BS ISO 6578:2017

BSI Standards Publication

Refrigerated hydrocarbon liquids — Static measurement — Calculation procedure

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National foreword

This British Standard is the UK implementation of ISO 6578:2017. It supersedes BS 7577:1992, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PTI/12, Petroleum Measurement and Sampling.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2017

ISBN 978 0 580 91065 4

ICS 75.180.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2017.

Amendments/corrigenda issued since publication

Date	Text affected

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INTERNATIONAL STANDARD

ISO 6578

Second edition
2017-10-10

Refrigerated hydrocarbon liquids — Static measurement — Calculation procedure

Hydrocarbures liquides réfrigérés — Mesurage statique — Procédure de calcul

Reference number
ISO 6578:2017(E)

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Contents

Page

Foreword ... **iv**

Introduction ... **v**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions and symbols ... **1**
3.1 Terms and definitions ... 1
3.2 Symbols ... 2

4 Outline of calculation ... **3**
4.1 LPG 3
4.2 LNG 4
4.3 Data for calculation ... 4

5 Mass ... **5**
5.1 Mass of liquid phase ... 5
5.2 Correction for vapour phase ... 6
5.3 Mass in vacuum to mass in air ... 8

6 Energy content (calorific content) ... **8**

7 Inter-conversion of liquid mass and vapour volume at standard conditions ... **10**

8 Calculation of liquid density from composition ... **12**
8.1 General ... 12
8.2 LPG 12
8.3 LNG 13

9 Calculation of calorific value from composition ... **14**
9.1 Volumetric basis ... 14
9.2 Mass basis ... 14

Annex A (informative) **Characteristics of static measurement of refrigerated hydrocarbon liquids** ... **16**

Annex B (normative) **Molar volume of individual component** ... **17**

Annex C (normative) **Correction factors for volume reduction of LNG mixtures** ... **18**

Annex D (normative) **Gross calorific values for individual components** ... **19**

Annex E (normative) **Molar mass, compression factor and summation factor of individual component** ... **20**

Annex F (informative) **Boiling point of individual component** ... **21**

Annex G (informative) **Alternative procedure to calculate liquid density from composition** ... **22**

Bibliography ... **25**

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Full document details: BS ISO 6578:2017

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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources,* Subcommittee SC 5, *Measurement of refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels*.

This second edition cancels and replaces the first edition (ISO 6578:1991), which has been technically revised.

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Introduction

Large quantities of refrigerated hydrocarbon liquids such as liquefied natural gas (LNG), liquefied petroleum gas (LPG), etc. are transported by marine carriers dedicated for these applications. These gases are traded based on static measurement on board marine carriers rather than the measurement at shore tanks or pipelines due mainly to the nature of the tank operation.

The measurement on board involves determination of liquid/vapour interface, i.e. liquid level, average temperatures of liquid and vapour, and vapour pressure in the tanks of marine carriers. The volumetric quantity of the liquid and gas is then computed with the tank capacity tables.

This document is applicable to calculate the volume at standard condition, liquid density from chemical composition, mass and energy content of fully refrigerated hydrocarbon liquids at a vapour pressure near to atmospheric pressure from the results of custody transfer measurement. This document is also applicable to ascertain the inventory in shore tanks. Calculation procedures for refrigerated hydrocarbon liquids consisting predominantly of ethane or ethylene, or for partially refrigerated hydrocarbon liquids at pressures substantially above atmospheric, are not included. No recommendations are given for the measurement of small parcels of refrigerated liquids, which are directly weighed.

Aspects of safety are not dealt with in this document. It is the responsibility of the user to ensure that the procedure of measurement meets applicable safety regulations.

Basic data and source references used in the calculation procedures are given in annexes.

Annexes A to G form an integral part of this document.

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INTERNATIONAL STANDARD ISO 6578:2017(E)

Refrigerated hydrocarbon liquids — Static measurement — Calculation procedure

1 Scope

This document specifies the calculation procedure to convert the volume of liquefied petroleum gas (LPG) and liquefied natural gas (LNG) under the conditions at the time of measurement to the equivalent volume of liquid or vapour at the standard condition, i.e. 15 °C and 101,325 kPaA, or to the equivalent mass or energy (calorific content). It applies to the quantities of refrigerated hydrocarbon liquids stored in or transferred to/from tanks and measured under static storage conditions. Calculation of pressurized gases is out of the scope of this document.

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.

ISO 91, *Petroleum and related products — Temperature and pressure volume correction factors (petroleum measurement tables) and standard reference conditions*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

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

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
compression factor
actual (real) volume of a given amount of gas at a specified pressure and temperature divided by its volume, under the same conditions as calculated from the ideal gas law

[SOURCE: ISO 6976:2016, 3.10]

3.1.2
gross calorific value
amount of heat that would be released by the complete combustion with oxygen of a specified quantity of gas, in such a way that the pressure, p_1, at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature, t_1, as that of the reactants, all of these products being in the gaseous state except for water, which is condensed to the liquid state at t_1

Note 1 to entry: t_1 and p_1 are combustion reference temperature and combustion reference pressure, respectively.

[SOURCE: ISO 6976:2016, 3.1, modified — Note 1 to entry has been replaced.]

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3.1.3
liquefied natural gas
LNG
liquid composed predominantly of methane

3.1.4
liquefied petroleum gas
LPG
liquid composed predominantly of any of the following hydrocarbons or mixtures thereof: propane, propene, butanes and butene

3.1.5
refrigerated hydrocarbon liquid
liquid composed predominantly of hydrocarbons, which are stored in a fully refrigerated condition at pressures near atmospheric

3.1.6
volumetric basis (ideal)
volume calculated on the basis that the vapour behaves like an ideal gas

3.1.7
volumetric basis (real)
volume calculated on the basis that the vapour behaves like a super-compressible gas

3.2 Symbols

The following symbols are defined here for use in this document, but additionally, some symbols are given more restricted meanings when used in some formulae. The restricted meaning is then given after the formulae.

$H_{s,\,m\,,\,i}$ gross (superior) calorific value on a mass basis, in megajoules per kilogram, of component i (see Table D.1)

$H_{s,\,m}$ gross (superior) calorific value on a mass basis, in megajoules per kilogram, of the liquid

$H_{s,\,V\,,\,i}$ gross (superior) calorific value on a volumetric basis (ideal), in megajoules per cubic metre, of component i (see Table D.1)

$H_{s,vol}$ gross (superior) calorific value on a volumetric basis, in megajoules per cubic metre, of the vapour at standard condition

m mass, in kilograms, of product transferred, i.e. liquid plus vapour

m_{liq} mass, in kilograms, of liquid

M_i molar mass, in kilograms per kilomole, of component i (see Table E.1)

M_{mix} relative molar mass, in kilograms per kilomole, of the vapour mixture

P_s standard reference pressure, i.e. 101,325 kPaA (kilopascal absolute)

P_{vap} pressure, in kilopascals absolute, of the vapour in the container

Q net energy, in megajoules, transferred, based on gross calorific value

Q_{liq} energy (calorific) content, in megajoules, of the liquid

R molar gas constant, 8,314 462 1 $J \cdot mol^{-1} \cdot K^{-1}$, see ISO 6976:2016, A.1

t temperature, in degrees Celsius, of the liquid

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T_s standard reference temperature, i.e. 288,15 K (15 °C)

T_{vap} temperature, in kelvins, of the vapour in the container

V_i molar volume, in cubic metres per kilomole, of component *i*, as a liquid at *t*

V_{liq} volume, in cubic metres, of the liquid at *t*

V_m ideal gaseous molar volume, in cubic metres per kilomole, at standard conditions:

i.e. $V_m = (R \times T_s)/P_s$ = 23,644 8 m^3/kmol at 15 °C and 101,325 kPaA (kilopascal absolute)

V_{vap} vapour volume, in cubic metres, in the container

$V_{vap,s}$ vapour volume at standard condition

x_i ; x_j mole fractions of the components *i* and *j*, respectively

x_1 mole fraction of methane in the LNG

x_2 mole fraction of nitrogen in the LNG

Z_i compression factor for component *i* at the required pressure and temperature

Z_{mix} compression factor for the vapour mixture under known conditions of temperature and pressure

ρ_s density, in kilograms per cubic metre, of the liquid at T_s

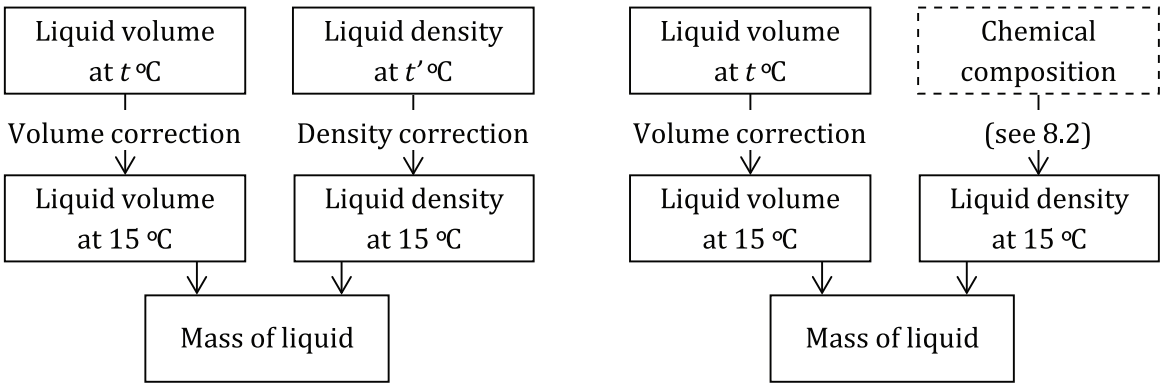
ρ_t density, in kilograms per cubic metre, of the liquid at *t*

NOTE Additional subscripts *F* and *I* indicate, respectively, the final and initial measurements or product properties in either of the two containers used for a transfer.

4 Outline of calculation

4.1 LPG

Figure 1 outlines the calculation of mass of LPG from liquid volume at *t* °C.



a) Density by hydrometer **b) Density from composition**

Figure 1 — Calculation flow (LPG)

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