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

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



Reference number
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## Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8217 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants.*



Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.





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

## 0 Introduction

**0.1** These specifications were prepared in co-operation with the marine and petroleum industries to meet the requirements for marine fuels supplied on a worldwide basis for consumption on board ships. Crude oil supplies, refining methods, ships' machinery and local conditions vary considerably, which factors have led historically to a large number of categories of residual fuels being available internationally, even though locally or nationally there may be relatively few categories. Consequently, it has not been possible during the preparation of these specifications to find sufficient common characteristics in order to limit the number of categories. Several of the residual fuels are unique in origin to one country or area but are nevertheless included in the specification because of their importance in the international marine fuel market.

The nature of marine fuel may change, in which case it will be necessary to update the specifications periodically in the future. It is hoped that the publication of these specifications will, in itself, encourage the number of categories to be reduced when opportunity permits.

**0.2** Fuel inspection properties for which suitable test methods and limits exist are given in tables 1 and 2. In preparing these specifications for fuels containing residuum, it was recognized that further inspection properties were highly desirable but that no internationally agreed test methods exist at present. These properties which are awaiting definition and test methods are referred to in annex B.

## 1 Scope and field of application

**1.1** This International Standard specifies the requirements for petroleum fuels for marine use in diesel engines and boilers, for the guidance of interested parties such as marine equipment designers, and suppliers and purchasers of marine fuels.

Requirements for gas turbine fuels used in marine applications are specified in ISO 4261.

This International Standard sets out the required properties of the fuels at the time and place of custody transfer.

**1.2** This International Standard describes four categories of distillate fuel, one for diesel engines for emergency purposes, and the other three for general purposes. There are also ten categories of fuel containing residual components for which a density limit is specified. Five categories of fuel are specified without a density limit.

**1.3** This International Standard takes account of the international requirements for flash point as given by the International Maritime Organization (IMO) Convention for Safety of Life at Sea (SOLAS) 1974, Amendment 1, Chapter II — 2, Regulation 15.

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

**1.5** This International Standard does not imply the availability of all the categories of fuel at all ports.

**1.6** Annexes A and B are included for information and do not form a mandatory part of this International Standard.



## 2 References

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

ISO 2719, *Petroleum products — Determination of flash point — Pensky-Martens closed cup method.*

ISO 3015, *Petroleum oils — Determination of cloud point.*

ISO 3016, *Petroleum oils — Determination of pour point.*

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

ISO 3170, *Petroleum products — Liquid hydrocarbons — Manual sampling.*

ISO 3675, *Crude petroleum and liquid petroleum products — Laboratory determination of density or relative density — Hydrometer method.*

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

ISO 3735, *Crude petroleum and fuel oils — Determination of sediment — Extraction method.*

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

ISO 4261, *Petroleum products — Fuels (class F) — Specifications — Gas turbine fuels for industrial and marine applications.* [1)]

ISO 4262, *Petroleum products — Determination of carbon residue — Ramsbottom method.*

ISO 5165, *Diesel fuels — Determination of ignition quality — Cetane method.*

ISO 6245, *Petroleum products — Determination of ash.*

ISO 6615, *Petroleum products — Determination of carbon residue — Conradson method.*

ISO 8216, *Petroleum products — Fuels (class F) — Classification*

- *Part 0 : General.* [1)]
- *Part 1 : Categories of marine fuels.*

ISO 8754, *Petroleum products — Determination of sulfur content — Non-dispersive X-ray fluorescence method.* [1)]

DIN 51 790, Part 2 (July 1978), *Testing of liquid fuels — Determination of vanadium content — Analysis by X-ray spectrometry.* [2)]

## 3 Sampling

Sampling of petroleum fuels for the purpose of this International Standard shall be carried out in accordance with the procedure given in ISO 3170.



## 4 General requirements

**4.1** The fuels shall be blends of hydrocarbons derived from petroleum refining. This shall not preclude the incorporation of small amounts of additives intended to improve some aspect of performance. The fuels shall be free from inorganic acid.

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

**4.2** The properties of the fuels shall not exceed the maximum values nor be less than the minimum values set out in tables 1 and 2 when tested by the corresponding methods referred to in clause 6.

## 5 Other properties

The gross and net specific energies of fuels, if required, should be calculated from the equations given in annex A.

## 6 Test methods

### 6.1 General

The requirements in tables 1 and 2 shall be determined by use of the latest issue of test methods referred to therein.

### 6.2 Density

The method referred to in table 2 shall be used at a temperature between 50 and 60 °C and the hydrometer readings obtained converted to 15 °C using table 53B referred to in ISO 91-1.

### 6.3 Carbon residue

If the method specified in ISO 4262 is not available, the method specified in ISO 6615 shall be used and the limits shall be as follows :

DMX 0,14; DMA 0,14; DMB 0,28; DMC 3,0.

### 6.4 Visual inspection

Inspect the sample in good light and at a temperature between 10 and 25 °C. It shall appear clear and bright.

### 6.5 Sulfur content

The sulfur content shall be determined in accordance with ISO 8754.

### 6.6 Vanadium content

An International Standard for the determination of vanadium content is being prepared. Pending its completion, vanadium content shall be determined by the method DIN 51 790, Part 2.

## 7 Precision and interpretation of test results

### 7.1 General

The majority of test methods specified in clause 6 contain a statement of precision (repeatability and reproducibility). Attention is drawn to ISO 4259, which covers the use of precision data in the interpretation of test results and this procedure shall be used in cases of dispute.

### 7.2 Cloud point results

The testing margin described in clause 8.2 of ISO 4259 shall not apply. If a single test result is above −16 °C, the procedure specified in clause 9 of ISO 4259 shall apply.

1) At present at the stage of draft.

2) Published by the Deutsches Institut für Normung, Berlin.

## Table 1 — Requirements for marine distillate fuels

NOTE — The values in this table are maximum or minimum values for each property. The actual values for any batch of fuel may vary within these limits.

| Characteristic | Test method | Limit | Designation ISO-F- | | | |
|---|---|---|---|---|---|---|
| | | | DMX | DMA | DMB | DMC |
| Density at 15 °C, kg/m$^3$ [1] | ISO 3675 | max. | [2] | 890,0 | 900,0 | 920,0 |
| Kinematic viscosity at 40 °C cSt[3] | ISO 3104 | min.<br>max. | 1,40<br>5,50 | 1,50<br>6,00 | —<br>11,0 | —<br>14,0 |
| Flash point, °C | ISO 2719 | min. | 43 | 60 | 60 | 60 |
| Pour point (upper), °C[4]<br>Winter quality<br>Summer quality | ISO 3016 | <br>max.<br>max. | <br>—<br>— | <br>−6<br>0 | <br>0<br>6 | <br>0<br>6 |
| Cloud point, °C | ISO 3015 | max. | −16[5] | — | — | — |
| Carbon residue, Ramsbottom % (*m*/*m*) on 10 % residue | ISO 4262 (See 6.3) | max. | 0,20 | 0,20 | — | — |
| Carbon residue, Ramsbottom % (*m*/*m*) | | max. | — | — | 0,25 | 2,50 |
| Ash, % (*m*/*m*) | ISO 6245 | max. | 0,01 | 0,01 | 0,01 | 0,05 |
| Sediment by extraction, % (*m*/*m*) | ISO 3735 | max. | — | — | 0,07 | — |
| Water, % (*V*/*V*) | ISO 3733 | max. | — | — | 0,30 | 0,30 |
| Cetane number | ISO 5165 | min. | 45 | 40 | 35 | — |
| Visual inspection | See 6.4 | — | See 6.4 | | — | — |
| Sulfur, % (*m*/*m*) | See 6.5 | max. | 1,0 | 1,5 | 2,0 | 2,0 |
| Vanadium, mg/kg | See 6.6 | max. | — | — | — | 100 |



1) Density in kilograms per litre at 15 °C should be multiplied by 1 000 before comparison with these values.

2) In some countries there will be a maximum limit.



3) 1 cSt = 1 mm$^2$/s

4) Purchasers should ensure that this pour point is suitable for the equipment on board, especially if the vessel is operating in both the Northern and Southern hemispheres.

5) This fuel is suitable for use at ambient temperatures down to − 15 °C without heating the fuel.

**Table 2 — Requirements for marine residual fuels**

NOTE — The values in this table are maximum or minimum values for each property. The actual values for any batch of oil may vary within these limits.

| Characteristics | Test method | Limit | Designation ISO-F- | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RMA 10 | RMB 10 | RMC 10 | RMD 15 | RME 25 | RMF 25 | RMG 35 | RMH 35 | RMK 35 | RML 35 | RMH 45 | RMK 45 | RML 45 | RMH 55 | RML 55 |
| Density at 15 °C, kg/m$^3$ [1] (see 6.2) | ISO 3675 | max. | 975,0 | 991,0 | | 991,0 | 991,0 | | 991,0 | | — | | 991,0 | — | | 991,0 | — |
| Kinematic viscosity at 100 °C, cSt[2] | ISO 3104 | max. | 10,0 | | | 15,0 | 25,0 | | 35,0 | | | | 45,0 | | | 55,0 | |
| Flash point, °C | ISO 2719 | min. | 60 | | | 60 | 60 | | 60 | | | | 60 | | | 60 | |
| Pour point[3] (upper), °C<br>Winter quality<br>Summer quality | ISO 3016 | max.<br>max. | 0<br>6 | 24<br>24 | | 30<br>30 | 30<br>30 | | 30<br>30 | | | | 30<br>30 | | | 30<br>30 | |
| Carbon residue, Conradson, % (*m/m*) | ISO 6615 | max. | 10 | | 14 | 14 | 15 | 20 | 18 | 22 | | — | 22 | | — | 22 | — |
| Ash, % (*m/m*) | ISO 6245 | max. | 0,10 | | | 0,10 | 0,10 | 0,15 | 0,15 | 0,20 | | | 0,20 | | | 0,20 | |
| Water, % (*V/V*) | ISO 3733 | max. | 0,50 | | | 0,80 | 1,0 | | 1,0 | | | | 1,0 | | | 1,0 | |
| Sulfur, % (*m/m*) | See 6.5 | max. | 3,5 | | | 4,0 | 5,0 | | 5,0 | | | | 5,0 | | | 5,0 | |
| Vanadium, mg/kg | See 6.6 | max. | 150 | | 300 | 350 | 200 | 500 | 300 | 600 | | | 600 | | | 600 | |

1) Density in kilograms per litre at 15 °C should be multiplied by 1 000 before comparison with these values.

2) 1 cSt = 1 mm$^2$/s

3) Purchasers should ensure that this pour point is suitable for the equipment on board, especially if the vessel is operating in both the Northern and Southern hemispheres.

# Annex A

## Specific energy

(This annex does not form an integral part of the Standard.)

**A.1** Specific energy is not controlled in the manufacture of fuel except in a secondary manner by the specification of other properties.

Specific energy can be calculated with a degree of accuracy acceptable for normal purposes from the equation given in clause A.2.

**A.2** Specific energy (gross), MJ/kg $= (52{,}190 - 8{,}802\,\varrho^2\,10^{-6})\,[1 - 0{,}01\,(x + y + s)] + 9{,}420\,(0{,}01\,s)$

Specific energy (net), MJ/kg $= (46{,}704 - 8{,}802\,\varrho^2\,10^{-6} + 3{,}167\,\varrho\,10^{-3})\,[1 - 0{,}01\,(x + y + s)] + 0{,}01\,(9{,}420\,s - 2{,}449\,x)$

where

$\varrho$ is the density at 15 °C, in kilograms per cubic metre;

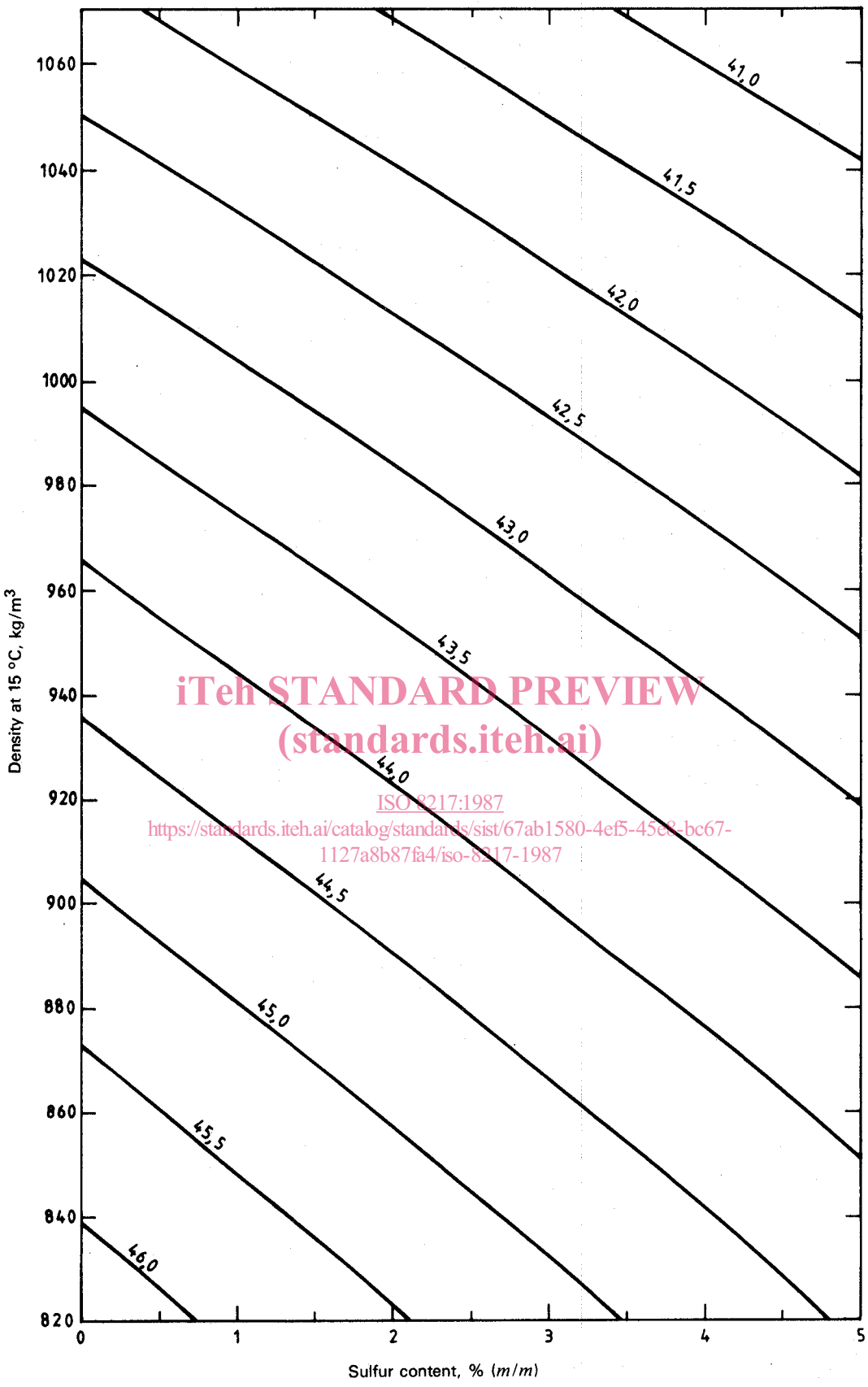
$x$ is the water content, expressed as a percentage by mass;

$y$ is the ash content, expressed as a percentage by mass;

$s$ is the sulfur content, expressed as a percentage by mass.



**A.3** Alternatively, for the purposes of rapid estimation, the gross and net specific energies may be conveniently read off from figures 1 and 2, which have been derived from the equation given in clause A.2. However, the values obtained may be only approximate.



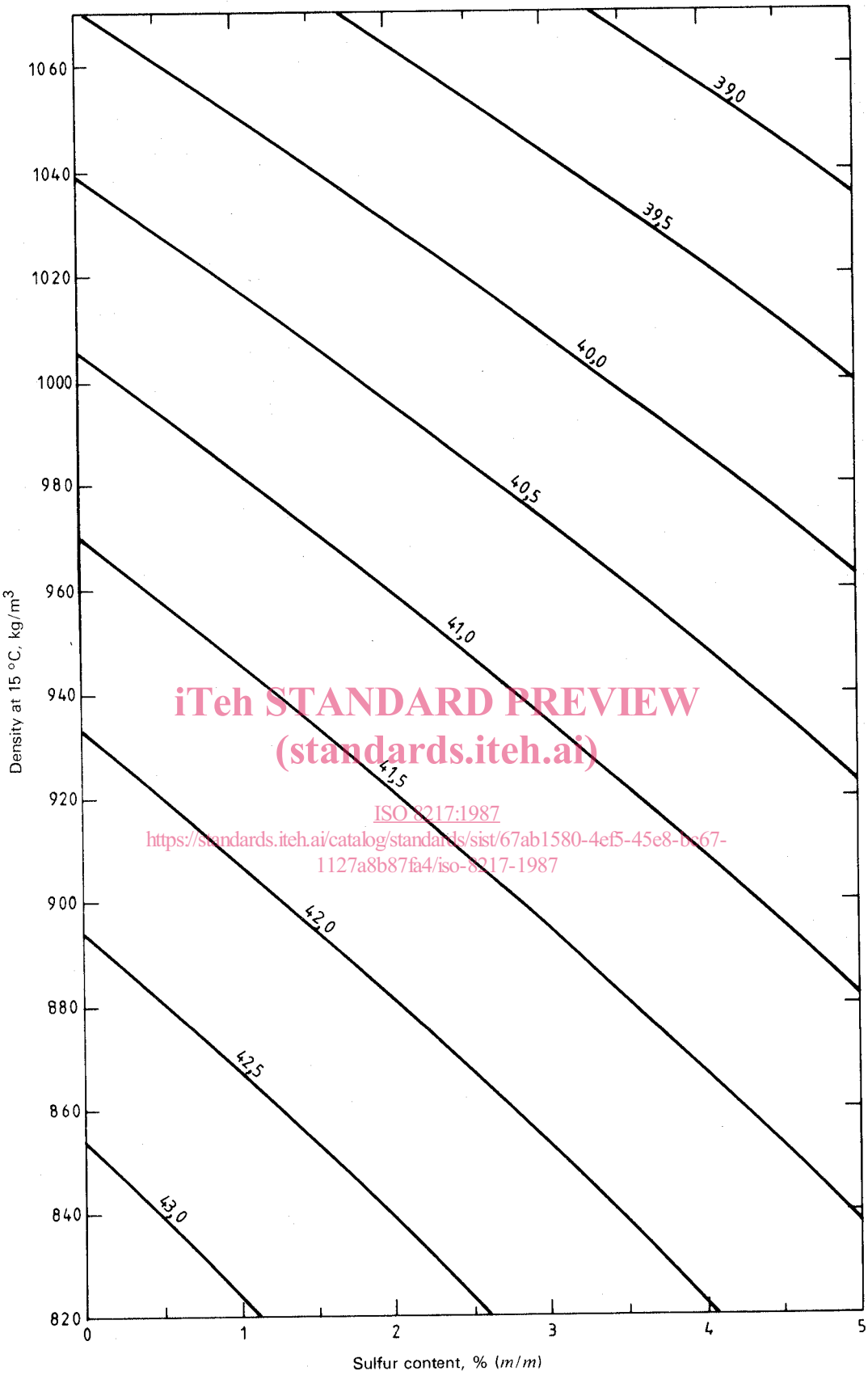



NOTES

1 To correct for ash and water, subtract 0,01 $Q$ (% ash + % water) from gross specific energy ($Q$) read from this graph.

2 Values read from this figure may not agree exactly with the calculated values (see clause A.2), and should be considered as approximate.

**Figure 1 — Gross specific energy, in megajoules per kilogram, of marine fuels**






NOTES

1 To correct for ash and water, subtract 0,01 $Q$ (% ash + % water) from net specific energy ($Q$) read from this graph.

2 Values read from this figure may not agree exactly with the calculated values (see clause A.2), and should be considered as approximate.

**Figure 2 — Net specific energy, in megajoules per kilogram, of marine fuels**