European Biofuels
TECHNOLOGY PLATFORM

Biofuel Fact Sheet

Fatty Acid Methyl Esters FAME

Lab scale | Bench scale | Pilot Plant | Demonstration | Production

Introduction

The physical characteristics of fatty acid esters are quite close to those of fossil diesel fuels. A mixture of different fatty acid methyl esters is commonly referred to as biodiesel, which is a renewable alternative fuel derived from vegetable oils, animal fats or waste cooking oils. Since it has physical properties similar to those of conventional diesel fuel, it can be considered as a renewable replacement for conventional petroleum-based diesel fuel. It is also non-toxic and biodegradable.

The EC Directive 2009/30/EC (FQD) allows for a maximum of 7% FAME in diesel fuel (B7). Above this level, suitability of blends requires guarantees by specific car manufacturers, and may be subject to amended servicing schedules (for example, more frequent oil and filter changes). Tests are typically carried out on blends with diesel fuel up to 5-10 %, or at 25-30 % and 100 % pure. Modifications (e.g. seals, piping) may be required for use at 100 % pure. The current use of biodiesel as a transport fuel has not required any significant changes in the distribution system, therefore avoiding expensive infrastructure changes.

Some properties of biodiesel are different from those of fossil diesel and for correct low temperature behaviour and for slowing down oxidation processes biodiesel requires a different set of additives than fossil diesel.

See page two for Production Process, 'State of the Art' and Major Stakeholders.

EC-funded projects on FAME

ALGFUEL - Biodiesel production from microalgae

ECODIESEL - High efficiency biodiesel plant with minimum GHG emissions for improved FAME production from various raw materials

SUPER METHANOL - Reforming of crude glycerine in supercritical water to produce methanol for re-use in biodiesel plants

InteSusAl - Demonstration of Integrated & Sustainable enclosed raceway and photobioreactor microalgae cultivation with biodiesel production and validation

Molecular Formula

$CH_3(CH_2)nCOOCH_3$

Properties of FAME

Specific gravity:	0.88 kg/l
C (%wt)	77
H (%wt)	12
O (%wt)	11
Density @ 20 °C	0.86-0.90 kg/m^3
Lower heating value	33.175 MJ/kg
Kinematic viscosity @ 40 °C	4-6 kPa s

Utilization

Substitute diesel; transportation fuel; power generation fuel

Relevant fuel regulations

EN14214 (Biodiesel specification), EN590

Main feedstocks

Oil seeds (rape, sunflower, soy, palm)

Scale of Production

Industrial scale

Costs and GHG Balance

Production costs for biodiesel from rapeseed oil are based on feedstock prices. In Germany 2007: 24€/GJ, predictions for 2020: 23€/GJ. A GHG reduction of 2.1 kg/l biodiesel is expected. Modelled savings of GHG emissions per hectare for 2020 are increasing due to increasing yields and potential increased production processes and energetic uses of residues.

Assumes crude oil at 50 US-$/bbl

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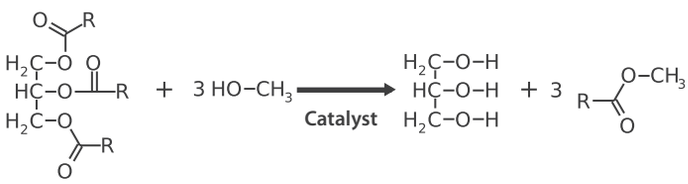
Production process

Fatty Acid Methyl Esters are produced from vegetable oils, animal fats or waste cooking oils by transesterification. In the transesterification process a glyceride reacts with an alcohol in the presence of a catalyst, forming a mixture of fatty acids esters and an alcohol. Using triglycerides results in the production of glycerol.

Transesterification is a reversible reaction and is carried out by mixing the reactants. A strong base or a strong acid can be used as a catalyst. At the industrial scale, caustic potash is mostly used. The following reaction occurs:



The production of biodiesel is relatively simple from a technical standpoint, also allowing the construction of small decentralised production units without excessive extra costs. This limits the need to transport raw materials long distances and permits operations to start with modest-sized installations.

Rapeseed, sunflower, soybean, palm oils and spent oils are the most common raw materials being used for the production of biodiesel. Using methanol in the transesterification process has the advantage that the resulting glycerol can be separated simultaneously during the transesterification process. When using ethanol during the process the ethanol needs to be free of water and the oil needs to have a low water content as well to achieve an easy glycerol separation.

The end products of the transesterification process are raw biodiesel and raw glycerol. After a cleaning step biodiesel is produced. The purified glycerol can be used in the food and cosmetic industries, as well as in the oleochemical industry. The glycerol can also be used as a substrate for anaerobic digestion.

State of the Art

Transesterification processes have been used since the establishment of the oleochemical industry. Industrial scale production of biodiesel for use as a transport fuel has taken place in Europe since 1992. To ensure conformity of biodiesel production the standard EN14214 was implemented in Europe. Global biodiesel production in 2009 was 17,929 Ml. The leading producer is Germany with 2,859 Ml (16%) of biodiesel produced, followed by France with 2,206 Ml (12%) and the United States with 2,060 Ml (11%).

The potential market for biodiesel is estimated at around 20 EJ by 2050, assuming the development of synthetic biofuel production technologies, using new feedstocks, achieving higher yields and reduced GHG emissions (see 'EU-funded projects on FAME' on page one).

Major stakeholders

The major biodiesel stakeholders in the EU are listed below:

Diester Industries (France)
ADM Biodiesel (Germany)
Biopetrol Industries (Switzerland)
Verbio (Germany)
Cargill (Germany)
Ital Green Oil (Italy)
Bioenergética Extremeña (Spain)
Acciona Energia (Spain)
Gate (Germany)
Biofuels Corporation (United Kingdom)
Novaol (Italy)
Natural Energy West (Germany)

With the inauguration in 2008 and 2009 of four new facilities and a total of 10 facilities, Diester Industries remains the largest producer of biodiesel in the EU in 2009 with a production capacity of 2,250 Ml/yr, only in France. ADM Biodiesel, a German subsidiary of the American group Archer Daniels Midland (ADM), runs three production plants in Germany with a total production capacity of 1,130 Ml/yr. The American group owns biodiesel plants also in Brazil, India, Indonesia and the United States. Its global production capacity is about 1,700 Ml/yr. The Swiss group Biopetrol Industries is also one of the leaders of the European biodiesel market, its biodiesel production is done in Germany in Schwarzheide (220 Ml/yr) and in Rostock (170 Ml/yr), and since 2008 in the Netherlands in Rotterdam (450 Ml/yr). The German company Verbio is active in both biodiesel and bioethanol markets. It owns two biodiesel production facilities in Germany, in Schwedt (280 Ml/yr) and Bitterfeld (230 Ml/yr). According to the EBB (European Biodiesel Board), the production capacity of biodiesel in the EU exceeded 23,500 Ml in 2008, with a total of 276 production facilities.

Further information

Up-to-date information on methanol from biomass R&D&D is available on the Euorpean Biofuels Technology Platform website **www.biofuelstp.eu**.