European Biofuels
TECHNOLOGY PLATFORM

Biofuel Fact Sheet

Fatty Acid Methyl Esters (FAME)

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

Introduction

Fatty Acid Methyl Esters (FAME) are esters of fatty acids. The physical characteristics of fatty acid esters are closer to those of fossil diesel fuels than pure vegetable oils, but properties depend on the type of vegetable oil. A mixture of different fatty acid methyl esters is commonly referred to as biodiesel, which is a renewable alternative fuel. FAME has physical properties similar to those of conventional diesel. It is also non-toxic and biodegradable.

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. Impurities, such as metals, in FAME must be limited for use as a motor fuel.

See page two for Production Process and State of the Art.

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

AllGas - Industrial Scale Demonstration Of Sustainable Algae Cultures For Biofuel Production (BioDiesel and BioGas)

BioFAT - Microalgae to biofuel demonstration

Applications

Tests have been undertaken by motor manufacturers in the European Union on blends with diesel oil up to 5-10 %, or at 25-30 % and 100 % pure. These have resulted in guarantees for each type of use. Modifications (seals, piping) are required for use at 100 % pure. The use of biodiesel as a low-blend component in transport fuel (up to 7 percent in Europe for the time being according to EN 590) does not require any changes in the distribution system, therefore avoiding expensive infrastructure changes.

Molecular Formula

$CH_3(CH_2)nCOOCH_3$

Comparison of Fuel Properties

	FAME	Diesel
Density at 20 °C [kg/l]*	0.88	0.83
Lower heating value [MJ/kg]*	37.1	43.1
Viscosity at 20 °C [mm^2 / s]*	7.5	5.0
Cetane number*	56	50
Fuel equivalence*	0.91	1
GHG [gCO_2eq/ MJ]**	Rape seed biodiesel: 46 Waste vegetable or animal oil biodiesel: 10 Palm oil biodiesel (process not specified): 54	

*Source: FNR 2012. * Median values are used for simplification. Please refer to the standards for ranges. ** Directive 2009/28/EC, total for cultivation, processing, transport and distribution*

Utilization

Substitute diesel; transportation fuel; power generation fuel

Relevant fuel regulations

EN14214 (Biodiesel specification), ASTM D 6751, EN590

Main feedstocks

Oil seeds (rape, sunflower, soy, palm), used cooking oil, waste animal fat

Scale of Production

Industrial scale

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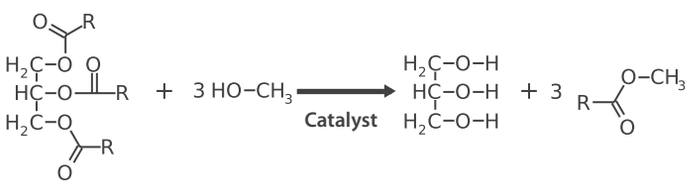
Production process

FAME is 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, sodium or potassium methanolate 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, UCO and animal fat 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

Industrial scale production of biodiesel for use as a transport fuel has taken place in Europe since 1991.

Global biodiesel production in 2011 was 18,826 Mtonnes. The leading producer was the USA with 2,800 M tonnes of biodiesel produced, followed by Germany with 2,780 M tonnes and Argentina with 2,427 M tonnes. Globally, 2011 has seen significant FAME output growth of around 2.5 M tonnes (growth rate 16 %), bringing worldwide production to a record high (F.O. Lichts, Vol.10, Is.14).

Major stakeholders

Some of 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**.