**LOGICAL SYSTEMS CONSULTING**
26 Surrey Road, Wilson, WA, 6107
Ph: 08 9458 1200 Fax: 08 9458 5658 Email: flegge@ozemail.com.au
ABN 31 009 172 776

20 April 2003

Mr Daniel Sheedy
Clean Fuels and Vehicles Section
Environment Australia
GPO Box 787
CANBERRA ACT 2601

**Re: Biodiesel discussion paper**

Dear Mr Sheedy

There are some good points made in the discussion paper suggesting that certain overseas standards may be not necessary or too strict. For example there is the reference to iodine number being used in Europe to exclude soy oil, shown in America to be a perfectly satisfactory feedstock. There are however other statements in the paper which suggest a tendency to follow the conventional wisdom without sufficient critical examination. This is made clear in my responses below.

It must be remembered that at the outset there was a high level of anxiety about the wisdom of using this new fuel in valuable engines. With the accumulation of experience showing that biodiesel is good fuel the anxiety is declining and Australia, coming along later, could take advantage of this to set more rational standards.

**Need for a mandated national standard?**

**Yes.** The standard should be national, but should only apply to suppliers who sell from bowsers to the public. For manufacturers not selling to the public the standard should be viewed as a reference point only and not mandated. Producer and wholesale purchaser should be free to simply agree on specifications and price, as presently occurs throughout the world with, for example, the sale of tallow.

To avoid complexity in administration and compliance the standards for bowser sales should be national. If regulation of some measure of lowest useful operating temperature is deemed necessary, and it may not, it should be based on regions and seasons rather than state boundaries. See comments in section 6.21 and under Feedstocks below.

**Harmonization with international standards?**

**No.** There is little to be gained and much to lose. International standards could contain frivolous requirements intended to give advantage to a local power group. For example by specifying a particular iodine number several European standards exclude perfectly good biodiesel made from soybean oil. Referring to Fatty Acid Methyl Esters excludes perfectly good biodiesel made with ethanol. Both soybeans and ethanol are produced in Australia and intense friction will occur if these are excluded by legislation.

**Feedstocks and Production Technology?**

**No.** These are totally irrelevant to the consumer. Certainly the consumer is interested in the lowest temperature at which the fuel can be used, best indicated by the CFPP. This

temperature is determined almost solely by the feedstock, but publication of the fuel composition and characteristics provides all the information needed by the consumer. Consideration should be given to requiring the CFPP to be displayed at every bowser, rather than having a specific CFPP standard. Users will always have the option of filling up with regular diesel if the CFPP of available fuel is not suitable for their intended use, and will also soon become familiar with lowering the CFPP by dilution with diesel. See further comments under 6.20, cloud point.

## Chapter 4

### 4.1 Emissions

No mention is made in the discussion paper of the fact that a limited supply of biodiesel will produce a greater reduction in emissions if distributed over a number of vehicles. This can be deduced from the curvature of the emissions graph. I am not aware of this point being mentioned anywhere in the literature but it is significant from a national and global perspective.

### 4.3 Lubricity

As we cannot expect a substantial increase in the production of vegetable oils for biodiesel manufacture in Australia, the amount of biodiesel that can be produced will just about equal the amount required to improve the lubricity of the forthcoming low sulphur diesel. It could be that most of the biodiesel produced will be consumed in this way and perhaps it is for this purpose, rather than as fuel, that the standard should be developed. Use in this manner will provide engine manufacturers with relief of anxiety rather than the concern some express when contemplating use of B100.

## Chapter 5 - Excise

Because of its inherently low emission characteristic, and especially its very low contribution to greenhouse gases, biodiesel should continue to be encouraged by excise exemption. Regarding blends it is clearly irrational to allow excise exemption for B100 but not for blends. As stated above the advantage in emission reduction arising from the use of a given amount of biodiesel will be greater if used in a blend distributed to all vehicles in a fleet, rather than if all is used as B100 while the remaining vehicles in the fleet use diesel. If the law continues to apply excise to blends but not B100 there will be avenues for corruption and the whole operation will appear ludicrous. It is imperative that this situation be corrected.

In the recent budget paper there is reference to a grant being applied to biodiesel rather than relief of excise. It appears that this grant will be available only to B100 and not blends, so it appears that authorities still do not understand that blends provide more advantage to the environment than B110 where the amount of biodiesel is limited.

### 6.1 Sulphur

The sulphur content of biodiesel, even from the worst source, is so low as to be of no concern. If a test is required the level set must be greater than found in the worst source. The American level, 50ppm, could be used. It could be felt that this test is useful to detect unscrupulous dilution with diesel, however other tests would be better for this. The gas chromatographic test for conversion to ester will identify diesel contamination at no additional cost. The sulphur test is not required.

## 6.2 Carbon Residue

The statement in the discussion paper that carbon residue indicates the "tendency of a fuel to cause carbon deposits in an engine" is an oversimplification at best. It may be true of diesel fuels but is misleading with respect to biodiesel. Carbon deposits certainly form when unmodified vegetable oil is used in a standard direct injection motor but this has nothing to do with the carbon residue. The deposit comes from incomplete combustion of the bulk of the fuel, not the residue. The problem is to do with the inappropriateness of the motor design for that fuel. The discussion paper needs amending.

If there is concern that poorly reacted biodiesel could contain damaging amounts of the feedstock oil then the gas chromatographic test for conversion will provide much more accurate and meaningful information. The carbon residue test appears to be a "left-over" from the petroleum industry and is of no relevance. It must be deleted.

The discussion paper's reference to Knothe et al who said that with rapeseed methyl ester the particulate emission was greater than with diesel is a strange inclusion as their finding is in contrast with the vast bulk of other research and should be viewed with some scepticism. Their own report that with tallow methyl ester the particulate emission was less appears to contradict their rapeseed finding and suggests that some unnoticed factor was interfering.

## 6.4 Ester Content

While a high ester content is of course the goal it is not logical to include ester content in the specifications. It is the unreacted and partly reacted feedstock which is the prime concern and it is these parameters that are directly measured in the gas chromatographic test. Tests are provided to determine all other detrimental contents: water, sediment and contamination. If one more test, for unsaponifiables, were included, the ester content could be calculated as 100% minus the rest.

No manufacturer has ever removed the unsaponifiables, mainly cholesterol and plant sterols, so they clearly must burn satisfactorily as fuel. There is therefore no point in separately specifying them or the ester content. Ester content should not be part of the standard.

I have a lot of trouble with the philosophical position of this chapter. It seems to embrace the "accepted truths" of biodiesel production and use. Many of these on examination turn out to be myths, either totally without foundation or in need of qualification.

Consider for example the first sentence: "A higher conversion of feedstock oils to ester gives better engine performance". This statement needs extreme qualification. There are vehicles that perform perfectly well on pure, unconverted vegetable oil!

A more appropriate opening to this paragraph would be something like this:

"No diesel engine has been found which operates poorly on biodiesel fuel in which the conversion to esters is greater than xx%."

Here there should be a reference to a paper, which shows which types of motor are most susceptible to carbon formation and what the level of conversion needs to be to avoid it. If such a paper cannot be found the limitations of current research should be outlined and proposals for further research made. The minimum safe level of conversion could turn out to be as low as 90%. I base this on the known mileage run up by people using biodiesel prepared with limited methanol, which cannot have more than this conversion, yet report no problems.

The paper quotes Howell as saying that “if specifications for impurities in biodiesel standards are adhered to ester content will inherently be over 98%”. This is a most alarming statement. Allowing that cholesterol and plant sterols and other unsaponifiables could make up to 2% the maximum theoretical conversion is 98%. It is totally unreasonable to enforce such a conversion on manufacturers. The ester content required should not be higher than 96%. Even to demand 96% conversion without proof that it is required would be regarded as unscientific and dictatorial.

On the evidence at hand the need to produce a conversion higher than about 90% is based more on the requirement to avoid emulsion formation during washing than any benefit to the motor. If biodiesel is used unwashed there is of course no problem with emulsion formation.

### 6.5 Viscosity

If a gas chromatographic test for degree of conversion is included in the specifications the viscosity test becomes redundant. This is because any fuel that passes the conversion test will be of suitable viscosity.

If a gas chromatographic test for degree of conversion is not included viscosity may be used for this purpose, but special steps are necessary to ensure that the results are meaningful. A suitable procedure would include treating a sample in such a manner as to ensure very complete conversion, washing to remove soaps and methanol, and then drying. The resulting material could be used as a reference to determine how close the bulk fuel approached this level. The reason for this procedure is that viscosity changes little with degree of conversion, and other factors, in particular the feedstock source, alter viscosity and can confound the results.

The viscosity test may however have value as a tool to detect deterioration due to oxidation after long storage. See reference in Biodiesel Parameters Affecting Stability below.

A gas chromatographic test for degree of conversion is accurate and straightforward and is the preferred method for determining degree of conversion. It has an additional advantage in that it can detect and identify adulterants. If it is included, the viscosity test should not be part of the standard.

### 6.6 Cetane number

The cetane number of biodiesel varies with the nature of the feedstock but is always higher than the specification for normal diesel. It is thus not a matter of concern. It is an expensive test to perform and only useful for consumers with special research interests. It would be reasonable to expect such consumers to pay for the tests themselves as part of their procurement process. Cetane number should therefore not be part of the standard.

It is possible to predict the cetane value of a biodiesel sample from its fatty acid profile. This would be based on gas chromatographic analysis, which is much cheaper than direct measurement and so would be preferred if a figure was felt to be indispensable. Thus there would be a “biodiesel cetane index” developed in a manner similar to the calculated diesel “cetane index”.

There is a procedure for measuring cetane using a conventional diesel motor which is throttled to the point of misfire. This test is cheaper than the standard method, which uses a special variable compression motor. If a direct measurement is required the throttling method should be investigated for accuracy, but for reasons stated above there is certainly no need for it.

### 6.7 Sulphated Ash

As stated in the discussion paper this test could give a measure of three items, the non-combustible solids, residual catalyst and soap. The test cannot distinguish between these three. Incidentally no residual catalyst can be found in biodiesel hence this test would only be a measure of non-combustible solids and soap.

In this test a substantial amount of oil must be evaporated and roasted with sulphuric acid repeatedly to give a minute amount of material. The test is expensive and prone to error. For the non-combustible solids, which would be expected to be abrasive and hence a concern, it would be much more effective and cheaper to filter a larger amount of biodiesel and ash the filter paper, thus getting a larger, less error prone measure. This would have the additional benefit of distinguishing this harmful contaminant from the soap as soap would pass through the filter. There would be no need to include the sulphuric acid treatment, thus further reducing costs.

Regarding the soap, this can be easily measured by titrating a small sample with acid. This is a cheap and accurate procedure. The sulphated ash test cannot provide any information which cannot be found by cheaper and better tests and should not be required.

### 6.8 Total Contaminants

Where the writer of this paper got the idea, referring to unsaponifiables, that "Most of these contaminants are removed during ester washing" is a puzzle. Long chain fatty alcohols, hydrocarbons, sterols, triterpenes and carotenoids will be virtually untouched by water washing. The only one that would be removed, to the best of my knowledge, is vitamin E. This is a phenol, hence acidic, and would be neutralized by the catalyst and become water-soluble. It is a pity that vitamin E is removed because it is an antioxidant and hence would be beneficial. The fact that everyone using biodiesel has been burning all these materials in their motors shows that they are not a concern. Clearly the title "total contaminant" as used at present covers both harmful and harmless materials so is worthless as a standard. It should not be required, as is the case in America.

The paper also asserts that if acid catalysis is used total contaminants should be specified. As acid catalysis is almost certain to be followed by alkaline catalysis, with all the normal outcomes of that process, there appears to be no cause for concern about use of acid.

### 6.9 Acid value

It is difficult to see how a high acid number could cause filter problems, as stated in the discussion paper, at the likely low levels that might arise, but corrosion from acidity is a real concern. Fortunately it is easy to produce biodiesel that meets the ASTM standard. There would seem no reason to use a higher standard than that, as American experience has been, in general, satisfactory. Any fuel not conforming to the ASTM standard should be suspected of containing mineral acid from processing and would be a concern. This is a cheap and easy test and should be included.

### 6.10 Iodine number

This indicates the degree of unsaturation and that in turn indicates the tendency to oxidize and polymerize. This is of no concern however because under present financial conditions no one is going to grow any crop in Australia specifically for biodiesel, and if they did they would not choose a high iodine number crop. The two highest iodine number oils are linseed oil and normal sunflower oil. Linseed oil is highly prized in the paint industry and normal sunflower is valuable as human food in salad dressing and the like, not as cooking oil. The

food industry avoids cooking with these oils, not only because of the high price, but also because they understand the stability question. They take care to choose more stable oils: tallow, high oleic sunflower, canola, soy, cotton seed and palm oil. It is inevitable therefore that waste cooking oil, which is an averaged material derived form many sources, will be low in unsaturation. The iodine number test is certainly not required.

In any event, if an iodine number is required, it would be better to calculate it from a gas chromatography analysis which could provide, at the same, time a "cetane index" as stated above and a linoleic and linolenic ester analysis (see below) at no extra cost.

### 6.11 Linoleic acid methyl ester and polyunsaturated methyl esters (>4 double bonds)

Exactly the same argument applies here as to iodine number. See above. A related issue is melting point, which varies with degree of unsaturation. See 6.21 below.

**Linoleic acid methyl ester**

Mittelbach is right in pointing out that linoleic acid content is more important than amount of unsaturation or iodine number. This is because when two double bonds are present on the one molecule the tendency to oxidize is not twice but about ten times as great as with one double bond. It is therefore true that, if unsaturation is a concern, linoleic acid analysis is much more useful than iodine number.

Regarding unsaturation it should not be forgotten that too low a level of unsaturation has its own problems, causing the fuel to be solid at normal temperatures. Heating equipment would have to be provided for transport and to use it in vehicles.

**Linolenic acid methyl ester**

This material, which has three double bonds on the chain, is much more easily oxidized than linoleic methyl ester. The points made above under iodine value, however, still apply: there is no likelihood that a substantial amount of linseed oil, the only oil which is largely linolenic, would find its way into the biodiesel stream – it is far too valuable in other uses. Soy oil contains a significant amount of linolenic acid but has found ready acceptance in America. Soy oil is only a minor component of yellow grease in Australia hence linolenic acid appears to be of no concern here.

Oils with more double bonds than three are only found in certain fish oils. These oils are never used in cooking and could only be present in yellow grease in minute amounts, of no concern in Australia.

### 6.12 Mono- and Di-Glycerides

It is certainly true that mono- and di-glycerides cause problems in washing biodiesel due to their emulsion stabilizing property. It is for this reason that manufacturers will be expected to push the reaction reasonably far toward completion. The fact that these materials raise viscosity should be totally ignored, as this effect must be very small at the expected concentrations. It would be as well however to include a gas chromatography test to confirm that these materials are at suitable levels as they can crystallize out. In the same test the unreacted triglycerides will also be measured at no extra cost.

The statement that "Bound glycerin is associated with carbon deposits on fuel injector tips and piston rings" needs qualification in exactly the same way as described under chapter 6.4, ester content, above. This, after all, is just the other side of the same coin.

The European standard which sets a limit for monoglyceride content of < 0.8 % and a diglyceride content of < 0.2 % should be achievable easily enough but that is not grounds for establishing these as standards. As before there is a need for a definitive study which shows how various levels of glycerides affect engine performance.

The fact that the American standard sets no limit, depending only on total glycerol, confirms that specific standards for mono- and di-glycerides are not needed.

### 6.13 Triglyceride content

As with ester content and mono- and di-glycerides, setting a standard requires definitive answers to the effect of a range of concentrations on performance.

The American approach in setting no limit on any of these, relying solely on bound glycerol appears to have merit in that it is surely the glycerol component of the glycerides which is the concern. There should be no Australian standard for triglycerides.

### 6.14 Free Glycerol

Free glycerol is invariably present at a low level in unwashed biodiesel as it has a slight solubility, which is enhanced at higher temperatures and by the methanol content. Methanol and glycerol are removed by water washing more easily than is soap, which is also invariably present. It is logical to assume therefore that if the soap level is reduced to an acceptable level that glycerol content will be negligible. As all biodiesel offered to the public will be water washed the free glycerol content is not a concern, so there is no need for a free glycerol test and there should be no Australian standard for it.

### 6.15 Total Glycerol

If there is any detrimental effect due to combustion of the typical low levels of unreacted material it seems likely that it will be related to the glycerol content, as glycerol can dehydrate to acrolein and acrolein can polymerize. Whether polymerized acrolein has been found in engine deposits I do not know but it seems prudent to assume, until proved otherwise, that the most logical measure of engine risk would be ester conversion as determined by total glycerol or bound glycerol. The American standard can be achieved but only with some difficulty. Again it seems necessary to find, or have carried out, a thorough study which determines the relationship between a typical range of total glycerol to detrimental effects in motors, and to identify those motor types which are most sensitive. Only with that information can there be a reasonable basis on which to set the standard.

The best method of determining total glycerol is by gas chromatography.

### 6.16 Alkaline metals

Free catalyst has been shown to be unmeasureable even before washing so must pass out with the glycerine. The washing of biodiesel is therefore mainly to remove soaps though it also ensures that methanol content is acceptably low and that free glycerol will be virtually eliminated. Soap content can be measured easily, cheaply and accurately by titration with acid, thus totally avoiding the need for the sulphated ash test.

I would not like to make a judgement about what the acceptable level for soap in biodiesel should be. Certainly high levels of soap can produce a gel on cooling which would clog a filter but I have never observed a gel in biodiesel which has been once washed with water,

even though appreciable soap was removed in a second washing. As washing would be a normal requirement of the manufacturing process, gel formation and filter clogging from soap could not occur hence this is not a concern.

The effect of residual soap upon combustion in the motor is a completely different issue. As many people are using unwashed biodiesel and reporting no problems it appears that even moderately large amounts of soap cause no problems. As in the argument stated above about ester content and total glycerol content, there is a need to be able to quote a definitive paper on the effect of various levels of soap on the diesel motor.

It could even be found that small amounts of soap are beneficial in countering the effects of fatty acid formation in storage, ensuring that any admitted water remains alkaline and hence non-corrosive to steel, thus protecting the valuable injector pump and injectors.

One would expect that most of the ash formed by burning soap would pass harmlessly out through the exhaust. Any that adhered to the cylinder walls might be found to be beneficial in neutralizing the acids that form in the lubricating oil. Again an authoritative paper on this would be welcome. As in the case with unreacted feedstock it appears dictatorial to set a high standard where there is a strong indication that it is not required.

There is no need for a standard for the alkaline metals as such but soap content may be worth consideration, with a fairly loose standard.

**Biodiesel Parameters Affecting Stability**

### 6.17 Thermal Stability

Thermal degradation is of no concern as the fuel will not reside long enough at a hot location to produce any significant thermal polymerization in the fuel system. In the crankcase, if it bypasses the piston rings, it will be exposed to air and will be subjected to the more rapid oxidative polymerization.

### 6.18 Oxidation Stability

The most appropriate test for oxidation depends on the material in question. A common test is peroxide value which is useful with edible oils but which appears unhelpful with regard to fuel because peroxides raise the cetane level and hence are beneficial.

After peroxides are formed further reaction produces cleavage products and also causes polymerization. It is not until polymerization has reached significant levels that deterioration could be said to have occurred, and by this time the peroxide level will have declined and become misleading. It is reasonable to suggest that chain cleavage products will burn perfectly well and thus it appears that the relevant characteristic for fuels is the degree of polymerization, as this causes viscosity to rise. Thus the viscosity test may be the most appropriate as a direct measure of fuel quality deterioration in terms of the ability of the fuel to be injected and burned.

However the discussion paper states that testing shows that the acid number reaches upper specifications before other parameters. It thus appears that acid number, a simpler indirect test, will give adequate information about oxidation, hence a standard for oxidation stability is not required.

It is certain that producers will be aware of the problem of oxidation and will take appropriate steps to minimize oxidation in long-term storage, the simplest of which is the exclusion of

air. Antioxidants may also be added. Addition of antioxidants would be a matter to be decided between producer and wholesale purchaser and should not be the subject of a standard. Most fuel will be consumed before oxidation becomes a concern.

### 6.19 Alcohol Content

Alcohol content and flash point are strictly related therefore only one of these tests is needed. It would be appropriate to require manufacturers to publish either, not both. As some difficulty has been reported in measuring the flash point it might prove to be cheaper to arrive at the flash point by measuring methanol content. See comments at 6.25, flash point, below.

Methanol will reduce cetane number but the amount present after transesterification appears to be acceptable even without washing hence methanol content after washing can never be a concern in relation to engine performance. Similarly it can never be a concern with regard to lubricity. As many people are using unwashed biodiesel, which would contain 3 or 4% methanol, without reporting corrosion problems it appears that the only reason for limiting methanol content is fire safety.

### 6.20 Cloud Point

Melting point will inevitably become a major factor in managing the biodiesel market. The growing of crops specifically for biodiesel will be very limited and will only occur for niche markets where the fuel may command a premium price, hence the main production will be from tallow and from used cooking oil, known as yellow grease. The melting point of biodiesel made from these materials is far higher than the American and European standards, and will present problems which are not encountered where crops are subsidized and grown for the purpose.

It would be rational for producers to distribute more than one line of fuel, allowing consumers to take advantage of cheaper lines by fitting their vehicles with heating equipment or dual tanks.

Cloud point is one of several measures which indicate the lowest useful operating temperature of the fuel. Cold Filter Plugging Point (CFPP) is thought to be a little more exact but cloud point has the advantage of being easily measured without special equipment.

Ambient temperatures in Australia are far higher than in Europe and America where most of the experience has been gained. Standards arrived at there are totally inappropriate here. The only sensible approach for Australia is to allow sale with the CFPP on display so that the consumer could make appropriate choices, which would involve avoidance or dilution. See further comments under Feedstocks and Production Technology above.

There should be no Australian standard for cloud point. If there must be a standard it should be based on region and season and more than one line should be permitted. Whether or not there is a standard the CFPP or cloud point must be displayed at the bowser.

### 6.21 Cold Filter Plugging Point

There should be no Australian standard for CFPP. See comments under 6.20, Cloud point, above, as the same arguments apply. Whether or not there is a standard the CFPP or cloud point must be displayed at the bowser.

### 6.22 Distillation Temperature

The only possible use for this test is to check for adulteration with high boiling material. Any person contemplating adulteration would use a low boiling material to circumvent this. A far better test is gas chromatography for ester content against an internal standard. This would readily show up both high and low boiling adulterants and at the same time could be designed to give the glyceride contents. This type of gas chromatography test is really analogous to a distillation test as the column is programmed to cover a wide temperature range. Gas chromatography provides all the information that a distillation test provides, and much more. Distillation temperature may be useful for petroleum based fuels should certainly not be part of the Australian standard for biodiesel.

### 6.23 Calorific Value

Calorific value is entirely dependent on the feedstock and is not significantly altered by degree of conversion. The biodiesel industry will use whatever material it can get. It cannot choose feedstock on the basis of calorific value. In any event the difference between various feedstocks is small and only of interest to special research groups who would be expected to get the test done themselves. Calorific value should not be part of the standard.

## Biodiesel parameters that affect other properties

### 6.24 Density

Howell is correct in stating that if other specifications are met, this parameter is redundant. Density varies little with degree of conversion. There is no need for this to be part of the standard.

### 6.25 Flash Point

Diesel has a modest flash point, about 52°C, so it is surprising that a standard as high as 100°C has been set for biodiesel when we accept the flammability of diesel without question. Diesel can only be ignited on a heated surface so is relatively safe. I would argue that all diesel fuel, whether petroleum or methyl esters, should have the same flash point standard. For general use a methanol content of 0.4% or a flash point of 55°C would suffice as a standard. In this way the safety procedures all diesel consumers presently use would continue to apply.

For niche markets where biodiesel is chosen for its potential safety a higher level would be negotiable between producer and consumer. This would not be a matter for a standard.

Flash point can be calculated from methanol content so there is need for only one test, flash point or methanol content, but not both.

One could argue that the only reason to limit methanol content is to reduce fire hazard. It would thus be reasonable for consumers who were prepared to accept the fire hazard to waive the methanol content or flash point standard. This would allow the marketing of unwashed biodiesel. While this material has a flash point lower than diesel it is still far higher than that of petrol, which we accept without question and handle appropriately. There would thus be two biodiesel products, low and high flash point, with appropriate price differential.

### 6.26 Dissolved Water Content

Water is only a concern if free. There should be no standard. See below.

### 6.27 Free Water and Sediment Content

There seems to be considerable variation in opinion as to a suitable standard for water content, judging by the range of standards that exist. The logical measure is that level which will just not cause the fuel to go hazy when cooled to the lowest likely temperature of use. Thus the standard should include a reference to the temperature at which the test is to be conducted. This test would normally be done by centrifugation in a calibrated conical tube but it seems appropriate to consider whether a visual test of clarity at a stated temperature would suffice.

### 6.28 Corrosion

As biodiesel invariably scores well in the copper strip corrosion test it seems this is of little value and hence an unnecessary cost.

### Final Remarks

The discussion paper reports (Mittelbach et al) that waste cooking oil contains from 0.26% to 2.12% free fatty acids. This is grossly in error for Australia. Levels of 3% to 5% are common and it can be much higher. As waste cooking oil is the only economically viable feedstock this misleading statement is to be deplored as it may induce some unwary business people to embark on a project which they will find very disappointing.

The paper is also misleading in suggesting (Appendix D, table 3) that the flash point of biodiesel is greatly affected by the oil source. Clearly the wide variation in the table is the result of widely differing procedures for removal of surplus alcohol. This sort of early publication should be recognized for what it is, a quick study of past reports, not definitive research.

The amount of biodiesel likely to be produced in Australia, a country which abhors subsidy, will be barely enough to satisfy the demand for a lubricity enhancer for low sulphur diesel. In view of this it seems the establishment of a standard suitable for use as B100 should be accompanied by a suitable standard for low-level blending. This standard, where massive dilution would be taken into account, would logically be much less strict in terms of level of conversion, methanol content and soap content.

The failure to find scientific studies which measure the dose-dependent effect of levels of unreacted feedstock on motors in long term studies is disappointing and severely limits the confidence that can be placed on limits for total or combined glycerol found in overseas standards. The fact that some users of biodiesel mix in substantial amounts of unreacted vegetable oil and report no problems strongly suggests that further work is needed in this area at least for indirect injection motors. Perhaps there is a case for having two standards, one for direct injection motors and another for indirect injection, with suitable price differential. We appear to be able to accommodate several types of petrol satisfactorily at the retail bowser so why not do the same with biodiesel?

The existence of strict overseas standards for unreacted feedstock in the absence of definitive studies of the effects of unreacted material is disconcerting. This situation leaves the biodiesel industry open to the charge that the standards have been set by asking large manufactures what they can achieve rather than by asking engine manufacturers what they require. This in turn suggests a political willingness to support the large manufacturer at the expense of the small to medium manufacturer. It is to be hoped that this situation, with its damaging effect on competition, will not arise in Australia.

My contention is that, while some standards are easy to set rationally and should be prescribed, in areas of uncertainty it will be labeling of bowsers with fuel parameters, rather than prescriptive standards, which will be the key to successful adoption of biodiesel by the community.

I urge the organizers of this process to consider the credit they will attract if the standard is as simple as it can safely be and avoids unscientific acceptance of previous standards. I strongly suggest that you look carefully at the way in which gas chromatography can provide essential information which renders many of the other proposed tests redundant.

Frank Legge (BSc, PhD)