



**International
Standard**

ISO 6583

**Methanol as a fuel for marine
applications — General
requirements and specifications**

*Méthanol comme carburant pour les applications marines —
Exigences générales et spécifications*

**First edition
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, Subcommittee SC 4, *Classifications and specifications*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was prepared in cooperation with ship owners, ship operators, national standards bodies, classification societies, fuel testing services, engine and fuel cell designers, marine fuel suppliers, methanol producers, governmental organizations, and other technical organizations to meet the requirements for methanol supplied as marine fuel on a world-wide basis for consumption on board ships.

This document specifies three categories of methanol: marine methanol grade A (MMA), marine methanol grade B (MMB) and marine methanol grade C (MMC).

For the purpose of this document, the term methanol comprises methanol from all forms of production.

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Methanol as a fuel for marine applications — General requirements and specifications

WARNING — The handling and use of products specified in this document can be hazardous if suitable precautions are not observed. This document does not purport to address all of the safety and health considerations as included in the safety data sheet of the product that can be associated with its use. Methanol is a low flash point product (typically 11 °C) and it is the responsibility of the users of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use (see also Reference [1]).

1 Scope

This document defines the general requirements and specifications for methanol from all forms of production at the point of custody transfer, prior to any onboard required treatment, for use as fuel in marine diesel engines, fuel cells and other marine applications. The specifications in this document can also be applied to methanol used as fuel in land-based applications of the same or similar type as those used for marine purposes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IMPCA 001, *Purity and impurities of methanol*

IMPCA 002, *Chloride as Cl⁻*

IMPCA 003, *Appearance of methanol*

ISO 4259-2, *Petroleum and related products — Precision of measurement methods and results — Part 2: Interpretation and application of precision data in relation to methods of test*

ISO 12185, *Crude petroleum, petroleum products and related products — Determination of density — Laboratory density meter with an oscillating U-tube sensor*

ASTM E1064, *Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration*

ASTM D1078, *Standard Test Method for Distillation Range of Volatile Organic Liquids*

ASTM D1613, *Standard Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products*

ASTM D5453, *Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence*

IP PM FK, *Methanol fuel — Assessment of lubricity using the high-frequency reciprocating rig (HFRR)*

IP PM FI, *Determination of the concentration of dispersed particles in marine methanol fuel — Automatic Particle Counter (APC) Light Obscuration Method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1
point of custody transfer
point of physical transfer of product that results in change in ownership and/or a change in responsibility
[SOURCE: ISO 20257-2:2021, 3.1.2, modified — “point of” added in the preferred term and in the definition; “hydrocarbon” deleted from the definition.]

3.2
initial boiling point
IBP
temperature indicated by the distillation thermometer at the instant the first drop of condensate leaves the condenser tube
[SOURCE: ASTM D1078-11, 3.1.3, modified — “IBP” added as an admitted term; “, *n*—the” deleted from the definition.]

3.3
dry point
DP
temperature indicated at the instant the last drop of liquid evaporates from the lowest point in the distillation flask, disregarding any liquid on the side of the flask
[SOURCE: ASTM D1078-11, 3.1.2, modified — “DP” added as an admitted term; “, *n*—the” deleted from the definition.]

4 Application and sampling

This document specifies the properties of methanol at the point of custody transfer (3.1).

Samples for quality verification may be taken in any location agreed between the parties concerned. Specific sampling requirements which are documented in the referenced test methods shall apply.

Methanol sampling should follow good industry practice of using glass sample bottles, and bottle caps that are UV resistant and have no influence on the quality of methanol (see also Reference [3]). Exposure of methanol to atmospheric moisture should be minimized.

5 General requirements

5.1 The methanol as supplied shall be homogeneous and conform to the characteristics and limits given in [Table 1](#) when tested in accordance with the methods specified in [Table 1](#).

5.2 The methanol shall be free from any materials, including added substances or chemical compounds or both, at a concentration that causes the methanol to be unacceptable for use by way of

- jeopardizing the safety of the ship,
- adversely affecting the performance of the machinery, or
- being harmful to personnel.

6 Generally applicable requirements and related test methods

6.1 Methanol grades

[Table 1](#) specifies the applicable requirements, limits and test methods for three grades of methanol:

- Marine methanol grade A (MMA): MMA lists the characteristics considered applicable when using methanol as a marine fuel with additional requirements in respect of lubricity and particle count;
- Marine methanol grade B (MMB): MMB lists the characteristics considered applicable when using methanol as a marine fuel;
- Marine methanol grade C (MMC): MMC grade provides for wider tolerances on some of the listed characteristics as compared to MMB.

When tested in accordance with the applicable test methods specified in [Table 1](#), methanol as a fuel for marine applications shall be in accordance with the limits specified in [Table 1](#).

Table 1 — Specifications for methanol as a fuel for marine applications

Characteristics	Units	Limit	MMA	MMB	MMC	Test method(s) ^a and references
General requirements			Clauses 5 to 7			
Appearance			Homogenous, clear and free of suspended matter			IMPCA 003
Density at 15 °C	kg/m ³	min.	795,0	795,0	795,0	ISO 12185; see 6.2
		max.	797,0	797,0	798,0	
Methanol mass fraction on dry basis	%	min.	99,85	99,85	99,70	b
Impurities mass fraction on dry basis ^c	%	max.	0,15	0,15	0,30	IMPCA 001
Ethanol content on a dry basis	mg/kg	max.	50	50	150	IMPCA 001
Acetone content on a dry basis	mg/kg	max.	30	30	30	IMPCA 001
Total sulfur content	mg/kg	max.	0,5	0,5	10,0	ASTM D5453; see 6.3
Water content by mass	%	max.	0,100	0,100	0,500	ASTM E1064
Distillation range at 101,3 kPa (760 mm Hg)	°C	max.	1,0	1,0	Report	ASTM D1078 ^d
Chloride content as Cl ^e	mg/kg	max.	0,5	0,5	0,5	IMPCA 002
Acidity as acetic acid ^e	mg/kg	max.	30	30	30	ASTM D1613
Lubricity			f	–	–	IP PM FK
Particle count			g	–	–	IP PM FI
^a For test methods that do not include precision data for methanol, ISO 4259-2 cannot be applied in case of dispute. ^b Methanol content by mass on a dry basis equals 100 % minus impurities content by mass on dry basis, according to IMPCA 001. ^c Impurities content by mass on dry basis shall be calculated as the sum of the individual impurities results obtained from the given test method and reported in per cent by mass instead of mg/kg. ^d Reported distillation range shall include reporting of the IBP. ^e See Annex E . ^f Lubricity characteristic shall be agreed between buyer and seller. See Annex C . ^g Particle count shall be agreed between buyer and seller. See Annex D .						

[Annex A](#) provides background information on how the methanol grades defined in this document have been established.

6.2 Density

The density at 15 °C of pure methanol is 796,1 kg/m³. The presence of impurities or water in methanol can affect the density. Density that is outside the permitted range specified in [Table 1](#) can be indicative of contamination.

To convert a density measurement at a different temperature to the corresponding density at 15 °C, see Reference [\[4\]](#).

6.3 Total sulfur content

ASTM D5453 covers various fuels containing 1,0 mg/kg to 8 000 mg/kg total sulfur. Following the IMPCA methanol reference specifications^[2], the method contained in ASTM D5453 has been found to be suitable for the determination of total sulfur content in methanol, provided that the laboratory performing the analysis has demonstrated that it can achieve a limit of detection <0,5 mg/kg.

6.4 Distillation range

The distillation range, to a precision of 0,1 °C, in combination with other characteristics is used as an identification and measurement of the quality of methanol. In this document, the distillation range is expressed as the difference between the initial boiling point (IBP) and the dry point (DP), which shall be determined in accordance with the test method specified in ASTM D1078. It provides an additional indication on whether there is a cross-contamination of the methanol with species, such as petroleum-derived fuel oils, which are not detected by the test method IMPCA 001.

The initial boiling point of methanol is 64,6 °C at 101,3 kPa (760 mm Hg). If contaminated, the initial boiling point and the dry point will significantly differ and the distillation range will exceed 1,0 °C.

NOTE Given the quality requirements of grade MMC, a distillation range of around 5 °C is expected in case of water content of about 0,5 % by mass.

6.5 Specific energy content

Given the quality requirements of the methanol grades included in this document, there is no requirement on specific energy content. Specific energy content of methanol as a marine fuel can be calculated using [Formula \(B.1\)](#).

7 Precision and interpretation of test results

In cases of dispute, the procedures described in ISO 4259-2 for resolving the dispute and interpreting the results based on test method precision shall be applied. Some of the test methods in [Table 1](#) do not include a statement of precision for the characteristics listed. In such cases, the relevant parties shall agree on the acceptable deviation of the measured property from the specified limit.

In case the product is not meeting the specifications defined in this document, and bearing in mind the level of variance from the specification value, parties involved should do their utmost to use the product as intended and to limit losses.

Annex A (informative)

Background to the establishment of a standard for methanol as a marine fuel

Methanol is the simplest of the alcohols with a chemical formula of CH_3OH . It exists as a low-flash point liquid under ambient conditions and hence is readily transportable in conventional road tankers, rail tank wagons and chemical tankships. As such, it is produced globally and widely traded internationally as the basic input to a broad range of manufactured products and consumer goods. To underpin this world-wide activity, the International Methanol Producers and Consumers Association (IMPCA) has developed reference specifications^[2], latest update in 2021 to Version 9, and sampling methods^[3] in order to provide a common basis for producers, traders and manufacturers of both intermediary and end products on which to operate.

At time of publication of this document, the bulk of methanol is produced from natural gas and as such is considered as a fossil fuel. When methanol is not associated with carbon capture and storage, it does not address the global climate change issue. However, methanol can also be produced from biological source material or as an e-fuel thereby being considered as sustainable methanol. This is the principal line of development which is expected to be followed in the future.

Sustainable methanol contains “modern” carbon originating from biogenic or atmospheric carbon, exhibiting high radiocarbon isotope ($\text{C}14$) content as compared to fossil methanol, as produced from natural gas, that is free from $\text{C}14$ due to radioactive decay since the carboniferous period. It is therefore possible to identify sustainable methanol produced from biomass or direct air carbon capture quantitatively, or to estimate the renewable methanol content from a mixed stream of supply from various sources of production. For further details, see ASTM D6866^[5]. Alternatively, methanol can be assigned as sustainable through application of the mass balancing principle whereby credits from a biomass-based product are applied to fossil methanol.

Currently, most methanol producers set their production objectives against the IMPCA specifications and therefore they were selected as the starting point for this document. For some characteristics, at time of publication, there are no internationally or nationally recognized test methods. Therefore, those as given in the IMPCA reference specifications are used instead.

However, it was also recognised that, as a specification of a traded chemical raw material, the IMPCA specifications included parameters that were not seen as critical to marine fuel users and conversely that there were fuel related aspects which were not covered. Furthermore, whereas in the IMPCA specifications there is only a single grade, it was considered that in terms of a marine fuel type product there was a need to differentiate between the grades of methanol used by equipment which can be highly sensitive to off-specification deviations through to more robust systems that can tolerate a less tightly defined product. Hence the three grades were developed as:

- Marine methanol grade A (MMA): this is based largely on the IMPCA specifications but with placeholders for additional requirements in respect of lubricity and cleanliness, as represented by the particle counting, on the basis of industry experience;
- Marine methanol grade B (MMB): this is based largely on the IMPCA specifications;
- Marine methanol grade C (MMC): although derived from the IMPCA specifications, some wider tolerances are provided in respect of a number of the listed characteristics.

One general difference from the IMPCA specifications for all three grades is that density, at 15 °C, is specified rather than specific gravity at 20 °C/20 °C, in order to conform to general marine practice and the documentary requirements of MARPOL Annex VI^[6].

Annex B (informative)

Net specific energy of methanol

B.1 Calculation

The net specific energy, E_{ns} , of methanol as marine fuel can be calculated using [Formula \(B.1\)](#). Only major compounds with concentrations above 1 000 mg/kg (mass fraction of 0,1 %) are considered of importance.

$$E_{ns} = \left\{ E_{ns,MeOH} \cdot X_{MeOH_{dry}} \cdot 10^{-2} \cdot \left[1 - (X_w \cdot 10^{-2}) \right] \right\} + \sum_{i=1}^n \left\{ E_{ns,i} \cdot X_{i_{dry}} \cdot 10^{-6} \cdot \left[1 - (X_w \cdot 10^{-2}) \right] \right\} - (X_w \cdot 2,449 \cdot 10^{-2}) \quad (B.1)$$

where

- $E_{ns,MeOH}$ is the net specific energy of methanol, expressed in MJ/kg (see [Table B.1](#));
- $E_{ns,i}$ is the net specific energy of individual impurities, expressed in MJ/kg (see [Table B.1](#));
- $X_{MeOH_{dry}}$ is the methanol content on a dry basis, expressed in per cent (%) by mass;
- $X_{i_{dry}}$ is the content of the individual impurities on a dry basis, expressed in mg/kg;
- X_w is the water content, expressed in per cent (%) by mass;
- $X_w \cdot 2,449$ is the latent heat of vaporization, expressed in MJ/kg, for water content X_w .

B.2 Example

This clause shows a calculation of E_{ns} for an example of methanol as a marine fuel, grade MMC. The composition of the methanol and the net specific energy values of the individual species in this example are shown in [Table B.1](#).

Table B.1 — Example of methanol as a marine fuel, grade MMC

Compounds	Composition mass fraction %	Composition mg/kg	Net specific energy MJ/kg
Methanol content on a dry basis	99,90		19,90 ^a
Ethanol content on a dry basis ^b		120	26,80 ^a
Acetone content on a dry basis ^b		30	29,60 ^c
Other impurities ^d		850	Not defined
Water	0,350		

^a Source: Resolution MEPC.364(79)^[7].

^b Species other than water with concentration below 1 000 mg/kg shall not be included in the calculation (see [B.1](#)).

^c Source: *Fuel*, Volume 210, 15 December 2017, Pages 133-144^[8].

^d "Other impurities" covers those detected by the IMPCA 001 test method, other than those identified in this example as ethanol and acetone. If such impurities are identified at a concentration exceeding 1 000 mg/kg, then they shall also be included in the calculation using accepted net specific energy values appropriate to the compound. Other impurities identified at concentrations less than 1 000 mg/kg shall not be included.

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The net specific energy of this methanol fuel can be calculated from [Formula \(B.1\)](#) as follows:

$$E_{\text{ns}} = \{19,90 \cdot 99,90 \cdot 10^{-2} \cdot [1 - (0,350 \cdot 10^{-2})]\} - (0,350 \cdot 2,449 \cdot 10^{-2}) \text{ MJ/kg}$$

$$E_{\text{ns}} = 19,81 \text{ MJ/kg}$$

Ethanol and acetone content in this example have no impact on the calculation of net specific energy as the ethanol and acetone concentrations are below 1 000 mg/kg. However, in cases where these compounds are present at higher levels, they will affect the result and therefore shall be included.

NOTE In case of dispute, ASTM D240^[9] can be used to determine net specific energy content.

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Annex C
(informative)

Lubricity

Historically, the test method described in ISO 12156-1^[10] has been used for the assessment of lubricity of petroleum-based middle distillate fuels, paraffinic diesel fuels, and biodiesel blends using the high frequency reciprocating rig. This test method is not applicable for methanol due to the low flash point and volatility of the product.

Test method IP PM FK has consequently been developed. At the time of publication of this document, the precision data has not been established. Furthermore, there is no industry experience as to what typical values can be acceptable. Therefore, it should be agreed between buyer and seller as to the inclusion of any lubricity improver.

A maximum lubricity wear scar value can be considered for inclusion in this document when sufficient data has been collected from the use of the test method as described in IP PM FK.

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