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Global, Regional and National level

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Abstract

The use of fossil but in first hand biobased alternative fuels in transportation has increased over the last decades. This change is primarily driven by concerns about climate change that is caused by emissions of fossil carbon dioxide and other greenhouse gases, but also by the impact on health and environment, caused by emissions of regulated as well as non-regulated emissions from the transport sector.

Most alternative fuels will help to reduce the emissions of regulated and non-regulated emissions, while alternative fuels based on biomass also will contribute to reduced net emissions of carbon dioxide.

Since the mid 1990s, the use of biomass based fuels such as ethanol and biodiesel has reached levels high enough in for example Europe, Brazil and the U.S. to motivate national or regional specifications/standards. Especially from the vehicle/engine manufacturer's point of view standards are of high importance. From early 2000 onwards, the international trade of biofuels (for example from Brazil to the U.S. and Europe) has grown, and this has created a need for common international specifications/standards.

This report presents information about national and regional standards for alternative fuels, but also, when existing and reported, standards on a global level are described and discussed. Ongoing work concerning new or revised standards on alternative fuels on national, regional or global level is also discussed.

In this report we have covered standards on all kind of alternative fuels, exemplified below. However, the focus is on liquid biofuels for diesel engines and Otto engines.

- Liquid fuels for diesel engines (compression ignition engines), such as Fatty Acid Methyl Esters (FAME), Fatty Acid Ethyl Esters (FAEE), alcohols, alcohol derivates and synthetic diesel fuels.
- Liquid fuels for Otto engines (spark ignition engines), such as alcohols, ethers and synthetic gasoline.
- Liquefied fossil petroleum gas (LPG).
- Di-Methyl Ether (DME).
- Fossil methane i.e. compressed natural gas (CNG) and liquefied natural gas (LNG).
- Bio methane (biogas from anaerobic fermentation or gasification of biomass), i.e. compressed biogas (CBG) and liquefied biogas (LBG).

Standardization work on alternative fuels by the following organizations/countries and organizations/regions are presented in this report:

- APEC (Asia-Pacific Economic Cooperation)
- ASTM (the U.S. and Canada)
- Brazil
- CEN (Europe)
- India
- ISO

- Japan
- People's Republic of China
- South Africa
- Thailand

The information in this report is based on information from web sites, reports and personal contacts, enriched by the author's expertise. The report is not, however, necessarily all-embracing.

The work on standardization is a continuous process that currently seems to be accelerating. This report gives a picture of the activities until early 2008. When reading this report please keep in mind that new initiatives may be on the agenda on a national, regional as well as a global level.

This report is produced under the framework of the International Energy Agency's Implementing Agreement on Advanced Motor Fuels (IEA/AMF) and its information Annex XXVIII. The report is IEA/AMF's latest contribution to the knowledge about standards and the ongoing work on standardization of alternative fuels.

Preface

This outlook report reviews the current situation on standardization of alternative vehicle fuels. It concentrates on the regional and national level but, when existing, it also addresses the global level.

This report predominantly describes existing standards. Additionally, it addresses standards that are currently under development and it briefly mentions discussions on future standards.

The information in this report is based on information from web sites, reports and personal contacts, enriched by the author's expertise, please se reference list for further information.

The study was carried out within Annex XXVIII (AMFI Information Service, www.iea-amf.vtt.fi) of the International Energy Agency's Implementing Agreement on Advanced Motor Fuels (IEA/AMF), as an independent sub-task.

The author would like to acknowledge the IEA Implementing Agreement on Advanced Motor Fuels (IEA/AMF) and EU Bioenergy Network of Excellence (NoE), the latter acting through VTT Technical Centre of Finland, for their support of this work.

October, 2008.

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1. Background

The use of alternative fuels in transportation has increased over the last decades. This change is primarily driven by concerns about climate change that is caused by emissions of fossil carbon dioxide and other greenhouse gases, but also by the impact on health and environment caused by emissions of regulated as well as non-regulated emissions from the transport sector.

Most alternative fuels will help to reduce the emissions of regulated and non- regulated emissions, while alternative fuels based on biomass also will contribute to reduced net emissions of carbon dioxide.

Although alternative fuels have been used since the mid 1970s, to begin with the total amount used (mostly in dedicated demonstration fleets/captive fleets) was low and there was no real need for a general specification or common specification standards. However, from the mid 1990s the use of for example ethanol and biodiesel has over time reached levels high enough in for example Europe, Brazil and the U.S. to motivate national or regional specifications/specification standards.

From the beginning of the year 2000 onwards, the international trade of biofuels (for example from Brazil to the U.S. and Europe) has grown, and this has certain implications for the need of common international specifications/specification standards.

Especially from the vehicle/engine manufacturer's point of view fuel specification standards are of high importance when it comes to define fuels to be used in their vehicles but also to avoid the use of unsuitable fuels.

In fuel specification standards a number of parameters are regulated with different purposes. The reason to regulate a parameter could be to:

- avoid unacceptable wear of the engine,
- avoid unacceptable impact on gaskets,
- improve lubricity,
- avoid impurities,
- keep cold flow properties on an acceptable level,
- control and lower the level of fuel components that itself or after reaction with other fuel components and/or oxygen might result in emission with an acceptable impact on health and environment.

Specification standards is a practical way for commercial market actors to, agree on common demands on fuels to be marketed, for the benefit of themselves but also for a number of other actors as well as consumers and other people in common. Specification standards are also issues to control emissions such as for example sulfur, and aromatics.

Every new fuel has impacts on the whole well-to-wheel fuel chain, on feedstock, fuel processing, fuel distribution and end-use, including environmental impacts and possible vehicle modifications. It is therefore necessary to have a good understanding of the whole complex system when choosing future fuel options. It is also important to engage experts and organizations representing all stages from well-to-wheel in the process of standardization.

The objective of the International Energy Agency's Advanced Motor Fuels collaboration program (IEA/AMF) is to deal with such aspects by co-operation in research and demonstration, by exchange of information and by creation of a network of experts in the field of advanced motor fuels. Participants are working on emissions, energy efficiency, field trials as well as system aspects (such as life-cycle analysis on energy use and greenhouse gas emissions). On the international level, the IEA/AMF collaboration program, where experts in advanced motor fuels share experiences and results of their endeavors, forms a suitable platform for co-coordinated efforts to evaluate new fuel options,

The IEA/AMF collaboration program has been involved in work on standardization of alternative fuels since 2002. The first phase of the work was carried out under Annex XXVII, and was reported in two separate reports. In this first phase the existence of specification standards on alternative fuels was analyzed for the U.S., Canada, Japan, Finland, France and Sweden as well as international organizations such as ISO, ASTM and CEN. Based on the information gathered, recommendations to IEA/AMF on their coming work on this item was established.

The report at hand, carried out under the framework of IEA/AMF's information Annex XXVIII, , is the result of IEA/AMF's further engagement in standardization of alternative fuels and a contribution to the knowledge about standards and the ongoing work on standardization of alternative fuels.

This report presents information about in first hand specification standards on alternative fuels on national, regional and when existing and reported global level, but also some information about standards for test methods. Ongoing work concerning new or revised specification standards on alternative fuels on national, regional and/or global level is also discussed.

The work on standardization is a continuous process that currently seems to be accelerating. This report gives a picture of the activities until early 2008. The report is not necessarily all-embracing. When reading this report please keep in mind that new initiatives may be on the agenda on a national, regional as well as a global level.

2. Introduction

The objective of the task undertaken was to identify in first hand specification standards on alternative vehicle fuels, existing ones as well as standards under development on national and regional level, and when available or applicable, also on international level.

In this context the term “alternative fuels” means all kinds of fuels, fossil or bio based, liquid or gaseous, which can replace diesel oil or gasoline while biofuels means all kind of alternative fuels produced with biomass feedstock.

Under the heading “ongoing work” the “running production” of draft specification standards, but even more so general work and discussions on the need for specifications/standards on alternative fuels are included.

Secondly, also standards concerning analytical methods relevant to fuel specifications have, on an overarching level, been identified and reported, by presenting reference numbers.

Thirdly, it is important to remember that there are also a number of specification standards on reference fuels, used for certification tests of engines/vehicles but not for daily use. However, these types of specification standards are not covered in this report.

In this report we have tried to as far as possible cover specification standards on alternative fuels, exemplified below. However, the focus is on liquid biofuels for diesel engines and Otto engines.

- Liquid fuels for diesel engines (compression ignition engines), such as Fatty Acid Methyl Esters (FAME), Fatty Acid Ethyl Esters (FAEE), alcohols, alcohol derivates and synthetic diesel fuels.
- Liquid fuels for Otto engines (spark ignition engines), such as alcohols, ethers and synthetic gasoline.
- Liquefied fossil petroleum gas (LPG).
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- Fossil methane i.e. compressed natural gas (CNG) and liquefied natural gas (LNG).
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It is important to notice that standards consist of intellectual property that is copyright protected and that normally has to be bought from national or international standardization organizations. For this Annex it was not possible to acquire all relevant standards. It is also not legally correct to reproduce in written form the complete text and data in a bought standard without permission from the responsible standardization organization, which most of the time requires financial compensation to the organization. That is the main reason why this report mainly just presents some overarching details from the actual standards. For more detailed information the reader is recommended to contact the relevant standardization organization.

Standardization work on alternative fuels by the following organizations/countries and organizations/regions is presented in this report.

- APEC (Asia-Pacific Economic Cooperation)
- ASTM (the U.S. and Canada)
- Brazil
- CEN (Europe)
- India
- ISO
- Japan
- People's Republic of China
- South Africa
- Thailand

3. Standardization organisations

3.1 Europe - CEN

CEN is the European Committee for standardization, a non-profit making technical organization set up under Belgian law with its headquarters in Brussels.

CEN was founded in 1961 by the national standards bodies in the European Economic Community and the EFTA countries.

Today CEN is contributing to the objectives of the European Union and the European Economic Area with voluntary technical standards.

CEN has 30 national members, 7 associate members and two counselors. CEN has also a close cooperation with other similar organizations such as for example ISO.

The work on a new CEN standard normally is initiated by a member country and under the frame of a CEN technical committee, for fuels - Technical Committee number 19 (TC19). If there is a common interest in such a standard the technical committee can decide to set up a new working group on the item or to give the issue to an existing working group in which all interested parties/members can take part. The goal for the working group is to come up with a proposal on a standard that have been agreed on by the participants in the working group.

If such a proposal can be presented a so called pre standard (PrEN) will be set up and distributed/balloted to all participating countries in the technical committee, for comments and finally adoption.

One other possibility for the ignition of the work on a CEN standard is also that the European commission mandates CEN to prepare and adopt a specific standard. In such a case there is often a clear connection between an EU-directive, for example the so called fuel directive 98/70/EC, updated by directive 2003/17/EC. Even if the initiative to a new standard comes from a member country there might be restrictions in EU-directives that has to be followed or fulfilled and has to be taken into account when drafting the standard.

Standards proposals adopted by CEN‘s national members will become CEN/European standards (EN: s) and must be transposed into national standards, while all kind of national conflicting standards must be withdrawn.

If there is a lack of interest in CEN (to few countries) on a proposed work on a new standard another possibility is that the interested countries as well as other interested stake holders, also outside CEN, under the frame of CEN set up a so called workshop. The purpose of the workshop is to come up with a joint agreement (a workshop agreement) on for example a fuel specification. Such a fuel specification can be used by the participants but also other interested parties in their work. However, such an agreement is not a formal CEN-standard.

3.2 USA –ANSI (American National Standards Institute) and ASTM International

ANSI – The American National Standards Institute was founded 1918 by five engineering societies and three government agencies. Today ANSI represents the interest of nearly 1000 companies, organizations, government agency, institutional and international members and overseas the creation, promulgation and use of standards in almost all sectors in the U.S.

ANSI facilitates the development of American National Standards (ANS) by accrediting the procedures of standards developing organizations (SDOs). These groups work cooperatively to develop voluntary national consensus standards. Accreditation by ANSI signifies that the procedure used by the standards body in connection with the development of American National Standards meet the institute’s essential requirement for openness, balance, consensus and due process.

ASTM International (ASTM), originally known as the American Society for Testing Materials, is one of the largest voluntary standards development organizations in the world formed over a century ago. .

Over the century ASTM has then been engaged in standardization in a growing numbers of different sectors and activities.

ASTM has it headquarter near Philadelphia with office in Washington DC, Mexico City and Beijing.

Over 3000 ASTM standards have been developed, based on the work of over 30 000 ASTM members in over 120 countries. ASTM standards have been adopted as either the basis of national standards or referenced in regulation by 66 countries outside the U.S.

3.3 Canada - CGSB etc

The accredited standards development organizations in Canada are:

- The Canadian General Standards Board of the government of Canada (CGSB)
- Canadian Standards Association (CSA)
- Underwriters Laboratories of Canada (ULC)
- Bureau de Normalisation de Québec (BNQ)

The Canadian General Standard Board (CGSB) is a federal government organization that offers client-centred, comprehensive standards development and conformity assessment services in support of the interest of stakeholders such as government, industry and consumers.

As an active participant in the National Standards System of Canada, the CGSB offers a wide range of development services, including development of CGSB-standards as well as National Standards of Canada (NSC)

CGSB has among a number of other areas been involved in the standardization process of fuels.

3.4 Japan – JSA - JISC

The Japanese Standards Association (JSA) is an organization formed through the merger of the Dai Nihon Aerial Technology Association and the Japan Management Association. JSA was authorized by the Minister of Trade and Industry (MTI) in 1945. The objective of the association is to educate the public regarding the standardization and unification of industrial standards, and thereby to contribute to the improvement of technology and the enhancement of production efficiency.

Governmental committees of The Ministry of Economy Trade and Industry (METI) carry out the main standardization work in Japan, including standardization of conventional and alternatives fuels.

In Japan, industrial standardization exists on three levels national, industrial and company level. Japanese standards (that are identified by the abbreviation JIS, followed by a serial number) are national standards. Use of these standards is voluntary. Regarding automotive fuels, JIS standards cover industrial mineral products. These JIS standards are comparable to standards established by various industrial associations for their specific needs, or standards established by different companies, the so-called company standards (operational manuals and product specifications (JISIC))

The Japanese Industrial Standards Committee (JISC) consists of several national committees such as a Committee on ISO, a Committee on IEC, a Technical Committee on environment and recycling, a committee on JIS marketing and several other specific technical committees. JISC plays a central role in standardization activities in Japan. In essence, the task of JISC can be summarized as follows:

- Establishment and maintenance of JIS standards
- Administration of accreditation and certification
- Participation and contribution in international standardization activities
- Development of measurement standards and technical infrastructure standardization.

3.5 India - BIS

The Indian Standards Institution (ISI) was established 1947.

In the mid 1980s, the Indian government recognized the need for strengthening the national standardization body, due to the fast changing socio-economic situation in India. The Bureau of Indian Standards act was established in 1986, and early in 1987 The Bureau of Indian Standards (BIS) took over the responsibility for the work on standards from ISI, including the activities on product quality and management system certification.

Indian Standards (IS) are considered to be legal documents.

So far, BIS has published about 18000 Indian Standards, and among them are specification standards on automotive fuels.

3.6 Thailand – TISI

On January 1st, 1969, the Thai Industrial Standards Institute (TISI) was established as the national standards body of Thailand, under the Ministry of Industry. TISI was upgraded to departmental status under the Ministry of Industry in 1979.

The main mission of TISI is to develop national standards and monitor quality of products and services to be in line with national requirements and international practices as well as to provide public information on standardization and Thai standards.

TISI develops both mandatory and voluntary Thai standards.

3.7 Asian-Pacific Economic Cooperation (APEC)

The Asian-Pacific Economic cooperation (APEC) was established 1989 and is the premier forum for facilitating economic growth, cooperation, trade and investment in the Asia-Pacific region.

APEC works to reduce tariffs and other trade barriers across the Asia-Pacific region, creating efficient domestic economies and dramatically increasing export.

APEC has 21 members: Australia Brunei Darussalam, Canada, Chile, and People's Republic of China, Hong Kong, China, Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, The Republic of the Philippines, The Russian Federation, Singapore, Chinese Taipei, Thailand, The United States of America and Vietnam.

The APEC Energy Working group (EWG) is one of eleven APEC working groups. Its objective is to maximize the contribution of the energy sector to the regions economic and social well being through activities in a numbers of areas including "Energy supply and demand" and "New and renewable energy technologies". APEC/EWG has as one out of many initiatives started an Expert Group on New and Renewable Energy Technologies, to promote and facilitate the expanded use of new and renewable energy in sectors where it is cost effective.

One of the expert group's running projects has as key objective to establish guidelines for development of biodiesel specification standards in the APEC region and to enhance the trade of biodiesel among APEC member's economies. In this project the ASTM as well as the CEN specification standard on biodiesel will be taken into consideration, but with adaptation to the region's different feedstock and climate compared to the U.S. and Europe.

Furthermore, the purpose of the project is to offer a possibility for a sustainable energy source with a neutral effect on greenhouse gas emissions. A draft final report can be expected during 2009.

3.8 People's Republic of China – SAC

In April 2001, the State Council decided to set up the General Administration of Quality Supervision, Inspection & Quarantine of the People's Republic China (AQSIQ) and at the same time, to establish the Standard Administration of the People's Republic of China (SAC).

SAC is a governmental agency responsible for the national work on standardization, to exercise administrative responsibilities by undertaking unified management, supervision and overall coordination of standardization work in China.

Today there are more than 260 technical committees and more than 300 sub-committees active under the SAC.

Chinese standards can be classified into 4 categories:

- National standards
- Professional standards
- Local standards
- Enterprise standards

Today China has more than 20 000 national standards, 12500 professional standards and 34 000 local standards, which include standards on automotive fuels.

3.9 Brazil

In Brazil the national Agency of Petroleum, Natural Gas and Bio Fuels (ANP) -under law 9.478/97- is responsible for regulatory measures, contracting and monitoring economic activities related to the petroleum, natural gas and bio fuels industries. ANP is also responsible for specifying biofuel properties and monitoring their quality.

However, technical standards in Brazil are often made by the national standardizing body, the Brazilian Association for Technical Standards (ABNT), in co-operation with the national institute of metrology, standardization and industrial quality (INMETRO).

3.10 South Africa – SABS - STANZA

The South African Bureau of Standards (SABS) is an autonomous standardization body established by the Parliament.

SABS offers standards development, information and conformity assessment services and is committed to provide standardization services and development of standards within South Africa and internationally.

Standards South Africa (STANZA) publishes South African standards (SANS) including specification standards on gasoline, diesel oil as well as biodiesel and ethanol.

3.11 International Standardization Organisation - ISO

ISO is the world largest standards developing organization. It is established in 1947 by 25 countries, by a merger of two other organisations – the International Federation of the National Standardizing Associations (ISA) and the United Nations Standards Coordinating Committee (UNSCC). ISO's main objective is to “facilitate the international coordination and unification of industrial standards”.

ISO is a non-governmental organization that is meant to form a bridge between the public and private sectors. It is based in Geneva (central secretariat) and today it has 157 members (1 per country), from all over the world.

Between 1947 and present, ISO has published more than 16 500 international standards that are ranging from standards for activities such as agriculture and construction, through mechanical engineering and medical devices, to the newest information technology developments.

ISO cooperates/networks with similar organisations such as ASTM and CEN. Concerning the cooperation with CEN, there is a signed agreement between ISO and CEN on technical cooperation, the so-called Vienna Agreement.

Regarding fuels and energy related activities, ISO has committees covering coal, gas, petrol, nuclear, hydrogen and solar. ISO also has committees working on fuel consuming products such as road vehicles (ISO TC 22) and Gas Turbines (ISO TC 192).

ISO’s activities on alternative fuels are rather limited. The work on alternative fuels that is being executed within ISO focuses on other applications than automotive use. Previous sections of this report present some information about ISO's work in this area, mainly under the sub-headings LPG, methane and DME.

4. Standards on biodiesel (FAME/FAEE)

The word biodiesel is often used for Fatty Acid Methyl Ester (FAME). FAME is in turn a "family name" for different products that are produced by methylisation (by the use of methanol) of primarily different vegetable oils, possibly also animal fats. As the name biodiesel indicates, biodiesel is a fuel to replace fossil diesel oil. Biodiesel can be blended into fossil diesel oil or used in neat (100%) form in diesel engines (compression ignition engines). However, some restrictions on biodiesel end-use exist.

The feedstock for the oil can vary. In Europe rapeseed is the most common feedstock, resulting in rapeseed methyl ester (RME). Also soy been oil and recycled frying oils are used to some extent, but RME is the dominant FAME product in Europe.

In the U.S. and Canada soy bean is the most common feedstock for biodiesel (SME). There is also an increasing use of recycled frying oils, animal fat, sunflower oil and palm oil in the U.S. but the quantities are still small.

In India and Brazil, jatropha and pongania, respectively jatropha, castor and mamona are possible feedstock for biodiesel production.

The commercial biodiesel/FAME production in Thailand is based on national raw material such as palm oil and waste cocking oil, while community-based biodiesel production is based on raw materials such as jatropha but also waste cooking oil.

It is possible to use ethanol instead of methanol when producing biodiesel from vegetable oils. Then the product will be a Fatty Acid Ethyl Ester (FAEE), which has very similar properties compared to FAME that is produced from the same feedstock.

4.1 The European Organization for Standardization and national standards on the European level

Biodiesel: Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines - Requirements and test methods - **EN 14214**

Biodiesel (The Czech Republic): Biodiesel Diesel fuel blends (containing rape seed oil methyl ester – Requirements and test methods - **CSN 656508:2003**.

Diesel oil: Automotive Fuels – Diesel – Requirement and Test Methods - **EN 590**

In Europe some countries have had their own FAME specification standard, for example Sweden, Germany and Austria, but today these specification standards have been replaced by the common European – CEN specification standard EN 14214.

The European/CEN FAME specification standard can be used for both neat use of biodiesel and for blending of biodiesel in conventional diesel. When blending in diesel oil the maximum amount of FAME is regulated by the European/CEN diesel oil specification standard EN 590, in which the maximum level of FAME today is restricted to 5%. The maximum amount of biodiesel in diesel oil is also restricted in the EU directive 98/70/EC, updated by directive 2003/17/EC.
However, for the moment there is also a process running to redraft this directive (Communication - COM (2008)19). One of the issues for discussion is to increase the level of biodiesel blending up to maximum 10 %.

There are some examples of national specification standards for higher blending of FAME in diesel oil. The Czech Republic has a specification standard for blending (5 – 30 %) – Diesel fuel blends (containing rape seed oil methyl ester – Requirements and test methods, CSN 656508:2003 Furthermore, in Germany DIN has set up a specification standard DIN V 51605 for rapeseed oil.

The European Commission (through the BIOScopes study, se reference list) supports work to improve the existing biodiesel or rather FAME specification standard, with a focus on some of the test methods on ester content etc, for more information see Bioscopes report “Improvement needed for the biodiesel standard EN 14214”.

The European Commission has also given CEN a mandate (M/393) to revise the diesel oil specification standard (EN 590) with the purpose to, if possible, allow up to 10% blending of FAME in diesel oil.

The European Commission also supports the work on a Fatty Acid Ethyl Ester (FAEE) specification standard through the work in the BIOscope project, see BIOscopes report “Fatty acid ethyl esters”.

A mandate (M/394) has also been given to CEN regarding a specification standard for the use of FAEE in diesel engines and as a heating fuel.

Furthermore, the French Oil institute (IFP) with support from CEN and the European Commission is working on a study with the purpose to come up with a proposal for a joint FAME and FAEE specification standard.

Table 1 Example of parameters in CEN standard EN 14214:2003 Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines - Requirements and test methods

Parameter	**Value**
Ester content min	96.5 % (m/m)
Density at 15^{o}C	860-900 kg/m^3
Viscosity at 40 ^{o}C	3.5 – 5.0 mm^2/s
Flash point, min	120 ^{o}C
Sulfur content, max	10.0 mg/kg
Cetane number, min	51.0
Water content, max	500 mg/kg
Oxidation stability at 110 ^{o}C, min	6 hours
Acid value, max	0.5 KOH/g
Iodine value, max	120 g Iodine/100 g
Methanol content, max	0.20 % (m/m)
Monoglyceride content, max	0.8 % (m/m)
Diglyceride content, max	0.20 % (m/m)
Triglyceride content, max	0.20 % (m/m)
Total glycerol, max	0.25 % (m/m)
Phosphorous content, max	10.0 mg/kg

4.2 USA –ANSI (American National Standards Institute) and ASTM International

Biodiesel: Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels - **ASTM - D 6751**

Diesel oil: Standard Specification for Diesel Fuel Oils – **ASTM D 975**

The ASTM Biodiesel (FAME) (B100) specification standard D 6751 is only for blending purposes (up to 20% biodiesel) and not for use of the biodiesel in neat form. As a result, some parameters with specific relevance for neat use (such as cold flow properties and stability) are not included in the ASTM specification standard. The ASTM specification standard also lacks minimum ester content.

However, in the U.S. there are currently no specification standards for blending of biodiesel/FAME and diesel oil. But, if B100 meets ASTM D 6751 and the fossil diesel oil meets ASTM D 975, up to 20% biodiesel can be blended to the biodiesel oil.

For the moment there is ongoing work on biodiesel specification standards in ASTM and there are also discussions concerning a B5 as well as a B20 specification standard. There are furthermore discussions concerning an amendment of the ASTM diesel oil specification standard (D 975) to allow up to 5% v/v blending of biodiesel in diesel oil.

ASTM D 6751 is a general specification standard for alkyl esters, whether they are methyl- or ethyl esters. However, there are no known production and use of FAEE in the U.S

Table 2 Examples of parameters in ASTM standard D 6751 Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels

Parameter	**Value**
Viscosity at 40 ^{o}C	1.9 – 6.0 mm^2/s
Flash point, min	130 ^{o}C
Sulfur content, max	15.0 mg/kg
Cetane number, min	47.0
Water and sediment, max	0.050 % (v/v)
Oxidation stability at 110 ^{o}C, min	3 hours
Acid value, max	0.5 KOH/g
Free glycerol/glycerin, max	0.02 / (m/m)
Total glycerol, max	0.240 % (m/m)
Phosphorus content, max	0.001 % (m/m)
Distillation, 90 % recovered max	360 ^{o}C

4.3 Canada

Biodiesel: Automotive (On-road) Diesel Fuel Containing Low Levels of Biodiesel Esters (B1 – B5) – **CGSB 3.520-2005**

Diesel: Automotive Low sulfur Diesel Fuel – **CGSB 3.517-2007**

In Canada CGSB has set up a national specification standard for diesel fuel and biodiesel. The CGSB specification standard is in place for 1-5 % biodiesel content in diesel oil (CGSB 3.520-2005) while amount lower than 1 % is considered an additive.

There are also discussions in Canada regarding a B6-B20 specification standard.

4.4 Japan

Biodiesel: Fatty Acid methyl ester (FAME) as blend stock – JIS K 2390:200

Diesel: Diesel fuel – **JIS 2204:2004**

An investigation carried out by the Japanese Ministry of Economy, Trade and Industry (METI) has just finalized the work on a Japanese non mandatory specification standard (JASO/JIS) for FAME as a blending component in diesel oil, as well an amended a mandatory diesel oil specification standard established under the Law of Quality Control of Gasoline allowing up to 5% m/m FAME in diesel oil as long as the content of methanol is not higher than 0.01 % (m/m). The Japanese FAME specification standard is similar to the European CEN FAME specification standard (EN 14214).

However, since the standard specification is for blending purposes, parameters with importance for neat use (such as for example oxidation stability and cold flow properties) are not included.

The Japanese Ministry of Agriculture, Forestry and Fishery (MAFF) as well as the Ministry of Land and Infrastructure for Transport (MLIT) and the Ministry of the Environment (MOE) are also interested and engaged in studying FAME.

Table 3 examples of parameter in the Japanese specification standard on FAME for blending purposes JIS K 2390:2008

Parameter	**Value**
Ester content, min	96.5 % (m/m)
Density	0.86 – 0.90 g/ml
Viscosity at 40 ^oC	3.5 – 5.0 mm^2/s
Flash point, min	120 ^oC
Sulfur content, max	10.0 ppm
Cetane number, min	51.0
Water, max	500 ppm
Methanol, max	0.20 % (m/m)
Acid value, max	0.5 KOH/g
Mono glyceride, max	0.80 % (m/m)
Di glyceride, max	0.20 % (m/m)
Tri glyceride, max	0.20 % (m/m)
Free glycerin, max	0.02 % (m/m)
Total glycerin, max	0.25 % (m/m)
Phosphorus content, max	10 ppm

4.5 India

Biodiesel: Biodiesel specification - **IS 15607:2005**

Diesel oil: Diesel - **IS 1460:2005**

India has a national specification standard for diesel oil (IS 1460), which allows biodiesel (B100) to be used as a blending component in diesel oil up to 5% v/v. The specification standard includes methyl as well as ethyl esters.

There is also a specification standard for the biodiesel to be used (IS 15607:2005). According to the specification standard, it is acid alkyl (methyl or ethyl) ester for use as blending component up to 20% v/v. However, as already mentioned, today the Indian diesel oil specification standard only allows up to 5% v/v biodiesel (FAME/FAEE) in diesel oil.

The specification standard is similar to the European/CEN as well as the ASTM specification standards, but also considers the impact of having jatropha and pongania as feedstock.

Table 4. Examples of parameters in the Indian Biodiesel specification standard IS 15607:2005 Biodiesel specifications (for blending in diesel oil up to 20%)

Parameter	**Value**
Ester content, min	96.5 % (m/m)
Density at 15 ^{o}C, max	860 – 900 kg/m^3
Viscosity at 40 ^{o}C	2.5 – 6.0 mm^2/s
Flash point, min	120 ^{o}C
Sulfur content, max	50.0 mg/kg
Cetane number, min	51.0
Water, max	500 mg/kg
Methanol, max	0.20% (m/m)
Ethanol, max	0.2 % (m/m)
Acid value, max	0.5 KOH/g
Free glycerol, max	0.02 % (m/m)
Total glycerol, max	0.25 % (m/m)
Phosphorus content, max	10 mg/kg

4.6 Thailand

Biodiesel: Standard specification of FAME B100 for Agricultural Engines (Biodiesel for Communities)

Biodiesel: Standard Specification of Biodiesel, FAME B100 (commercial-based Biodiesel)

In Thailand the Department of Energy Business under the Ministry of Energy has set up specification standards for commercial-based as well as community-based biodiesel. These specification standards are in force since October 1, 2006, and July 21, 2006, respectively.

Table 5 Examples of parameters in Thailand's specification standard on Biodiesel for Agricultural Engines (Biodiesel for communities)

Parameter	**Value**
Density at 15 ^oC, min	*860 kg/m^3*
Viscosity at 40 ^oC, min	1.9 CSt
Flash Point, min	120 ^oC
Sulfur, max	0.0015 % (v/v)
Cetane number, min	47
Water and sediment, max	0.2 % (v/v)
Acid number, max	0.8 mg KOH/g
Free glycerin, max	0.02 % (v/v)
Total glycerin, max	1.5 % (v/v)

Table 6 Examples of parameters in Thailand's specification standard on Biodiesel FAME (Commercial-based Biodiesel)

Parameter	**Value**
Methyl Ester, min	96.6 % (v/v)
Density at 15 ^oC, min	860 kg/m^3
Viscosity at 40 ^oC, min	3.5 CSt
Flash Point, min	120 ^oC
Sulfur, max	0.0010 % (v/v)
Cetane number, min	51
Water, max	0.050 % (v/v)
Oxidation stability at 110 ^oC, min	6 hours
Methanol, max	0.2 % (v/v)
Acid number, max	0.5 mg KOH/g
Monoglyceride, max	0.80 % (v/v)
Di glyceride, max	0.20 % (v/v)
Tri glyceride, max	0.20 % (v/v)
Free glycerin, max	0.02 % (v/v)
Total glycerin, max	0.25 % (v/v)

4.7 People's Republic of China

Diesel oil: Diesel oil for vehicle use **– GB/T19147-2003**

China sometimes has a problem with poor diesel oil quality with dark color, a cetane number of as low as 40, a sulfur content ranging from below 0.2% m/m up to 0.5% m/m and an aromatic content between 30% v/v and 50% v/v.

In order to improve the quality of diesel oil and to meet national environmental protection requirements, the state authority has set up a quality upgrading program and national specification standards have been implemented, as shown below.

Table 7 Examples of parameters in Chinas specification standard GB/T 19147-2003 Diesel oil for vehicle use

Parameter	**Value**
Sulfur content, max	0.05 % (m/m)
Lubricity, Wear scar diameter (60 ^{o}C), max	460 um
Kinematic viscosity (20 ^{o}C), max	3.0 – 3.8 2.5 – 8.0 1.0 – 7.0 mm^2/h
Flash point (closed end)	55, 50, 45 ^{o}C
Cetane number, min	49
Cetane index, min	46
Distillation range, 50 % recovery temperature, max	300 ^{o}C
Distillation range, 90 % recovery temperature, max	355 ^{o}C
Distillation range, 95 % recovery temperature, max	365 ^{o}C
Density (20 ^{o}C), min - max	820 – 860 800 – 840 kg/m^3

To meet new requirement of diesel oil hydrogenation, refining and desulphurization will be increased at the refineries.

However, China also considers biodiesel as a clean substitute to diesel oil possible to produce from indigenous raw material such as:

* Recovered waste oil,
* Wild oil crop,
* Waste animal/seed oil,
* Leftover seed oil,
* Neutral grease,
* Acidizing oil,
* Waste edible oil,
* Left over from grease plants.

In 2006 China used the former German DIN specification Standard DIN 51606-1997 for biodiesel.

4.8 Brazil

Biodiesel: Blending component in diesel oil - ANP **No 42 Act 05/2005**

As a result of the Brazilian governmental efforts to initiate the use of biodiesel, there is a regulation on a commercial specification for biodiesel since 2005 (ANP No 42 Act 05/2005).

Brazil is also engaged in finding new feedstock for biodiesel production such as jatropha, castor and mamona.

Table 8 Examples of parameters in the Brazilian biodiesel specification standard (ANP No 42 Act 05/2005). *Specification of biodiesel for automotive use*

Parameter	**Value**
Flash point, min	100 ^{o}C
Water and sediment, max	0.05 % (v/v)
Oxidation stability (110 ^{o}C), min	6 hours
Methanol content, max	0.5 % (m/m)
Total glycerol, max	0.38 % (m/m)

Figures for example ester content, density, viscosity etc shall be reported, but so far no values have been decided on.

4.9 South Africa

Biodiesel: Automotive biodiesel fuel - **SANS 1935:2004**

Diesel fuel: Automotive diesel fuel - **SANS 342:2006**

Since the 1950s, South Africa has produced synthetic fuels from coal. Today also natural gas is used as feedstock. It is clear that the South African standards take the “synfuel” industry in South Africa into account, and also their possibilities to meet the specifications for different parameters in their synthetic vehicle fuels. Furthermore, the specification standards have been designated to ensure that the fuels can be used without complications under South African conditions. For example, a large part of the vehicles is operating at high altitude (1600 meter or more above sea level).

In 2006 the sulfur content in diesel oil was reduced to maximum 500 ppm. Additionally, a diesel oil grade with a maximum sulfur content of 50 ppm exists for application in niche markets.

Even though diesel oil are not alternative fuels, table 23 present selected parameters of the South African diesel fuel specifications to give an impression of today’s South African fuel standards situation, and how blending of biodiesel in diesel oil are taken into account in this specification standard.

Table 9 Selected parameters of the South African Automotive diesel fuel specification standard SANS 342:2006

Parameter	**Value**
Sulfur content, standard grade, max	500 mg/kg
Sulfur content, low sulfur grade, max	50 mg/kg
Biodiesel content (SANS 1935), max	5 % (v/v)
Cetane number, min	45
Flash point, min	55 ^{o}C
Lubricity (WSD 1,4) at 60 ^{o}C, max	460
Viscosity at 40 ^{o}C, min – max	2.2 – 5.3 mm^2/s
Density at 20 ^{o}C, min	0.8000 kg/l

The South African biodiesel specification standard is essentially the same as the European EN 14214 biodiesel specification standard, except for the iodine value.

5. Standards on alcohols

When speaking about alcohols as a vehicle fuel, it mainly concerns methanol and ethanol. Alcohols and in first hand ethanol was the original fuel for which Henry Ford optimized his vehicle engines. However, soon oil took over the role as energy carrier for vehicles, in the U.S. and elsewhere. Later -during the 70s, 80s and 90s- a number of fleet tests with neat methanol and methanol-gasoline blends were carried out in for example the U.S, Sweden and Japan. Today, methanol as a vehicle fuel is of growing importance in China.

However, ethanol is the most commonly used alcohol fuel for vehicles today. The use of ethanol started in Brazil during the 70s, using sugar cane as feedstock. This initiative was followed by corn based fuel ethanol production in the U.S. and grain based production in Sweden. More recently, sugar cane has become an important feedstock for the production of fuel ethanol in South East Asia.

5.1 The European Organization for Standardization and national standards on the European level

Ethanol: Automotive Fuels – Ethanol as a blending component for petrol - Requirements and Test Methods - **prEN 15376**

E85: CEN Workshop Agreement 2005 on ethanol based E85 for FFV - **CWA 15293**

Ethanol (The Czech Republic): Fermentative denatured ethanol determine for application in automotive petrol – Requirements and test methods – **CSN 656511:2004**

Ethanol (Austria): Automotive fuels – Petrol Superethanol E 85 – Requirements and test Methods.

E85 (Sweden): Automotive Fuels – Ethanol E85 – Requirements and test methods - **SS 155480**

Ethanol (Sweden): Motor Fuels – Fuel Alcohols for high-speed diesel engines - **SS 155437**

Gasoline: Automotive fuels - Unleaded Petrol – Requirements and Test Methods - **EN 228**

Ethanol

Ethanol can be blended into regular European gasoline up to maximum 5% v/v (% by volume) according to the European/CEN specification standard for gasoline EN 228 and the so called fuel directive 98/70/EC, updated by directive 2003/17/EC.

For the moment the CEN has a Task Force working on a specification for ethanol, CEN/TC 19/WG21/TF – Specification for ethanol, which has presented a pre CEN specification standard pr EN 15376 for ethanol that is used for blending in gasoline (up to 5% v/v). However, for the moment there is also a process running to redraft this directive (Communication - COM (2008)19). One of the issues for discussion is to increase the level of ethanol blending up to maximum 10 %.

Table 10 Examples of parameters in CEN pre specification standard prEN 15 376 Automotive Fuels – Ethanol as a blending component for petrol - Requirements and Test Methods

Parameter	**Value**
Ethanol and higher alcohols, min	98.7 % (m/m)
Higher alcohols C3-C5, max	2.0 % (m/m)
Methanol, max	1.0 % (m/m)
Water content, max	0.3 % (m/m)
Inorganic Chloride content, max	20 mg/l
Phosphorus, max	0.5 mg/l
Sulfur, max	10 mg/kg
Acidity (as acetic acid), max	0.007 % (m/m)

CEN has (after discussions with the European Commission) also decided to make a revision of the European gasoline specification standard EN 228, to see if it is possible to include up to 10% v/v ethanol. If that appears to be possible, the coming specification standard for ethanol as a blending component might also be adjusted in the same way as the specification for FAME for blending in diesel oil. Then ethanol fulfilling the requirements in the specifications might be used for blending up to much higher levels than 5% and it might also be used in neat form (E100).

Currently the Czech Republic has an ethanol specification standard, CS 656511:2004 for ethanol to be used in the production of ETBE.

Currently there is no specification standard that allows blending of ethanol in diesel oil in Europe. Tests with ethanol in diesel oil so far have shown that there many problems regarding for example solubility, safety aspects and lubricity. However, in Sweden neat ethanol (E100) with an ignition improver additive is being used in adapted diesel engines (mainly in buses). For this purpose Sweden has since many years a technical specification standard: SS 155437 Motor Fuels – Fuel Alcohols for high-speed diesel engines. Earlier the specification standard included methanol as a possible alcohol, but after the latest revision, even though it is not yet fully clear, it seems that only ethanol could fulfill the requirements in the specification standard.

Table 11 Examples of parameters in the Swedish specification standard SS 155437 Motor Fuels – Fuel Alcohols for high-speed diesel engines

Parameter	**Value**
Ethanol content, min	92.4 % (m/m)
Density (at 15 ^{o}C)	805 +/- 10 kg/m^3
Acidity (as acetic acid), max	0.0025 % (m/m)
Acetic aldehyde, max	0.0025 % (m/m)
Sulfur, max	10 mg/kg

E85

During the last 3 to 5 years the number of so called Flexible Fuel Vehicles (FFV), which can run on all kinds of ethanol/gasoline blends, from neat gasoline up to a mix of 85% ethanol and 15% gasoline (v/v), has increased in Europe. In Sweden the number of FFVs has increased from approximately 2000, in the beginning of the year 2000, to approximately 100 000 by early 2008. With that in mind, some countries and other stakeholders together with Ford initiated a CEN workshop on the issue of a technical fuel specification for E85. Such a specification (workshop agreement) based on work in CEN as well as ASTM has been agreed upon by the participants (CWA 15293:2005). So far the agreement has been used at least in Germany and the Netherlands. Sweden, Austria and France have transcribed it into a Swedish E85 standard (SS 155480) an Austrian E85 standard (ÖNORM C 1114) and into a French standard. CEN has also established a task force, CEN/TC 19/WG 21/TF – Specification for ethanol (E85) as automotive fuel, with the purpose to take the workshop agreement further to, if possible, a proposal for an E 85 specification standard.

Table 12 Examples of parameters in CEN Workshop agreement CWA 15293 Automotive fuels – Ethanol E85 – Requirements and test methods

Parameter	**Class A Value**	**Class B Value**
Ethanol and higher alcohols, min	75 % (v/v)	70 % (v/v)
Gasoline (EN 228), min – max	14 – 22 % (v/v)	14 – 30 % (v/v)
Vapor pressure, min – max	35.0 – 60.0 kPa	50.0 – 100 kPa

Parameter	**Value**
Research octane number (RON), min	95
Motor octane number (MON), min	85
Higher alcohols (C_3 – C_8), max	2.0 % (v/v)
Methanol, max	1.0 % (v/v)
Ethers (C_5 or more), max	5.2 % (v/v)
Water content, max	0.3 % (v/v)

Table 13 Examples of parameters in the Swedish specification standard SS 155480 Automotive Fuels- Ethanol E85 – Requirements and test methods

Parameter	**Summer Value**	**Winter** Value
Ethanol and higher alcohols, min	75 % (v/v)	70 % (v/v)
Gasoline (SS 155422), min – max	14 – 25 % (v/v)	14 – 30 % (v/v)
Vapor pressure, min – max	35.0 – 70.0 kPa	50.0 – 95 kPa

Parameter	**Value**
Research octane number (RON), min	95
Motor octane number (MON), min	85
Higher alcohols (C_3 – C_8), max	2.0 % (v/v)
Methanol, max	1.0 % (v/v)
Ethers (C_5 or more), max	5.2 % (v/v)
Water content, max	0.3 % (v/v)

Methanol

Concerning methanol, the European gasoline specification standard EN 228 allows up to 3% v/v blending in gasoline. Today, according to communication (COM (2008)19) there are no discussions in CEN concerning a European fuel methanol specification standard. It is more likely that the European commission in its redrafted “Fuel directive” further might restrict the possibility to blend methanol into gasoline to a lower level.

5.2 USA –ANSI (American National Standards Institute) and ASTM International

Fuel Ethanol: Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines - **ASTM – D 5798**

Denatured ethanol: Standard Specification for Denatured Fuel Ethanol for Blending with Gasoline for Use as Automotive Spark-Ignition Engine Fuel – **ASTM D 4806**

Gasoline: Standard specification for Automotive Spark-Ignition Engine Fuel – **ASTM D 4814**

Ethanol

Already in 1988 the ASTM specification standard D 4814 on gasoline and gasoline blends was established. This specification standard allows up to 10% v/v ethanol in gasoline. D 4814 has been adopted by 31 US States, while 13 States have developed their own gasoline standard.

Furthermore in 1988 ASTM established an ethanol specification standard (D 4806) for denatured ethanol to be used as a blending component in gasoline. This specification standard applies for ethanol concentrations up to 10% v/v. D 4806 is today adopted by 12 US States.

Table 14 Examples of parameters in ASTM specification standard D 4806 Specification for Denatured Fuel Ethanol for Blending with Gasoline for Use as Automotive Spark-Ignition Engine Fuel

Parameter	**Value**
Ethanol and higher alcohols, min	92.1 % (v/v)
Methanol, max	0.5 % (m/m)
Water content, max	1.6 % (m/m)
Denaturant content	1.96 – 5.0 % (v/v)
Inorganic Chloride content, max	40 mg/l
Sulfur, max	30 ppm
Acidity (as acetic acid), max	0.007 % (m/m)

E85

Considering fuel ethanol or rather E85 for Flexible Fuel Vehicles (FFV), ASTM established a specification standard for E75 – E85 fuel in 1996 (D 5798). 18 US States have adopted D 5798 and the number of adopting States seem to grow. An ASTM Task Group was also initiated in June 2006 to examine all D 5798 specifications, including some of the D 4806 denatured ethanol specifications.

Table 15 Examples of parameters in ASTM specification standard D 5798 Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines

Parameter	**Value Class 1**	**Value Class 2**	**Value Class 3**
Ethanol + higher alcohols, min	79 % (v/v)	74 % (v/v)	70 % (v/v)
Hydrocarbon/aliphatic ether, min - max	17 – 21 % (v/v)	17 – 26 % (v/v)	17 – 30 % (v/v)
Vapor pressure, min - max	38 – 59 kPa 5.5 – 8.5 psi	48 – 65 kPa 7.0 – 9.5 psi	66 – 83 kPa 9.5 – 12.0 psi
Sulfur, max	210 mg/kg	260 mg/kg	300 mg/kg

Parameter	**Value**
Methanol, max	0.5 % (v/v)
Higher alcohols (C_3 - C_5), max	2 % (v/v)
Acidity (as acetic acid), max	0.005 % (m/m) 40 mg/l
pH_e, min - max	6.5 – 9.0
Inorganic chloride, max	1 mg/kg
Water, max	1.0 % (m/m)

5.3 Canada

Ethanol: Oxygenated Unleaded Automotive Gasoline Containing Ethanol – **CGSB 3.511-2005**

Gasoline: Unleaded Automotive Gasoline **– CGSB 3.5-2004**

In Canada CGSB has set up a national specification standard on fuel ethanol for blending in gasoline.

Table 16 Examples of parameters for the ethanol in CGSB specification standard 3.511-2005 Oxygenated Unleaded Automotive Gasoline Containing Ethanol

Parameter	**Value**
Ethanol, min	92.0 % (v/v)
Water content, max	1.0% (m/m)
Ethanol denaturant content, max	4.76 % (v/v)
Sulfur, max	40 mg/l
Acidity (as acetic acid), max	40 mg/l
Methanol, max	0.5 % (v/v)

5.4 Japan

Gasoline: Gasoline - **JIS K 220**

According to the Japanese gasoline specification standard, up to 3% (v/v) ethanol can be blended into gasoline as long as the oxygen content is kept at a level of maximum 1.3 % (v/v). However, no methanol is accepted in gasoline.

5.5 India

Ethanol: Specification of anhydrous Ethanol for use in automotive fuels - **IS 15464:2004**

Gasoline: Motor Gasoline - **IS 2796:2000** (reaffirmed 2005)

India has a gasoline specification (IS 2796), which allows up to 5% ethanol in gasoline since the year 2000. The ethanol has to be denatured and in line with the Indian specification standard IS 15464:2004. This specification standard is also valid for ethanol for mixing with diesel oil.

There is also a study running In India for the evaluation of the possibilities (focused on engine performance and possible impact on engine etc) to accept blending of up to 10% ethanol in gasoline, and if this would be acceptable to redraft the Indian specification standard for that purpose.

Table 17 Examples of parameters in the Indian ethanol specification standard IS 15464:2004 Specification of anhydrous Ethanol for use in automotive fuels

Parameter	**Value**
Ethanol, min	99.5 % (v/v)
Methanol, max	300 mg/l
Aldehydes, max	60 mg/l
Acidity (as acetic acid), max	30 mg/l

5.6 Thailand

In Thailand ethanol is produced from sugar- and starch-based materials such as sugarcane, molasses and cassava. Most of the ethanol production (95%) is used as solvents for general purposes. However, anhydrous ethanol (99.5% ethanol content) is blended with gasoline (a mixture known as gasohol in Thailand) and used in gasoline engines.

Thailand has two different technical specifications for gasoline: Gasohol octane 91 and Gasohol octane 95. Both standards demand a minimum content of 9% v/v denatured ethanol and a maximum ethanol content of 10% v/v.

5.7 People's Republic of China

Ethanol: "Production standard" of ethanol for vehicle use.

Methanol: Quality standard for methanol **– GB338-92**

Gasoline: Lead free gasoline for vehicle use **– GB17930-1999**

Because of high catalyzing capacity in the refineries in Peoples Republic of China (China), the olefin content in Chinese gasoline is relative high, about 43%. Furthermore, all together the catalytic components account for about 80% of the total gasoline components.

In order to improve the quality of gasoline and to meet national environmental protection requirements, the state authority has set up a quality upgrading program and National specification standards have been implemented, as shown below.

Table 18 Examples of parameters in Chinas specification standard GB 17930-1999, Lead free gasoline for vehicle use

Parameter	Value
Research octane number (RON) min - max	90 – 93, 93 – 95, >95
Vapor pressure, Sept 16 – March 15, max	88 kPa
Vapor pressure, March 16 – Sept 15, max	74 kPa
Sulfur Content, max	0.05 %
Benzene content, max	2.5 % (v/v)
Aromatic content, max	40 % (v/v)
Olefin content, max	35 % (v/v)

The upgrading of the gasoline quality in China will be implemented in three steps:

* Generally reduce the sulfur content to below 0.05%, starting from July 2005, to be able to meet the Europe II emission standards.
* Implement the No. III exhaust emission standard for light-duty vehicles (Guo III, equivalent to the EU III emission standard) in the whole country, starting from July 2007, with a reduction of the olefin content to below 18%, the aromatic content to below 42% and the sulfur content to below 150 ppm.
* Implement the No. IV exhaust emission standard for light-duty vehicles (Guo IV, referenced to the EU IV emission standard) in the whole country, starting from July 2010, with sulfur content below 50 ppm, and in some big cities a sulfur content below 15 ppm.

Ethanol
Apparently China does not have an official specification standard for ethanol as a vehicle fuel. However in a report, see reference list a so called production standard of ethanol for vehicle use is shown but without any standard number etc.

Table 19 Examples of parameters in Chinas "Production standard" of ethanol for vehicle use

Parameter	Value
Ethanol, min	92.1 % (v/v)
Methanol, max	0.5 % (v/v)
Water content, max	0.8 % (v/v)
Inorganic chlorine, max	32 mg/l
Denaturant, min – max	2.0 – 5.0 % (v/v)
Density (20 ^{o}C), min – max	0.7918 – 0.7893 g/cm^{3}

Methanol
In China methanol is regarded as a possible substitute of gasoline, with good combustion performance, high octane number and reduced exhaust gas emissions in comparison with gasoline. With that in mind the Chinese authorities have supported research and popularization of methanol as a substitute for gasoline, as well as low level blends in gasoline as a Flexible Fuel Vehicle fuel.

During the last two decades both blending from 3 to 15% (M3, M5, M10 and M15) as well as neat (M100) methanol have been tested in several fleet trials with LD-vehicles, HD-vehicles and buses.

However, no national technical specification standard in China for the use of methanol as a vehicle fuel has been found, but according to information, se reference list, there might be some local standards.

When methanol is used as a vehicle fuel, technical specifications for other applications of methanol are used. The exception for vehicle use is that the content of higher alcohols in the methanol is not as strict as for some other applications.
Below, a product specifications and quality standards adopted by methanol production enterprises in China are presented.

Table20 Examples of parameters in Chinas quality standard GB 338-92 l Quality standard for methanol

Parameter	**Supreme quality**	**First quality**	**Acceptable part**
Density (20 ^{o}C), min – max	0.791 – 0.792 g/cm^{3}	0.791 – 0.793 g/cm^{3}	0.791 – 0.793 g/cm^{3}
Temperature range (0 ^{o}C, 101.325 kPa), min – max	64.0 – 65.5 ^{o}C	64.0 – 65.5 ^{o}C	64.0 – 65.5 ^{o}C
Boiling range, max	0.8 ^{o}C	1.0 ^{o}C	1.5 ^{o}C
Water content, max	0.10 %	0.15 %	------

5.8 Brazil

Ethanol – ANP Act 36/2005

Since 1974 Brazil has by law a national ethanol program. According to this program, ethanol has been used for many years in two different forms:

- Anhydrous ethanol mixed with gasoline, 20 – 25% v/v (compulsatory).
- Hydrous ethanol used in ethanol cars (E100) and Flexible Fuel Vehicles (FFV) (voluntary).

Brazil has two different ethanol specification standards. One is for anhydrous ethanol and one for hydrous ethanol. Both are under regulation ANP Act 36/2005.

Anhydrous ethanol is blended in all gasoline up to a level of 20 – 25% v/v, while hydrous ethanol is used in vehicles optimized for E100 or in Flexible Fuel Vehicles (FFVs).

Table 21 Examples of parameters in the Brazilian ethanol specification standard (ANP Act 36/2005**)** *Specification of anhydrous ethanol for automotive use*

Parameter	**Value**
Ethanol content, min	99.6 % (v/v)
Ethanol and higher alcohols, min	99.3 % (m/m)
Higher alcohols (C_3 – C_5), max	3.0 % (v/v)
Sulfur, max	30 ppm
Density at 20 ^oC, min	791.5 kg/m^3

Table 22 Examples of parameters in the Brazilian ethanol specification standard (ANP Act 36/2005**)** *Specification of hydrated ethanol for automotive use*

Parameter	**Value**
Ethanol content, min	95.1 % (v/v)
Ethanol and higher alcohols, min – max	92.6 – 93.8 % (m/m)
Sulfate, max	4 mg/kg
Density at 20 ^oC, min – max	807.6 – 811.0 kg/m^3

5.9 South Africa

Ethanol: Standard on specification for denaturated fuel ethanol for blending with gasoline, for use as automotive spark-ignition engine fuel - **SANS 465:2005**

Gasoline: Unleaded petrol - **SANS 1598:2006**

Since the 50s, South Africa has produced synthetic fuels from coal. Today also natural gas is used as feedstock. It is clear that the South African standards take the “synfuel” industry in South Africa into account, and also their possibilities to meet the specifications for different parameters in their synthetic vehicle fuels. Furthermore, the specification standards have been designated to ensure that the fuels can be used without complications under South African conditions. For example, a large part of the vehicles is operating at high altitude (1600 meter or more above sea level).

It is worth to notice that South Africa phased out leaded gasoline as late as January 1st, 2006, although unleaded gasoline has been a market commodity since 1996

Even though gasoline is not a alternative fuel, tables 23 present selected parameters of the South African gasoline fuel specifications to give an impression of today’s South African fuel specification standards situation, and how blending of alcohols in gasoline is taken into account in these standards.

Table 23 Selected parameters of the South African unleaded metal free gasoline (Petrol) specification standard SANS 1598:2006

Parameter	**Value**
Research octane number (RON)	91, 93, 95
Motor octane number (MON) for petrol blends containing less than 2 % (v/v) alcohol	81, 83, 85
Motor octane number (MON) for petrol blends containing more than 2 % (v/v) alcohol	83, 85, 87
Lead content, max	13 mg/l
Aromatic content, max	50 % (v/v)
Benzene content, max	5 % (v/v)
Sulfur content, max	500 mg/kg
Reid vapour pressure (RVP), min – max	45 – 75 kPa
Oxygen content inland, max	3.7 % (m/m)
Oxygen content coastal, max	2.8 % (m/m)

6. Standards on gaseous fuels

6.1 Liquefied Petroleum Gas – LPG

Petroleum products LPG - ISO 8216-3 and ISO 9162

Standard specification for LPG - ASTM 1835

Automotive Fuels – LPG – Requirements and test method - EN 589,

Technical specification for LPG for vehicle use - GB19159-2003

Liquefied Petroleum Gas (LPG) is a rest product from the refinery industry, consisting of propane, propene, butane and mixtures of these compounds. LPG can be used for different purposes, mainly in industries and for heating, but it can also be used as a fuel in spark ignition engines. In some countries such as the Netherlands and Italy, LPG has had and still has a significant market share as vehicle fuel. Approximately 20 years ago LPG was also a commonly used alternative fuel in Sweden, but because of changes in taxation the use of LPG more or less disappeared overnight.

ISO, ASTM and CEN all have published specification standards for LPG.

ISO has two specification standards, ISO 8216-3 and ISO 9162 (from 1989) Petroleum products LPG, which give the base for classification as well as the technical specification itself (9162) for LPG. However, these specification standards are mainly meant for international trade and not specifically for vehicle use.

The ASTM LPG specification standard (ASTM 1835 Standard specification for Liquefied Petroleum (LP) Gases) covers four basic types of LPG for use in applications such as domestic and industrial heating and as engine fuels.

The CEN LPG specification standard (EN 589, Automotive Fuels – LPG – Requirements and test methods) covers the use of LPG as vehicle fuel.

China has developed a specification standard for automotive LPG (GB19159-2003). Below are some examples of parameters included in the Chinese LPG specification standard.

Table 24 Examples of parameters in the Chinese Technical specification standard for LPG for vehicle use GB 19159-2003

Parameter	**Value Propane for vehicle use**	**Value propane and butane compound for vehicle use**
Vapor pressure (37.8 ^{o}C), max	430 kPa	430 KPa
Propane, min	-	60 %
Butane, max	2.5 %	-
Pentane, max	-	2 %
Propylene, max	5 %	5 %
Total sulfur content (10^{-6}) mass fraction, max	123	140

Furthermore, there are also examples of specification standards covering different components in LPG as well as technical standards covering installations in vehicles.

6.2 Methane

Compressed natural gas: Natural Gas - Designation of the quality of natural gas for use as a compressed fuel for vehicles – **ISO15403**

Compressed bio gas: Biogas as fuel for high – speed Otto engines – **SS155438**

6.2.1 Compressed natural gas and biogas – CNG/CBG

Compressed natural gas (CNG) is a fossil alternative fuel that is a huge energy source for heat and electricity production. Over the years natural gas has also gained importance as vehicle fuel, in countries such as Argentina, Brazil, Pakistan, China and Italy.

Since the natural gas composition differs all over the world, it has been difficult to agree on a global natural gas specification standard. However, the ISO specification standard ISO 15403 “Natural Gas – Designation of the quality of natural gas for use as a compressed fuel for vehicles” has in several cases been used as a starting point.

No Chinese specification for CNG has been found, but so called “main physical and chemical indicators” have been found in reports.

Table 25 Examples of Chinese main physical and chemical indicators of natural gas

Parameter	**Value**
Combustible concentration range	5 – 15 % (v/v)
Self ignition point	630 -730 ^{o}C
Specific density (Air = 1.0)	0.65
Octane number	130

Biogas, methane from digestion of biomass, is a growing alternative vehicle fuel in Sweden but also in other countries such as France and Italy.

Many years ago Sweden established a national specification standard for biogas used in vehicles, SS 15 54 38. This specification standard might be used as a base for the production of other national specification standards, at least in Europe.

Table 26 Examples of parameters in the Swedish technical specification standard for biogas as vehicle fuel SS 15 54 38

Parameter	Value Biogas A (lean-burn engines without lambda sond/closed loop control)	Values Biogas B (stoichiometric combustion, engines with lambda sond/closed loop control)
Wobbe index	44.7 – 46.4 MJ/Nm^3	43.9 – 47.3 MJ/Nm^3
Methane (at 273.15 K and 101.325 kPa)	97 +/- 1 % (v/v)	97 +/- 2 % (v/v)
Water content, max	32 mg/Nm^3	32 mg/Nm^3
CO_2 + O_2 + N_2, max Of which max O_2	4.0 % (v/v) 1.0 % (v/v)	5.0 % (v/v) 1.0 % (v/v)
Total content sulfur, max	23 mg/Nm^3	23 mg/Nm^3
Total Nitrogen compounds (exclusive N_2) Calculated as NH_3, max	20 mg/Nm^3	20 mg/Nm^3
Particle size, max	1 micro meter	1 micro meter

Furthermore, there are also examples of technical standards covering installations for the use of natural gas or biogas (compressed) in vehicles.

6.2.2 Liquefied Natural Gas and Biogas – LNG/LBG

It has not been possible to find any specification standards for Liquefied Natural Gas or Liquefied Biogas. However, ISO discuss the possibility to start work on a LNG specification standard.

In Chinese reports there is also, in the same way as for CNG, presented so called main physical parameters for LNG as shown below.

Table 27 Examples of Chinese main physical indicators of liquefied natural gas

Parameter	**Value**
Boiling point (atm)	- 162.12 °C
Density (liquid)	0.42 kg/l
Latent heat of vaporization	121.8 kcal/kg
Methane content	90 – 99 % (v/v)
Calm value	9200 kcal/m^3
Research octane number	130
Liquid density/gas density	625:1

6.3 Di-Methyl Ether – DME

For many years, DME has been used as a propellant in spray cans. It has also become an energy carrier for heat production and it is also used as a household gas in countries such as India and Japan.

In the 1990s it was discovered in Denmark by the company Haldor Topsoe that DME also is an excellent fuel for compression ignition engines. However, since it is a gas at ambient pressure (similar to LPG), the conventional diesel oil injection system has to be replaced by a system that is adapted for DME, just as the vehicular fuel storage tank. The tanks, similar to LPG tanks, have to be constructed for a pressure up to approximately 5 – 7 bars, which is much lower than for CNG tanks.

There have been discussions about DME as a fuel in many forums and for example IEA/AMF has as a result of its Annex XIV presented a possible technical specification for DME.

Table 28 Examples of parameters in the proposed IEA/AMF automotive specification standard

Parameter	**Value**
Water	< 0,01 % (W/W)
Methanol	< 0,05 % (W/W)
Methyl Ethyl Ether	< 0,20 % (W/W)
Higher Alcohols	< 0,05 % (W/W)
Higher Ethers	< 0,05 % (W/W)
Ketones	< 0,05 % (W/W)
Odorant	20 ppm
Lubricant	500 – 2000 ppm

Also the International DME Association (IDA) has a technical DME specification on its agenda.

In China, as well as the rest of the world, DME is not yet used in quantities large enough to motivate work on a technical specification standard. However, in China two common product specifications, as shown below, can be used by most of the producers

Table29 Examples of Chinese product specification for industrial di-methyl ether

Parameter	**Value First Quality**	**Value Second Quality**	**Value Third Quality**
DME	99.9 %	99.0 %	98 %
Methanol	0.05 %	0.5 %	1.0 %
Moisture	0.05 %	0.5 %	1.0 %

Table 30 Examples of Chinese product specification for liquefied di-methyl ether

Parameter	**Value**
DME	93 % (v/v)
Methanol	3 % (v/v)
Moisture	1 % (v/v)
Residue	1 % (v/v)
Heat value	28 000 KJ/kg

Among international standardization organizations, ISO is in an early phase of starting activities on the standardization of DME. On request of Japan, ISO has accepted to include DME in its scope and probably work on DME will be initiated under ISO/TC 28/SC 4 concerning a technical specification and under ISO/TC 28/SC 5 concerning measuring standards.

7. Standards on synthetic fuels

Synthetic fuels -such as synthetic diesel oil and synthetic gasoline- can be made from synthesis gas (shifted natural gas or gasified carbon containing feedstock) by using Fischer Tropsch technology or it can be made by direct liquefaction of coal.

Today there is a common opinion that these synthetic fuels might be the most promising future solutions when it comes to replacing fossil gasoline and diesel oil.

So far, synthetic fuel production has been rather limited, but South Africa is an exception. Both coal and natural gas are used as feedstock for synthetic fuel production in this country. However, some production plants have also been built or are under construction elsewhere, for example in South East Asia, China and the Middle East. All these plants use natural gas as feedstock.

Regarding synthetic fuel production from gasified biomass, there are only a few pilot plants operating in the world, for example Choren´s Alfa and Beta plants in Freiburg in Germany. Choren is also building what should be the world's first commercial BTL (Biomass To Liquid) plant in Freiburg. This plant will have a capacity of 15 000 ton synthetic fuel per year and is scheduled to start production in 2008.

As mentioned above, synthetic fuels have been produced and used in South Africa for many decades, but there still are no specific standards for these fuels in that country. Instead, the specification standards for petroleum based gasoline and diesel oil have been adjusted to also include synthetic fuels for neat use or for blending. (See also sub-section 3.10.)

Also in China, no specification standards for synthetic fuels have been established yet. However, a Chinese report present figures for typical properties of directly liquefied naphtha fractions and directly liquefied diesel fractions. (See reference list)

Table 31 Selected properties of directly liquefied naphtha fraction, in Chinese reports

Parameter	**Value**
Density (20 ^{o}C)	0.785 g/cm^3
Basic nitrogen	48 ppm
N	61 ppm
Mercaptan – Sulphur	12 ppm
Sulphur	23 ppm
Aromatic latent content	79.49 % (m/m)
Initial boiling point / 5 %	94/103 ^{o}C
90 % / dry point	165 / - ^{o}C

Table 32 Selected properties of directly liquefied diesel fraction, in Chinese reports

Parameter	**Value**
Density (20 ^oC)	0.9214 g/cm^3
Viscosity (20 ^oC)	6.730 mm^2/s
Freezing point	-18 ^oC
Aniline point	25.1 ^oC
Sulphur	117 ppm

According to information in the Chinese reports (See reference list), diesel oil -produced either by indirect or direct liquefaction of Coal may have a cetane number higher than 50. The octane number of synthetic gasoline may vary from 100 down to 70 (indirect liquefaction).

In Europe -under the supervision of CEN- a so-called CEN workshop has been created (CEN workshop 38 - XTL Gasoil for use in automotive diesel engines') to establish a voluntary specification covering synthetic fuels for captive fleets, synthetic fuels that are produced from natural gas (GTL), biomass (BTL) and coal (CTL. The general reference X for the target fuel defines the feedstock.

Because gas to liquid is the most commonly produced synthetic fuel today, this will be the first XTL standard activity. The CEN workshop has so far produced a draft "workshop agreement" that has been sent out for comments.

8. Standards for test methods

This chapter lists the test methods for automotive fuels that have been standardized by CEN, ASTM and ISO. When dealing with the same issue, the standards of these organisations are often very similar. Still, all of them are listed in the subsections of this chapter.

Standards are continuously under development and work on draft standards is progressing. This means that decisions may have been taken for some of the standards that are listed as draft standards here -such as CEN's prEN standards- and they are now formally accepted standards.

Besides the test standards shown below, there exist also a number of national test standards in for example Brazil, Sweden and Japan. However, these national standards are often more or less copies of ASTM or ISO standards, and for that reason they are not mentioned in this report. National standards often refer to ASTM or ISO test standards when defining how different parameters have to be measured/tested.

8.1 CEN Methods

EN 116: 1997, Diesel and domestic heating fuels - Determination of cold filter plugging point.
EN 1601, Liquid petroleum products - Unleaded petrol - Determination of organic oxygenate compounds and total oxygen content by gas chromatography (O-FID).
EN 12662: 1998, Liquid petroleum products - Determination of contamination in middle distillates.
EN 13132, Liquid petroleum products — Unleaded petrol — Determination of organic oxygenate compounds and total organically bound oxygen content by gas chromatography using column switching.
EN 14103, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Ester and Linolenic Acid Methyl Ester Contents.
EN 14104 Fat and oil derivatives – Fatty acid methyl esters (FAME) – Determination of acid value.
EN 14105, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of free and total glycerol and mono -, di and triglyceride contents (Reference Method).
EN 14106, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Free Glycerol Content.
EN 14107, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Phosphorus Content by Inductively Coupled Plasma (ICP) Emission Spectrometry.
EN 14108, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Sodium Content by Atomic Absorption Spectrometry.
EN 14109, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Potassium Content by Atomic Absorption Spectrometry.
EN 14110, Fat and oil derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Phosphorus Content by Inductively Coupled Plasma (ICP) Emission Spectrometry.
EN 14111, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Iodine Value.

EN 14112, Fat and Oil Derivatives - Fatty Acid Methyl Esters (FAME) - Determination of Oxidation Stability (accelerated oxidation test).
EN 14538, Fat and Oil derivatives – Fatty Acid Methyl Esters (FAME) – Determination of Ca, K, Na and Mg Content by Optical Emission Spectral Analysis with Inductively Coupled Plasma (ICP OES).
prEN 15484:2006, Ethanol as a Blending Component for Petrol - Determination of Inorganic Chloride – Potentiometric method.
prEN 15485:2006, Ethanol as a Blending Component for Petrol - Determination of Sulphur Content - Wavelength Dispersive X-ray Fluorescence Spectrometric Method.
prEN 15486:2006, Ethanol as a Blending Component for Petrol - Determination of Sulphur Content - Ultraviolet Fluorescence Method.
prEN 15487:2006, Ethanol as a Blending Component for Petrol — Determination of Phosphorus Content — Ammonium Molybdenum Spectrometric Method.
prEN 15488:2006, Ethanol as a Blending Component for Petrol — Determination of Copper Content — Graphite Furnace Atomic Absorption Spectrometric Method.
prEN 15489:2006, Ethanol as a Blending Component for Petrol - Determination of Water Content – Karl-Fischer Coloumetric Titration Method.
prEN 15490:2006, Ethanol as a Blending Component for Petrol - Determination of pHe.
prEN 15491:2006, Ethanol as a Blending Component for Petrol - Determination of total Acidity – Colour Indication Titration Method.
prEN 15492:2006, Ethanol as a Blending Component for Petrol - Determination of Inorganic Chloride Content – Ion Chromatographic Method.

8.2 ASTM methods

ASTM D 86, Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure.
ASTM D 93, Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester.
ASTM D 95, Standard Test Methods for Water in Petroleum Products and Bituminous Materials by Distillation.
ASTM D 97, Standard Test Method four Pour Point of Petroleum Products.
ASTM D 130, Standard Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test.
ASTM D 189, Standard Test Method for Carbon Residue of Petroleum Products.
ASTM D 240, Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter.
ASTM D 287, Standard Test Method for API Gravity of crude Petroleum and Petroleum Products (Hydrometer Method).
ASTM D 381, Standard Test Method for Gum Content in Fuels by Jet Evaporation.
ASTM D 445, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity).
ASTM D ASTM D 482, Standard Test Method for Ash from Petroleum Products.
ASTM D 512, Standard Test Method for Chloride Ion in Water.
ASTM D 524, Standard Test Method for Rams bottom Carbon Residue of Petroleum Products.
ASTM D 613, Standard Test Method for Cetane Number of Diesel Fuel Oil.
ASTM D 664, Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration.

ASTM D 874, Standard Test Method for Sulfated Ash from Lubricating Oils and Additives.
ASTM D 974, Standard Test Method for Acid and Base Number by Colour Indicator Titration.
ASTM D 976, Standard Test Methods for Calculated Cetane Index of Distillate Fuels.
ASTM D1125 Standard Test Methods for Electrical Conductivity and Resistivity of Water.
ASTM D 1152, Standard Specification for Methanol (Methyl Alcohol).
ASTM D 1160, Standard Test Method for Distillation of Petroleum Products at Reduced Pressure.
ASTM D 1193, Standard Specification for Reagent Water.
ASTM D 1266, Standard Test Method for Sulphur in Petroleum Products (Lamp Method).
ASTM D 1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
ASTM D 1552, Standard Test Method for Sulphur in Petroleum Products (High-Temperature Method).
ASTM D 1613, Standard Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer and Related Products.
ASTM D 1688, Standard Test Methods for Copper in Water.
ASTM D 1796, Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure).
ASTM D 2274, Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method).
ASTM D 2500, Standard Test Method for Cloud Point of Petroleum Products.
ASTM D 2622, Standard Test Method for Sulphur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry.
ASTM D 2709, Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge.
ASTM D 3117, Standard Test Method for Wax Appearance Point of Distillate Fuels.
ASTM D 3242, Standard Test Method for Acidity in Aviation Turbine Fuel.
ASTM D 4052, Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter.
ASTM D 4294, Standard Test Method for Sulphur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry.
ASTM D 4530, Standard Test Method for Determination of Carbon Residue (Micro Method).
ASTM D 4737, Standard Test Method for Calculated Cetane Index by Four Variable Equations.
ASTM D 4815, Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 and C4 Alcohols in Gasoline by Gas Chromatography.
ASTM D 4928, Standard Test Methods for Water in Crude Oils by Coulometric Karl Fischer Titration.
ASTM D 4951, Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry.
ASTM D 5452, Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration.
ASTM D 5453, Standard Test Method for Determination of Total Sulphur in Light Hydrocarbons, Motor Fuels and Oils by Ultraviolet Fluorescence.
ASTM D 5501, Standard Test Method for Determination of Ethanol Content of Denatured Fuel Ethanol by Gas Chromatography.
ASTM D 5580, Standard Test Method for Determination of Benzene, Toluene, ethylbenzene, p/m-Xylene, o-Xylene, C9 and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography.

ASTM D 5863, Standard Test Methods for Determination of Nickel, Vanadium, Iron, and Sodium in Crude Oils and Residual Fuels by Flame Atomic Absorption Spectrometry.
ASTM D 5949, Standard Test Method for Pour point of Petroleum Products (Automatic Pulsing Method).
ASTM D 6217, Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration.
ASTM D 6371, Standard Test Method for Cold Filter Plugging Point of Diesel and Heating Fuels.
ASTM D 6423, Standard Test Method for Determination of pHe of Ethanol, Denatured Fuel Ethanol, and Fuel Ethanol (Ed75-Ed85) / Note: Reapproved 2004.
ASTM D 6468, Standard Test Method for High Temperature Stability of Distillate Fuels.
ASTM D 6584, Standard Test Method for Determination of Free and Total Glycerine in B-l00 Biodiesel Methyl Esters by Gas Chromatography.
ASTM D 6585, Standard Specification for Unsintered Polytetrafluoroethylene (PTFE) Extruded Film or Tape.
ASTM D 6731, Standard Test Method for Determining the Aerobic, Aquatic Biodegradability of Lubricants or Lubricant Components in a Closed Respirometer / Note: Reapproved 2005.
ASTM D 7042, Standard Test Method for Dynamic Viscosity and Density of Liquids by Viscometer (and the Calculation of Kinematic Viscosity).
ASTM E 203, Standard Test Method for Water Using Volumetric Karl Fisher Titration.

8.3 ISO methods

ISO 2160, Petroleum Products. Corrosiveness to Copper. Copper Strip Test.
ISO 2719, Determination of Flash Point – Pensky -Martens Closed Cup Method.
ISO 3015, Petroleum Products - Determination of Cloud Point.
ISO 3104, Petroleum Products. Transparent and Opaque Liquids. Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity.
ISO 3405, Petroleum Products. Determination of Distillation Characteristics at Atmospheric Pressure.
ISO 3675, Crude Petroleum and Liquid Petroleum Products. Laboratory Determination of Density. Hydrometer Method.
ISO 3679 Petroleum Products – Determination of flash point – Rapid equilibrium closed cup.
ISO 3733, Petroleum products and bituminous materials - Determination of water - Distillation method.
ISO 3987, Petroleum Products. Lubricating Oils and Additives. Determination of Sulfated Ash.
ISO 4260, Petroleum Products and Hydrocarbons. Determination of Sulphur Content. Wickbold Combustion Method.
ISO 4264, Petroleum Products. Calculation of Cetane Index of Middle. Distillate Fuels by the Four- Variable Equation.
ISO 5165, Petroleum Products. Determination of the Ignition Quality of Diesel Fuels. Cetane Engine Method.
ISO 6245, Petroleum products - Determination of ash.
ISO 6296, Petroleum products - Determination of water - Potentiometric Karl Fischer titration method.
ISO 6618, Petroleum Products and Lubricants. Determination of Acid or Base Number. Colour-Indicator Titration Method.

ISO 8754, Petroleum Products. Determination of Sulphur Content. Energy-Dispersive X-ray Fluorescence Spectrometry.
ISO 10370, Petroleum Products. Determination of Carbon Residue. Micro Method.
ISO 12156-1, Diesel fuel - Assessment of lubricity using the high-frequency reciprocating rig (HFRR) - Part 1.
ISO 12185, Crude Petroleum and Petroleum Products. Determination of Density. Oscillating U-tube Method.
ISO 12205, Petroleum Products. Determination of the Oxidation Stability of Middle-Distillate Fuels.
ISO 12662 Liquid Petroleum Products – Determination of contamination in middle distillates.
ISO 12937, Petroleum Products. Determination of Water. Coulometric Karl Fisher Titration Method.
ISO 14596 Petroleum Products – Determination of sulphur content – Wavelength dispersive X-ray fluorescence spectrometry.
ISO 20846, Petroleum Products. Determination of Sulphur Content of Automotive Fuels. Ultraviolet Fluorescence Method.
ISO 20884, Petroleum Products. Determination of Sulphur Content of Automotive Fuels. Wavelength - Dispersive X-ray Fluorescence Spectrometry.

9. Tripartite Task Force – Brazil, EU and the U.S.

In February 2007, the European Commission (EC) and the European Standardization organization (CEN) organized a conference on the issue of standardization of biofuels, in Brussels. The conference had active participation of the U.S. National Institute of Standards and Technology (NIST) and the Brazilian National Institute of Metrology, Standardization and Industrial Quality (INMETRO). The conference convened a broad range of private-sector biofuels experts and government representatives from different countries.

To support the global trade of biofuels, representatives of Brazil, the European Union (EU) and the U.S. agreed to promote, whenever possible, the compatibility of biofuels-related standards to facilitate the increasing use of biofuels in their respective regions, but also to avoid adverse trade implications in a growing global market.

In March 2007, a governmental initiative among Brazil, China, EC, India, South Africa and the U.S. – the International Biofuels Forum – was launched, to promote the sustained use and production of biofuels around the globe.

In April 2007, a biofuels standards roadmap was developed that delineated the necessary steps that need to be undertaken by the U.S., Brazil and the EU to achieve greater compatibility among existing biofuels standards.

In June 2007, a Biofuels symposium in Washington DC, supported by NIST and INMETRO, convened representatives from Brazil, the EU and the U.S. to continue the work started at the meeting in Brussels, to review existing ABN, ASTM and CEN-standards on biodiesel and bio ethanol, and to identify areas where greater compatibility could be achieved in the short and long term, the so called Tripartite agreement.

In July 2007, representatives from private and public sectors started two task forces, one for biodiesel and one for bio ethanol. In December 2007, the government Tripartite Leaders -based on the result of the work in the task forces- presented a joint report including a number of recommendations regarding common standards for bio ethanol and biodiesel. They also presented a road map for the future work on bio fuels standards. The recommendations include:

- Broad dissemination of the report.
- Continuation of the work defined in the road map.
- The standardization bodies of the Tripartite agreement should whenever possible consider adapting existing national standards according to the conclusions in the report, and they should consider the opportunity to align with the other related standards.

Some of the conclusions in the Tripartite report are presented here:

- At present the bio ethanol specifications are more similar amongst the three regions than the biodiesel specifications, mainly because bio ethanol is a single chemical compound while biodiesel is a blend of different molecules. Additionally, biodiesel is derived from several types of feedstock, which can translate to variations in the performance characteristics of the final fuel.
- 9 out of a total of 16 ethanol standards are similar, while 6 could be aligned in the short term.
- One important regional difference is the water content that is allowed in the different specifications. The water content as high as proposed by Brazil and the U.S. is so far not acceptable for the EU.
- Six biodiesel standards were found to be aligned.
- Since FAME and FAEE are two chemically different mixtures, it is a challenge to develop a common standard that addresses the complex fuel and engine requirements.

The future of the Tripartite agreement and the future wok on biofuel standards has been discussed at the International Biofuels Forums quarterly meeting on March 3, 2008.

10. Summary

The use of alternative fuels in transportation has increased over the last decades. This change is primarily driven by concerns about climate change that is caused by emissions of fossil carbon dioxide and other greenhouse gases. These emissions can be reduced by replacing conventional fossil fuels (gasoline and diesel oil) by alternatives that are produced from biomass or other feedstock. Most alternative fuels also reduce emissions that are harmful for health and the environment.

When new fuels are introduced, standards for fuel specifications are especially important for vehicle/engine manufacturers. Although alternative fuels have been used since the mid 1970s, at first the amounts used (mostly in dedicated demonstration fleets/captive fleets) were low and there was no need for a general specification or for common specification standards. However, from the mid 1990s onwards, the use of for example ethanol and biodiesel in Europe, Brazil and the U.S. has reached levels that are high enough to justify the introduction of national or regional specifications/specification standards. From the year 2000 onwards, the international trade of biofuels (for example from Brazil to the U.S. and to Europe) has grown, and this has increased the need for common international specifications/specification standards.

With this in mind, the objective of the task undertaken was to identify specification standards for alternative vehicle fuels (existing and under development) on national and regional level. When available or applicable, also international standards should be included. In this context the term “alternative fuels” means all kinds of fuels -independent from the feedstock from which they are produced and both liquid and gaseous fuels- which can replace diesel oil or gasoline.

In this report we have tried to cover specification standards for all alternative fuels. However, the focus is on liquid biofuels for diesel and Otto engines. Furthermore we have also listed standards on test methods established by CEN, ISO and ASTM, but in this report there is no information on specification standards for reference fuels that are only used for certification tests of engines/vehicles.

Standardization work on alternative fuels by the following organizations/countries and organizations/regions has been studied and is presented in this report.

- APEC (Asia-Pacific Economic Cooperation)
- ASTM (the U.S. and Canada)
- Brazil
- CEN (Europe)
- India
- ISO
- Japan
- People’s Republic of China
- South Africa
- Thailand

It appears that regions/countries such as Europe and the U.S. are the frontrunners regarding alternative fuel specification standards. They already have or they are establishing specification standards for ethanol and biodiesel (FAME) as vehicle fuels. For example China, Thailand and India have more recently started working on alternative vehicle fuel specification standards, but different national specification standards already exist in these countries.

It is clear that the U.S./ASTM standards as well as the CEN /European standards are often used as a model for other standardization organizations/countries when drafting new standards, including the standardization of test methods.

On a global level, standardization of alternative fuels is just beginning. There are initiatives in ISO to start joint work on global standards. Furthermore the U.S./ASTM, Europe/CEN and Brazil/ABN have started joint work on common standardization of alternative fuels, in the 'Tripartite task force'. Similarly, APEC (Asia-Pacific Economic Cooperation) works on a joint biodiesel (FAME) standard.

This report presents information about specific specification standards on alternative fuels. Complete standards may be obtained from the respective standardization organizations.

Finally - please keep in mind that the work on standardization is a continuous process that currently seems to be accelerating. This report gives a picture of the activities until early 2008. When reading this report please don't forget that new initiatives may be on the agenda on a national, regional as well as a global level.

Acronyms and Abbreviations

ABNT	The Brazilian Association for Technical Standards
ANP (Brazil)	The National Agency of Petroleum, Natural gas and Bio Fuels
ANSI	The American National Standards Institute
APEC	Asian-Pacific Economy Cooperation
AQSIQ	The General Administration of Quality Supervision, Inspection & Quarantine of the People’s Republic China
BIS	The Bureau of Indian Standards
CBG	Compressed Biogas
CEN	The European Organisation for Standardization
CGSB	The Canadian General Standards Board of the Government of Canada
CNG	Compressed natural gas
DME	Di-methyl Ether
EC	The European Commission
EU	The European Union
FAEE	Fatty Acid Ethyl Ester
FAME	Fatty Acid Methyl Ester
INMETRO	The Brazilian National Institute of Metrology, Standardization and Industrial Quality
ISO	International Standards Organization
JSA	The Japanese Standardization Organization
LBG	Liquefied Biogas
LNG	Liquefied Natural gas
LPG	Liquefied Petroleum Gas
NIST	The U.S. National Institute of Standards and Technology
SABS	The South African Bureau of Standards
SAC	The Standard Administration of the People’s Republic of China
STANZA	Standards South Africa
TISI	The Thai Industrial Standards Institute

Tables

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