volume is the ratio to the 10 ml of biodiesel of unreacted oil in the biodiesel. The finest thin layer on the bottom is acceptable more than that is generally not. In this test biodiesel dissolves easily in methanol, oil does not - simple as that.

Phosphor lipids - very fine particles may get through the fuel filter and eventually lead to build up of a waxy substance on the injectors - can block them eventually. Biodiesel needs to be centrifuged and put through flocculation system or preferably both. I don't do this as don't have the resources. My used cooking oil source is good but if it was the local chippy then the flour and muck from the fryers may get through the filtering system and I might have to deal with this. Also oils that have been extracted from seed using a heated crushing system will release phosphor lipids into the oil. Cold crushing does not do this but a cold crusher is like \$50 k compared to an el cheepo heated chinese crusher for \$3k.

Measuring Free Fatty Acid (FFA) material in the Fatty Acid Methyl Ester (FAME) (ie Measuring unreacted oil in biodiesel)

Equipment required:

200 ml measuring cylinder
200 ml beaker
Magnetic stirrer
Magnetic flea
Thermometer

Chemicals required:

Methanol anhydrous 100 ml
Fatty acid methyl ester (biodiesel) 20 ml, Clear and bright, ie low water content (max water content 500 ppm)

Notes:

To assess the completeness of the trans-esterification process, it is useful to be able to perform a quick quality check of the result. This method roughly determines the methanol solubility of the ester produced, and indicates the quantity of methyl ester produced in the process. It is assumed that the methyl esters are fully soluble in anhydrous methanol, which is the case for fatty acid chains with 18 or less carbon atoms. In practice this means that Methyl esters from with long carbon chains (e.g. fish oil) cannot be assessed with this method. Empirically, the results of this method are in close correspondence to the determination of ester content using the EN norm for FAME (fatty acid methyl esters) tests.

Performing the analysis:

Caution, thoroughness and cleanliness are required to get a useful result.

Optimal results will be obtained at room temperature. Equipment, methyl ester (biodiesel) and chemicals should all be at this temperature.

1. Make sure that the 100 ml measuring cylinder is absolutely clean and dry.
2. Add exactly 90 ml of methanol to the measuring glass.
3. Add exactly 10 ml of methyl ester to the methanol. (If the beaker and the magnetic stirrer mentioned above are available, pour the content of the measuring glass into the beaker, then put to stir at moderate speed).
4. Agitate the content well with a proper tool, until only one phase is visible (a).
5. Stop agitating and put the cylinder to an even surface for five minutes. (or pour the contents of the beaker into the cylinder and put the cylinder to an even surface for five minutes.)
6. Almost all methanol soluble material will stay in the upper phase. The non-soluble material (unreacted oil etc) will drop out and form a separate phase at the bottom of the cylinder (b). The volume of the lower phase (V_{phase2}) can be used to calculate the success of the reaction:

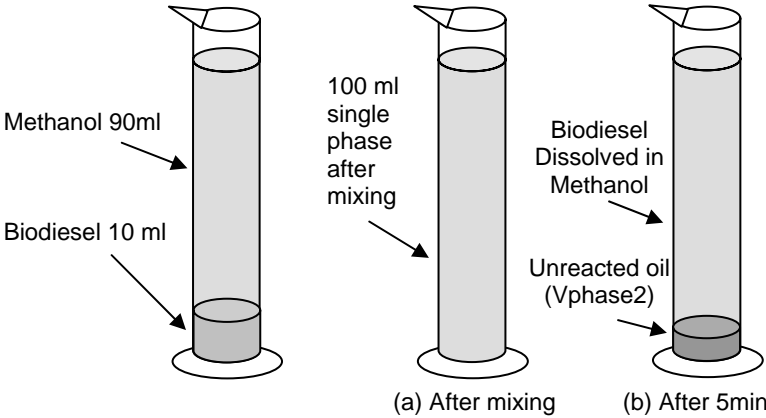
$$\text{Reacted oil \% by volume} = (10 - \text{Vol}(\text{phase2}))/10$$

$$\text{Unreacted oil \% by volume} = \text{Vol}(\text{phase2})/10$$

Where 10 = the volume of the added methyl ester (biodiesel)

Vol(phase2) = the volume of the lower phase

NB: There has to be a sharp line between the phases, and at least one of the phases has to be clear and bright before estimation of the lower phase can be made.



Density determination

Density is one of the most important parameters for establishing biodiesel quality. The densities of the raw oil and biodiesel will differ greatly, with the oil having a higher density than the biodiesel, if the trans-esterification process has been successful. The European standard EN 14214 allows densities of FAME (fatty acid methyl ester) 860 - 900 g.cm³ at 15°C. This test provides a clear indication of whether the product meets the standard for this parameter or not. It is important for comparisons to carry out the test at the same temperature since the density varies with temperature (see the example below). The optimal measuring temperature is 15°C as stipulated in the standard.

Equipment required:

100 ml measuring cylinder

Aerometer

Thermometer

Performing the analysis:

1. Determine the temperature of the sample and adjust if necessary by heating or cooling the sample. Never heat oil directly on a stove or open flame. The oil should be heated in a warm water bath under regulated conditions. For accurate reading the equipment temperature should be the as the sample.
2. Fill the measuring glass with biodiesel until approx. 75-90% full.
3. Drop slowly the aerometer into the measuring glass until it floats. Allow the aerometer to stabilize for a few minutes (see picture 3).
4. The density value is shown on the aerometer scale. The value is indicated when observed horizontally and where the fluid bow reaches its highest point.

Alternative Density determination

Equipment required:

250 ml calibrated conical flask

Scales electronic

Performing the analysis:

1. Determine the temperature of the sample and adjust if necessary by heating or cooling the sample. Never heat oil directly on a stove or open flame. The oil should be heated in a warm water bath under regulated conditions. For accurate reading the equipment temperature should be the as the sample.
2. Weigh the flask.
3. Fill the conical flask with biodiesel until exactly at the calibrated mark.
4. Weigh the flask and biodiesel.
5. The density is weight of biodiesel/250 g.cm³.