INTERNATIONAL STANDARD

ISO 8217

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Petroleum products — Fuels (class F) — Specifications of marine fuels

Produits pétroliers — Combustibles (classe F) — Spécifications des combustibles pour la marine

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8217 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 4, *Classifications and specifications*.

This fourth edition cancels and replaces the third edition (ISO 8217:2005), which has been technically revised.

Introduction

0.1 General

The specifications in this International Standard were prepared in co-operation with ship owners, ship operators, shipping associations, national standards bodies, classification societies, fuel testing services, engine designers, fuel suppliers and the petroleum industry to meet the requirements for fuels supplied on a world-wide basis for consumption on board ships. Crude oil supplies, refining methods, ships' machinery, environmental legislation and local conditions vary considerably. These factors have led historically to a large number of categories of residual fuels being available internationally, even though locally or nationally there can be relatively few categories available.

0.2 Classification

The categories of fuel in this International Standard have been classified in accordance with ISO 8216-1.

0.3 International statutory requirements

This International Standard takes into account the SOLAS Convention[1] in respect of the allowable minimum flash point of fuels.

The Revised MARPOL Annex VI[2], which controls air pollution from ships, includes a requirement either that the fuel not exceed specified maximum sulfur content or that an approved equivalent alternative be used. During the lifetime of this International Standard, regional and/or national bodies can introduce their own local emission requirements, which can impact the allowable sulfur content, for example EU Sulfur Directive[3]. It is the users' responsibility to establish the requirement to comply with such statutory requirements and to specify the maximum sulfur content of the fuel to the supplier.

0.4 Changes from ISO 8217:2005

This fourth edition of this International Standard reflects several important and significant changes. These include category rationalizations of both distillate and residual fuels and substantial amendments to Clause 5. These changes reflect market demand, recognize regulatory developments and current industry experiences with the use of fuels.

The limits contained in Tables 1 and 2 now reflect the test method reporting requirements. For example, viscosity limits are given to four significant figures.

a) Changes to the distillate fuels (4 categories) include the following.

- An additional grade, DMZ, has been added with a minimum viscosity of 3,000 mm^2/s at 40 °C, but is otherwise identical in its characteristics to the DMA.
- The previous DMC category has been modified and moved to Table 2 as RMA10.
- Specifications for the following characteristics have been added to Table 1: hydrogen sulfide, acid number, oxidation stability and lubricity.
- The minimum viscosity requirement for DMA has been raised to 2,000 mm^2/s.
- A minimum viscosity requirement of 2,000 mm^2/s has been added for DMB.
- The specifications for the "appearance" characteristic in Table 1 have been amended.

b) Changes to the residual fuels (6 categories) include the following.

- RMA 10 has been added.
- RMG and RMK have been expanded to include additional viscosity grades.
- RMF and RMH categories have been removed.
- To Table 2 have been added the Calculated Carbon Aromaticity Index (CCAI) and specifications for the following characteristics: hydrogen sulfide, acid number and sodium content.
- Sulfur limits have not been tabulated, as these are controlled by statutory requirements. See 0.3 and Annex C.
- Potential Total Sediment (TSP) has been assigned as the reference test method. Accelerated Total Sediment (TSA) has been added as an alternative test method.
- Ash limit values have been reduced for many of the categories.
- Vanadium limit values have been reduced, with the exceptions of those for RMB 30 where the limit value is unchanged and for RMG 380 where the limit value has been slightly increased.
- Aluminium-plus-silicon limit values have been reduced.
- The criteria for assessing whether a fuel contains used lubricating oil have been amended.

c) Changes to the informative annexes include the following.

- Amendments have been made to a number of the annexes.

- Annex C of the previous edition, dealing with viscosity conversions, has been deleted.
- The equations dealing with specific energy in Annex E of this new edition have been revised and a gross specific energy equation for distillate fuel has been added.
- Four new annexes have been added:
  - Annex A, dealing with bio-derived products;
  - Annex B, dealing with deleterious materials;
  - Annex C, dealing with sulfur content;
  - Annex D, dealing with hydrogen sulfide.

Petroleum products — Fuels (class F) — Specifications of marine fuels

WARNING — The handling and use of products as specified in this International Standard can be hazardous, if suitable precautions are not observed. This International Standard does not purport to address all of the safety and health considerations that can be associated with its use. It is the responsibility of the users of this International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies the requirements for petroleum fuels for use in marine diesel engines and boilers, prior to appropriate treatment before use. The specifications for fuels in this International Standard can also be applicable to fuels for stationary diesel engines of the same or similar make and type as those used for marine purposes.

This International Standard specifies four categories of distillate fuel, one of which is for diesel engines for emergency purposes. It also specifies six categories of residual fuel.

NOTE 1 For the purpose of this International Standard, the term “petroleum” is used to include oil from tar sands and from shale.

NOTE 2 Appropriate guidance about fuel treatment systems for diesel engines is published by the International Council on Combustion Engines (CIMAC)[4].

NOTE 3 Requirements for gas turbine fuels used in marine applications are specified in ISO 4261[5].

NOTE 4 For the purposes of this International Standard, the terms “mass %” and “volume %” are used to represent the mass and volume fractions respectively.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 91-1:1992, *Petroleum measurement tables — Part 1: Tables based on reference temperatures of 15 °C and 60 °F*

ISO 2719:2002, *Determination of flash point — Pensky-Martens closed cup method*

ISO 3015:1992, *Petroleum products — Determination of cloud point*

ISO 3016:1994, *Petroleum products — Determination of pour point*

ISO 3104:1994, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3675:1998, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 3679:2004, *Determination of flash point — Rapid equilibrium closed cup method*

ISO 3733:1999, *Petroleum products and bituminous materials — Determination of water — Distillation method*

ISO 4259:2006, *Petroleum products — Determination and application of precision data in relation to methods of test*

ISO 4264:2007, *Petroleum products — Calculation of cetane index of middle-distillate fuels by the four-variable equation*

ISO 6245:2001, *Petroleum products — Determination of ash*

ISO 8216-1:2010, *Petroleum products — Fuels (class F) classification — Part 1: Categories of marine fuels*

ISO 8754:2003, *Petroleum products — Determination of sulfur content — Energy-dispersive X-ray fluorescence spectrometry*

ISO 10307-1:2009, *Petroleum products — Total sediment in residual fuel oils — Part 1: Determination by hot filtration*

ISO 10307-2:2009, *Petroleum products — Total sediment in residual fuel oils — Part 2: Determination using standard procedures for ageing*

ISO 10370:1993, *Petroleum products — Determination of carbon residue — Micro method*

ISO 10478:1994, *Petroleum products — Determination of aluminium and silicon in fuel oils — Inductively coupled plasma emission and atomic absorption spectroscopy methods*

ISO 12156-1:2006, *Diesel fuel — Assessment of lubricity using the high-frequency reciprocating rig (HFRR) — Part 1:Test method*

ISO 12185:1996, *Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method*

ISO 12205:1995, *Petroleum products — Determination of the oxidation stability of middle-distillate fuels*

ISO 12937:2000, *Petroleum products — Determination of water — Coulometric Karl Fischer titration method*

ISO 13739:2010, *Petroleum products — Procedures for transfers of bunkers to vessels*

ISO 14596:2007, *Petroleum products — Determination of sulfur content — Wavelength-dispersive X-ray fluorescence spectrometry*

ISO 14597:1999, *Petroleum products — Determination of vanadium and nickel content — Wavelength-dispersive X-ray fluorescence spectrometry*

EN 14078:2009, *Liquid petroleum products — Determination of fatty acid methyl ester (FAME) content in middle distillates — Infrared spectrometry method*

EN 14214, *Automotive fuels — Fatty acid methyl esters (FAME) for diesel engines — Requirements and test methods*

IP 470:2005, *Determination of aluminium, silicon, vanadium, nickel, iron, calcium, zinc and sodium in residual fuel oil by ashing, fusion and atomic absorption spectrometry*

IP 500:2003, *Determination of the phosphorus content of residual fuels by ultra-violet spectrometry*

IP 501:2005, *Determination of aluminium, silicon, vanadium, nickel, iron, sodium, calcium, zinc and phosphorus in residual fuel oil by ashing, fusion and inductively coupled plasma emission spectrometry*

IP 570:2009, *Determination of hydrogen sulfide in fuel oils — Rapid liquid phase extraction method*

ASTM D664-09, *Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration*

ASTM D6751, *Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels*

LEWIS, C.P.G; SCHENK, C.; STASSEN, W.J.M., *Ignition quality of residual fuel oils,* Conference paper in Proceedings of the 22nd CIMAC International Congress on Combustion Engines, Volume **2**, Copenhagen, DK, May 18-21, 1998[1)]

3 Application

This International Standard specifies the required properties for fuels at the time and place of custody transfer. Samples for quality verification may be taken in any location agreed between the parties.

4 Sampling

The sampling of petroleum fuels for analysis shall be carried out in accordance with the procedures given in ISO 13739 or an equivalent national standard. Where specific sampling requirements are documented in the referenced test methods, these shall be adhered to.

5 General requirements

5.1 The fuel shall conform to the characteristics and limits given in Table 1 or Table 2, as appropriate, when tested in accordance with the methods specified.

5.2 The fuel shall be a homogeneous blend of hydrocarbons derived from petroleum refining. This shall not preclude the incorporation of additives intended to improve some aspects of the fuel's characteristics and performance. The fuel shall be free from inorganic acids and used lubricating oils.

5.3 Fuels shall be free from any material that renders the fuel unacceptable for use in marine applications.

5.4 The fuel shall be free from bio-derived materials other than '*de minimis'* levels of FAME (FAME shall be in accordance with the requirements of EN 14214 or ASTM D6751). In the context of this International Standard, "*de minimis*" means an amount that does not render the fuel unacceptable for use in marine applications. The blending of FAME shall not be allowed.

NOTE See Annex A.

5.5 The fuel shall not contain any additive at the concentration used in the fuel, or any added substance or chemical waste that

a) jeopardizes the safety of the ship or adversely affects the performance of the machinery; or

b) is harmful to personnel; or

c) contributes overall to additional air pollution.

NOTE See Annex B.

1) This paper describes the CCAI calculation and is available from www.cimac.com.

6 New requirements

6.1 Requirements for distillate and residual fuels

a) The hydrogen sulfide, H_2S, concentration shall be as specified in Table 1 or Table 2.

NOTE H_2S is a highly toxic gas. Exposure to high vapour concentrations is hazardous and in extreme cases can be fatal. It is critical that ship owners, operators and other responsible parties continue to maintain appropriate safety practices designed to protect the crew and others who can be exposed to H_2S; see Annex D.

b) Acidity shall be as specified in Table 1 or Table 2.

NOTE Acid number limits are included in this International Standard; see Annex H.

6.2 Requirements for distillate fuels

a) Oxidation stability shall be as specified in Table 1.

NOTE The refinery processes used to manufacture distillate fuels can lead to products that can have limited oxidation stability. In addition, today's non-marine distillate fuels can contain a significant amount, for example in some areas currently 5 volume % to 7 volume %, of bio-derived products i.e., fatty acid methyl esters (FAMEs) that can impact on the oxidation stability of the fuel. Furthermore, the transportation of pure distillate fuel and distillate fuel containing bio-derived material (FAME), especially through multi-product pipeline installations, have shown that some FAME is transferred into the pure distillate fuel; see Annex A.

b) The lubricity shall be as specified in Table 1.

NOTE A lubricity requirement has been included in this International Standard and is applicable to clear and bright distillate fuels with a sulfur content below 500 mg/kg (0,050 mass %). The lubricity limit is based on the existing requirements for high-speed automotive and heavy-duty industrial diesel engines.

6.3 Requirements for residual fuels

a) Ignition characteristics, as determined by the Calculated Carbon Aromaticity Index (CCAI), shall be as specified in Table 2.

NOTE 1 CCAI, an indication of ignition performance, has been added in Table 2 in order to avoid fuels with uncharacteristic density-viscosity relationships. For a determination of CCAI, see Annex F.

NOTE 2 For engines and/or applications where the ignition quality is known to be particularly critical, Annex F provides a basis for suppliers and purchasers of residual fuels to agree on tighter ignition quality characteristics.

NOTE 3 For RME 180 and RMK 380, when blending at or close to the maximum density, the CCAI limit can restrict the combination of density and viscosity.

b) The sodium concentration shall be as specified in Table 2.

NOTE A limit for sodium content has been included due to concerns regarding the influences of metals in fuels on ash deposition and high-temperature corrosion. Information on the subject is given in Annex I.

7 Test methods

7.1 Density

When density is determined in accordance with ISO 3675, the hydrometer readings obtained at ambient temperature for distillate fuels, and at elevated temperatures of between 50 °C and 60 °C for fuels containing residual components, shall be converted to results at 15 °C using ISO 91-1:1992, Table 53B. When density is determined in accordance with ISO 12185, an appropriate correction for the glass expansion coefficient shall

be applied to readings obtained by a digital density analyser at any temperature other than 15 °C, before conversion and application of ISO 91-1:1992, Table 53B.

The reference test method shall be ISO 3675.

7.2 Sulfur content

The reference test method shall be ISO 8754.

In the event of a dispute concerning sulfur content, all parties shall agree, prior to testing, upon the same sulfur certified reference material.

NOTE See Annex C.

7.3 Flash point

The flash point for fuels in Table 1 shall be determined in accordance with ISO 2719:2002, Procedure A. If the flash point result of DMX is less than 40 °C, it shall be determined in accordance with ISO 3679.

The flash point of fuels in Table 2 shall be determined in accordance with ISO 2719:2002, Procedure B.

NOTE See Annex G.

7.4 Total sediment by hot filtration

If the appearance of DMB is assessed as not clear and bright (see 7.6), the total sediment shall be determined by the test method ISO 10307-1, typically called total sediment existent.

7.5 Total sediment — Aged

Either of the standard procedures for ageing in ISO 10307-2 can be used; Accelerated Total Sediment (TSA) or Potential Total Sediment test (TSP).

The reference test method shall be the Potential Total Sediment test.

7.6 Appearance

For distillate fuel, the appearance of a sample shall be assessed by visual inspection in good light, free from glare and shadow, at a temperature between 10 °C and 25 °C.

— DMX, DMA or DMZ shall appear clear and bright. It has been reported that in some countries these grades of fuel are dyed (e.g., black) and not transparent. This affects the compliance with the requirement for clear and bright appearance and, in such circumstances, the water content shall not exceed 200 mg/kg, as determined by the Coulometric Karl Fischer titration method in accordance with ISO 12937.

— If the appearance of DMB affords visual inspection and appears clear and bright, then testing for total sediment by hot filtration and for water is not required.

7.7 Vanadium

The reference test method shall be IP 501.

NOTE See Annex I.

7.8 Sodium

The reference test method shall be IP 501.

NOTE See Annex I.

7.9 Aluminium plus silicon

The reference test method shall be IP 501.

NOTE See Annex J.

7.10 Used lubricating oil (ULO)

A fuel shall be free from ULO.

In the context of this International Standard, a fuel shall be considered to contain ULO when combinations of calcium and zinc or calcium and phosphorus are above the specified levels; see Table 2.

The reference test method shall be IP 501.

NOTE See Annex K.

8 Precision and interpretation of test results

The test methods specified in Tables 1 and 2 all contain a statement of precision (repeatability and reproducibility). The determination of reproducibility for CCAI is contained in Annex F.

ISO 4259:2006, which covers the use of precision data in the interpretation of test results, shall be used in cases of dispute. Information about precision and interpretation of test results is also given in Annex L.