BIODIESEL

Running vehicles successfully on bio-diesel

Product quality requirements for FAME

Dr. Jens Haupt and Dieter Bockey, Bio-Diesel Quality Management Work Group (AGQM, registered association)

Arbeitsgemeinschaft Qualitäts- management Biodiesel e. V.

Running vehicles successfully on bio-diesel

Product quality requirements for FAME

Dr. Jens Haupt and Dieter Bockey, Bio-Diesel Quality Management Work Group (AGQM, registered association).

Introduction

Within the space of a decade, bio-diesel has turned from a virtually unknown product into a significant fuel on the market. Germany's bio-diesel turnover accounted for just 45,000 t in 1995, but had risen to about 1,800,000 t in 2005.

Although the emergence of bio-diesel in Germany is undoubtedly a success story, questions continue to arise with regards to the fuel's potential applications, problems and properties. The diversity of expressions "Bio-diesel", "FAME", "PME", "RME" and "AME" is causing increasingly confusion among sellers and buyers. Bio-diesel is often mistaken for vegetable-oil fuel, although both products differ in terms of basic properties. This article is intended to improve the reader's understanding of this topic.

Market situation

Up until the end of 2003, bio-diesel sold to public filling stations and fleet operators was tax-deductible only as a pure fuel. However, at the beginning of 2004 a modified petroleum law was introduced. According to this, bio-diesel is also tax-deductible when used in mixtures, if permission for petroleum processing has been granted (bonded warehouse) or if the mixture is manufactured by the final user. This modified legal framework prompted many petroleum companies to add bio-diesel of up to 5% by volume to petroleum diesel.

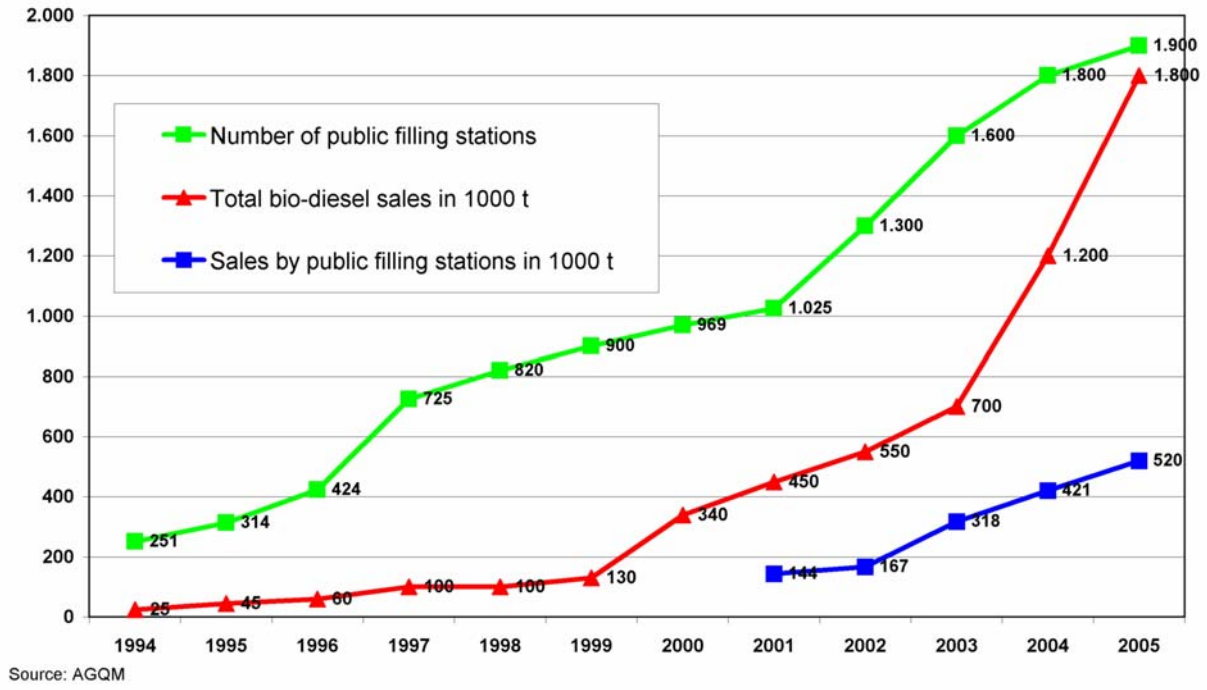

Figure 1: Development of the bio-diesel market in Germany.

Bio-diesel is currently used in about equal measure for the following purposes:

- Admixture to petroleum diesel (bio-diesel proportion of up to 5% by volume according to DIN EN 590; the added bio-diesel must also comply with EN 14214)
- Pure fuel for operating fleets of commercial vehicles (DIN EN 14214)
- Pure fuel for sale at public filling stations (DIN EN 14214). Commercial vehicles account for a significant proportion - about 40% - of the bio-diesel sold at public filling stations. This proportion is expected to increase yet further.

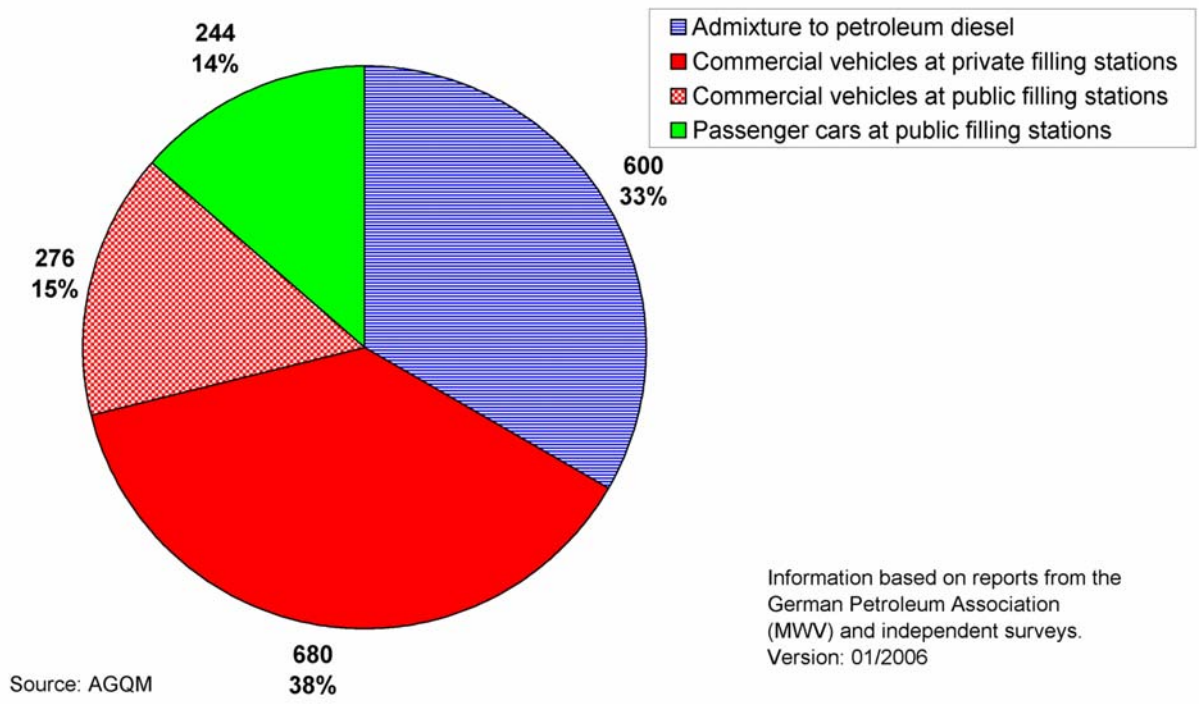

Figure 2: Applications of bio-diesel according to user groups (in 1000 t for 2005).

Sharp petroleum price rises since spring 2005 have led many operators of in particular vehicle fleets to increasingly use bio-diesel. This has resulted in a notable scarcity of bio-diesel on the market.

New establishments of bio-diesel facilities are expected to ease the situation from the middle of 2006 onwards, and are likely to cover further possible increases in demand.

However, uncertainty remains over what effects a possible introduction of a tax rate of 10 cents/litre may have on markets. The currently discussed introduction of this tax is intended to compensate for tax relief bio-diesel enjoyed over the past years and is in accordance with §2a of the petroleum law, (possibly accompanied by drops in diesel prices).

Comparison of properties of important liquid bio-fuels

Bio-diesel is currently the most widely used bio-fuel. In addition vegetable oils (especially rapeseed oil) are increasingly employed directly as fuel. Mixtures of petrol and ethanol are being discussed as petrol-based fuels. Table 1 provides an overview of the manufacture and deployment of these fuels:

Table 1: Manufacture and deployment of bio-fuels

	Bio-diesel (FAME)		**Rapeseed oil**	**Ethanol**	
Manufacture	Interestification of vegetable oils with methanol in the presence of a catalyst to form fatty-acid methylester.		Production with the help of cold-pressing or extraction mills, crude-oil refining.	Fermentation of grain, 2-stage dehydration to result in absolute alcohol.	
Basic raw materials	Rapeseed, soya, other vegetable oils, biogenetically recyclable oils (from restaurants and households), animal fat in limited quantities.		Rapeseed.	Grain, maize, sugar, also lignocellulose in future.	
Application	Pure fuel.	Admixture, max. 5% by volume.	Pure fuel.	E85 (mixture of 15% petrol and 85% ethanol by volume.	Admixture, max. 5% by volume.
Vehicle requirements	Serial vehicles with factory approval for bio-diesel.	Serial vehicles.	Vehicle retrofitting required.	Some passenger car types are available internationally.	Serial vehicles.
Standard	DIN EN 14214	DIN EN 590	E DIN V 51605	No standard as yet.	DIN EN 228

Source: Bio-Diesel Quality Management Work Group

Manufacturing fuel techniques from biomass, involving the production of synthetic gases followed by Fischer-Tropsch reaction to form liquid hydrocarbons (BTL) are currently being researched. Such processes for converting biomass are expected to become marketable within 8-10 years,

"Bio-fuels" which can supposedly be manufactured by small facilities using biomass of any type (or other organic residue) in a catalytic pyrolysis process have been also promoted for some time. However, many of these technological concepts fail to pass simple material balance tests, and it is extremely doubtful whether the resultant fuels are able to consistently exhibit the assured properties.

The following table compares certain properties of bio-diesel (FAME) and rapeseed-oil fuel in more detail.

Table 2: Comparison between selected properties of bio-diesel and rapeseed-oil fuel

	Bio-diesel (FAME) according to DIN EN 14214	**Rapeseed-oil fuel** according to E DIN V 51605
Density	860 to 900 mg/kg	900 to 930 kg/m³
Viscosity at 40 °C	3.50 mm²/s to 5.00 mm²/s	36 mm²/s
Flash point [1]	Min. 120 °C	Min. 220 °C
Lower calorific value	Typical: 38,000 kJ/kg [2]	Min. 36,000 kJ/kg (typically around 37,500 kJ/kg)
Proportion of alkaline elements (Na + K)	Max. 5.0 mg/kg	Not specified

[1] Different test techniques

[2] No standard parameters

Table 2 continued

Proportion of alkaline earth elements (Mg + Ca)	Max. 5.0 mg/kg	Max. 20 mg/kg [3]
Phosphorous content	Max. 10.0 mg/kg	Max. 12.0 mg/kg [3]
Ash content [1]	Max. 0.02 %	Max. 0.01 %
Total contamination	Max. 24 mg/kg	Max. 24 mg/kg
Acid value	Max. 0.5 mg KOH/g	Max. 2.0 mg KOH/g
Cetane value	Min. 51	Min. 39 [4]
CFPP	0 °C, -10 °C, -20 °C [5]	Not determinable [6]

Source: Bio-Diesel Quality Management Work Group

A comparison between the properties of bio-diesel and rapeseed oil reveals notable differences between the two products. Bio-diesel is similar to petroleum diesel in terms of many parameters, whereas rapeseed oil is extremely viscous, thus proving more difficult to handle at low temperatures. The high permissible proportion of ash-forming substances compared with bio-diesel can pose problems in modern exhaust-gas re-treatment systems. As a result conversions for rapeseed-oil fuel need to meet technical prerequisites preventing these variations in properties from impairing vehicle operation. This also applies to the effects on passenger cars and commercial vehicles with diesel particle filters and other modern exhaust-gas re-treatment systems currently being introduced to the market.

The properties of bio-diesel depend decisively on the selected raw materials. In principle, bio-diesel produced from initial materials with a high content of saturated fatty acids (for example, palm oil or animal fat) has poor low-temperature properties. Experience shows that in several cases, mixtures of palm oil and methylester have been known to clog filters and thus cause problems for users as well as filling-station operators.

Bio-diesel made from raw materials with a high content of multiple unsaturated fatty acids (for example, sunflower oil) typically exhibits an excessively low oxidation stability. Rapeseed oil is an excellent raw material for the manufacture of bio-diesel, making it possible to achieve a CFPP of -10 to -12°C as well as an oxidation stability of 9 h or more even without additives.

It is also worth noting that the majority of additives have so far only been tested for the use with rapeseed methylester. For chemical and physical reasons, methylesters with a very high (unfavourable) CFPP content - for instance palm-oil methylester and mixtures containing large proportions of palm methylester - cannot be expected to attain specified winter handling properties through mixing with additives.

---

[3] Limiting values still under discussion

[4] Use of a special test technique, if necessary

[5] Seasonal

[6] Application below -5°C is severely restricted by high viscosity.

Whether esters comprising highly unsaturated oils such as soya methylester can achieve a sufficient (and durable) oxidation stability through mixing with additives is currently not known.

The selected interestification technique also determines the requirements needed from the raw materials and the residual proportions of undesirable substances, e.g. water, alkaline metals, alkaline earth metals and phosphorous in the product. Handling and transport conditions can also notably influence a product's quality-related parameters.

Requirements for rapeseed oil as a fuel in accordance with draft standard E DIN V 51605 at any rate include a thorough conditioning of the rapeseed oil. In contrast to refined phases and specially filtered oils, crude oil from the cold-pressing phase often fails to meet the standard as demonstrated by attendant chemical analyses of fuel samples as part of the *100 Tractor Project*.

Effects of inadequate quality

Following the pressure of rising petroleum prices, the market has shown a broad acceptance of alternative fuels not governed by any standards. Although poor quality fuels have resulted in considerable damage, experimentation in this area continues. This is facilitated by the fact that damage caused directly or indirectly by deficient or inadequate fuels only becomes evident after long periods of usage. By this stage, the correlation between the damage and its source is no longer apparent to users.

Table 3 displays selected standard parameters for bio-diesel to show how transgressions of limiting values affect vehicle components.

Table 3: Effects of limit transgression in the case of bio-diesel

Property (DIN EN 14214)	**Effect / Comment**
Kinematic viscosity at 40 °C	Fuel conveyance problems (fuel pump, injection pump).
Flash point	A flash point of less than 100°C renders the product hazardous.
CFPP (filtration limit)	Machine standstill through crystallization of fuel in the pipes and the fuel filter at low temperature.
Residual coke	Coke deposits on the injection pump and piston rings. Problematic in the case of FAME with a high content of multiple bonds or glycerine/glycerides.
Ash content	Damage to exhaust-gas re-treatment systems.
Water content	Corrosion problems, turbidity of DK/FAME mixtures (resulting in separation of the water phase in the worst case).
Total contamination	Machine standstill through filter backfill, potential consequential damage to the injection pump as a result of insufficient lubrication / cooling by circulating fuel.
Oxidation stability (induction period)	Filter backfill, precipitation of polymers in diesel / bio-diesel mixtures throughout the fuel supply system.
Acid number	Corrosion problems.
Glycerine and glycerides	Coke deposition on the injection pump and piston rings; possible reason for increased coke residue.

Table 3 continued

Iodine number	Indicates unfavourable fatty acid properties, deviations can affect oxidation stability and CFPP.
Alkaline content (Na + K) Alkaline earth content (Ca + Mg)	Machine standstill through filter backfill; possible reason for increased ash content.

Source: Bio-Diesel Quality Management Work Group

Figures 3 and 4 show damage on injection pumps to demonstrate the long-term effects of bio-diesel with an insufficient oxidation stability or non-compliant proportions of alkaline and alkaline earth elements.

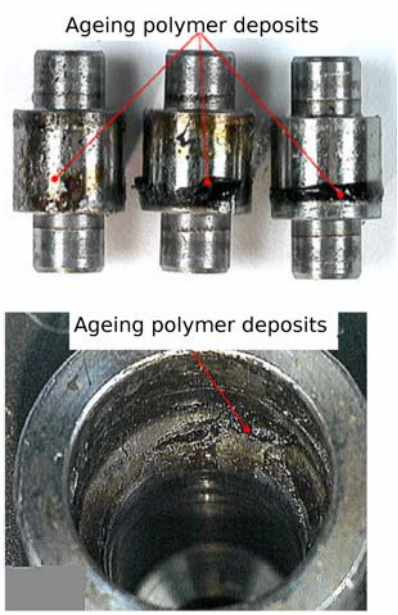

Figure 3: Polymer deposition resulting from a use of bio-diesel with an inadequate oxidation stability.

Source: Robert Bosch GmbH.

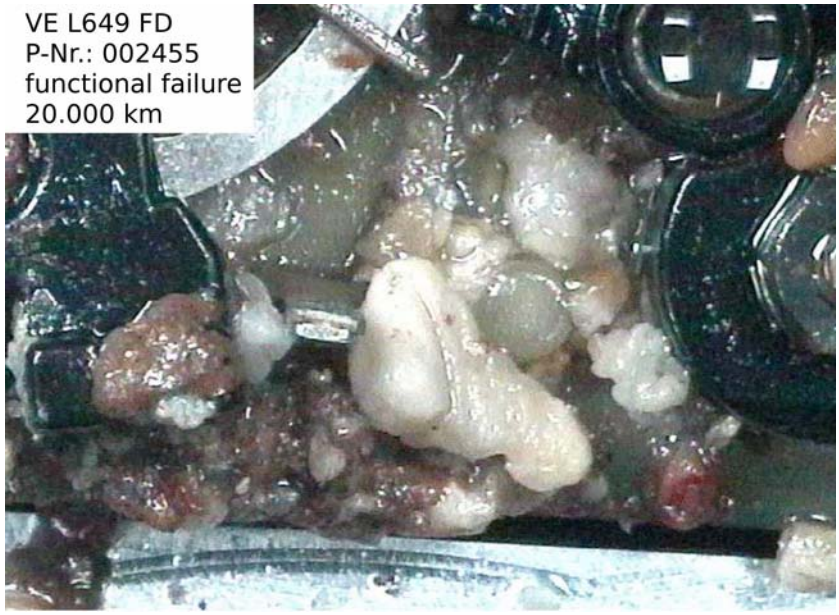

Figure 4: Damage resulting from soap deposition (bio-diesel with an excessively high alkaline or alkaline earth content).

Often seemingly minor initial damage leads to further, grave consequences. For instance, operating a vehicle for extended periods with a backfilled fuel filter can lead to inadequate fuel circulation, resulting in the failure of the injection pump's lubrication and cooling system and, ultimately serious wear.

Technological requirements

Bio-diesel is basically compatible with all diesel engines and tanks designed originally for petroleum-based fuels , thanks to its chemical similarity to petroleum diesel. Despite this, bio-diesel possesses certain special features which necessitates technological adaptations.

Vehicles

Adaptation of automotive technology to obtain serial approval for bio-diesel primarily involves the aspects described in the following. Release conditions must also account for changes in maintenance requirements.

- Bio-diesel poses different material-related requirements compared with petroleum diesel. All parts coming into contact with media (for example, hoses and seals) must be resistant to bio-diesel.
- The combustion process is different compared with petroleum diesel. To ensure adherence to all emission limits, the engine and exhaust-gas re-treatment system must ideally be matched by the fuel parameters (as in the case of petroleum diesel).
- Because bio-diesel is very hard to evaporate, it can accumulate in engine oil especially during low-load operation by commercial vehicles. Consequently, all manufacturers of commercial vehicles prescribe shorter oil-change intervals in order to avoid damage by diluted engine oil.
- After extended periods of running on pure petroleum diesel vehicles converted to bio-diesel should undergo a one-time fuel filter replacement after 2-3 tankfuls of bio-diesel outside the regular service intervals. This prevents old depositions of petroleum diesel removed by the flow of bio-diesel through the fuel system from blocking the new fuel filter.

Vehicle approval is based on DIN EN 14214, including certain restrictions related to the exclusive approval of rapeseed methylester. To preserve vehicle functionality and uphold guarantee terms, it is absolutely necessary to fulfil these requirements as well as the relevant operating and maintenance conditions. A list of all approvals can be found at www.ufop.de.

Public and private filling stations

In principle, bio-diesel filling stations need to fulfil largely the same legal requirements as filling stations selling petroleum-based fuel. These will dependent on the individual states' requirements concerning facilities for filling and transferring water-endangering substances; the details can differ from state to state. General technical conditions for tank systems at motor-vehicle filling stations are explained in related technical regulations for water-endangering substances. Filling stations for low, private consumption receive exemptions but still need to fulfil minimum requirements.

Filling stations dealing in moderately or highly inflammable substances as well as bio-diesel are subject to operational safety regulations, requiring extensive documentation. Only filling stations dealing exclusively in bio-diesel are exempt from these regulations, due to bio-diesel's high flash point.

Specific requirements are needed during establishment or conversion of filling stations to bio-diesel outlets:

1. The sealing surface should be made of concrete of at least grade B35. Large slabs or in-situ concrete have preference over other variants. The joint material should be resistant to bio-diesel.
2. The storage tank should have a collecting reservoir (if the capacity exceeds 1000 litres and double-walls are not part of the design).
3. Rainwater accumulating on the sealing surface together with droplets resulting from leakage and discharge resulting from accidents is to be channelled off via a light-liquid separator. Until publication of a technical regulation adapted to bio-diesel, the requirements mentioned in the DIN report titled "Bio-diesel and Separation Facilities …DIN 1999 and DIN EN 858" (01/2004) should apply to all new filling stations.
4. The stability of tank coatings (especially those installed as part of repair measures) should be checked. Manufacturers should receive certification of appropriate materials from recognized institutes.
5. Tanks converted from petroleum diesel to bio-diesel should be fully emptied and cleaned in the dry state. Tanks should be cleaned every 2 years to prevent an accumulation of residue in the tank sump.

6. All seals on fuel pump components and screw connections should be made of material resistant to bio-diesel. Mesh widths prescribed for the suction filter and fuel pump filter should not be changed.
7. The fuel nozzle and hose should be made of material resistant to bio-diesel. Important: A standard hose's outer jacket is often not lastingly resistant to bio-diesel.
8. Avoid a use of components made of zinc, copper and copper alloys. Bio-diesel can decompose some zinc layers and result in a formation of soap, as in the case of bio-diesel with an insufficient alkaline (earth) content. Copper acts as an oxidation catalyst and accelerates drops in oxidation stability.

Correct handling of bio-diesel includes its clear identification. This applies in particular to legally specified stickers for petrol pumps and filling-station supply connections in order to avoid inadvertent filling with different products.

Users of privately owned filling stations often want to run their vehicles on mixtures of bio-diesel and petroleum diesel in which the proportion of bio-diesel far exceeds 5% by volume. It should be noted that the manufacture of such mixtures outside bonded warehouses is only approved for end users (commercial production of such mixtures for sale is otherwise considered illegal by petroleum tax legislation). Furthermore, the filling stations must be equipped with appropriate technical facilities permitting homogeneous mixing (the differing densities of petroleum diesel and bio-diesel otherwise lead to stratification in tanks containing highly variable proportions of diesel / bio-diesel).

Assurance of high product quality

Bio-diesel according to DIN EN 14214 is now being produced and sold by numerous manufacturers in Germany and neighbouring EU countries. However, practices for monitoring the quality of these products vary widely.

The Bio-Diesel Quality Management Work Group (AGQM), a registered association, was founded 6 years ago to raise users' confidence in bio-diesel. This association comprises a voluntary group of bio-diesel manufacturers and commercial enterprises implementing consistent quality assurance as a leading corporate policy and assisting other market participants in supplying high-quality bio-diesel to users. The AGQM's network now includes about 1400 public filling stations offering consumers bio-diesel of an assured quality and guaranteeing that batches can be traced if they ever prove deficient (further details on the AGQM's activities and members are available at www.agqm-biodiesel.de).

To monitor and improve quality, the AGQM is continuously advancing their quality management system. This includes spot checks of products ranging from the manufacturer's outlet through to intermediate warehouses and to filling stations, annual audits, provision of information and educational courses. And, in particular, ensuring adherence to limiting values agreed beyond those specified by DIN EN 14214. For example, the bio-diesel manufacturers organized under AGQM guarantee that winter consignments are delivered already 4 weeks prior to the deadlines specified in the related standard. Stricter requirements are also imposed on water content and total contamination. Bio-diesel intended for public filling stations must comprise rapeseed methylester furnished with an oxidation stabilizer. Every batch is delivered together with a factory certificate or analysis indicating the batch's test values.

Bio-diesel in AGQM quality has become synonymous for successful quality assurance of bio-diesel.

Contracts regarding a supply of bio-diesel should

1. contain mandatory and testable specifications on product quality
2. specify procedures agreed by both parties in response to actual or presumed deviations from standards

This includes clear labelling of supplied products: The designation "bio-diesel" alone is not sufficient and must be accompanied by at least a reference to DIN EN 14214. Deliveries required to comprise exclusively rapeseed methylester must be declared explicitly as such. Suppliers should clearly describe their internal quality assurance measures (especially as regards to batch tracing).

All products intended for sales at public filling stations should be furnished with oxidation stabilizer. Assurance of high oxidation stability ex works alone does not guarantee fulfilment of specifications on transfer of the product to the final customer. Delivery quality should be borne out by an updated, concise, batch-specific factory certificate or analysis. In the case of bio-diesel intended simultaneously for several suppliers, it is advisable to determine, for example, whether different flow improvers for adjusting low-temperature stability are in use in order to assess the potential for incompatibility.

As part of their product-related responsibilities, AGQM members ensure a continuous supply of all necessary information to users. Further details on incorporation of quality aspects into supply contracts are provided by a corresponding instruction leaflet available and can be downloaded from our homepage.

Outlook

The federal German government intends to uphold successful policies for promoting bio-fuels, possibly in a modified legal framework.

As always, however, a prerequisite for continued market presence and development of new application types is assurance of a constant and reliable quality of these alternative fuels for users. The example of bio-diesel proves that commitment by all participants allows very rapid establishment of an effective quality assurance system. Bio-diesel will continue to play an important role as an alternative fuel, both in pure form and in mixtures with petroleum diesel.

Short glossary of terms

AGQM product

Bio-diesel according to DIN EN 14214, produced or distributed via the AGQM's quality assurance system ("Bio-diesel in AGQM Quality"). Detailed documentation and evidence are required, some parameters needing to meet stricter standards than those specified in DIN EN 14214. Public filling stations are to receive only rapeseed methylester (RME) to which oxidation stabilizer has been added. These specifications are based on current vehicle approvals, the fact that independent tests currently only provide reliable outcomes concerning a use of additives for RME, as well as results of independent tests on oxidation stability and the influence of oxidation stabilizers.

Alkaline elements

A generic expression for the elements of the periodic system's first main group; sodium and potassium are implied in the case of bio-diesel. These elements form salts (soaps) which can result in filter backfill.

AME

AME is a frequently used acronym for Acid MethylEster obtained from recyclable fats or oils. Depending on the type of raw material and plant technology, such products are able to meet the requirements of DIN EN 14214. A high proportion of recyclable fats in raw materials typically poses problems in terms of CFPP (low-temperature stability) and total contamination.

Factory certificate / analysis

A bio-diesel manufacturer's report describing a current batch's *measured* properties in terms of adherence to DIN EN 14214. Qualified factory certificates and analyses also indicate whether the product is rapeseed methylester and whether it has been furnished with oxidation stabilizer, for instance.

Bio-diesel

Bio-diesel is a generic term for fatty-acid methylester intended for use as fuel. In Germany, this term as defined in the *10th Decree on Implementation of the Federal Emission Protection Law Concerning the State and Indication of Fuel Quality* must only be used for fuels compliant with DIN EN 14214.

Vegetable oils and their mixtures with fossil fuels or other organic ingredients are not bio-diesel.

CFPP

Acronym for "Cold Filter Plugging Point", a parameter for testing a fuel's low-temperature stability.

Alkaline earth elements

A generic term for the elements of the period table's second main group; magnesium and calcium are implied in the case of bio-diesel. These elements form salts (soaps) which can result in filter backfill.

FAME

FAME is an acronym for Fatty-Acid MethylEster. European standard EN 14214 and the derived German standard DIN EN 14214 specify properties of FAME needed for approving this material class as diesel fuel. These standards do not directly specify types of raw material for manufacturing the required fatty-acid methylesters. However, limiting values for certain parameters (like oxidation stability, iodine number, proportion of multiple unsaturated fatty acids, coke residue) indirectly restrict the range of raw materials. In addition, releases by automobile manufacturers explicitly specify permissible types of raw material.

Accordingly FAME is a generic term for all types of fatty-acid methylester made of various raw materials, including rapeseed-oil (fatty-acid) methylester. Especially in the commercial sector, the designation FAME is often incorrectly used for bio-diesels not comprising RME.

Fatty acid

The chemically bound proportion of natural fats and oils. Fatty acids can have different chain lengths and might exhibit double bonds. Fatty acids without double bonds are termed "saturated fatty acid". By contrast, unsaturated fatty acids contain at least one double bond per molecule.

Total contamination

A test parameter commonly used for petroleum products and bio-diesel to indicate the presence of non-specific contamination not assignable to any other test parameter.

Oxidation stability

A test parameter characterizing resistance of fuels to the damaging effects of atmospheric oxygen during transport and storage. Inadequate oxidation stability leads to a formation of polymers which can settle in the fuel supply system and fuel injection pump.

RME

RME is the standard acronym for Rapeseed-oil (fatty-acid) MethylEster. The basic materials here result in a specific distribution of individual fatty-acid content (also termed fatty-acid *profile* or *spectrum*) which can be used to check whether or not a FAME was made from rapeseed oil. Most releases issued by automobile manufacturers refer to a use of RME. Current knowledge of the effects of additives (for example, flow improvers) and their mutual interactions is also limited largely to RME.

The declaration that a product comprises RME does not automatically mean that it also complies with DIN EN 14214. This compliance needs to be verified by a factory certificate or analysis.

Safety data sheet

A safety data sheet describes product properties relevant in terms of health risks, water / soil protection, fire / explosion protection, as well as necessary / authorized measures in the event of damage. This sheet is a declaration of responsibility by the manufacturer / distributor of a product.

Technical regulations for water-endangering substances at motor-vehicle filling stations

§19g of the Water Resource Laws serves as a basis for stipulating special water-protection requirements at filling stations; some of these requirements vary from state to state. The technical regulations for water-endangering substances at motor-vehicle filling stations standardize requirements on the basis of currently available findings.

Requirements concerning facilities for filling and transferring water-endangering substances

Governing the handling of water-endangering substances, these requirements are stipulated at the state level as part of the water-resource laws (refer to §19g).

The following **instruction leaflets** and additional items of information can be downloaded from www.aggm-biodiesel.de:

- Instruction leaflet on the transport of bio-diesel
- Instruction leaflet on handling bio-diesel at public filling stations
- Instruction leaflet on handling bio-diesel at private filling stations
- Notes on defining product quality in supply contracts
- Definition of terms related to bio-diesel
- Removal of reserve and quality-control samples from bio-diesel products
- Equipment for bio-diesel filling stations

Facts about the AGQM

Founded and registered as Bio-Diesel Quality Management Work Group (AGQM) in 1999.

Conclusion of brand licensing contracts with filling stations since 2002.

Members: 14 bio-diesel manufacturers
27 commercial enterprises
12 sponsoring members and associations

Areas of activity:

- Establishment of a bio-diesel quality management system
- Regular quality monitoring of manufacturers, warehouses and filling stations
- Organization of cooperative laboratory tests for bio-diesel quality assurance
- Advanced training courses for quality-assurance and laboratory staff
- Provision of information on handling bio-diesel
- Cooperation with the automotive and petroleum industries
- Implementation and attendance of R&D projects

MBW

The manufacturer / distributor must clearly be indicated.

Muster Biodieselwerke GmbH
Biodieselstraße 13
08151 Esteringen

Phone: +49-0815-1234
Fax: +49-0815-1235

MBW bio-diesel company certificate (SAMPLE)

Date: 23.11.2005

Sampling date: 23.11.2005

Weighing note: X83-15

These details should clearly identify consignment .

AGQM manufacturers use their QM concept to test <u>every batch</u> in terms of at least 11 characteristic parameters listed below.

Measurement results should be specific numbers wherever possible; no vague entries like "Within Limit".

Parameter	**Test**	**Unit**		**DIN EN 14214**	**MBW bio-diesel**
Acid value	EN 14104	mg KOH/g	max.	0.5	0.25
Water content	EN ISO 12937	mg/kg	max.	500	145
Total contamination	EN 12662	mg/kg	max.	24	5
Free glycerine	EN 14105			0.02	0.001
Monoglycerides	EN 14105	% (m/m)	max.	0.8	0.42
Diglycerides	EN 14105	% (m/m)	max.	0.2	0.15
Triglycerides	EN 14105	% (m/m)	max.	0.2	0.09
Total glycerine	EN 14105	% (m/m)	max.	0.25	0.14
Alkaline content (Na+K)	EN 14108(9)	mg/kg	max.	5	0.73
Alkaline earth content (Ca+Mg)	prEN 14538	mg/kg	max.	5	0.93
Filtration limit	EN 116	°C	max.	- 20	-22

Assured use of an oxidation stabilizer for rapeseed methylester.

The standard specifies different, seasonal limiting values for low-temperature stability.

The supplied rapeseed methylester (RME) is furnished with an oxidation stabilizer.

Intended for customer information, this factory certificate refers specifically to the delivered consignment. The certificate's use for later product identification is only permitted if the received consignment is transferred to the next trading stage without any modifications. This applies particularly to those resulting from mixing with other substances or damage during transport / storage.

Person responsible for issuing the company certificate.

(Signature)

Tester
Laboratory director