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Standardisation of Biodiesel on a European Level

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ABSTRACT

As the production of biodiesel in Europe has gained a considerable market position it is essential to develop a common European standard for Fatty Acid Methyl Ester (=FAME, biodiesel). Standards are of vital importance for the producers, suppliers and users of biodiesel. Authorities need approved standards for the evaluation of safety risks and environmental pollution. Standards are necessary for approvals of vehicles operated with biodiesel and are therefore a prerequisite for the market introduction and commercialisation of biodiesel.

In 1997 the European Commission mandated CEN to develop standards and test methods for biodiesel used as a fuel for diesel engines and for domestic heating plants. In CEN the standardisation of biodiesel is dealt with in 2 Technical Committees and 4 Working Groups. The 1st draft can be expected for the end of 1999, the final standard for the year 2002.

1 INTRODUCTION

The European Commission has set itself the ambitious aim to increase the market share of renewable energy to 12% until 2010. The ways and means used for accomplishing this aim, i.e. establishing regulations concerning the creation of favourable conditions for renewable sources of energy, are summarised in the "White Paper on Renewable Sources of Energy" [1].

The "campaign for take-off" 1999-2003 determines to support different key sectors, like e.g. "5 million tons of liquid biofuels", by means of specific programmes and actions of the Community [2]. Within the internal market European standards for technical equipment using renewable sources of energy will be developed in CEN. The creation of standards shall help to expand the industry for renewable sources of energy on a EU level.

The European Commission mandated CEN to develop standards for biodiesel used as a fuel for diesel engines and as a fuel for the production of heat as well as the necessary standards concerning the methods applied [3].

2 GENERAL ASPECTS OF STANDARDISATION

2.1 What is a standard? [6], [7]

According to a definition in ISO a 'standard' can be characterised as:

- * a written document, approved by a recognised body,
- * available to the public,
- * drawn up by a method requiring the consensus of all parties concerned and to the benefit of all,
- * intended for repeated or continuous application,
- * normally not mandatory (except for being explicitly referred to in regulations).

To ensure that standards are generally accepted and suitable for practical application some principles of standardisation have to be fulfilled:

- * **Neutrality of teamwork (access and transparency):** All parties affected by the standard should participate at all levels of the standardisation process by sending experts to the meetings.
- * **Consensus:** The process of standardisation should definitely result in a consensus. But European standards do not have to be accepted unanimously.
- * **Publicity:** Every draft is subject to a public enquiry process.
- * **Coherence:** Standards have to be consistent and unified on a European as well as on a national level. This means that conflicting national standards have to be withdrawn as soon as a European standard is published.

2.2 The levels of standardisation

National standards: The national standards institutes (mostly organisations under civil law) are responsible for standardisation on a national level. These institutes provide the infrastructure and the organisational framework for efficient standardisation work.

European standards: CEN (Comité Européen de Normalisation) is responsible for standardisation on a European level. European standards have to be included in all national standards and conflicting national standards have to be withdrawn.

International standards: International standards are set up by the International Organisation for Standardisation (ISO) located in Geneva. In contrast to European standards, ISO standards do not have to be implemented as national standards.

2.3 The organisation of CEN

CEN (Comité Européen de Normalisation) is the European Committee for Standardisation. It is a non-profit-making international association of a scientific and technical nature registered in accordance with Belgian law and founded in 1961. The CEN central secretariat is located in Brussels and is responsible for promoting the activities of the association.

The Technical Board (BT) is primarily responsible for the co-ordination of CEN standardisation work. Technical Committees (TC) are responsible for the drafting of European standards in well-defined sectors. This system ensures that more than 270 TCs are working according to sectorial priorities and avoid the duplication of work. The TCs involve experts from all areas affected by the activities of CEN (industry, public administration, science, consumers, trade unions, etc.).

2.4 The standardisation process in CEN

In each standardisation process four phases can be distinguished:

- * **Programming:** A process can be initiated by national standardisation institutes, trade organisations, associated standardising bodies or the European Commission / EFTA.
- * **Drafting:** The real standardisation work is done in working groups by experts under the collective responsibility of the Technical Committee. The draft is given a standard number and called prEN.
- * **Adoption:** The prEN is passed to the national members and is submitted to public comment for six months. The comments are collected and evaluated. The TC works out a final draft reaching a broad consensus. The paper is submitted to a 'formal vote' by the national members.
- * **Implementation:** The full status of a European standard is only acquired if it is transposed and made applicable on a national level. To ensure technical consistency divergent national standards have to be withdrawn.

3 NATIONAL STANDARDISATION OF BIODIESEL

The introduction of biodiesel as a fuel for diesel engines called for the development of standards in the respective countries. Thus, a working group was installed in Austria in 1990 which was instructed to prepare a standard for rape oil methyl ester. Currently, standards or specifications for biodiesel are available in Austria, the Czech Republic, France, Germany, Italy, Sweden, and the US.

The level of development was summarised comprehensively at the "International Conference on Standardization and Analysis of Biodiesel" in Vienna in November 1995 [5]. The conference also determined the need for research concerning the description of quality parameters and the determination methods.

The following table shows a summary of currently valid national standards.

*Excerpt of the national biodiesel standards
(without cross check of the determination methods / without guarantee)
(Original data are provided at the national standards institutes)*

		Austria	Czech Republic	France	Germany	Italy	Sweden	USA
Standard / Specification		ON C1191	CSN 65 6507	Journal Officiel	DIN E 51606	UNI 10635	SS 155436	ASTM PS121-99
Date		1 July 1997	Sep 1998	14 Sep 1997	Sep 1997	21 April 1997	27 Nov 1996	July 1999
Source		[8]	[9]	[10]	[11]	[12]	[13]	[14]
Application		FAME	RME	VOME	FAME	VOME	VOME	FAMAE
Density 15°C	g/cm ³	0.85 - 0.89	0.87 - 0.89	0.87 - 0.90	0.875 - 0.90	0.86 - 0.90	0.87 - 0.90	-
Viscos. 40°C	mm ² /s	3.5-5.0	3.5 - 5.0	3.5-5.0	3.5-5.0	3.5-5.0	3.5-5.0	1.9-6.0
Distillat. 95%	°C	-	-	≤ 360	-	≤ 360	-	-
Flashpoint	°C	≥ 100	≥ 110	≥ 100	≥ 110	≥ 100	≥ 100	≥ 100
CFPP	°C	0/-15	-5	-	0/-10/-20	-	-5	-
Pourpoint	°C	-	-	≤ -10	-	≤ 0/≤-15	-	-
Sulfur	% mass	≤ 0.02	≤ 0.02	-	≤ 0.01	≤ 0.01	≤ 0.001	≤ 0.05
CCR 100% 10% dist.resid.	% mass % mass	≤ 0.05	≤ 0.05	≤ 0.3	≤ 0.05	≤ 0.5	-	≤ 0.05
Sulfated ash	% mass	≤ 0.02	≤ 0.02	-	≤ 0.03	-	-	≤ 0.02
(Oxid) Ash	% mass	-	-	-	-	≤ 0.01	≤ 0.01	-
Water	mg/kg	-	≤ 500	≤ 200	≤ 300	≤ 700	≤ 300	≤ 0.05%
Total contam.	mg/kg	-	≤ 24	-	≤ 20	-	≤ 20	-
Cu-Corros. 3h/50°C		-	1	-	1	-	-	≤ No.3
Cetane No.	-	≥ 49	≥ 48	≥ 49	≥ 49	-	≥ 48	≥ 40
Neutral. No.	mgKOH/g	≤ 0.8	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.6	≤ 0.8
Methanol	% mass	≤ 0.20	-	≤ 0.1	≤ 0.3	≤ 0.2	≤ 0.2	-
Ester content	% mass	-	-	≥ 96.5	-	≥ 98	≥ 98	-
Monoglycides	% mass	-	-	≤ 0.8	≤ 0.8	≤ 0.8	≤ 0.8	-
Diglyceride	% mass	-	-	≤ 0.2	≤ 0.4	≤ 0.2	≤ 0.1	-
Triglyceride	% mass	-	-	≤ 0.2	≤ 0.4	≤ 0.1	≤ 0.1	-
Free glycerol	% mass	≤ 0.02	≤ 0.02	≤ 0.02	≤ 0.02	≤ 0.05	≤ 0.02	≤ 0.02
Total glycerol	% mass	≤ 0.24	≤ 0.24	≤ 0.25	≤ 0.25	-	-	≤ 0.24
Iodine No.		≤ 120	-	≤ 115	≤ 115	-	≤ 125	-
C18:3 and high. unsat.acids	%mass	≤ 15	-	-	-	-	-	-
Phosphor	mg/kg	≤ 20	≤ 20	≤ 10	≤ 10	≤ 10	≤ 10	-
Alcaline met. (Na, K)	mg/kg	-	≤ 10	≤ 5	≤ 5	-	≤ 10	-

RME.....Rape seed oil methyl ester
VOMEVegetable oil methyl ester

FAMEFatty acid methyl ester
FAMAEFatty acid mono alkyl ester

In Europe biodiesel is predominantly produced from rape seed oil, and most information and data available is dealing with the practical experience gained in the use of rape seed oil methyl ester (RME). In Austria and the Czech Republic standards for RME have been developed. In France, Italy and Sweden the specifications for biodiesel deal with plant oil used as a raw material. In Austria and Germany general standards for fatty acid methyl ester have been developed. The US define biodiesel as "mono-alkyl esters of long chain fatty acids derived from vegetable oils and animal fats". However, the choice in raw material is limited considerably in the standards because of the selection of limiting values.

4 **STANDARDISATION OF BIODIESEL IN CEN**

4.1 **The mandate**

In 1997 the European Commission mandated CEN to develop standards and test methods concerning the minimum requirements of fatty acid methyl ester used as a fuel for diesel engines and for heating purposes [3]. The proposed standard is aimed at the following 2 targets:

- * enabling a free movement of goods concerning biodiesel and
- * providing guarantees for the use of biodiesel on the part of vehicle and plant producers.

As a consequence an essential contribution to the accomplishment of the common aims - preserving the environment, guaranteeing the energy supply and preserving jobs - shall be made.

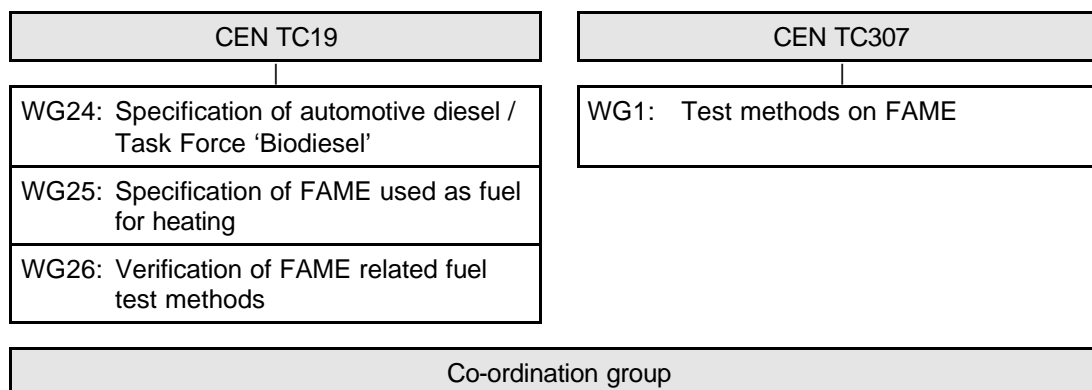
Currently biodiesel is used as a fuel for diesel engines and as fuel used for the production of heat. Therefore, the mandate provides for the development of the following standards :

- * biodiesel as sole diesel engine fuel (100%)
- * biodiesel as extender to diesel engine fuel according to EN590
- * biodiesel sole or as extender to mineral oil products, in particular for the production of heat.

It was decided by CEN to divide the work between two existing Technical Committees (TCs) [4]:

- * TC 19: Petroleum products, lubricants and related products
- * TC 307: Oilseeds, vegetable and animal fats and oils and their by-products - methods of sampling and analysis.

The following working groups (WGs) are involved:



A co-ordination group (Convenor: Mr GIRARD, TOTAL France) was installed, where the Chairmen and Secretaries of TC19 and TC307 and the Convenors of the Working Groups are involved to ensure an overall co-ordination.

4.2 **Co-operation with NTB**

NTB net is a European Network for removing **Non Technical Barriers** to the development of liquid biofuels. The aim of the project is to identify barriers and to suggest solutions for the promotion of liquid biofuels. NTB has united representatives from different market sectors. The participants defined the lack of specification for biofuels, especially on a European level, as one of the common barriers.

In the current phase of NTB a support programme is devoted to the standardisation of biodiesel in CEN. The collaboration with CEN is based on a liaison, which is normally existing between European trade organisations and CEN Technical Committees. The liaison status between CEN and NTB was agreed by CEN TC307 and CEN TC19 for a period of 3 years (1998-2001).

4.3 **The current state of biodiesel standardisation in CEN**

The 4 working groups have started work in January 1998. Until the end of 1999 every WG will have met 6-8 times. The following description is based on the information level of August 1999.

CEN/TC19/WG24: Specification of automotive diesel / Task Force 'Biodiesel'

Convenor: Mr G.F. CAHILL (P.S.A. France)

The task is to standardise requirements for 100% FAME and for mixtures of FAME to mineral oil based fuel for diesel engines and to verify the applicability of EN590 for blends of mineral oil based fuel with FAME (5% maximum). A sub group of the working group 24 ("Task Force Biodiesel") was entrusted with the standardisation. The 1st priority is to work out drafts for 100% biodiesel and for biodiesel used as a 5% blend to mineral diesel fuel.

The following parameters were considered to be necessary:

- Ester content
- Density
- Viscosity
- Flash point
- CFPP / Pourpoint
- Sulfur content
- Conradson carbon residue
- Distillation
- Cetane number
- Sulfated ash content
- Water content
- Sediment
- Copper corrosion
- Thermal and storage stability
- Acid number
- Iodine number
- Methanol content
- Mono-, Di-, Triglycerides
- Free and total glycerol
- Alkaline metals (Na, K)
- Phosphorus content

Due to the comprehensive experience gained with biodiesel in Europe the determination of limiting values does not pose problems with most parameters. The difficulties in the elaboration of standards consist in the fact that so far most experience is concentrating on biodiesel produced from rape seed oil or sunflower oil, but that the new standard shall be valid for fatty acid methyl ester in general. The raw material is not pre-determined and thus the choice of the limiting values is attributed special importance.

CEN/TC19/WG25: Specification of FAME used as fuel for heating

Convenor: Mr Franz HEGGER (OMV AG, Austria)

The task of the working group is proposed as follows: Specification (requirements and references to the test methods) for FAME used as fuel for heating and as a blending component for the production of heating oil.

Oil used for the production of heat has so far only been standardised on a national level, but not on a European level. Besides, the national requirements differ fundamentally. Thus, the instructions given to the WG have been altered. Henceforth, only one standard is to be developed, which determines the requirements for biodiesel as pure heating oil as well as the requirements for biodiesel used as mixing component for fossil heating oil. The resulting blends have to meet the requirements of the national standards for heating oil in the countries applying the standards.

The following parameters were considered to be necessary:

- Density
- Flash point
- Viscosity
- CFPP
- Pour point
- Conradson carbon residue
- Water content
- Ash content
- Ester content
- Mono-, Di-, Triglycerides
- Sediments
- Heating value
- Free glycerol
- Methanol content
- Neutralisation number
- Stability
- Bio vulnerability

CEN/TC19/WG26: Verification of FAME related fuel test methods

Convenor: Mrs Marie-France BENASSY / Mr Frederic TORT (ELF ANTAR France)

The task of the working group is to establish the applicability of already existing standards for petroleum test methods including precision data and to develop new standards for test methods, if necessary. Round robin tests have to be carried out for each test method. If necessary, the methods have to be revised. The working items were defined as follows:

Working item	Parameter	Methods considered
WI6	Density at 15°C	EN ISO 3675, EN ISO 12185
WI7	Viscosity at 40°C	EN ISO 3104
WI8	Flash point	EN 22719, ISO/CD2719
WI9	CFPP	EN 116
WI10	Sulfur content	UV fluorescence (?)
WI11	Conradson carbon residue (10%)	EN ISO 10370
WI12	Cetane Number	EN ISO 5165
WI13	(Sulfated) Ash content	ISO 3987
WI14	Water content	EN ISO 12937
WI15	Total contamination	prEN 12662 (?)
WI16	Copper corrosion	EN ISO 2160
WI17	Oxidation stability	→ see TC307/WG1
WI18	Distillation I.B.P	ASTM D1160
WI19	Acid Value	EN12634
WI20	Pour Point	ISO 3016
WI20	Cloud Point	EN 23015
WI21	FAME content in mineral oil	NF M07 084 (infra red) (?)

CEN/TC307/WG1: Test methods on FAME

Convenor: Mr Francois MORDRET (ITERG France)

The task is to standardise necessary test methods for the determination of the composition of 100% FAME, including the establishment of precision data. The following working items are under the responsibility of TC307:

Working item	Parameter	Methods considered
00307040	Ester content	ISO 5508, NF T60-703
00307041	Acid value	prEN ISO 660
00307042	Free and total glycerol, Mono-, di- and tri-glycerides	NF T60-704, UNI 22054
00307043	Phosphorus content	NF T60-705 (ICP)
00307044	Sodium content	NF T60706-1,-2
00307045	Potassium content	NF T60706-1,-2
00307046	Methanol content	NF T60-701, E DIN 51608
00307047	Iodine value	prEN ISO 3961
00307048	Oxidation stability	ISO 6886:1996, IP 306 modified

As only little information is available on the parameter "stability" a separate working group has been founded. It results difficult to distinguish between oxidation stability, storage stability and thermal stability. Although test methods used in the mineral oil industry and food industry would be available, only little experience has been gathered in the use of FAME.

5 SUMMARY

Biodiesel has already reached a considerable position on the market. It has become necessary to determine the quality requirements for the new fuel by means of a standard in order to allow for a free movement of goods. The producers of vehicles and boilers need a standardised quality for an approval of their products and for granting guarantees.

The European Union seeks to facilitate the expansion of the industrial sector dealing with renewable sources of energy by means of the development of standards. In 1997 the Commission mandated the European organisation for standardisation CEN to develop the following standards for the different forms of use of biodiesel:

- * biodiesel as sole diesel engine fuel (100%)
- * biodiesel as extender to diesel engine fuel according to EN590
- * biodiesel sole or as extender to mineral oil products, in particular for the production of heat.

At the beginning of 1998 4 working groups within CEN were instructed to develop the standards and to examine the respective test methods. The tasks were distributed as follows:

TC19/WG24: Specification of automotive diesel / Task Force 'Biodiesel': The task is to standardise requirements for 100% FAME and mixtures of FAME to mineral oil based fuel for diesel engines and to verify the applicability of EN590 for blends of mineral oil based fuel with FAME (5% maximum).

TC19/WG25: Specification of FAME used as fuel for heating: The task is proposed as follows: Specification (requirements and references to the test methods) for FAME used as fuel for heating and as a blending component for the production of heating oil.

TC19/WG26: Verification of FAME related fuel test methods: The task of the working group is to establish the applicability of already existing standards for petroleum test methods including precision data and to develop new standards for test methods, if necessary.

TC307/WG1: Test methods on FAME: The task is to standardise necessary test methods for the determination of the composition of 100% FAME, including the establishment of precision data.

So far various round robin tests have been carried out on determination methods and the applicability on fatty acid methyl ester was tested. The first draft standards shall be available at the end of 1999. The standards shall be completed in the year 2002.

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